"RISK ASSESSMENT OF CANCER IN PEOPLE LIVING NEAR CAUVERY BELT OF ERODE, NAMAKKAL AND SALEM DISTRICTS - A PILOT STUDY"

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REG. NO: 26074216

Under the guidance of

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This is to certify that the dissertation entitled **"RISK ASSESSMENT OF CANCER IN PEOPLE LIVING NEAR CAUVERY BELT OF ERODE, NAMAKKAL AND SALEM DISTRICTS - A PILOT STUDY"** submitted to The Tamilnadu Dr. M. G. R Medical University, Chennai was carried out by **Mr. PRAKASHAM. S (Reg.no-26074216)** in the Department of Pharmacy Practice, Swamy Vivekanandha College of Pharmacy, Tiruchengode for the partial fulfillment for the degree of Master of Pharmacy under my direct supervision .

This work is original and has not been submitted earlier for the award of any other degree or diploma of this or any other university.

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CHAPTER - 1

INTRODUCTION

Cancer (malignant neoplasm) is a class of diseases in which a group of cells display uncontrolled growth, invasion and sometimes metastasis.[1] Cancer reflects disturbances of properties and behavior of cells in a multi cellular system. The vast majority of cancers are connected with mutagenesis, i.e. with changes of Deoxy Ribonucleic Acid (DNA). Cancer evaluation is a multi step micro evolutionary process that triggers a vast spectrum of biological, biochemical and biophysical changes.[2] Proliferation is a general feature of cancer. The initial non-invasive local growth of cancer very often forms a structure lacking the typical organized pattern of corresponding normal tissue.[3]

Malignant tumors are usually the name used for carcinoma, sarcoma or blastoma as a suffix, with the Latin or Greek word for the organ of origin as the root. A cancer of the liver is called hepatocarcinoma. A cancer of fat cell is called liposarcoma. The comman type of breast cancer is called ductal carcinoma of the breast or mammary ductal carcinoma.[4]

There are over 20 million people living with cancer in the world today. The estimated number of new cases each year is expected to increase from 10 - 15 million in 2020. Some 60% of all these new cases will occur in the less developed countries. Cancer is currently the cause of 12% of all deaths worldwide. In approximately 20 years time, the number of cancer deaths annually will increase from about 6-10 million. Cancer has now become the third leading cause of death in South East Asian Countries. Cancer becomes a major cause of death once the individual survives the first 5 years of life. Age is the single most risk factor for cancers.[5]

According to the Madras Metropolitan Tumour Registry (MMTR), the lifetime cumulative risk (0-74 years) of cancer in Madras is one in eight. Stomach (AAR: 15.2) is the leading site of malignancy among males, followed by cancers of the lung (AAR: 9.8) and oral cavity (AAR: 9.4). Among females, cancer of the cervix (AAR: 44.0) is the commonest, followed by breast (AAR: 21.7) and oral cavity cancers (AAR: 9.8).[6]

Increasing trend of requirement and productivity of dyes and dye intermediates is associated with the anticipated generation of wastes, both liquid and solid in future. The wastes thus produced will contain toxic and hazardous substances, which are not acceptable to the recipient environment, if released uncontrolled.[7]

Many of the dyes used by textile industries are known carcinogens.[8] Dyes are introduced into the environment through industrial effluents of these industries. There are ample evidences of their harmful effects. Triple primary cancers involving kidney, urinary bladder and liver in a dye workers have been reported.[9] The textile industry poses threat of various types of occupational diseases including cancer.[10]

Mortality related to kidney, lung, liver, and skin cancer in this area could be associated to the ingestion of arsenic-contaminated water.[11]

Chronic exposure of Arsenic via drinking water causes various types of skin lesions such as melanosis, leucomelanosis, and keratosis. Other manifestations include neurological effects, obstetric problems, high blood pressure, diabetes mellitus, diseases of the respiratory system and of blood vessels including cardiovascular, and cancers typically involving the skin, lung and bladder. Arsenic-induced skin lesions seem to be the most common and initial symptoms of arsenicosis. More systematic studies are needed to determine the link between Arsenic exposure and its related cancer and noncancer end points.[12]

The textile industry effluents are reported to have a high mutagenic activity.[13] Long-term exposure to arsenic in drinking-water is mainly related to increased risks of skin and other cancers, as well as other skin lesions such as hyperkeratosis and pigmentation changes. Occupational exposure to arsenic, primarily by inhalation, is closely associated with lung cancer.[14]

Water pollution is a growing hazard in many developing countries. Present concern is much related to the chemical pollutants in water that have cumulative toxic properties, carcinogenic potential and cause adverse health effects on prolonged exposure such as heavy metals.[15]

Since Hippocrates's time, heavy metals have been used in medicinal and homicidal preparations. In addition, occupational and environmental exposure occasionally causes toxic manifestations.[16]

All human beings are exposed to it in one form or the other. However, water and food constitutes major source of exposure to population.[17, 18] Worldwide, the main reason for chronic human intoxication with arsenic is intake of contaminated drinking water.[19]

Erode, Namakkal and Salem surrounding town, (Tamilnadu, India) is famous for its dyeing and printing textile industries. There are about more than 500 industries involved in textile dying/printing processes, which discharge effluents into nearby Cauvery River, without any treatment. These effluents contain highly toxic dyes, bleaching agents, salts, acids, and alkalies. Heavy metals like cadmium, arsenic, lead, mercury, chromium, copper, zinc, chromium, and iron are also found in the dye effluents. People are exposed to such waters with no control over the length and frequency of exposure.

Further, as the untreated effluents are discharged into the environment they can cause severe contamination of surface and underground water. Environmental pollution caused by such textile effluents results in adverse effects on general health of the residents of Erode and surrounding town.

In this present study, we have assessed the various risk factors for Cancer, excluding the known risk factors, in Cancer patients living in the Cauvery belt and other than Cauvery belt of Erode and surrounding town by using a specially designed questionnaire.

Then we have analysed the water and soil samples from the Cauvery belt for the presence of various heavy metals like Arsenic(As), Cadmium(Cd), Chromium(Cr), Lead(Pb), Magnesium(Mg), Mercury(Hg) and compared with the samples taken from other than Cauvery belt by using Atomic Absorption Spectroscopy (AAS).[20]

Finally the same procedure was followed for the blood sample of cancer patients and volunteers from both Cauvery belt and other than the Cauvery belt of Erode, Namakkal and Salem Districts.

CHAPTER - 2

LITERATURE

2.1 Cancer

Cancer is a term used for the diseases in which abnormal cells divide without control and are able to invade other tissues. Cancer cells can spread to other parts of the body through the blood and lymph systems.

Cancer is not just one disease but many diseases. There are more than 100 different types of cancer. Most cancers are named for the organ or type of cell in which they start. For example, cancer that begins in the colon is called colon cancer; cancer that begins in basal cells of the skin is called basal cell carcinoma.

2.1.1. Types of cancer

Cancer types can be grouped into broader categories. The main categories of cancer include:

Carcinoma: Cancer that begins in the skin or in tissues that line or cover internal organs.

Sarcoma: Cancer that begins in bone, cartilage, fat, muscle, blood vessels, or other connective or supportive tissue.

Leukemia: Cancer that starts in blood-forming tissue such as the bone marrow and causes large numbers of abnormal blood cells to be produced and enter the blood.

Lymphoma and myeloma: Cancers that begin in the cells of the immune system.

Central nervous system cancers: That begins in the tissues of the brain and Spinal cord.

2.1.2. Origins of cancer

All cancers begin in cells, the body's basic unit of life. To understand cancer, it's helpful to know what happens when normal cells become cancer cells.

The body is made up of many types of cells. These cells grow and divide in a controlled way to produce more cells as they are needed to keep the body healthy. When cells become old or damaged, they die and are replaced with new cells.

2.1.3. Cancer statistics

A new report from the nation's leading cancer organizations show cancer death rates decreased on average 2.1 % per year from 2002 through 2004, nearly twice the annual decrease of 1.1 percent per year from 1993 through 2002.

Estimated new cases and deaths from cancer in the United States in 2008:

New cases: 1,437,180 (does not include non-melanoma skin cancers)

Deaths: 5, 65,650.

The most common types of cancer:

The list of common cancer types includes cancers that are diagnosed with the greatest frequency in the United States. Cancer incidence statistics from the American Cancer Society and other resources were used to create the list. To qualify as a common cancer, the estimated annual incidence for 2008 had to be 35,000 cases or more.

The most common type of cancer on the list is non-melanoma skin cancer, with more than 1,000,000 new cases expected in the United States in 2008. Non-melanoma skin cancers represent about half of all cancers diagnosed in this country.

The cancer on the list with the lowest incidence is thyroid cancer. The estimated number of new cases of thyroid cancer for 2008 is 37,340.

Because colon and rectal cancers are often referred to as "colorectal cancers," these two cancer types were combined for the list. For 2008, the estimated number of new cases of colon cancer is 108,070, and the estimated number of new cases of rectal cancer is 40,740.

Kidney cancers can be divided into two major groups, renal parenchyma cancers and renal pelvis cancers. Approximately 85 percent of kidney cancers develop in the renal parenchyma, and nearly all of these cancers are renal cell cancers. The estimated number of new cases of renal cell cancer for 2008 is 46,232.

Leukemia as a cancer type includes acute lymphoblastic (or lymphoid) leukemia, chronic lymphocytic leukemia, acute myeloid leukemia, chronic myelogenous (or myeloid) leukemia, and other forms of leukemia. It is estimated that more than 44,270 new cases of leukemia will be diagnosed in the United States in 2008, with chronic lymphocytic leukemia being the most common type (approximately 15,110 new cases).

Table no: 1 Estimated numbers of new cases and deaths for each common cancer type.[21]

Cancer Type	**Estimated New Cases**	**Estimated Deaths**
Bladder	68,810	14,100
Breast (Female - Male)	182,460 -- 1,990	40,480 - 450
Colon and Rectal (combined)	148,810	49,960
Endometrial	40,100	7,470
Kidney (Renal Cell)	46,232	11,059
Leukemia (all)	44,270	21,710
Lung (including bronchus)	215,020	161,840
Melanoma	62,480	8,420
Non-Hodgkin Lymphoma	66,120	19,160
Pancreatic	37,680	34,290
Prostate	186,320	28,660
Skin (non-melanoma)	>1,000,000	<1,000
Thyroid	37,340	1,590

2.1.4. Cancer Prevalence

Cancer prevalence is defined as the total number of people living with cancer at any point in time. It includes people diagnosed with cancer in the past (who are still alive) as well as people recently diagnosed.

Cancer prevalence is not a measure of how common a cancer is. This number is reflected by cancer incidence, which is the number of people newly diagnosed with cancer in a given time period (usually a year). Prevalence is affected both by the incidence of a cancer and by how long people normally live with the disease.

For example, lung cancer is the second most common cancer in both men and women. But, lung cancer prevalence is not as high as that of some less common cancers because people with lung cancer tend not to live as long once diagnosed.

The numbers on the chart come from the US National Cancer Institute's Surveillance Epidemiology and End Results (SEER) database for the year 2005, the most recent year for which good estimates are available.

Table no: 2 Estimates are based on a sampling of the US population.[21]

Estimated cancer prevalence in the United States, 2005			
Primary site	**Estimated prevalence**		
	Total	**Males**	**Females**
All sites	10,701,000	4,955,000	5,746,000
Brain & other nervous system	109,000	58,000	51,000
Breast	2,521,000	13,000	2,478,000
Cervix	195,000	0	195,000
Colon & rectum	1,168,000	570,000	598,000
Endometrial cancer & Uterine sarcoma	554,000	0	554,000
Esophagus	32,000	24,000	8,000
Hodgkin disease	144,000	74,000	70,000
Kidney & renal pelvis	280,000	166,000	114,000
Larynx	98,000	79,000	20,000
Leukemias	231,000	131,000	100,000
Liver & bile duct	24,000	16,000	8,000
Lung & bronchus	418,000	199,000	219,000
Melanoma of skin	725,000	361,000	364,000
Multiple myeloma	63,000	35,000	28,000
Non-Hodgkin lymphoma	431,000	222,000	209,000
Oral cavity & pharynx	246,000	157,000	88,000
Ovary	170,000	0	170,000
Pancreas	34,000	17,000	17,000
Prostate	2,244,000	2,244,000	0
Stomach	70,000	40,000	30,000
Testis	168,000	168,000	0
Thyroid	362,000	82,000	281,000
Urinary bladder	575,000	425,000	151,000
Childhood cancer (age 0 -19 years)	249,000	128,000	121,000

Numbers may not add up because they have been rounded to the nearest 1,000. [21]

2.1.5. Risk factors of cancer

Cancer is a group of more than 100, different diseases, each with their own set of risk factors. The risk of developing cancer increases as we age, so age along with gender, race and personal and family medical history are risk factors of cancer. Other risk factors are largely related to life style choices, while certain infections, occupational exposures and some environmental factors can also be related to developing cancer. Some common risk factors are the following.

Mouth Cancer: Tobacco and alcohol usage accounts for most mouth cancer. Another risk factor is a diet low in fruits and vegetables and possible risk factors are tooth development and oral hygiene.

In Coliorectal Cancer: The risks factors are personal are family history of colorectal polyps or inflammatory bowel disease, certain rare hereditary conditions and a diet high in fat and or low in fiber, fruits and vegetables.

In Pancreatic Cancer: Risk factors are cigarette smoking and possible alcohol, coffee or tea consumption, diabetes, chronic pancreatitis, cirrhosis, allergies etc,

Stomach Cancer: Risk factors are dietary nitrites (in pickled, salted and smoked foods) pernicious anemia and diet low in fruits and vegetables, possible factors are high doses of ionizing radiation, cigarette smoking and genetic factors.

In Liver Cancer: The possible risk factors are use of steroids, smoking and inherited metabolic diseases (eg; hemachromatosis).

In Lung Cancer: Tobacco smoking is responsible for nearly 90% of all lung cancers. Other contributing risk factors are smoking cigars or pipes and environmental tobacco smoke (second hand smoke). Possible risk factors are air pollution and insufficient consumption of fruits and vegetables.

In Laryngeal Cancer: Most cases are caused by cigarette smoking and other factors are alcohol and occupational exposure to asbestos and mustard gas.

In Breast Cancer: The risk factors are family history, personal history of breast, ovarian or endometrial cancer, menstruation at an early age, late menopause, obesity after menopause, excessive alcohol consumption. Possible risk factors are dietary fat and physical inactivity.

In Prostate Cancer: The possible risk factors are hormone factors, obesity, asexually transmitted agent, smoking, alcohol, and physical in activity.

In Cervical Cancer: The risk factors are infection with HPV, early age at first sexual intercourse, many sexual partners, multi births, long term oral contraceptive use, cigarette smoking. Possible risk factors are certain vitamin deficiencies and hormonal factors.

In Bladder Cancer: The most important risk factor is cigarette smoking. Possible risk factors are heavy coffee consumption, bladder infection with schistosoma haematobium (a parasitic flat worm), urinary tract infection, or low urine flow, tobacco use other than cigarettes and genetic factors.

In Kidney Cancer: Cigarette smoking is the most important risk factor. Possible risk factors are regular use of prescription diuretic and increased meat consumption.

In Leukemia: The risk factors are family history, high dose of ionizing radiation, alkylating drugs used to treat cancer and other diseases. Possible risk factors are exposure to electromagnetic fields, pesticides, smoking, and several immune related diseases.

In Brain Cancer: The risk factors are the genetic factors, certain rare inherited syndrome such as neurofibromatosis, being a parent or sibling of a child with brain cancer, high doses of ionizing radiation. Possible risk factors are exposure to electro magnetic field, exposure to farm animals and pets, severe head trauma, loud noise and N-nitroso compounds in the diet, cigarettes and alcohol.

In Thyroid Cancer: The risk factors are high doses of ionizing radiation and goiter.[22]

2.2. Heavy Metals

A heavy metal is a member of an ill-defined subset of elements that exhibit metallic properties, which would mainly include the transition metals, some metalloids, lanthanides, and actinides. Many different definitions have been proposed—some based on density, some on atomic number or atomic weight, and some on chemical properties or toxicity. The term heavy metal has been called "meaningless and misleading" in an IUPAC technical report due to the contradictory definitions and its lack of a "coherent scientific basis". There is an alternative term toxic metal, for which no consensus of exact definition exists either. As discussed below, depending on context, heavy metal can include elements lighter than carbon and can exclude some of the heaviest metals. Heavy metals occur naturally in the ecosystem with large variations in concentration. Nowadays anthropogenic sources of heavy metals, i.e. pollution, have been introduced to the ecosystem. Waste derived fuels are especially prone to contain heavy metals so they should be a central concern in a consideration of their use. [23]

2.2.1. Heavy Metals and Health

The various mineral elements are generally being imbibed into the plants from the soil, water and atmosphere. The level of mineral elements in plant varies depending upon the environmental factors and the type of plant itself. Among plant types growing in the same environment, fungi lichen and mosses accumulate more metals than the others. For a particular species, the concentration level generally decreases in the order root >stem > leaves > fruit > seed when the source of the mineral element is only the soil. Moreover the concentration of elements also varies with the age of the plant.

Levit, et al 1984 Mineral elements are more useful to man than being harmful. Human body requires mineral elements to certain extent. At the same time, when it crosses the limit, it becomes toxic and degenerate the system. High level of toxic elements occurs in medicinal preparations when they are used as active ingredients as in the case of Pb and Hg in some Chinese, Mexican and Indian medicines. [24] or when the plants are grown in polluted areas fertilizers, such as near roadways, metal mining and smelting operations. [25] and one uses fertilizer containing cadmium and organic mercury or lead based pesticides, and contaminated irrigation water. [26] Hence, analysis of various mineral/metal elements is imperative in the use of plants as drugs.

Table no: 3. *Permissible levels of trace elements/heavy metals in drinking water and in blood.* [20, 27]

S.No.	Name of the Elements	Permissible Level in Water			Concentration in Blood
		WHO (1984)	**US.EPA (1992)**	**TWAD**	
1.	Arsenic	0.05mg/L	0.05 mg/L	0.05 mg/L	~1.1 µg/L (S)
2.	Aluminum	0.2 mg/L	0.02 mg/L	0.2 mg/L	1-10 ng/ml (S or P)
3.	Calcium	75-150 mg/L	-	200 mg/L	8.5-10.3 mg/dL (S)
4.	Cadmium	0.005 mg/L	0.005 mg/L	0.01 mg/L	0.4 µg/L (S)
5.	Cobalt	0.05 µg/L	-	-	0.03-0.3 ng/ml (S or P)
6.	Copper	1.0 mg/L	1.3 mg/L	1.5 mg/L	100-200 µg/dL (S or P)
7.	Chromium	0.05 mg/L	0.1 mg/L	-	0.01-1.0 ng/ml (S or P)
8.	Iron	0.3 mg/L	0.3 mg/L	1.0 mg/L	50- 175 µg/dL (S)
9.	Lead	0.05 mg/L	0.015 mg/L	0.05 mg/L	0.02-1.0 µg/L (S)
10.	Magnesium	30 mg/L	-	30-100 g/L	1.8 – 3 mg/dL (S or P)
11.	Manganese	0.1 mg/L	0.05 mg/L	0.3 mg/L	~ 0.05 ng/ml (S or P)
12.	Mercury	0.001 mg/L	0.002 mg/L	0.001 mg/L	0.2-3 ng/ml (S)
13.	Molybdenum	0.07 mg/L	-	-	~1.1 µg/L (P)
14.	Nickel	0.05 mg/L	-	-	0.05-1 ng/ml (S or P)
15.	Potassium	200 mg/L	-	-	3.5-5.0 meq/L (S)
16.	Selenium	0.01 mg/L	0.05 mg/L	-	0.03-2 ng/ml (S)
17.	Sodium	200 mg/L	-	-	136-145 meq/L (S)
18.	Tungsten	-	-	-	~0.4 µg/L (S)
19.	Thallium	-	0.0005 mg/L	-	~0.2 µg/L (S)
20.	Vanadium	-	-	-	0.01-1 ng/ml (S or P)
21.	Zinc	5 mg/L	5 mg/L	5 mg/L	50-150 µg/L (S)

(S) – Serum, (P) - Plasma

2.2.2. Relationship to living organisms

Living organisms require varying amounts of "heavy metals." Iron, cobalt, copper, manganese, molybdenum, and zinc are required by humans. Excessive levels can be damaging to the organism. Other heavy metals such as mercury, plutonium, and lead are toxic metals that have no known vital or beneficial effect on organisms, and their accumulation over time in the bodies of animals can cause serious illness. Certain elements that are normally toxic are, for certain organisms or under certain conditions, beneficial. Examples include vanadium, tungsten, and even cadmium.

2.2.3. Heavy metal pollution

Motivations for controlling heavy metal concentrations in gas streams are diverse. Some of them are dangerous to health or to the environment (e.g. Hg, Cd, As, Pb, Cr), some may cause corrosion (e.g. Zn, Pb), some are harmful in other ways (e.g. Arsenic may pollute catalysts). Within the European community the 13 elements of highest concern are As, Cd, Co, Cr, Cu, Hg, Mn, Ni, Pb, Sn and Tl, the emissions of which are regulated in waste incinerators. Some of these elements are actually necessary for humans in minute amounts (Co, Cu, Cr, Ni) whilst others are carcinogenic or toxic, affecting, among others, the central nervous system (Hg, Pb, As), the kidneys or liver (Hg, Pb, Cd, Cu) or skin, bones or teeth (Ni, Cd, Cu, Cr).

Heavy metal pollution can arise from many sources but most commonly arises from the purification of metals, e.g., the smelting of copper and the preparation of nuclear fuels. Electroplating is the primary source of chromium and cadmium. Through precipitation of their compounds or by ion exchange into soils and muds, heavy metal pollutants can localize and lay dormant. Unlike organic pollutants, heavy metals do not decay and thus pose a different kind of challenge for remediation. Currently, plants or microorganisms are tentatively used to remove some heavy metals such as mercury. Plants which exhibit hyper accumulation can be used to remove heavy metals from soils by concentrating them in their bio matter. Some treatment of mining tailings has occurred where the vegetation is then incinerated to recover the heavy metals.[23]

2.3. Environmental Pollutions and Cancer

Moutchen., 1985 discussed on introduction to genetic toxicology. In that, Human is exposed to a large number of physical or chemical agents which can cause a variety of health hazards. Majority of human cancers are known to arise as a direct consequence of environmental exposure to mutagenic and carcinogenic agents, mainly through diet, habit and occupation.[28]

Hulka et al., 1990 reported as the formation of many DNA adducts in human is directly related to exposure to carcinogens associated with life style, contact with many pollutants. Recently, increasing attention has been paid to the development of monitoring methods by which human exposure to mutagens and carcinogens can be detected and several biomarkers were also developed for this purpose. [29]

Berglund et al., 2000 reported as People may be exposed to potentially harmful chemical, physical and biological agents in air, food, water or soil. [30]

Mutuku et al., 2000 Implications of the Dandora Municipal Dumping Site in Nairobi, Kenya reported that Soil samples analyzed from locations adjacent and within the dumpsite show high levels of heavy metals emanating from the site in particular lead, mercury, cadmium, copper and chromium. At the same time, a medical evaluation of the children and adolescents living and schooling near the dumpsite indicates a high incidence of diseases that are associated with high exposure levels to these metal pollutants. For example, about 50% of children examined who live and school near the dumpsite had respiratory ailments and blood lead levels equal to or exceeding internationally accepted toxic levels (10 µg/dl of blood), while 30% had size and staining abnormalities of their red blood cells, confirming high exposure to heavy metal poisoning . This pilot study has linked environmental pollution to public health.[31]

Sanjeev Lalwani et al., 2006 studied that exposure to arsenic has been associated with several health hazards. Worldwide the main reason for chronic human intoxication with arsenic is intake of contaminated drinking water. Mean arsenic level detected in water samples collected from booster pumping stations was 0.00976 ppm (Range 0.000-0.017 ppm, Standard Deviation 0.006 and Standard error of Mean 0.00118). Maximum arsenic level (0.017 ppm) was found in water samples of booster pumping stations of Mehrauli, Punjabi Bagh and Ramjas Road. Mean arsenic level detected in samples collected from tap water supply was 0.013 ppm (Range 0-0.0430 ppm, Standard Deviation 0.00911 and Standard error of Mean 0.000515). In water samples of 42 areas arsenic level detected was exceeding WHO/EPA permissible limit of 0.01 ppm (10 ppb). Mixing of ground water and contamination through broken or leaking channel could be the possible reason of higher arsenic level in tap water. Continuous monitoring of quality of drinking water is required particularly in view of water contamination caused by industrial waste and uncontrolled ground water extraction.[20]

Longle P 2005 says the nature has bestowed us wits a precious gift in the form of pure natural water. As rain water flows from mountains to the oceans, on its way it dissolves many substances. Some of these substances are useful mineral, while others may be considered as contaminants, causing water pollution. The sources of water pollution are mainly industry, municipal sewage, urban storm water and non point pollution especially due to run off from agriculture fields, etc, which discharge fluids laced with various contaminants including heavy metals into our water bodies. Heavy metals are known to be potentially hazardous substances. They can be absorbed by green plants, which are the primary procedures in the ecosystem. As they move up food chain from procedures to consumers, they rend to bioaccumulate in the plant animal tissues and can cause physiological and neurological disorders. In Punjab, various studies have already reported bioaccumulation of heavy metals like lead, mercury and zinc in aquatic fauna. Metals like cadmium, lead, zinc and chromium have also been found beyond permissible limits in green vegetables grown in fields irrigated with water from drains like Hudiara nallah and Gandha nallah in Amritsar and Budha nallah in Ludhiana. Studies by the Punjab Pollution Control Borad have also reported the presence of heavy metals in waters and sediments of major rivers.[32]

2.4. Textile Industry, Heavy Metals and Cancer

Preussman., 1984 were shown his recent studies have that occupational exposure to chemicals in rubber, leather, chemical and dye industries pose a major carcinogenic risk.[33]

Kuo et al., 2006 suggested that, metallic carcinogenicity is generally thought to generate of free radicals, and thus some metals were reported to play a role in lung tumorigenesis. In order to verify the role of heavy metals in the development of Taiwanese lung cancer, a case-control study was conducted to compare heavy metal contents between 60 tumor and 42 normal lung tissues surgically resected from lung cancer and noncancer patients. The tissue concentration of heavy metals, including cadmium (Cd), chromium (Cr), cobalt (Co), lead (Pb), and nickel (Ni), was measured using by atomic absorption spectrometry (AAS). Our results indicated that Cr and Ni contents in lung tumors of lung cancer patients were significantly higher than those in normal lung tissue of noncancer controls, but Co content was markedly lower in lung tumors. Data suggest that accumulation of Cr and Ni in lung tumors may play a role, at least in part, in the development of lung cancer in Taiwan.[34]

Prival et al., 1999 reported as the presence of impurities in the commercially available dyes has been reported to contribute to the mutagenicity of this dyes.[35]

Rajagopalan., 2003 was assessed that India's dye industry produces every type of dyes and pigments. Production of dyestuff and pigments in India is close to 80,000 tonnes. India is the second largest exporter of dyestuffs and intermediates developing countries, after China. The textile industry accounts for the largest consumption of dyestuffs, at nearly 80%. The textile industries are to satisfy the ever-growing demands in terms of quality, variety, fastness and other technical requirements. However, a recent study conducted under the National Biodiversity strategy and Action Plan (BSAP) has revealed that chemical colors have all but wiped out India’s wonderful vegetable dyes. The Indian textile industries now predominantly use synthetic organic dyes like direct dyes, processing dyes, reactive dyes, etc. The large variety of dyes and chemicals used in an attempt to make more attractive popular shades of fabrics for a competitive market render them very complex.[36]

Mohnot et al., 1987 assessed that Increasing trend of requirement and productivity of dyes and dye intermediates is associated with the anticipated generation of wastes, both liquid and solid in future. The wastes thus produced will contain toxic and hazardous substances, which are not acceptable to the recipient environment, if released uncontrolled.[7]

Anonym., 1982 reported as many of the dyes used by textile industries is known carcinogens.[8]

Morikawa et al, 1997 examining dyes are introduced into the environment through industrial effluents of these industries. There are ample evidences of their harmful effects. Triple primary cancers involving kidney, urinary bladder and liver in a dye worker have been reported.[9]

International Agency for Research in Cancer., 1990 says that the textile manufacturing industry consists of a wide range of occupations including spinning, weaving, knitting, dyeing and finishing of natural and synthetic fibres to produce fabrics, yarns and carpets. The range of exposures in the industry includes textile related dusts, chemicals used in making synthetic textiles, sizing, and oil mist, dyes, solvents, crease-resistance agents, flame retardants and mothproofing agents. The International Agency for Research in Cancer has reported that working in the industry entail exposures that are possibly carcinogenic for to Humans. But many studies examining the Cancer risk in this industry used mortality rather than incident data and had poor exposure data.[37]

Mirkova et al., 1990 reported as benzidine is used as a reactant in dye synthesis, workers could be directly exposed to the carcinogen.[38]

Park., 2001 discussed as water pollution is a growing hazard in many developing countries. Present concern is much related to the chemical pollutants in water that have cumulative toxic properties, carcinogenic potential and cause adverse health effects on prolonged exposure such as heavy metals.[15]

Gregory VU., 1997 Health Consultation reviewed, 103 children in Toms River, Dover Township, New Jersey had been diagnosed with cancer in what is believed to be the nation's largest child cancer cluster. In 1995, a state study found that incidence of cancer among children in Toms River was higher than any other part of the state. In Dover Township, it was reported that 90 children were found to have various types of cancer between 1979 and 1995. Since the original cases, 28 more children there have been found to have cancer, the families said. It was reported that 16 of the 118 children have died. Over a period of decades, chemical plants, including ones owned by Ciba-Geigy released industrial pollutants into the Toms River. Industrial pollutants leached into the township's groundwater supply. The pollutants included chemicals used in the manufacture of epoxies, resins, and dyestuffs. In 1983, the United States Environmental Protection Agency (USEPA) listed the site on the Superfund National Priorities List that includes the country's most polluted sites. Remediation is now underway at the site and is expected to be completed by 2010. The remediation efforts do not include removal of all the drums. The drums should not be left there in order to keep costs down. The problem here is that loopholes in the law regarding how remediation is carried out in New Jersey allow for too much agency discretion. The compromises that are made between state officials and businesses to lower remediation costs should never raise the citizen's health risk. This compromise means that drums will be left on-site. The drums will leak again. It is just a matter of time. Leaving the drums there is a danger, an unnecessary risk that leaves children at risk for further injuries.[39]

Above the same study in *2001-2005*, there were 26 cases of cancer among children in the Township of Toms River, with about two-thirds of the cases occurring in the final two years. In the Township, the most frequently diagnosed cancers over this time were brain/CNS cancers (6), leukemias (4), and soft tissue sarcomas (4). Total cancer incidence in female children was higher than expected, although the difference was not statistically significant; total cancer incidence in male children was similar to expected. Total leukemia incidence was lower than expected for both males and females. Brain/CNS cancer incidence in males was higher than expected, although not statistically significant, while brain/CNS cancer incidence in Township females was similar to expected. Soft tissue sarcoma in females was the only statistically significant elevation (4 observed cases, 0.7 expected); there were no cases of soft tissue sarcoma diagnosed in Township males. The overall incidence of cancer in children under age five years in the Township was lower than expected for both males and females, including no cases of childhood leukemia. In the smaller sub-Township area, five cases were reported in the period 2001-2005, with all occurring in the final two years. Overall cancer incidence was similar to expected for both males and females. There were three cases of soft tissue sarcomas in females, which was statistically significantly higher than expected. An analysis of time trends in the period 1979-2005 showed a pattern of higher childhood cancer rates from the middle 1980s through the early to middle 1990s for Township children, for total childhood cancer and for leukemia. Childhood brain/CNS cancer rates for the Township have been similar to state rates throughout the time period.[40]

Bielicka et al., 2005 reviewed that Chromium is a heavy metal whose concentration in the environment is increasing. Chromium in inorganic systems occurs in several chemical forms. Only Cr (III) and Cr (VI) are significant in biological systems. Trivalent chromium is an essential nutrient component while excess chromium (VI) in biological systems has been implicated in specific forms of cancer.[41]

Malik et al., 2006 reported that dyes may be harmful for living organisms because these contain toxic heavy metals. Labour and handling workers may affect by toxic metal by contact directly to soft organs, wounds or by inhalation. Heavy metals may affect a community by consumption of contaminated water. Textile industries in general consume large volume of water of high purity. Consequently, these units discharge large quantities of effluent that normally exhibit polluting characteristics and polluted the surface and ground water, which may cause serious problems to, agriculture crop, livestock, human beings, clothes and properties.[42]

Lars Jarup., 2003 observed as the main threats to human health from heavy metals are associated with exposure to lead, cadmium, mercury and arsenic. Heavy metals have been used by humans for thousands of years. Although several adverse health effects of heavy metals have been known for a long time, exposure to heavy metals continues, and is even increasing in some parts of the world, in particular in less developed countries, though emissions have declined in most developed countries over the last 100 years. Exposure to arsenic is mainly *via* intake of food and drinking water, food being the most important source in most populations. Long-term exposure to arsenic in drinking-water is mainly related to increased risks of skin cancer, but also some other cancers, as well as other skin lesions such as hyperkeratosis and pigmentation changes. Occupational exposure to arsenic, primarily by inhalation, is causally associated with lung cancer. Clear exposure–response relationships and high risks have been observed.[14]

***Abida Begum et al.,* 2009** study reveals that analysis of water, plankton, fish and sediment reveals that the Cauvery River water in the downstream is contaminated by certain heavy metals. Water samples have high carbonate hardness. Concentrations of all elements and ions increase in the downstream. Main ions are in the sediments the heavy metal concentration was Co > Cr > Ni _ Cu > Mn > Zn > Pb. Although, the quality of Cauvery River may be classified as very good based on the salt and sodium for irrigation, Zn, Pb and Cr concentration exceeded the upper limit of standards. Metal concentrations in the downstream indicate an increase in the pollution load due to movement of fertilizers, agricultural ashes, industrial effluents and anthropogenic wastes. An immediate attention from the concerned authorities is required in order to protect the river from further pollution.[43]

Dinesh C Sharma., 2005 By Order of the Court: Environmental Cleanup in India- says today, more than 13,000 licensed industries generates about 4.4 million metric tons of hazardous waste every year, according to estimates from the Indian Ministry of Environment and Forests (MEF). This doesn't include small-scale businesses such as backyard smelters. According to the ministry, the five states of Maharashtra, Gujarat, Tamil Nadu, Karnataka and Andhra Pradesh generate about 80% of the waste in India. Unsound practices have caused widespread degradation of the environment and adverse health impacts on Indian communities and industrial workers. In that totally Potential Affected People: 2,671,000, Type of Pollutants: Chemicals and hexavalent chromium and other heavy metals, Source of Pollution: Industrial estates and Chromite mines and processing.[44]

Magar et al., 2008 reported as elevated levels of chromium, partly attributable to historical disposal of chromite ore processing residue, are present in sediment along the eastern shore of the lower Hackensack River near the confluence with Newark Bay. Due to anaerobic conditions in the sediment, the chromium is in the form of Cr (III), which poses no unacceptable risks to human health or to the river ecology. Total chromium released from sediment to elutriate water in the oxidation and suspension experiments ranged from below detection (<0.01 mg/L) to 0.18 mg/L, below the freshwater National Recommended Water Quality Criteria (NRWQC) of 0.57 mg/L for Cr (III). These results support conclusions of a stable, in situ geochemical environment in sediments in the lower Hackensack River with respect to chromium. Results showed that chemicals other than Cr(VI), including copper, lead, mercury, zinc, and PCBs, were released at levels that may pose a potential for adverse ecological effects.[45]

Singh., 2001 discussed as the Kanpur City has become a large industrial complex with nearly 800 industries. This has increased the social and economic status of the city, but these industries are also causing severe environmental pollution. In addition to smoke, dust and pollutant gases, water pollution through the discharge of industrial effluents is causing severe problems. The pollutants include As, Cr, Cd, Cu, Fe, Hg, Pb and Zn, which are considered as toxicants. The presence of various ions, such as Fe^{2+}, Ca^{2+}, Mg^{2+}, Cl^{-} and $SO_4{}^{-}$, significantly changes the water characteristics, including its ability to stain, its hardness and salinity. The presence of some other oxidizing and reducing agents, such as ammonia, nitrite, nitrate and sulphate, causes problems such as depletion of oxygen, foul odour and microbial growth. The extent of pollutants in the wastewater discharge from different types of industries and the hazards of these pollutants in wastewater are discussed.[46]

Wei Zheng et al., 1984 studied to investigate occupational determinants of bladder cancer in the urban area of Shanghai, occupation and industry information for 1,219 incident bladder cancer cases diagnosed during the period 1980 to 1984 were compared with 1982 census data on employment. Standardized incidence ratios (SIR) for bladder cancer were estimated for occupation and industry classifications. Significant excess risks were observed for textile products manufacturing (female: SIR = 204); paper processing (male: SIR = 146; female: SIR = 226); this study indicates that many of the industries and occupations that are responsible for increased risk throughout the world are also associated with occupational bladder cancer in Shanghai.[47]

Paolo Vineis et al., 2001 considered a case-control study of 512 male cases of bladder cancer and 596 male hospital controls (all living in the province of Turin, Northern Italy, an area with a high proportion of car workers) has been analyzed for occupations. Relative risks were 1.8 (95% c.1. 0.9-3.6) for the textile industry, 3.8 (1.3-11.5) for the leather industry, 1.8 (0.8-4.0) for printing, 8.8 (2.7-28.6) for dyestuff production, 1.2 (0.6-2.4) for tire production and 2.5 (1.0-6.0) for other rubber goods, 2.0 (0.9-4.5) for brickyards and related activities. A relative risk of 3.1 (0.9-10.5) was found for turners having started work before 1940 and with at least 10 years of activity. For truck drivers the relative risk was 1.2 (0.6-2.5). A job-exposure matrix was developed for the development of new hypotheses; an association with bladder cancer was found for aromatic amines only. The attributable risk percent in the population was estimated as 10%, when only those occupations consistently associated with bladder cancer were considered.[48]

Rowbotham et al., 2000 reviewed Chromium in the hexavalent form, Cr (VI), has long been recognized as a carcinogen and there is concern as to the effects of continuous low-level exposure to chromium both occupationally and environmentally. This review summarizes the available exposure data and known health effects and evaluates the potential risk to human health in the United Kingdom. The human body has effective detoxification mechanisms that can reduce ingested or inhaled Cr (VI) to Cr (III). In conclusion, there is no clear evidence to relate exposure to environmental levels of chromium with adverse health effects in either the general UK population or subgroups exposed to chromium around industrialized or contaminated sites. It can be expected that an improved understanding of the relevance of possible long-term accumulation of Cr (III) in the body may facilitate a more complete assessment, in the future, of the health risks in the general population associated with environmental exposure to chromium.[49]

Shankar., 2009 analysed chromate poisoning causes severe skin disorders such as allergic dermatitis and liver and kidney damage. The present study attempts to capture the environmental impacts of industrial effluent irrigation from a tanning industrial cluster. Thirty groundwater samples were identified for sampling and chromium analysis, from the area covering about 1.4 km^2, in and around the industrial cluster. The analysis reveals that 53.33% of the samples are non-potable due to the presence of excess chromium and the results show that there is a definite correlation between the ill health faced by the residents of the area and ground water contamination.[50]

Kursad Turkdo et al., 2003 reported as the environmental exposure to heavy metals is a well-known risk factor for cancer. We investigated levels of seven different heavy metals, (Co, Cd, Pb, Zn, Mn, Ni and Cu) in soil, fruit and vegetable samples of Van region in Eastern Turkey where upper gastrointestinal (GI) cancers are endemic. Heavy metal contents of the samples were determined by flame atomic absorption spectrometer. Four heavy metals (Cd, Pb, Cu and Co) were present in 2- to 50-fold higher concentrations whereas zinc levels were present in 40-fold lower concentrations in soil. The fruit and vegetable samples were found to contain 3.5- to 340-fold higher amounts of the six heavy metals (Co, Cd, Pb, Mn, Ni and Cu) tested. The volcanic soil, fruit and vegetable samples contain potentially carcinogenic heavy metals in such a high levels that these elements could be related to the high prevalence of upper GI cancer rates in Van region.[51]

Mingli Huang et al., 2008 suggested heavy metals (HMs) may cause deleterious effects on human health due to the ingestion of food grain grown in contaminated soils. Concentrations of HMs (Hg, As, Cr, Cu, Ni, Pb, Zn and Cd) in wheat grains were investigated in different areas of a developed industry city in Southeast China (Kunshan city), and their potential risk to health of inhabitants was estimated. The results showed that concentrations of HMs in the top soil (0–15 cm) were in this order: Zn > Cr > Ni > Pb > Cu > As > Hg > Cd. The Zn, Cr, Ni Cd and Hg concentrations of several soil samples exceeded the permissible limits of China standard. In addition, concentrations of HMs in wheat grain decreased in the order of Zn > Cu > Pb > Cr > Ni > Cd > As > Hg. There were 1, 6 and 10 wheat samples whose Zn, Pb and Cd concentrations were above the permissible limits of China standard, respectively. Health risk due to the added effects of eight HMs was significant for rural children and rural adults, but not for urban adults and urban children. HQ (individual risk) and HI (Hazard Index of aggregate risk) to different inhabitants due to HMs followed the same sequence of: country children > country adults > urban children > urban adults. Amongst the HMs, potential health hazards due to As, Cu, Cd and Pb were great, and that due to Cr was the minimum. It was suggested to pay more attention on the potential added threat of HMs to the health of country inhabitants (both children and adults) through consumption of wheat in Kunshan.[52]

CHAPTER – 3

OBJECTIVES

- To study the prevalence of various Cancers in Erode and surrounding areas.
- To study the risk assessment in Cancer patients.
- To study the heavy metal content in soil and water samples from Cauvery belt and other than Cauvery belt.
- To study the heavy metal content in blood samples of Cancer patients and volunteers from Cauvery belt and other than Cauvery belt.

CHAPTER - 4

METHODOLOGY

4.1 Prevalence Study

Study Centre

Erode Cancer Centre (ECC), Erode.

Period of Study

1 Month.

Method

The study was conducted at the Erode Cancer Centre (ECC), Erode, Tamilnadu, India. The available data of the entire patients who attended the OPD or admitted during the study periods of January 1st to December 31st, 2008 were noted. The collected data were fed into a computer, analyzed and presented in the form of suitable figures, male, female, rates and percentages. The different sites of cancers were classified according to the International Classification of Diseases (ICD-10) given by the WHO.[5]

4.2. Risk Assessment

Study Centre

Erode Cancer Centre (ECC), Erode.

Period of Study

2 Month.

Method

In this study the risk factor was assessed among the Cancer Patients by using specially designed questionnaire-Patient Interview Form (Annexture-1). For this study around 100 cancer patients were added to the questionnaire. From this data, the cancer patients are divided into two criteria. That is known risk factors for the cancer patients and unknown risk factors for the cancer patients. The known risk factors for the cancer patients were excluded for these studies. The unknown risk factors for the cancer patients are considered for the further studies. Both known and unknown risk factor of the cancer patients were separated into two categories. That is cancer patients from Cauvery belt and cancer patient from other than Cauvery belt.

4.3 Heavy Metal Analysis

Study Centre

Erode Cancer Centre (ECC), Erode.

Period of Study

6 Month.

4.3.1. Heavy Metal Analysis of Water and Soil samples from Cauvery belt and other than Cauvery belt

Collection of Samples

Total 27 samples, in that 14 water samples and 13 soil samples were collected from 14 different areas of Erode and surrounding town, naming as Group-I (Cauvery belt) and Group-II (Other than Cauvery belt) as shown in table no: 2.

Table no. 4

S.No	Group-I (Cauvery belt)-Samples		
	Places	***Water***	***Soil***
1	Pallipalayam River water-1	✓	✓
2	Pallipalayam River water-2	✓	✓
3	Pallipalayam River water-3	✓	✓
4	Ganapathypalayam(before Kodumudi) River water	✓	✓
5	Ganapathypalayam(before Kodumudi) Tab water	✓	✓
6	Kodumudi	✓	✓
7	Bhavani Kududurai	✓	✓
8	Neringipet(Before Bhavani)	✓	✓
9	Mettur Dam	✓	✓
S.No	**Group-II (Other than Cauvery belt) -Samples**		
	Places	***Water***	***Soil***
1	Puthukombai	✓	✓
2	Pottiretipatty	✓	✓
3	Erumaippatty	✓	✓
4	Ponnary	✓	✓
5	Kolli Hills	✓	✓

Water samples were collected by using plastic bottles of capacity one liter. All bottles used were washed with 1% nitric acid. Before collecting the samples, bottles were rinsed three to five times with the water to be filled. Then the bottles were filled with water. Few drops of concentrated nitric acid were added to the water samples for preservation till analysis.

Water of river Cauvery is a major source of raw water for the supply to the public of Erode and surrounding areas. Total twenty seven water and soil samples were collected from fourteen different points of stretch of Cauvery River in Erode and surrounding areas. This water and soil samples were analysed for Heavy Metals like Arsenic (As), Cadmium (Cd), Chromium (Cr), Lead (Pb) and Mercury (Hg). The test was done by Atomic Absorption Spectroscopy with Perkin Elmer model 400/HGA900/AS800 coupled with Mercury Hydride System-15 (MHS-15). The heavy metal analysis was carried out by the following principle and procedures.

4.3.2. Methodology for Analysis of Metals by Atomic Absorption Spectrometer

Principle

Atomic absorption is the process that occurs when a ground state atom absorbs energy in the form of light of a specific wavelength and is elevated to an excited state. The amount of light energy absorbed at this wavelength will increase as the number of atoms of the selected element in the light path increases. The relationship between the amount of light absorbed and the concentration of analytes present in known standards can be used to determine unknown sample concentration by measuring the amount of light they absorb.

The absorption of light is proportional to the concentration of free atoms in the flame. It is given by Lambart-beer law.

Absorbance = $\log_{10} I_0/I_t = k.c.l$

Where,

I_o = intensity of incident radiation emitted by the light source.
I_t = intensity of transmitted radiation.
c = concentration of sample (free atoms).
k = consent.
l = path length.

Methodology for Heavy Metal Analysis

a) Sample collection

The samples are cleaned and dried under shade. The dried samples are then ground and powdered in an agate pestle and mortar. Samples are labeled and stored in pre-cleaned polyethylene bottles for further analysis.

b) Reagents and apparatus

All the reagents such as HCl: HNO3 (3:1) are purchased from MERCK. Millipore water is used for all analytical works. All the digestion vessels, Polyethylene bottles (sample container) Micro Pipette tips and others are washed with 10 % HCl, rinsed with de-ionized water before preparing standards, reagents and samples.

c) Digestion of samples (Sample Preparation)

A Multiwave 3000 micro oven system (from Anton paar, USA) with 16 position teflon vessels with capping is being used for digestion process. The digestion vessels are provided with a controlled pressure, temperature and release valve. Before use, all Teflon vessels are soaked with 10 % HNO_3. The system is initially programmed by giving gradual rise of 20 %, 40 %, and 50 % power for 5, 15 and 20 minutes, respectively for the due warming up. The powder samples are being used without any further treatment for sample preparation. 0.2 – 0.5 gm of sample is weighed into the Teflon vessels, followed by digestion mixture of HCl: HNO_3 in the ratio of 3:1, according to the nature of samples is being applied.

The resulting solution after microwave digestion is filtered through whatman # 40 filter paper (if necessary) and diluted to 50 ml with Millipore water. A sample blank containing only acid mixture is prepared at the same time. The method of standard addition is generally adapted to calibrate the instrument before going for the observation of the samples.

Determination of Metals

All the atomic measurements are carried out with Perkin Elmer model 400/HGA900/AS800 coupled with Mercury Hydride System-15 (MHS-15). Electrode-less Discharge Lamp (EDL) for As, Cd, Cr, Pb & Hg analysis are used as a light source to provide specific wavelength of the elements to be determined and high purity (99.999 %). Acetylene is used to provide constant thermal energy for atomization process. Argon gas is used as carrier gas for purging purposes of Graphite furnace to the analysis of As and Hg by Mercury Hydride System MHS-15.

Calibration of Instruments

More than three working standard solutions of the respective element to be determined have to be prepared. The standards are expected to cover the concentration range as recommended by the manufacturer of the instrument for the respective element to be determined. Before the analyses of samples, the instrument is calibrated with prepared working standard solution. The calibration curves are obtained for concentration vs. absorbance data by statically analyzed mode. Calibration of the instrument is repeated periodically during operations and blanks is carried with each set of 10 samples or aspirate any one of the prepared working standards for every 10 samples to check the instrument drift and to validate analytical procedures and performance. Reagent blank reading is taken and necessary correction is made during the calculation of concentration of various elements.

As, Cd, Cr, Pb, Hg and Mg analysis by Flame AAS/Graphite furnace

After calibrating the instrument with prepared working standard, the digested liquid sample solution is subjected to analysis of As, Cd, & Pb by flame/Graphite furnace with specific instrumental conditions as given by instrument's manufacturer. Introduce the solution into flame, record the reading, using the mean of the three readings. The quantity of the concentration of the respective metal is provided after verifying the programmed calibration of the reading with the standard calibration curve of the respective element obtained from Concentration vs. Absorbance of the prepared known concentration on the day of the analysis.

Hg analysis by Cold Vapour Method using Mercury Hydride System (MHS-15):

After calibrating the instrument with prepared working standard, the 10 ml of digested liquid sample is pipetted out to a specific container of Mercury Hydride system analyzer followed by adding 10 ml 1.5 % of HCl as diluents for each flask and blank, 3 % of $NaBH_4$ solution in 1 % of NaOH in reaction flask. The digested sample is run through the reaction flask to quartz cell. It is done with out any heating. As there is a standard curve already calibrated in the programme, the values are printed out after calibrating with the standard curve obtained from concentration Vs absorbance of the prepared known concentration on the day of the analysis.[53, 54]

The values of heavy metal contents for the water and soil samples of Cauvery belt and other than Cauvery belt areas were statistically analysed by using 'GraphPad Instat Software" following unpaired "t" test. The value of $P<0.05$ was considered significant.

4.3.3. Heavy Metal Analysis of Blood samples from Cauvery belt and other than Cauvery belt of Patients and Volunteers

Blood Sample Collection

Initially prepare Four Group namely, Group-I volunteer from other than Cauvery belt. Group-II Cancer patients from Other than Cauvery belt, Group-III volunteer from Cauvery belt and Group-IV is Cancer patients from Cauvery belt.

About 3-5 ml of blood samples were collected from the each group of each patients and volunteers with the help of lab technician, after getting the consent using Patient and volunteer Consent Form (Annexure – 2 & 3). Then collection of blood samples was stored in 5ml capacity of anticoagulant (EDTA) added blood collecting tube from each patients and volunteers with the consent. It was preserve in the refrigerator and analysed for the Heavy Metals like As, Cd, Cr, Pb, Hg & Mg. The Heavy Metal analysis was done by **“Atomic Absorption Spectroscopy”** with Perkin Elmer model 400/HGA900/AS800 coupled with Mercury Hydride System-15 MHS-15.

The heavy metal analysis was carried out by the above same principle and procedures. Then the value of heavy mental contents for the blood samples from different groups were statistically analysed by using “GraphPad Instat Software” following “Dunnett Multiple Comparisons Test”. The value of $P<0.05$ was considered significant.

The study has been conducted after receiving approval from the Institutional Ethical Committee (IEC) for Clinical Studies (Annexure - 4).

CHAPTER - 5

RESULTS

5.1. Prevalence Study

A totally 765 cancer patients are registered at the ECC hospital at erode. In that 271 numbers of male patients and 494 of female patients are registered. Region/site wise, namely, Brain (12), Head/Neck (189), Breast (88), Cervix (136), Chest (38), Oesophagus (59), Lung (8), Stomach (72), Prostate (14), others (149) was reported. It was shown below the table. In total 765 cases in that male 42% and female 58%.

Table no: 5 Prevalence of different cancer

REGION / SITE	**MALE**	**FEMALE**	**Total**
Brain	7	5	12
Head & Neck	91	98	189
Breast	0	88	88
Cervix	0	136	136
Chest	21	17	38
Oesophagus	32	27	59
Lung	8	0	8
Stomach	38	34	72
Prostate	14	0	14
Others	60	89	149
Total	**271**	**494**	**765**

Fig – 1. Prevalence of different Cancer

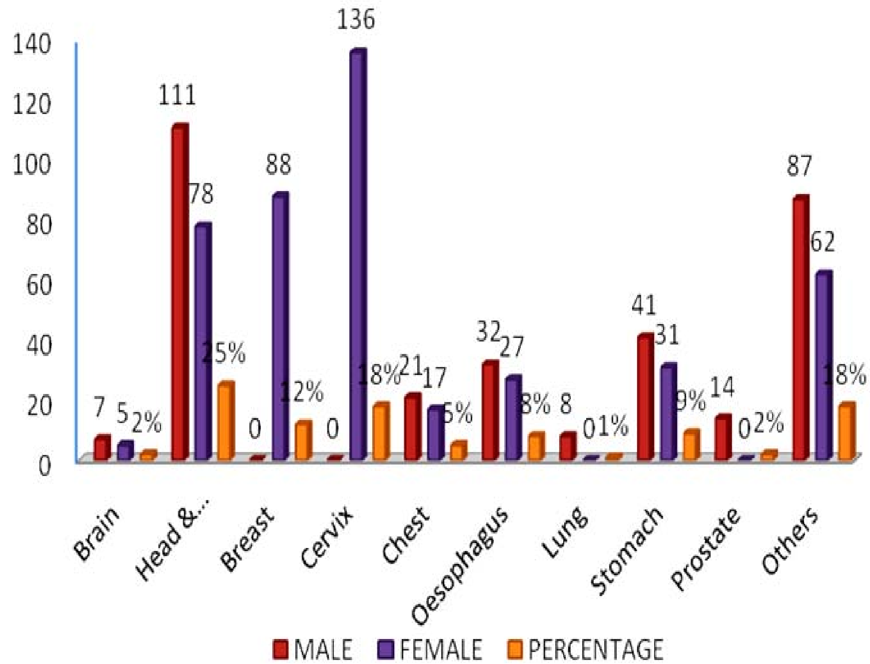
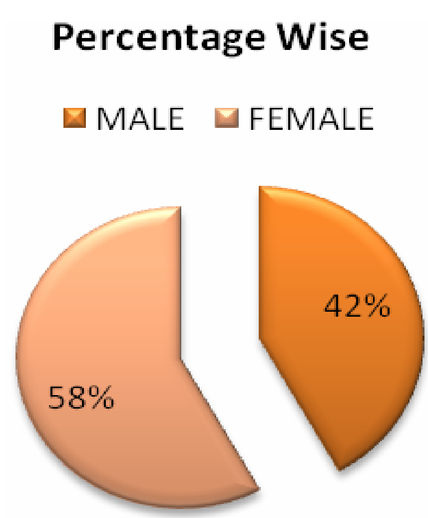


Fig – 2. Male and Female distribution of Cancer



5.2. Risk Assessment

Totally 100 cancer patients were interviewed to the questionnaire. There are about 44% patients are reported to have known risk factors, 56% are with unknown risk factors. Out of 100 cancer patients 63% are from Cauvery belt and 37% patients from other than Cauvery belt. From the result it was revealed that most of the patients are from Cauvery belt area.

Fig - 3. Pie diagram of Cancer risk factor

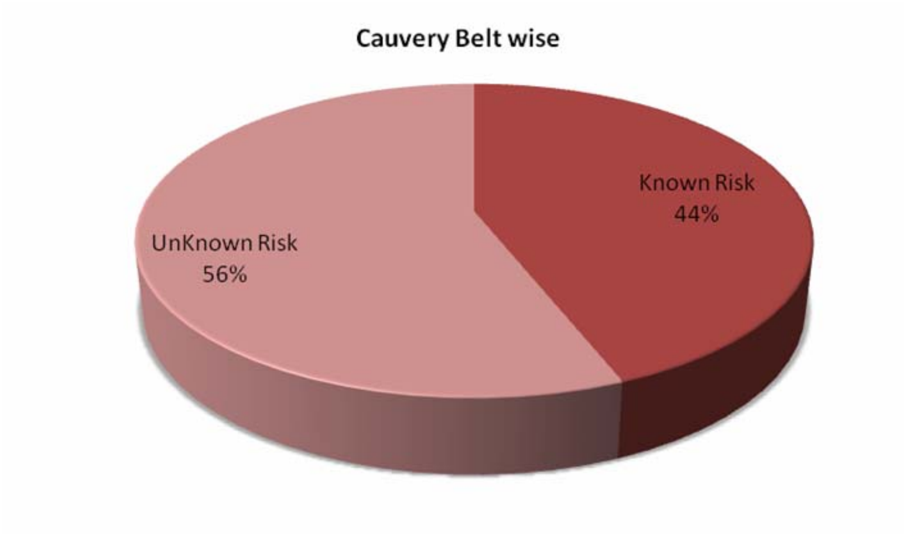
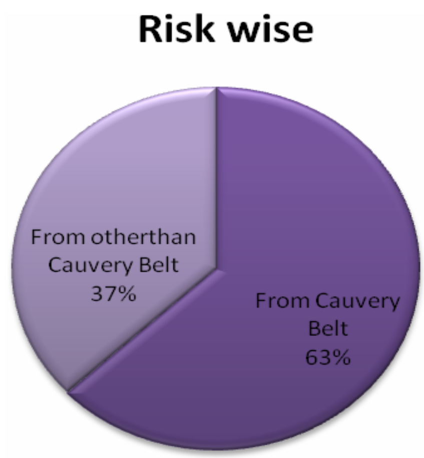


Fig – 4 Prevalence of Cancer in Cauvery Belt



5.3. Water Sample Analysis for Heavy Metals

Table no: 6 Other than Cauvery Belt Area

Name of the Places	Heavy Metal Content in Water (*ppm*)				
	Pb	Cd	As	Hg	Cr
Puthukommbai (Ground state of Kolli hills)	0.0982	0.0121	0.1122	0.2844	0.0629
Pottiretipatty	0.1024	0.0070	0.1084	0.2976	0.0468
Erumaipatty	0.1124	0.0050	0.1076	0.3042	0.0488
Ponnery	0.1216	0.0060	0.1094	0.2924	0.0472
Kolli hills	0.1184	0.0080	0.1102	0.2796	0.0522
Mean	**0.111**	**0.008**	**0.11**	**0.29**	**0.0516**
SD	**0.0101**	**0.0027**	**0.002**	**0.01**	**0.0066**
SEM	**0.0045**	**0.0012**	**0.008**	**0.004**	**0.0029**

Table no: 7 Cauvery Belt Areas

Name of the Places	Heavy Metal Content in Water (*ppm*)				
	Pb	Cd	As	Hg	Cr
Pallipalayam River water-1	0.558	0.0050	0.0665	0.0047	0.7236
Pallipalayam River water-2	0.714	0.0042	0.0682	0.0044	0.6524
Pallipalayam River water-3	0.622	0.0038	0.0589	0.0047	0.6492
Ganapathypalayam(before Kodumudi) River water	0.664	0.0041	0.0624	0.0044	0.5826
Ganapathypalayam(before Kodumudi) Tab water	0.661	0.0042	0.0639	0.0045	0.5788
Kodumudi	0.598	0.0022	0.0662	0.0043	0.5515
Bhavani Kududurai	0.633	0.0023	0.0638	0.0042	0.4929
Neringipet(Before Bhavani)	0.636	0.0013	0.0610	0.0043	0.4054
Mettur Dam	0.642	0.0021	0.0626	0.0042	0.4211
Mean	**0.636**	**0.0032**	**0.0637**	**0.0044**	**0.5619**
SD	**0.4368**	**0.0012**	**0.0029**	**0.0001**	**0.1072**
SEM	**0.1456**	**0.0004**	**0.0009**	**6.3343**	**0.0357**

Table no: 8 Water Samples -Other than Cauvery Belt Vs Cauvery Belt

Heavy Metals	Groups	N	Mean (*ppm*)	SD	SEM	t	P
Pb	Test Control	9 5	0.6364 0.1106	0.04368 0.01008	± 0.01456 ± 0.00450	26.092	<0.0001
Cd	Test Control	9 5	0.003244 0.007620	0.001276 0.002743	± 0.00042 ± 0.00123	4.139	<0.0007
As	Test Control	9 5	0.06372 0.1096	0.002907 0.001774	± 0.00097 ± 0.00079	31.787	<0.0001
Hg	Test Control	9 5	0.004411 0.2916	0.000190 0.009890	± 6.334 ± 0.00442	90.154	<0.0001
Cr	Test Control	9 5	0.5619 0.05158	0.1072 0.006676	± 0.03572 ± 0.00299	10.448	<0.0001

5.3.1. Lead Content

Mean Lead content was found to be (0.6364 ± 0.01456 ppm) in the test sample and it was very much higher than the control group (0.1106 ± 0.004506 ppm). The results were analysed by unpaired "t" test and the difference in two groups was significant (P<0.0001). The values are well above the normal value (0.05mg/l) and water sample from Cauvery belt area was five times greater than the other area.

5.3.2. Cadmium Content

Mean Cadmium content was found to be higher in control sample than test sample (0.007620 ± 0.00123 Vs 0.003244 ± 0.00042 ppm). But the metal content in test sample was less than that of normal value (0.005 mg/l).

5.3.3. Arsenic Content

Both control and test samples showed higher than the content of Arsenic when compared to normal value (0.05 mg/l) with control sample showing greater Arsenic content than test sample (0.1096 ± 0.00079 Vs 0.06372 ± 0.00097 ppm) and the difference in two group was extremely significant.

5.3.4. Mercury Content

Mercury content in both samples was greater than normal (0.001 mg/l) and control sample showed a very high content of Arsenic difference was extremely significant (0.2916 ± 0.00442 Vs 0.00441 ± 6.334 ppm).

5.3.5 Chromium Content

Unlike other metals, Chromium showed higher content in test sample than control group 0.5619 ± 0.03572 ppm and 0.05158 ± 0.00299 ppm respectively with normal value being 0.05 mg/l.

From these results we can say Lead and Chromium content were higher in Cauvery belt same while other metals such as Cadmium, Arsenic and Mercury were higher in control samples. (Table no: 8)

5.4. Soil Samples Analysis for Heavy Metals

Table no: 9 Other than Cauvery Belt Area

Name of the Places	Heavy Metal Content in Water (*ppm*)				
	Pb	**Cd**	**As**	**Hg**	**Cr**
Puthukommbai (Ground state of Kolli hills)	4.3980	0.3370	0.8842	2.5080	7.9400
Pottiretipatty	3.9850	0.1770	0.7964	2.3160	10.370
Erumaipatty	4.4980	0.2430	0.8241	2.4640	9.1770
Ponnery	4.4420	0.1720	0.8364	2.3560	3.6490
Kolli hills	4.3980	0.3370	0.8842	2.5080	7.9400
Mean	**4.344**	**0.253**	**0.85**	**2.43**	**7.815**
SD	**0.205**	**0.0815**	**0.039**	**0.089**	**2.538**
SEM	**0.0917**	**0.0364**	**0.017**	**0.04**	**1.135**

Table no: 10 Cauvery Belt Areas

Name of the Places	Heavy Metal Content in Water *(ppm)*				
	Pb	**Cd**	**As**	**Hg**	**Cr**
Pallipalayam River soil-1	11.27	0.1050	1.7424	0.0426	12.130
Pallipalayam River soil -2	7.830	0.0600	0.7435	0.0403	10.440
Pallipalayam River soil -3	6.333	0.0620	0.7621	0.0395	10.240
Ganapathypalayam(before Kodumudi) River soil	3.777	0.0610	0.7458	0.0412	10.460
Ganapathypalayam(before Kodumudi) soil	7.622	0.0820	0.6834	0.0424	10.600
Kodumudi	6.106	0.0520	0.7122	0.0369	9.6770
Bhavani Kududurai	9.417	0.0430	0.6734	0.0403	8.7130
Neringipet(Before Bhavani)	9.085	0.0130	0.7222	0.0424	8.3430
Mettur Dam	6.793	0.0600	0.6942	0.0409	8.5030
Mean	**7.5814**	**0.0607**	**0.8310**	**0.0407**	**9.9006**
SD	**2.183**	**0.2519**	**0.3431**	**0.0017**	**1.226**
SEM	**0.7277**	**0.0083**	**0.1144**	**0.0006**	**0.4086**

Table no: 11 Soil samples-Other than Cauvery Belt Vs Cauvery Belt

Heavy Metals	**Groups**	**N**	**Mean** *(ppm)*	**SD**	**SEM**	**t**	**P**
Pb	Test Control	9 5	7.581 4.344	2.183 0.2050	± 0.7277 ± 0.0916	26.092	<0.0001
Cd	Test Control	9 5	0.05978 0.2532	0.02519 0.08147	± 0.0084 ± 0.0364	4.139	0.0007
As	Test Control	9 5	0.8310 0.8451	0.3431 0.03856	± 0.1144 ± 0.0172	0.08956	0.4651
Hg	Test Control	9 5	0.04072 2.430	0.001798 0.08916	± 0.0006 ± 0.0398	83.198	<0.0001
Cr	Test Control	9 5	9.901 7.815	1.226 2.538	± 0.408 ± 1.135	2.107	0.0284

5.4.1. Lead Content

Lead content was found to be very high in test soil sample (7.581 ± 0.7277 ppm) with control group having a mean Lead content of (4.344 ± 0.0916 ppm) and the difference was extremely significant with a P value (<0.0001).

5.4.2. Cadmium Content

Cadmium shows an opposite picture, with control soil sample showing very high value than test sample (0.2532 ± 0.0364 Vs 0.05978 ± 0.0084 ppm). However values were greater than normal value (0.005 mg/l) and the difference was statistically significant.

5.4.3. Arsenic Content

Both control and test soil samples (0.8451 ± 0.0172 & 0.8310 ± 0.1144 ppm) showed dense Arsenic content than the normal value (0.05 mg/l) and the difference was insignificant.

5.4.4. Mercury Content

Mercury content in Cauvery belt area soil sample was less than the control (0.0407 ± 0.0006 Vs 2.430 ± 0.0398 ppm) but more than the normal value (0.001 mg/l) and the difference were extremely significant.

5.4.5. Chromium Content

Chromium content was found to be more in both groups than normal value and the test sample Chromium content was the highest (9.901 ± 0.408 Vs 7.815 ± 1.135 ppm) and the difference was significant. Interestingly Chromium content was greater in water sample also.

When compare to the heavy metal content of other than Cauvery belt, Lead and Chromium content were significantly higher in the soil and water samples from Cauvery belt area. (Table no: 11)

5.5. Heavy Metal Content in Blood Samples of Cancer Patients and Volunteers

Table no: 12 Group-I (volunteers from other than Cauvery belt)

Units: ppm

S.No	Pb	Cd	As	Hg	Cr	Mg
1	0.4624	0.0342	0.0426	0.1308	0.4135	0.8210
2	0.4662	0.0322	0.0395	0.0912	0.4432	0.8240
3	0.4658	0.0353	0.0402	0.1108	0.4646	0.8260
4	0.4644	0.0361	0.0378	0.0988	0.4542	0.8190
5	0.4628	0.0334	0.0369	0.0912	0.3988	0.8170
Mean	**0.4643**	**0.0342**	**0.0394**	**0.1045**	**0.4348**	**0.8214**
SD	**0.0007**	**0.00069**	**0.0009**	**0.0075**	**0.0124**	**0.0016**
SEM	**0.0017**	**0.0015**	**0.0022**	**0.0167**	**0.0277**	**0.0036**

Table no: 13 Group-II (Cancer patients from other than Cauvery belt)

Units: ppm

S.No	Pb	Cd	As	Hg	Cr	Mg
1	0.4524	0.0322	0.0242	0.0220	0.7714	0.8240
2	0.4622	0.0288	0.0264	0.0156	0.7881	0.8360
3	0.4608	0.0292	0.0232	0.0139	0.4978	0.8280
4	0.4586	0.0316	0.0225	0.0162	0.5421	0.8330
5	0.4602	0.0287	0.0224	0.0184	0.6424	0.8360
6	0.4588	0.0281	0.0214	0.0205	0.5342	0.8290
7	0.4564	0.0276	0.0198	0.0192	0.6440	0.8680
Mean	**0.4585**	**0.0295**	**0.0228**	**0.0179**	**0.6314**	**0.8362**
SD	**0.0013**	**0.0007**	**0.0008**	**0.0010**	**0.0435**	**0.0055**
SEM	**0.0036**	**0.002**	**0.0021**	**0.0028**	**0.1153**	**0.0146**

Table no: 14 Group-III (volunteers from Cauvery belt)

Units: ppm

S.No	Pb	Cd	As	Hg	Cr	Mg
1	0.3337	0.0254	0.0184	0.0136	0.7027	0.8350
2	0.3682	0.0272	0.0168	0.0128	0.6195	0.8340
3	0.3506	0.0271	0.0166	0.0127	0.7212	0.8420
4	0.3484	0.0274	0.0158	0.0118	0.5984	0.8360
5	0.3526	0.0273	0.0192	0.0120	0.6620	0.8350
Mean	**0.3507**	**0.0268**	**0.0173**	**0.0125**	**0.6607**	**0.8364**
SD	**0.0055**	**0.0003**	**0.0006**	**0.0003**	**0.0234**	**0.0014**
SEM	**0.0122**	**0.0008**	**0.001**	**0.0007**	**0.0524**	**0.0032**

Table no: 15 Group –IV (Cancer patients from Cauvery belt)

Units: ppm

S.No	Pb	Cd	As	Hg	Cr	Mg
1	0.4764	0.0342	0.0343	0.0399	0.4682	0.8330
2	0.4735	0.0360	0.0321	0.0418	0.4226	0.8380
3	0.4712	0.0366	0.0295	0.0358	0.5070	0.8420
4	0.4723	0.0322	0.0278	0.0368	0.5220	0.8280
5	0.4744	0.0316	0.0302	0.0359	0.4920	0.8190
6	0.4701	0.0364	0.0343	0.0382	0.5410	0.8120
7	0.4742	0.0336	0.0304	0.0378	0.5830	0.8250
8	0.4686	0.0361	0.0294	0.0566	0.4420	0.8180
9	0.4654	0.0342	0.0325	0.0486	0.3344	0.8160
10	0.4646	0.0352	0.0332	0.0506	0.3640	0.8140
11	0.4662	0.0348	0.0285	0.0548	0.0342	0.8220
12	0.4658	0.0364	0.0304	0.0536	0.3540	0.8190
Mean	**0.47023**	**0.03478**	**0.03105**	**0.0442**	**0.42203**	**0.82383**
SD	**0.00117**	**0.00048**	**0.00063**	**0.00232**	**0.04181**	**0.00277**
SEM	**0.00405**	**0.00167**	**0.00219**	**0.00804**	**0.1448**	**0.00961**

Table no: 16 Heavy Metal contents in blood samples of cancer patients and volunteers *Units: ppm*

S.No	Groups	Pb	Cd	As	Hg	Cr	Mg
I	Volunteers from other than Cauvery Belt	0.46432 ± 0.0007658	0.03424 ± 0.0006875	0.0394 ± 0.0009925	0.10456 ± 0.007475	0.43486 ± 0.01242	0.8214 ± 0.001631
II	Patients from other than Cauvery Belt	0.4584 ± 0.00123	0.0294571** ± 0.0006633	0.022842** ± 0.0007910	0.017971** ± 0.001087	0.63142* ± 0.04356	0.83628* ± 0.005541
III	Volunteers from Cauvery Belt	0.3507** ± 0.005496	0.02688** ± 0.0003734	0.01736** ± 0.0006242	0.01258** ± 0.0003200	0.66076* ± 0.02346	0.8364 ± 0.001435
IV	Patients from Cauvery Belt	0.47022 ± 0.001170	0.034775 ± 0.0004831	0.03105** ± 0.0006319	0.0442** ± 0.00232	0.42203 ± 0.04181	0.82383 ± 0.002774

Values are expressed in Mean ± SEM, *P<0.05; **P<0.01; ***P<0.001 when compared to Group-I

n = Group-I (5) Group-I (5); Group-II (7); Group-III (5); Group-IV (12)

5.5.1. Lead Content

Blood Lead contents were found to be same in all the groups, except the volunteers from Cauvery belt (Group-III) 0.3507 ±0.005496 ppm. It showed significantly less (P<0.01) compared to other groups.

5.5.2. Cadmium content

Volunteers from other than Cauvery belt (Group-I) and patients from Cauvery belt (Group-IV) showed almost equal Cadmium content, but other two groups showed significantly (P<0.01) less when compared to volunteers from other than Cauvery belt.

5.5.3. Arsenic Content

All the groups showed significantly (P<0.01) less Arsenic content when compared to volunteers from other than Cauvery belt (Group-I).

5.5.4 Mercury Content

Mercury content was significantly ($P<0.01$) less (Group-I, II, III) when compared to volunteers from other than Cauvery belt (Group-I).

5.5.5. Chromium Content

Volunteers from other than Cauvery belt (Group-I) and patients from Cauvery area (Group-IV) showed almost equal Chromium content. Other two groups showed significantly higher ($P<0.05$) Chromium content, when compare to other than Cauvery belt (Group-I).

5.5.6. Magnesium Content

Magnesium content was almost same in all the four groups. Surprisingly all the four groups of Magnesium content was lesser than normal value (0.084 Vs 1.8 mg/dl). (Table no: 16)

CHAPTER – 6

DISCUSSION

Cancer (malignant neoplasm) is a class of diseases in which a group of cells display un controlled growth, invasion and some times metastasis.[1]

There are over 20 million people living with cancer in the world today. The estimated number of new cases each year is expected to increase from 10 million in 2000 to 15 million in 2020.[5]

Increasing trend of requirement and productivity of dyes and dye intermediates is associated with the anticipated generation of wastes, both liquid and solid in future. The wastes thus produced will contain toxic and hazardous substances, which are not acceptable to the recipient environment, if released uncontrolled.[7]

Many of the dyes used by textile industries are known carcinogens.[8] Dyes are introduced into the environment through industrial effluents of these industries. There are ample evidences of their harmful effects. Triple primary cancers involving kidney, urinary bladder and liver in a dye worker have been reported.[9] That textile industry poses threat of various types of occupational diseases an including cancer.[10] The textile industry effluents, reported to high mutagenic activity.[13]

Erode, Namakkal and Salem surrounding town, (Tamilnadu, India) is famous for its dyeing and printing textile industries. There are about more than 500 industries involved in textile dying/printing processes, which discharge effluents into nearby Cauvery River, without any treatment. These effluents contain highly toxic dyes, bleaching agents, salts, acids, and alkalis. Heavy metals like cadmium, arsenic, lead, mercury, chromium, copper, zinc, chromium, and iron are also found in the dye effluents. People are exposed to such waters with no control over the length and frequency of exposure.

Further, as the untreated effluents are discharged into the environment they can cause severe contamination of surface and underground water. Environmental pollution caused by such textile effluents results in adverse effects on general health of the residents of Erode and surrounding town.

In this present study, we have studied the prevalence of various Cancers in Erode and surrounding areas and then we have assessed the various risk factors for Cancer, excluding the known risk factors, in Cancer patient living from Cauvery belt and Cancer patient from other than Cauvery belt of Erode and surrounding town by using specially designed questionnaire.

Then we have analysed the water and soil samples from the Cauvery belt for the presence of various heavy metals like Arsenic, Cadmium, Chromium, Lead, Mercury and compared with the samples taken from other than Cauvery belt by using Atomic Absorption Spectroscopy (AAS). [20]

Finally the same procedure as followed for the blood sample of cancer patients and volunteers from the both Cauvery belt and other than the Cauvery belt.

In prevalence study totally 765 cancer patients are registered at the ECC hospital at erode. In that 274 numbers of male patients and 494 numbers of female patients are presented. Region/site wise cancer patients in descending order are Head/Neck (189)> Cervix (136)> Breast (88)> Stomach (72)> Oesophagus (59)> Chest (38)> Prostate (14) >Brain (12) > Lung (8). In total 765 cases in that male 42% and female 58%. Out of these cancers most prevalence was Head/neck (25 %). (Table no: 5) and (Fig – 1, Fig – 2).

In Risk assessment, there are about 44% patients are reported to have known risk factors, 56% are with unknown risk factors. Out of 100 cancer patients 63% are from Cauvery belt and 37% patients from other than Cauvery belt. From the result it was revealed that most of the patients are from Cauvery belt area (Fig – 3, Fig – 4).

Considering the contamination of Cauvery water by the dyeing industry effluents and possibility of this contamination for the development of cancer was perceived in our study.

Metallic carcinogenicity is generally thought to generate of free radicals.[34] The presence of impurities in the commercially available dyes has been reported to contribute to the mutagenicity of this dyes.[35]

India's dye industry produces every type of dyes and pigments. The textile industry accounts for the largest consumption of dyestuffs, at nearly 80%.[32] Increasing trend of requirement and productivity of dyes and dye intermediates is associated with the anticipated generation of wastes, both liquid and solid in future. The wastes thus produced will contain toxic and hazardous substances, which are not acceptable to the recipient environment, if released uncontrolled.[7]

Many of the dyes used by textile industries are known carcinogens.[8] Dyes are introduced into the environment through industrial effluents of these industries. There are ample evidences for their harmful effects. Triple primary cancers involving kidney, urinary bladder and liver in a dye worker has been reported. [9] Our study also shows atleast 18% of patients with such type of cancer.

The range of exposures in the industry includes textile related dusts, chemicals used in making synthetic textiles, sizing, and oil mist, dyes, solvents, crease-resistance agents, flame retardants and mothproofing agents. The International Agency for Research in Cancer has reported that working in the industry entail exposures that are possibly carcinogenic to Humans.[37]

Water pollution is a growing hazard in many developing countries. Present concern is much related to the chemical pollutants in water that have cumulative toxic properties, carcinogenic potential and cause adverse health effects on prolonged exposure such as heavy metals.[15]

NJDHSS reported that over a period of decades, chemical plants, including ones owned by Ciba-Geigy released industrial pollutants into the Toms River which lead various types of cancers in children from 1979 to 1995. It was reported that 16 out of the 118 children have died.[35] This has been already highlighted in the earlier study revealing that analysis of water, plankton, fish and sediment reveals that the Cauvery River water in the downstream is contaminated by certain heavy metals.[39]

Environmental exposure to heavy metals is a well-known risk factor for cancer. They have investigated levels of seven different heavy metals, (Co, Cd, Pb, Zn, Mn, Ni and Cu) in soil, fruit and vegetable samples of Van region in Eastern Turkey where upper gastrointestinal (GI) cancers are endemic. [51]

Singh., 2001 highlighted already, the pollutants include As, Cr, Cd, Cu, Fe, Hg, Pb and Zn, which are considered as toxicants. The presence of various ions, such as Fe^{2+}, Ca^{2+}, Mg^{2+}, Cl^{-} and $SO_4{}^{-}$, significantly changes the water characteristics, including its ability to stain, its hardness and salinity. The extent of pollutants in the wastewater discharge from different types of industries and the hazards of these pollutants in wastewater.[46]

Our study revealed that there was a significant increase in the Lead ($P<0.0001$), Chromium ($P<0.0001$) contents in Cauvery water samples when compared water samples from other than Cauvery belt (Table no: 6). The soil samples from Cauvery belt also revealed that there was a significant increase in the Lead ($P<0.0001$), Chromium ($P<0.0284$) contents in Cauvery water samples when compared water samples from other than Cauvery belt (Table no: 9).

McConnell studies have shown that hexavalent chromium causes lung cancer in humans in certain occupational settings as a result of inhalation exposure. [55] Similarly in our study the content of Chromium were high in water and soil samples from Cauvery belt. Therefore maximum number cancer patients from Cauvery belt is may be due to increased exposure to chromium.

Magar et al., 2008 already reported as elevated levels of chromium, partly attributable to historical disposal of chromite ore processing residue, are present in sediment along the eastern shore of the lower Hackensack River near the confluence with Newark Bay. Due to anaerobic conditions in the sediment, the chromium is in the form of Cr (III), which poses no unacceptable risks to human health or to the river ecology. Chromium is released from sediment to elutriate water.[45]

Chromium in the hexavalent form, Cr (VI), has long been recognized as a carcinogen and there is concern as to the effects of continuous low-level exposure to chromium both occupationally and environmentally. This review summarizes the available exposure data and known health effects and evaluates the potential risk to human health in the United Kingdom.[45]Also, there is strong evidence that hexavalent Cr causes cancer in laboratory animals when it is consumed in drinking water. [56]

Chronic occupational and environmental exposure to Pb has lead to increase in serum Pb level which causes anaemia, peripheral neuropathy and venal tubular dysfunction. [57]

Lead is classified as a possible carcinogen in human. Higher levels of Lead in cancer patients were also reported of the study in United States. [58]

The blood samples of cancer patients from Cauvery belt showed increased in lead content when compared to blood sample of volunteers from other than Cauvery belt, even though it is not statistically significant. The chromium contents of blood from volunteer from Cauvery belt was significantly ($P<0.05$) more than that of volunteers from other than Cauvery belt. The cancer patients from other than Cauvery belt also reported to have in blood chromium level.

Kathy Presented at the Veterinary Cancer Society Meeting says that, Serum chromium concentrations were significantly lower in dogs with lymphoma (2.6 ± 2.6 µg/L, *P*= .0007) and osteosarcoma (2.4 ± 3.1 µg/L, *P*= .0001) compared to normal dogs (4.7 ± 2.8 µg/L**).** [59] The same results we found that Chromium concentration were significantly less in cancer patients from Cauvery belt area

The study also revealed that there was decrease in blood Magnesium level in the entire group when compared to the normal blood value. Magnesium deficiency can paradoxically increase the risk of, or protect against oncogenesis It has been proposed that Mg is central in the cell cycle, and that its deficiency is an important conditioner in precancerous cell transformation. In addition, immunocompetence (that eliminates transformed cells) is Mg-dependent. [60] The increase in the level of Magnesium in breast cancer patients is an indication of its protective effects against cancer. Our study revealed that in all the four groups in blood samples, Magnesium was less than the normal values (Table 16). So this could be strong risk factors for cancer patients in these groups of people.

Our study gives a clear message to the Government to control the pollution of Cauvery water from the Textile/Dyeing industry effluents. It also gives the alarming message to the people living near by Cauvery belt to use the water after proper deionization and purification to avoid serious health hazards.

CHAPTER - 7

CONCLUSIONS

- In prevalence study totally 765 cancer patients were registered at the ECC hospital at erode, Out of that male 42% and female 58%.
- In risk assessment, there are about 44% patients are reported to have known risk factors, 56% are with unknown risk factors. Out of 100 cancer patients 63% are from Cauvery belt and 37% patients from other than Cauvery belt.
- Our study concluded that there was a significant increase in the Lead, Chromium contents in Cauvery River water and soil samples when compared to water samples from other than Cauvery belt.
- The blood samples of cancer patients from Cauvery belt showed increased in lead content and chromium contents when compared to blood sample of volunteers from other than Cauvery belt. The increase incidence of cancer patients from Cauvery belt area is may be due to the contamination of Cauvery River water by the Textiles/Dyeing industry effluents.

The result of our study is an eye opener for the people living nearby Cauvery belt and the environment. Our study gives clear message to the Government to control the pollution of Cauvery mater by the Textile/Dyeing industry effluents.

CHAPTER - 8

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APPENDIX
Annexure - 1
Swamy Vivekanandha College of Pharmacy
Department Of Pharmacy Practice
Patient Interview Form

Name	:	Age	:	Sex	: M/F
Marital Status	: Single/Married	Height	:	Weight	:
Op.No	:	Obesity:		Area of Residence	:

Full Address :

Diagnosis :

Past Medical History :

Past Medication History :

Occupational History:

- Occupation :
- Working place of the Job? :
- Working hours of the Job? :
- Details about nature of job? :
- How you feel (about) after and before your job? :
- Whether you like the Job? :
- No. of Children :
- Did any of family members had any type of cancer before 40 years or after? : **Yes/No**
  If yes specify the details

Social History:

- Did you have the habit of smoking? : **Yes/No**

- How many months/years you are smoking? :
- How much you smoke : **No's/day**
- Specify the brands of cigars or pipes?
    - Cigarette
    - Beedi
    - Filter Cigarette
    - Flavored Cigarette
    - Others
- How you feel before and after smoking? :
- Did you feel any breathing difficulty while smoking? : **Yes/No**
- Are you frequently affected by cough/cold : **Yes/No**
- Still you continue smoke? : **Yes/No**
- Did you have the habit of chewing/eating betel-nut/tobacco/paan?

    : **Yes/No**
- How many months/years you are chewing/eating betel-nut/tobacco/pann?:
- How many/much times you take? : **times/day**
- Did you have the habit of drinking alcohol? : **Yes/No**
- How many days / months / years you are drinking? :
- Per day how much you are drinking? : **ml/Day**
- Specify the brands of alcohol

    Beer Whisky Rum

    Scotch Brandy Others
- Along with alcohol what type of food you used to take? :
- How you feel before and after or the next day? :
- What is the reason behind the drinking habit? :
- Have you lost more than 10 pds in the past few months

    unrelated to eating habits or excessive? : **Yes/No**
- Have you vomited blood in past six months? : **Yes/No**

Environmental History:

- Which area you are living?
- Near by any factory/companies are present? : **Yes/No**
- Details about those factory/companies? :
- Which type of house you are living?

    - Asbestos roof
    - concrete Roof
    - Other Roof house
- Nature of water you are taking and using?

Salt water	Tank water
Water	River Water
Purified/Mineral water	Bore Water

- How many litters of water you are drinking per day? :
- Do you have fair skin and or sunburn easily? : **Yes/No**
- Do you spend a great deal of time in the sun because of your work or recreational activities? : **Yes/No**
- Do you work in the Leather, Rubber or dye industries? : **Yes/No**

DIET HISTORY:

- Which is your food habit? :
  Ve**getarian/NonVegetarian**
- **For non vegetarians:**
    - Which type of food you are taking more usually? :
- Whether you are taking any additional nutrition?
    - Horlicks
    - Boost
    - Bourn vita
    - Complan
    - Malt ova
    - Others
- How you are taking food?
    - Boiling

- Full boiling
- Half boiling
- Without boiling
- Steamed
- Fried

➢ In your food what are you adding more?

- Salt
- Sugar
- Chilly
- Cornet
- Fruits
- Seeds
- Nuts
- Roots
- Fibrous
- Grain products
- Beans
- Ghee
- Oil
- Refined oil
- Others

➢ Whether you are having the habit of taking tea/coffee/milk? : **Yes/No**

➢ If yes specify the quantity : **Cups/day**

- How many times you are taking? : **Per day**

➢ Saturated fat intake : **Yes/No**

➢ Fruit intake : **Yes/No**

➢ Vegetable intake : **Yes/No**

➢ Vitamin C intake : **Yes/No**

For Non Vegetarian

➢ What type of high fat meat are you taking?

Chicken	Fish	
Mutton	Egg	
Beef	Pork	Others

➢ How many times you eat meat?

- Per day
- per week
- per month

➢ How you are taking meat?

- Boiling
  - Half boiling
  - Without boiling
  - Boiling with oil
- How do you eat?
  - With chewing? How long?
  - With out chewing
  - With hot condition
  - With out hot condition
- Do you keep cooked food in refrigerator? : **Yes/No**
  - It yes means how many hours? : **per day**
- How much quantity you are taking? : **gm/day**
- Whether you are taking hygienic meat? : **Yes/No**
- Do you take the ice cream and/or other? : **Yes/No**

PERSONAL HISTORY:

For Women

- Marital status : **Single/Married**
- Pre menopausal : **Yes/No**
- Post menopausal : **Yes/No**
- Age at menarche :
- Menstrual regularity :

  Regular/Irregular
- Average months of breast feeding : **Never/1to 5, etc**
- Did you consult your Doctor yearly once? : **Yes/No**
- Have you used any oral contraceptives? : **Yes/No**
  - If yes specify the details
- Have you undergone any Gynecologic surgery? : **Yes/No**
  - If yes specify the details
- No of birth :
- Age at first full term pregnancy : **Yes/No**
- Delivery : **Yes/No**

- Has Doctor ever told you that had genital warts? : **Yes/No**
- Did you first have sex before the age of 18? : **Yes/No**
- Have you had two or more sexual partners? : **Yes/No**
- Whether used the drug Clomiphene citrate [Clomid]? : **Yes/No**
    - If yes specify the details
- Have you used any hormone replacement therapy? : **Yes/No**
    - If yes specify the details
- Have you used Estrogen without progesterone? : **Yes/No**
- Whether you are frequently taking any analgesic like aspirin and acetaminophen? : **Yes/No**

Annexure - 2

PATIENT CONSENT FORM

I Mr/Miss/Mrs……………………………………….. Patient of **Dr.K.VELAVAN.MD. RT.,** Consultant Radiation Oncologist & Cancer Chemotherapist, Erode Cancer Centre, Erode, and I fully agree to participate in the interview conducted by **Mr. S.Prakasham.** II M.Pharm, Swamy Vivekanandha College of pharmacy, regarding his project work on **"Risk assessment of Cancer in people living near Cauveri belt of Erode, Namakkal and Salem Districts – A Pilot Study".** So I hereby give my consent after understanding about the above said programme.

Patient Signature

Pharmacist Signature Physician

Signature

Date :

Place :

Annexure - 3

Form of consent

1.	Name of the Volunteer	
2.	Age	
3.	sex	
4.	Type of Sample	
5.	Amount of Sample	
6.	Date of Sampling	

The purpose of the sample collection has been explained to me, I volunteer to give my sample.

Person obtaining Consent **Signature of the Volunteer**