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Measuring the Concentrations of Heavy Elements in Some Human Organs (Breast, Thyroid Gland, and Uterus) Affected by Cancer in Thi-Qar Governorate

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Abstract*— Heavy elements are one of the three causes of cancer. Heavy elements in cancerous tissues from certain organs (breast, thyroid, and uterus) are measured. 36 samples were collected from malignant and benign tumors divided into three groups, 12 samples for each one (breast, thyroid, and uterus), consisting of six affected samples and six healthy samples. Measurements were conducted using an inductively coupled plasma mass spectrometry (ICP-MS) device for heavy metals such as Bi, Co, Cr, Cu, Ni, Sr, Mn, and Mo. The current study recorded the highest concentration of strontium in breast cancer patients and the lowest cobalt concentration. It was found that there was a decrease in bismuth, cobalt, and nickel in cancerous tissues compared to benign tissues. At the same time, all other elements increased in cancerous tissues compared to healthy tissues. In the thyroid, the highest concentration was Sr , and the lowest was Ni. It was found that Bi, Cr, and Sr had low values in affected tissues compared to healthy tissues, while all other elements increased in cancerous tissues compared to healthy ones. In the uterus, the highest concentration was also strontium , and the lowest was molybdenum. There was a decrease in bismuth and copper in cancerous tissues compared to healthy ones, while all other elements increased at a value of $p < 0.05$.

Keywords*—Heavy elements, Thyroid gland, Breast, uterus, Radiation effects, ICP-MS.

I. INTRODUCTION

The environment is defined as a collection of non-living elements, which include soil, air, and water, as well as living elements that represent humans, plants, animals, and microorganisms, along with a set of complex factors and relationships that ensure the achievement of ecological balance between the living and non-living elements of the environment [1]. Due to this interconnection, any disruption in the ecological balance system harms human health or the health of other organisms surrounding it [2]. In general, environmental pollution occurs when additional materials are present in the air, water, or food, as this addition leads to a change in the natural composition of these materials in both quantitative and qualitative terms. Quantitative change refers to the disruption of the natural quantitative ratios that consist of air, water, and food, while qualitative change represents the introduction of new materials into the natural substances necessary for life, called specific pollutants [3]. Therefore, there is an increasing interest among individuals, whether they are specialists, intellectuals, or the general public, in the topics, problems, and impacts of the types of pollution occurring in many components of life, such as water, air, food, soil, workplaces, or living spaces, as most of them tend to be polluted, sometimes at high levels and with significant effects [4]. After all this, the concept of pollution arises, which is the presence of a high quantity of a compound or substance in an incorrect place. Therefore, it is incorrect to label some materials as non-polluting (or non-toxic), as it is necessary to precisely and clearly define the maximum quantity that is non-influential, safe, and does not cause pollution or toxicity [5].

Radiation pollution (radioactive materials) of the environment is considered one of the most significant problems of modern times that faces all living beings on the surface of the Earth due to the exposure of the environment (soil, water, and air) to the spread of these materials, whether this spread is natural or due to external pollution resulting from wars and explosions for nuclear weapon tests conducted by superpowers [6]. Therefore, studies and radiation surveys of air, soil, food, housing, and construction materials have increased [7]. Despite this significant progress made by specialists in various fields of science and technology, people still suffer from problems related to pollution by radioactive materials, particularly pollution by radon gas Rn222, as atomic radiation and radioactive materials pose a significant threat to human life and living organisms, accompanied by serious health phenomena such

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as leukemia, skin, bone, epithelial cancers, breast cancer, thyroid cancer, and their direct impact on genetic traits and congenital malformations [8].

Cancer is a disease characterized by the abnormal growth of cells. This disease results from changes in the DNA of cells, leading to their abnormal proliferation and an increased ability to divide at an unusual rate [9]. Resulting in the formation of malignant tumors. Cancer is not a single disease but a group of many diseases. The human body consists of many types of cells; there are normal cells that grow and divide to form new cells when the body needs them to help maintain good health. However, due to some errors, certain cells continue to divide when there is no need for new cells. These unwanted new cells form a mass of tissue known as a tumor [10]. Tumors are classified into two types: benign tumors and malignant (cancerous) tumors. Malignant tumors have an unlimited potential for continuous cell growth, which can either spread locally, invade and destroy the surrounding normal tissue, or metastasize through the blood or lymphatic vessels to other parts of the body, forming new growing sites known as metastatic cancerous foci. These metastatic cancerous foci are the primary cause of the destruction of human organs [11].

Although they comprise less than 0.01% of body weight, the elements that are referred to as "heavy metals" are found in the human body [12] These elements include non-essential (toxic) elements like cadmium, lead, and nickel elements essential like zinc, iron, cobalt (B12), chromium (needed), and copper (cofactor). Waste streams from mining activities, metal plating plants, power plants, electronic device manufacturing facilities, and tanneries are usually where these materials can be found. Cadmium (Cd), lead (Pb), and arsenic (As) are all found in large quantities in the environment and can frequently be detected in the blood of the majority of people due to years of industrial use. Humans can be exposed to these compounds through dietary intake, occupational exposure, and environmental pollution [13]. Humans can be exposed to these compounds through food accumulation, occupational exposure, and environmental pollution. Trace element levels in the serum may be changed in patients with polycystic ovary syndrome. Environmentally significant levels of heavy metals are defined as a set of metallic elements having a density greater than 5 grams/cm³ and specific chemical and electrical characteristics[14]. They are also linked to minor variations in the levels of reproductive hormones [15]. Heavy element pollution can happen directly or indirectly in a variety of ways. In addition to contaminating the air, pollutants are also directly deposited on plants, soil, and water. "Humans are generally exposed to these metals through ingestion (drinking or eating) or inhalation (breathing) [14]. Given their connection to human existence and other living things, as well as their toxicity has increased death rates, these dangerous and important pollutants have drawn the attention of several researchers. Transportation and gas stations are just two of the many factors that contribute to the pervasive spread of dangerous pollution [16]. Trace components released by automobiles, trucks, buses, and motorbikes include fuel consumption, motor oil, tire and brake wear, road friction, and emission sources. Elements like Cd, Cr, Cu, Ni, Pb, Co, and Zn are considered components of emissions. According to reports, many of these substances are regarded as highly harmful and persistent pollutants threatening the ecosystem [17].

II. METHOD OF WORK

A. *Sample Collection*

A total of 36 samples were collected from breast, thyroid, and ovarian Thi-Qar of various ages from hospitals in Thi-Qar Governorate, with 12 samples for each organ, divided into six samples of cancerous tumors and six samples that are healthy (benign) used as a control unit (reference) for all three organs, based on histological analysis from the medical laboratories in the hospitals. The samples were fixed in a 10% formalin solution for 28 hours.

B. *Measurements*

Table: Evaluation of heavy elements in breast cancer women compared with the control group

Trace elements	Breast Patients	Breast Control	p. value
	Mean ± S. D		
Bi	0.020 ± 0.000	0.400 ± 0.020	<0.001**
Co	0.040 ± 0.000	0.060 ± 0.078	0.701
Cr	0.270 ± 0.060	0.030 ± 0.000	0.021*
Cu	0.903 ± 0.156	0.326 ± 0.055	0.015*
Mn	0.280 ± 0.020	0.070 ± 0.010	<0.001**
Mo	0.320 ± 0.036	0.040 ± 0.000	<0.001**
Ni	0.053 ± 0.011	0.100 ± 0.000	0.003**
Sr	2.646 ± 0.620	1.733 ± 0.110	0.066

The samples were washed with running water several times to remove formalin and dried to eliminate water, and approximately $0.1 < x < 0.3$ grams of the sample were taken and placed in a Falcon tube free from any contamination. Added 5 cm³ of HNO_3 to the tube and let it sit for 24 hours. Then placed the Falcon tube in a beaker filled with water and heated it using a laboratory heater until the sample completely dissolved in the acid. Once this occurs, filter the solution and diluted it with distilled water to a final volume of 15 ml. A calibration curve is prepared by preparing standard solutions with known concentrations of the elements to be measured (e.g., 1 ppb, 5 ppb, 10 ppb). These solutions are used to determine the sensitivity of the device for each element. Operated the device and let it stabilize (usually 30-60 minutes for heating). Introduced the standard solutions into the device to form the calibration curve. Checked the device's response and ensured that the values

match the standard concentrations. We introduced the samples one by one using the probe. Each sample is analyzed using high-temperature ionized plasma. The resulting ion for each element is measured by the mass detector.

The initial results read from the ICP-MS device must be multiplied by the dilution factor to obtain the final results.

III. RESULTS AND DISCUSSION

A. *Evaluation of Heavy Elements in Breast Cancer women compared with control group*

The current study recorded a significant decrease in the concentration of Bi, and Ni in patients in the control group, while the concentration of Cr, Cu, Mn, and Mo increased significantly in patients than in the control group. In addition, a non-significant difference was recorded in the concentration of Co and Cr at p-value<0.05, as in Table.

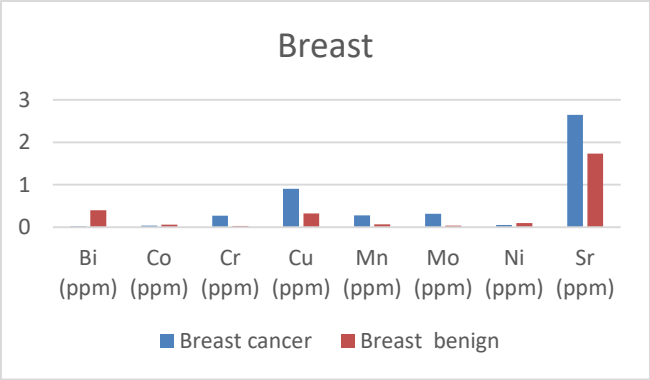

Fig. 1: Shows the concentration of heavy elements in cancerous and healthy breast tissues.

B. *Evaluation of Heavy Elements in Thyroid Cancer Women Compared with Control Group*

The current study recorded a significant decrease in the concentration of Bi and Cr in patients in the control group. In contrast, the concentration of other trace elements increased significantly in patients compared to the control group. In addition, a non-significant difference was recorded in the concentration of Mn, Ni, and Cr at p-value <0.05, as in Table (2).

Table2 : Evaluation of heavy elements in thyroid cancer women compared with the control group

Trace elements	Thyroid Patients	Thyroid Control	p. value
	Mean ± S. D		
Bi	0.496 ± 0.032	3.093 ± 0.032	<0.001**
Co	0.186 ± 0.020	0.123 ± 0.020	0.020*
Cr	0.123 ± 0.010	0.260 ± 0.055	0.027*
Cu	1.366 ± 0.064	0.683 ± 0.095	<0.001**
Mn	0.530 ± 0.065	0.513 ± 0.080	0.795
Mo	0.133 ± 0.020	0.073 ± 0.092	0.334
Ni	0.103 ± 0.015	0.113 ± 0.020	0.542
Sr	4.900 ± 0.695	5.963 ± 1.127	0.237

Statistical Note: Each p-value has two stars that indicate a high significance at p-value 0.01, the p-value has one star that indicates significance at 0.05, while the p-value without a star indicates a non-significant difference.

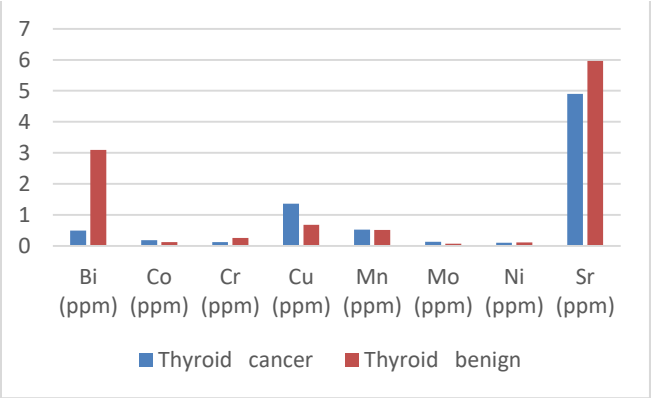

Fig. 2: The concentration of heavy metals in the tissues of cancerous and healthy thyroid glands.

C. *Evaluation of Trace Elements in Uterus Cancer Women Compared with Control Group-*

The current study recorded a significant decrease in the concentration of Bi in patients in the control group. In contrast, the concentration of other trace elements increased significantly in patients compared to the control group. In addition, a non-significant difference was recorded in the concentration of Co at p-value<0.05, as in Table (3).

Table3 : Evaluation of heavy elements in uterus cancer women compared with the control group

Trace elements	Uterus Patients	Uterus Control	p. value
	Mean ± S. D		
Bi	0.123 ± 0.023	0.416 ± 0.047	0.003**
Co	0.246 ± 0.055	0.173 ± 0.025	0.133
Cr	0.123 ± 0.015	0.030 ± 0.000	0.009**
Cu	1.563 ± 0.198	1.996 ± 0.175	0.015*
Mn	0.390 ± 0.052	0.133 ± 0.025	0.002**
Mo	0.040 ± 0.010	0.060 ± 0.000	0.026*
Ni	0.186 ± 0.040	0.010 ± 0.000	0.002**
Sr	6.536 ± 0.921	2.250 ± 0.150	0.001**

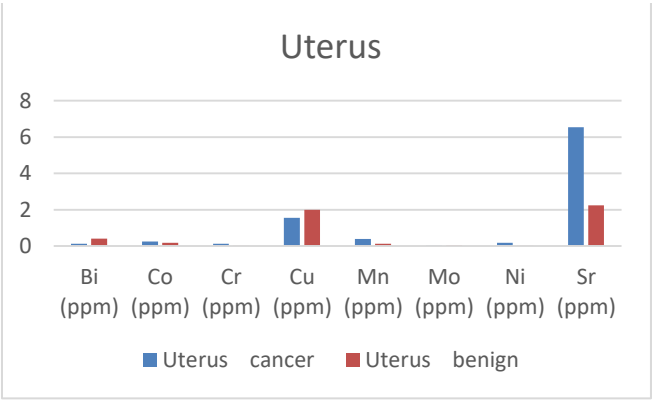

Fig. 3**:** The concentration of heavy elements in cancerous and healthy uterine tissues.

Heavy elements increase in cancerous tissues for several reasons. One reason is the change in cell membrane permeability, as cancer cells often alter their membranes to

enhance the absorption of heavy metals needed for rapid growth. This can lead to an increase and the accumulation of heavy metals in cancerous tissues [18]. Another reason is the high metabolic activity of cancer cells, which are characterized by elevated metabolic rates for energy production and cellular construction, such as DNA and protein replication [19]. Dysregulation of detoxification mechanisms can be another cause, as the liver and kidneys work to remove heavy metals from the body, and these mechanisms may change due to alterations in body functions, leading to heavy metal accumulation. The production of new blood vessels is also a reason for heavy metal accumulation in tissues, which tend to be functionally irregular. Cancer is often associated with changes in the local microbiome and microstructural alterations, which contribute to increased heavy elements [20]. Some heavy metals can interact directly with DNA or proteins, damaging genetic material and increasing mutation rates. The most significant reason is environmental sources and increased exposure to these elements, directly or indirectly, resulting in elevated heavy metals.

However, the deficiency of bismuth arose because the element bismuth has significant functions in diagnosing and treating cancer, as it has low toxicity. Bismuth is used in bismuth-based nanomaterials and in delivering drugs to cancerous tumors. A review of 50 research papers found that almost all bismuth compounds inhibit the growth and spread of breast, thyroid, and other tumors [21]. Therefore, there is a clear decrease in the bismuth element between diseased and healthy tissues, while almost all other elements increased in cancerous tumors compared to healthy tumors.

IV. CONCLUSIONS

After collecting samples and conducting measurements of heavy metals using the ICP-MS device for cancerous and healthy tissues of the breast, thyroid gland, and uterus, the study found an increase in the concentration of heavy elements in cancerous tissues compared to healthy tissues, except for bismuth, which decreased in cancerous breast tissues compared to healthy tissues. In thyroid tissues, the levels of bismuth and strontium

in tissues, while all other heavy elements increased in cancerous tissues. In uterine tissues, all heavy metals increased in cancerous tissues compared to healthy tissues, except for bismuth and copper, which decreased in the affected tissues compared to healthy tissues.

CONFLICT OF INTEREST

Authors declare that they have no conflict of interest.

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