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The Relationship between Lead and Iron Concentrations in Hair and Blood and Their Association with Head and Neck Cancer: A Human-Based Study

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Abstract

Head and neck cancer is both severe and multifaceted. For advanced world analysis, head and neck cancer is responsible to the second most cancer-related fatalities. This study assessed the presence of lead (Pb) and iron (Fe) in the scalp hair and blood of male head and neck cancer patients (n=175) aged 30-60, and 149 age-matched controls. The control subjects' hair and blood samples were also analyzed. Samples were prepared for atomic absorption spectrometry by being mixed with a solution of different acids and then digested in a microwave. The determination of Pb and Fe concentration was post acid digestion. This study found that compared to the age-matched controls, the patients with head and neck cancer had lower Fe levels and higher Pb levels in both hair and blood ($p < 0.001$). This study has the potential to improve the treatment of head and neck cancer patients.

Keywords: Concentrations, Cancer, Iron Concentrations, Lead Concentrations, Neck cancer

Introduction

This systematic review examined the biological biomarkers available for diagnosing head and neck cancers. The primary finding is that the combination of several biomarkers may optimize the accuracy of diagnostics. It necessitates more validation as well (Marakala, 2023). It is a prominent public health concern as the 6th most frequent cancer globally (Vigneswaran & Williams, 2014). Cancer can occur in the larynx, face, and the nasal cavity (Parkin, 2005; Wu et al., 2014). Changes to voice, laryngeal pain, and chronic laryngeal sore throat are common symptoms (Siegel et al., 2013). As the disease progresses, patients can develop laryngeal hemorrhaging, cancer of the larynx, and swelling in the face and neck due to the involvement of the cervical lymphatic system. HNC may cause the obstruction of respiration (Sturgis & Cinciripini, 2007). The leading cause of HNC is the combination of (smokeless) tobacco and ethanol. This human study analyzed the toxic and essential metals found in the blood serum, hair, and nails of patients with head and neck cancer (Hecht, 2003). Considerable variations in metal levels indicate that hair and blood may be useful disease detection biomarkers (Pan et al. 2025). The HNC rate attributed to Human Papillomavirus (HPV) is increasing (Sturgis & Cinciripini, 2007). Other causes include Epstein-Barr virus, Betel nut, and radiation, as well as other risks from employment (Oertel & Huhn, 2000). Pathologically, the majority of HNC, 90%, are diagnosed as squamous cell cancers. Diagnosis can include a multitude of techniques: imaging studies, blood draws, biopsies, and

the staging of neoplasms (Oertel & Huhn, 2000; Sturgis & Cinciripini, 2007). HNC patients are primarily concentrated in many of the developing nations and regions of South Asia and North Africa and in southern and central Europe (Rodu, 2004).

Iron is especially important for growing mammals, as it is crucial for the delivery of oxygen and DNA synthesis (Waalkes et al., 1992; Wadhwa et al., 2015). Normal mammals lack a way for the controlled excretion of iron. Thus, the metabolism of iron is controlled by the absorption of dietary iron in the duodenum. Three proteins are important for the transport and metabolism of iron: 1. DMT1, a protein that helps in the transport of dietary iron across the enterocyte apical membrane; 2. Transferrin receptor 1, a protein that helps in the transport of iron across the enterocyte basolateral membrane; 3. Ferroportin, a protein that helps in the export of iron from the enterocyte to the blood. Hepcidin is a hormone that helps control iron metabolism. It causes the internalization and degradation of Ferroportin, thus reducing the amount of iron that is exported into the blood. The levels of Hepcidin are controlled by the iron storage levels of the body, hypoxia, anaemia, and erythropoiesis (Nicolas et al., 2002; Ganz et al., 2008). The cause of anaemia of chronic disease and inflammation, is the opposite of the anemic condition that causes an increase of erythropoiesis, that is, hypoxia and iron deficiency. These metals can negatively impact homeostasis and chronic overconsumption can lead to chronic diseases such as diabetes and cardiovascular disease (Witte, et al, 2005).

Imbalances in homeostasis due to exposure to cadmium, arsenic, lead, and other toxic elements coupled with deficiency in key nutrients, can result in development of chronic diseases including cancer (Kishi and Yamaguchi, 1994; Witte et al, 2005). Cadmium, arsenic, and lead are metals that inflict damage to tissues due to their capacity to cause injury to tissues in the kidney and liver (Csalári & Szántai, 2002).

Disruption of homeostasis because of the ingestion of these trace and toxic elements can result in lack of an antioxidant and manifest in increased levels of blood sugar and greater risk of development of chronic diseases including diabetes and cardiovascular disease (Kobal et al, 2004; Kasprzak, 2002).

This section describes the data collection process, specifically the analysis of hair, serum, plasma, whole blood, and urine (Hartwig & Schwerdtle, 2002; Nemeth et al., 2004). Several studies have shown that hair can be used to detect toxic trace elements at higher concentrations than can be detected in blood and other body fluids (Ding et al., 2015; Hengstler et al., 2003; Joo et al., 2009; Park et al., 2009). Furthermore, the interactions and relationships of trace elements within the biological systems contribute significantly to the understanding of the cancer phenomenon (Denaro et al., 2016; Ding et al., 2015).

This study attempts to evaluate the levels of lead, an established toxic trace element, and Iron, an essential trace element, in hair and blood of head and neck cancer patients in the age group of 30 to 60 years (Spitz et al., 2004). As there have been no studies discussing lead and Iron, this study attempts to provide evidence and discuss the possible roles of lead and Iron with head and neck cancer. The role of environmental pollutants and trace elements in cancer has been well documented. However, there has been little focus on analyzing lead (Pb) and iron (Fe) concentrations in hair and blood of head and neck cancer patients. Most studies have

focused on blood and tissue studies (Jia et al., 2015; Lönnerdal, 2000). Compared to other studies, hair analysis, which is a non-invasive biomarker and shows exposure to heavy metals over a long period, is notably lacking. Additionally, there has been little focus on the combined status of lead and iron in cancer patients and healthy controls to study the progression of the disease (Stohs & Bagchi, 1995; Su et al., 2010). Most studies have been concentrated on the analysis of molecular biomarkers, genetic mutations, and lifestyle risk factors of cancer like the consumption of tobacco and alcohol (Li et al., 2012). However, there is insufficient evidence on the role of heavy metal burden and the imbalance of micronutrients in the head and neck cancer (Chiang et al., 2010). There is a scarcity of studies in developing countries, where the exposure of the population to environmental toxic metals may be high. Concentration of lead and iron in hair and blood studies of patients with head and neck cancer may provide a basis to study the diagnosis, assessment of risks and the treatment of head and neck cancer.

Research Objectives

1. The study investigates the connection between head and neck cancer and the concentrations of lead and iron in hair, blood, and how they correlate with the disease. The study specifically seeks to:
2. Evaluate the levels of lead (Pb) found in hair and blood of head and neck cancer patients compared to control subjects.
3. Evaluate the levels of iron (Fe) found in hair and blood of head and neck cancer patients compared to control subjects.

Research Questions

1. What are the concentrations of iron and lead in head and neck cancer patients compared to control subjects of the same age?
2. What is the correlation between increased levels of lead and the diagnosis of head and neck cancer?
3. What is the correlation between decreased levels of iron and the diagnosis of head and neck cancer?
4. Can hair and blood of head and neck cancer patients determine the presence of lead and iron?
5. Can hair and blood of head and neck cancer patients determine the presence of iron and toxic trace elements and lead to enhanced treatment and prevention techniques?

Materials and Methods

Recruitment: This study was granted ethical approval from the Ethical Committee of the University of Sindh, Jamshoro, Pakistan.

Study design and pretreatment: In one study carried out in 2018, 9,609 cancer cases were recorded. Out of all cases recorded, cases of head and neck cancers were 3.48%.

From the location of cancer, they have identified two sub-groups of head cancer (Sphenoid

and frontal sinuses) and neck cancer (Nasopharynx, Soft Palate, Tonsil, Throat, Maxillary Sinus, Nasal Cavity and Hard Palate). In this study, 23 head cancer patients from frontal Sinus and 32 head cancer patients from Sphenoid were studied. In neck cancer 15 patients from Nasopharynx, 19 from Soft Palate, 21 from Tonsils, 16 from Throat, 17 from Maxillary Sinus, 15 from Nasal Cavity and 16 from Hard Palate were studied. The total population under this analysis comprised 174 head and neck cancer patients.

Patient selection involved individuals with biopsy-confirmed, untreated head and neck cancer. Treatment naïve was defined as not undergoing any form of treatment, including surgery, chemotherapy, or radiation. Patients also had to refrain from using any form of mineral supplements in the last three months. The average age and standard deviation (SD) of the head cancer patients (Sphenoid sinus (44.5± 3.52); Frontal sinus (46.3± 5.32)) and the neck cancer patients (Nasopharynx (46.7± 5.15); Soft palate (48.3± 4.55); tonsil (43.5± 2.69); Throat (45.0± 3.65); Maxillary sinus (48.3± 1.95); Nasal cavity (44.6± 3.69); Hard Palate (47.5± 1.43)) were also given.

Healthy controls were mainly the patients' relatives. All male controls were 30 to 60 years, mean age 46.8 (SD=8.05). The selection criteria for the 258 control subjects (149 males, 109 females) were the same age range, no cancer, no mineral supplements, same number of subjects, same socioeconomic status and dietary habits. The controls underwent a routine medical examination before biological sampling.

Subjects had to list all the jobs they had done in the last 15 years that they had done for more than a year. All subjects were building and workshop laborers (automobile, battery recycling, etc.).

Exclusion criteria for both patients and controls included alcohol consumption and use of tobacco for patients, while participants and controls should not have used smokeless tobacco. Biochemical tests for patients and controls are included in Table 2. For this study, histological distribution is not included.

Participants were required to have malignant head and neck lesions with a confirmed biopsy and had to have not used any form of supplements three months prior to inclusion in the study.

One hundred forty-nine controls were selected based on no malignant lesions, no use of minerals supplements, and similar age, dietary patterns, and social class. Controls were required to pass a primary medical check-up prior to a biological sampling. Smoking and alcohol consumption were prohibited for both groups. Biochemical tests are included in Table 1. For this study, histological distribution is not included.

Table 1 ***Clinical and biochemical characteristics of head and neck cancer patients and referents according to subtypes, gender, age group (30–60 years), and normal range.***

Biochemical tests	Referents (149)	Head cancer		Neck cancer						
		Sphenoid Sinus (32)	Frontal Sinus (23)	Nasopharynx (15)	Soft Palate (19)	Tonsil (21)	Throat (16)	Maxillary Sinus (17)	Nasal Cavity (15)	Hard Palate (16)
Male										
Hb/(mg)/dl) 13-16	15.2±0.32	9.55±0.66	7.62±0.52	9.28±1.01	7.38±0.47	8.75±0.57	6.39±0.50	7.83±0.64	6.41±0.52	7.89±0.79
p- value		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
RBC(x^{10} 12 /L) 4.6.6	6.2±0.2	2.48±0.29	1.82±0.20	2.18±0.38	1.80±0.27	1.89±0.11	3.03±0.29	2.27±0.18	3.07±0.35	2.35±0.24
p- value		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
PVC (%) 40-54	52.3±1.3	26.3±0.72	16.3±0.40	24.3±1.81	21.6±1.21	16.7±0.56	17.5±0.61	25.7±0.67	18.6±0.72	26.8±0.67
p- value		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
MCH (pg) 27-32	30.3±0.5	48.5±1.69	52.6±1.28	48.6±3.61	48.2±1.84	47.8±1.21	52.6±3.09	52.8±3.58	53.7±3.11	54.9±3.64
p- value		0.005	0.004	0.005	0.005	0.005	0.004	0.004	0.004	0.003
MCHC (g/dl) 32-36	35.6±0.7	18.7±0.81	16.7±0.61	15.6±0.67	16.8±0.51	16.1±0.26	18.3±0.48	14.7±0.39	19.7±0.59	15.6±0.44
p- value		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
MVC(fl) 76-94	93.2±0.3	189±0.93	180±8.39	167±7.28	208±8.56	227±9.82	174±10.4	210±9.13	189±10.9	213±9.17
p- value		0.002	0.002	0.003	0.002	0.002	0.003	0.003	0.002	0.003
Serum Fe(ug/100 ml) 60-160	147±9.4	264±7.61	301±7.50	279±9.18	327±7.32	248±8.25	311±5.72	320±4.58	318±5.89	325±4.69
p- value		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
TIBC (ug/100 ml) 280-400	362±35.2	572±34.7	577±27.3	578±15.9	603±20.2	669±16.3	590±24.1	617±30.1	593±25.3	620±30.5
p- value		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

Blood Sample Collection: The data is taken by a male, registered nurse. He used a 5ml sterile, single-use syringe. Venipuncture sites were cleaned with, sealed, plastic, chemical-free, alcohol swabs. Serum and blood samples were taken per the study protocol cited in the study.

Scalp Hair Sample Collection: The data is collected from those who are showed for industrial development and growth.

Apparatus: The tool was used to trace and measure some of the elements that are toxic. Instrument parameters and settings for the experiment are found in Table-2. The device was used to collect and compute the signals for the Absorbance. A microwave oven (PMO23) Pel, with an approximate 900W of power, was used to digest materials.

Table 2: Measurement conditions for atomic absorption spectrophotometer 700

Parameters	Lead	Iron	
Lamp current (mA)	8.0	7.5	
Wave length (nm)	283.3	248.5	
Slit-width (nm)	0.7	0.2	
Drying temp (°C/ramp/hold(s)	140/15/5	Burner height (mm)	7.5
Ashing temp (°C/ramp/hold(s)	700/10/20	Oxidant (Air) L/min	17
Atomization temp (°C)/ramp/hold(s)	1800/0/5.0	Fuel (Acetylene) L/min	2
Cleaning temp (°C)/ramp/hold(s)	2600/1/3		
Chemical modifier	15 µg $Mg(NO_3)_2$		

Reagents and glassware

The standard and the prepared diluted solutions were stored for further experiments at 4-6 o C. Plastic containers and equipment were treated with Millipore water and, after being soaked for 24 hr in 2 mol/L HNO3, thoroughly washed and rinsed with Millipore water.

Microwave-assisted Acid Digestion Method (MWDM)

Biological samples for microwave digestion were split into equal portions. The remaining biological samples and the CRMs were included in the remaining six replicate samples. Each biological sample (0.5 ml) is used with 1 ml of the freshly prepared H2O2-HNO3 (1:2, v/v) solution. Sample digestion was achieved by applying microwave energy for 2-3 minutes at the maximum power (950 W). Digested set then allowed to cool to room temperature and were subsequently diluted to 10 ml with Mili-Q water. These samples were analyzed by AAS for the determination of the trace elements. Blank samples were prepared in a similar manner as described above. For a more sensitive procedure, the CRMs of blood and scalp hair were used.

Statistical Analysis

Excel X state and Minitab were the software used for the statistical analyses. As shown in Table-3, the highest validity of the method was with a recovery of the examined elements in the range of 97.5-99.2 % with a relative standard deviation (RSD) of 2 % and a total digestion time of less than 5 minutes with an allowable variation of 1-2 % from the mean values of the examined elements.

Results

Table 3: Elemental concentration in certified biological samples (CRM) by microwave digestion method (MWD)

Element	Certified values	MDM	t value^	% Recovery
CRM of human hair (µg/ g)				
Fe	**580±10**	**575±21.9 (3.81)**	**0.0054**	**99.2**
Pb	**33+1.2**	**32.2±2.2 (6.8)**	**0.0095**	**97.5**
CRM of whole blood (µg /L)				
Fe	**14.2±3.24**	**14.07± 1.03 (7.32)**	**0.035**	**99.1**
Pb	**105.00/±24**	**105.67±/8.2 (7.76)**	**0.011**	**99.2**

Table 4: Iron and Lead concentration in the blood and scalp hair of normal and Head and Neck Cancer patients

	Refe rents	Head Cancer		Neck Cancer						
		Sphenoid sinus	Frontal sinus	Nasopharynx	Soft Palate	tonsil	Throat	Maxillary Sinus	Nasal Cavity	Hard Palate
Iron										
Scalp hairs (µg/g)										
	29.6 ±2.8 5	15.3±1. 90	16.5±0. 80	18.6±1.02	22.4±1.4	19.2±0 .82	22.3±0. 49	19.7±2.72	20.5±1.7 9	21.2±2.80
p-value		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	Blood (mg/l)									
	670± 40.5	290±62. 3	355±45. 5	272±39.5	352±40. 9	295±2 8.5	287±33. 9	269±42.7	295±30. 4	245±22.9
p-value		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	Lead									
	Scalp hairs (µg/g)									
	6.67 ±0.5 1	14.5±1. 20	15.0±1. 44	13.5±0.80	14.8±0.9 5	13.9±0 .90	15.3±0. 90	15.2±1.25	14.9±0.4 7	16.5±0.90
p-value		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

	Blood (µg/l)									
	175±19.5	350±40.5	364±34.5	330±250	435±40.7	370±25.0	385±40.2	409±27.2	402±40.2	445±42.2
p-value		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

	Referents	**Head Cancer**		**Neck Cancer**						
		Sphenoid sinus	**Frontal sinus**	**Nasopharynx**	**Soft palate**	**tonsil**	**Throat**	**Maxillary Sinus**	**Nasal Cavity**	**Hard Palate**
Iron										
Scalp hairs (µg/g)										
	29.6±2.85	15.3±1.90	16.5±0.80	18.6±1.02	22.4±1.4	19.2±0.82	22.3±0.49	19.7±2.72	20.5±1.79	21.2±2.80
p-value		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	Blood (mg/l)									
	670±40.5	290±62.3	355±45.5	272±39.5	352±40.9	295±28.5	287±33.9	269±42.7	295±30.4	245±22.9
p-value		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	Lead									
	Scalp hairs (µg/g)									
	6.67±0.51	14.5±1.20	15.0±1.44	13.5±0.80	14.8±0.95	13.9±0.90	15.3±0.90	15.2±1.25	14.9±0.47	16.5±0.90
p-value		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	Blood (µg/l)									
	175±19.5	350±40.5	364±34.5	330±250	435±40.7	370±25.0	385±40.2	409±27.2	402±40.2	445±42.2
p-value		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

The data of given sample bracket of 30 to 60 years was subjected to an unpaired student t-test. The difference in the concentration of essential and non-essential trace elements was highly significant ($p = 0.001$) since the calculated t was greater than the t of 95% level of confidence.

Discussion and Conclusion

Discussion

According to Denaro et al. (2016), HNC is ranked among the top cancer-related public health concerns in developed countries. Chuang et al. (2012) report that head and neck cancer is likely to be associated with the Human Papilloma Virus (HPV) and the abuse of alcohol, smoking, and drug use.

All mammals need iron because it aids in the production of hemoglobin and DNA and boosts energy metabolism. Iron catalyzes oxygen sensing proteins and detoxification, P450 enzymes, catalase, and defense strategies against Reactive Oxygen Species (ROS), and also plays a role in the electron transport chain and the immune system (myeloperoxidase). Iron (Fe) exists in its ionic forms, the reduced (FeII) and oxidized (FeIII) states, both of which are pro-oxidant and cause the production of numerous other ROS, along with Reactive Oxygen Species (ROS). The combination of Ferric and ROS causes the iron overload syndromes and cancer. Several studies have shown the association between breast, colorectal, gastric, pancreatic, head and neck cancer and the disruption of iron homeostasis (Torti & Torti, 2013; Zhang & Zhang, 2015). Most of the cancer patients that have been studied are reported to be iron deficient (anemic) (Muñoz et al., 2014). The anemia and cancer correlate with the dysfunction of the immune system and metabolic and dietary factors, and underscores the significance of iron homeostasis at the systemic and cellular levels. For more references regarding iron homeostasis, please see (Bogdan et al., 2016; Manz et al., 2016; Muñoz et al., 2014; Wang & Pantopoulos, 2011).

The pro-oxidant activity of iron and its capacity to inflict oxidative damage to DNA and initiate carcinogenesis have prompted investigations into iron and its association with many types of cancers (Bystrom & Rivella, 2015; Ghaffari, 2008). Interesingly, iron can also be considered a cancer cell growth factor due to the high demand for iron by cancer cells and by tumors themselves. One pathology that is generally associated with cancer is related to the ability of cancer cells to acquire nutrients to the highest possible level and through the highest possible means (Pavlova & Thompson, 2016).

Numerous carcinogenic risk factors for these cancers can be identified. For example, Wozniak et al. (2016) mention that while working, exposure to wood dust may be compounded with negative oral health, a passive smoking habit, low vegetable intake, and a family history of cancer. Binazzi et al. (2015) and Verougstraete et al. (2003) explain the exposure of these harmful metals. Chen et al. (2002) have mentioned among other heavier metals, that Nickel (Ni) in combination with others can participate in a dismutation reaction and will produce superoxide, and stimulate the formation of hydrogen peroxide. These studies have shown that during the poisoning of a heavy metal, the crosslink of protein sulfhydryl groups can be applied to enhance the electron transfer and the increase of reactive oxygen species. It has also been reported that the combination of areca and tobacco nuts can produce a significant amount of free hydroxyl radicals and lead to oral cavity DNA damage and oral cancer. Chen et al. (2002), Kazi et al. (2010), Khlifi et al. (2013), and Yoshida & Tuder (2007).

Lead is especially potent as a neurotoxin (Caffo et al., 2014; Dolecek et al., 2012; Liu et al., 2013; Vargo, 2017). Exposure causes damage to many structures (e.g., the prefrontal cortex, the cerebellum, and the hippocampus) and may cause new nervous system disorders. Prolonged lead exposure may cause the development of malignant brain tumors (Caffo et al., 2014). Brain tumors are a type of central nervous system (CNS) tumor that is almost exclusively restricted to the brain (Dolecek et al., 2012). The presence of a brain tumor can cause a disruption of normal function (Vargo, 2017). Despite tumors of the brain representing 1.4% of all tumors, they are a type of tumor that is relatively common (Vargo, 2017).

Although research has been done to study the relationships between other heavy metals and brain tumors, the only study that explored lead and brain tumors concluded that there are many reasons to believe that lead could relate to the formation of brain tumors (Caffo et al., 2014). Since the brain contains the highest concentration of lead in the body (White et al., 2007), and lead is the second most toxic element to humans after mercury, this justifies a reason to study the possibility of a relationship (and hopefully not) between lead and brain tumors. Lead poisoning is said to occur when the blood lead concentration is at 100 μg/L or above (Centers for Disease Control and Prevention, 2017).

Increased attention has been brought to how heavy metals affect not only health but also principal bioelements. This area of research includes not only metals such as Cd, Pb, and Hg, but also the biometals that include zinc, copper, iron, selenium and calcium. Cadmium and mercury, and other toxic metals disrupt metalloenzymes, and biometals such as zinc, copper, selenium and calcium can substitute these metallo cofactors. Considering also the diminishing levels of zinc and iron in the population and selenium that can be attributed to poor diet, it is important to understand the role of Cd, Pb, Cu, Ni and Fe which have been reported in studies as pollutants of concerns due to increasing exposure of toxic metals in the population.

Most of the study participants came from low SES and were unaware of their poor health. Evidence from their study indicated that the health problems reported were due to a combination of insufficient social engagement, poor and imbalanced nutrition, disorganized health screenings, delays in diagnosis, poor health care, and a lack of essential vitamins and minerals, especially iron and zinc. The study participants health was poor, the situation was even worse for patients with head and neck cancer. Among the cancer patients, particularly the patients with oral cancer, one of the main complaints from them was malnutrition.

A meta-analysis found that oral and laryngeal cancer patients had fruit and vegetable-rich diets and that higher fruit and vegetable intake were associated with lower risks of developing head and neck cancers (Li, 2012; Lucenteforte, 2009).

Conclusion

The study demonstrates that there are substantial variations regarding bound diseased referents and the essential trace element iron (Fe) and the toxic element lead (Pb) in samples from head and neck cancer patients of both genders. The data illustrates how the toxic (carcinogenic) element Pb is countered by the anti-carcinogenic element of Fe (among other elements). The findings indicate that head and neck cancer patients had lower levels of Fe in

their biological samples. The study states that research on the biochemical markers for head and neck cancer should be prioritized because such markers would allow for the better identification of the stage of the cancer. The study also argues that the increasing head and neck cancer mortality is also due to the declining socioeconomic status (increased poverty), which is characterized by unbalanced and insufficient diets, absence of timely and adequate medical interventions, and infrequent medical examinations and check-ups due to the inability to afford cancer treatment. Further research is needed on borderline cancers to investigate the latent characteristics and carcinogenic mechanisms.

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