Health Impacts of Toxic and Essential Trace Elements on Asthma Patients in Basrah, Iraq using ICP Technique

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Abstract

This study examines the role of toxic metals—lead (Pb), nickel (Ni), chromium (Cr), cobalt (Co), and cadmium (Cd)—as potential contributors to respiratory dysfunction in asthma patients of Basra city in Iraq. Additionally, the physiological roles of zinc (Zn), magnesium (Mg), iron (Fe), copper (Cu), and selenium (Se) are explored in the context of asthma and overall respiratory health. Study sample comprises of fifty asthmatic patients (30 females and 20 males), aged 20–60 years. They were matched with twenty healthy individuals as control ranging in age from 20 to 60 years (10 females and 10 males). Concentrations of heavy metals and essential elements were analyzed using the inductively coupled plasma (ICP) technique. The analysis revealed that the concentrations of lead (Pb), nickel (Ni), cobalt (Co), cadmium (Cd) and chromium (Cr), in the blood samples of patients with asthma were significantly higher ($p < 0.01$) than in the control group. The concentrations of all measured metals showed a relative correlation with one another and with the severity of asthma. Levels of the essential elements, zinc, magnesium and selenium showed a significant reduction ($P< 0.01$) in asthma patients, while copper iron and showed a significant elevation. These findings may reflect a potential role of nutrient imbalances in the pathophysiology or severity of asthma. As a conclusion, regular monitoring and managing metal exposure and public health assessment are crucial to mitigate environmental risk factors for asthmatic populations in Basra city.

Keyword ;trace metals ,asthma patient ,Basrah province, ICP

Introduction

Asthma is a chronic heterogeneous disease of the lower airways. It represents common disorder affecting both children and adult across the world. Millions of people suffer from asthma annually causing a heavy healthy and economic burden globally (Bousquet and Khaltaev 2007). Environmental exposures, including pollutants and metals, are increasingly recognized as significant factors that modulate asthma severity. Impact mechanisms of heavy metals can be summarized in three categories (Sveum et al., 2012):

1. Oxidative stress: Heavy metals generate free radicals, exacerbating inflammation in airways.

2. Immune modulation: Metals may alter cytokine production and immune cell activity, increasing allergic response.
3. Epigenetic changes: Long-term exposure may modify gene expression relevant to asthma.

Basra has undergone significant environmental transformations, particularly concerning heavy metal contamination as a result of human activities including oil extraction, processing, and transportation (Al-Rubaye & Al-Yassen, 2023; Albadr & Albadr, 2024). Heavy metals are known environmental pollutants with potential to aggravate respiratory conditions. Exposure to these metals has been increased by industrial and anthropogenic activities and modern industrialization. Emerging evidence suggests a link between heavy metal exposure and asthma severity, particularly in urban and industrial settings. The heavy metals enter the body from different ways including drinking water, air, food, or occasionally dermal exposure. Following absorption, heavy metals are retained, and they accumulate in the human body. Chen et al. (2019) stated that bioaccumulation of toxic metals leads to a diversity of toxic effects on a variety of body tissues and organs. The prevalence of asthma has been increasing in recent years. This increase is closely related with inhaling airborne metallic particulates or ingesting metals through food and drinking water as pointed out by Landrigan et al. (1998) and Esra et al. (2019).

Major trace elements such as zinc and copper are part of the structure of antioxidant enzymes like super oxide dismutase. These enzymes act as antioxidant defense and are able to regulate the host immune system, and alter viral genome. As stated by Bhaskar et al. (2019), changes in Zinc and copper level decrease the efficiency of this antioxidant system and this leads to hyper-reactivity and inflammation in the respiratory tract. Poor antioxidants diets may leave the person vulnerable to reactive oxygen species. Major trace elements have immunomodulator effects and thus have an important effect on the course of respiratory tract infections (Riedl and Nel, 2008; Esra et al., 2019). Essential trace metals such as copper and zinc act as co-factor for a number of enzymes and if they are in natural level they prevent effects of antioxidant materials and inflammation (Bilan et al., 2014). According to Shazia et al. (2012) and Bhaskar et al. (2019), deficiency of trace elements may be associated with production of free radicals with subsequent tissue damage and infectious diseases are often concomitantly.

It has been hypothesized recently that essential elements may play important roles in asthma genesis since they take part in oxidative stress reactions as cofactors of antioxidant enzymes (Malapati et al., 2020). Asthma may create disturbances in the homeostasis of trace minerals. Disturbances in plasma trace minerals' homeostasis can influence the states of oxidative stress, inflammation and immune responses. Abnormalities in the homeostasis of one mineral affect the distribution patterns of other minerals, which is one possible reason for conflicting results. In addition, possible correlations between these minerals with oxidative stress, inflammation, immune system response and lung function in asthmatic patients (Mahdi et al., 2021). Understanding the differential effects of harmful metals and essential trace elements is critical for improving asthma management and prevention strategies (Luo et al., 2020).

The present study aims to assess the levels of some heavy metals and trace elements concentrations in sera of patients with allergic asthma attending Center for Allergy and Asthma in Basra, Iraq. It aims to investigate the relationship between metal exposure and asthma severity in a cohort of people residing in southern Iraq, specifically in Basra, which experiences elevated levels of trace metals. Understanding the health impacts of trace metals on asthmatic children is crucial for comprehending the health consequences of persistent military conflicts in low and middle-income countries, as well as for formulating more effective health protection and mitigation strategies for these communities. It aims also to compare metal concentrations between asthmatic and non-asthmatic control groups to investigate correlations between heavy metal exposure and asthma severity. The second goal was to show whether these associations would be used in the follow-up and treatment of asthma. It is important to identify the additional risk factors of asthma because of the developing more effective treatment strategies can be effective in asthma control.

Materials and Methods

Study Sample

Study sample comprises of fifty asthmatic patients (30 females and 20 males), aged 20–60 years. They were randomly selected from the Consultation Center for Allergy and Asthma in Basra Governorate during the year 2024. They were registered at the center as asthmatic patients. They were matched with twenty healthy individuals as control ranging in age from 20 to 60 years (10 females and 10 males).

Analytical Procedure

Blood samples were taken from all study subjects (patients and control) and collected into 5.5-mL acid-washed tubes using a 21-gauge needle in an effort to minimize hemolysis. Tubes were centrifuged at 3400 g for 10 minutes within 3 hours of collection. Serum was then removed, placed into 1.5 mL acid-washed tubes, and frozen at −20 °C until analysis. Frozen samples were thawed at room temperature, and a 100 µL aliquot of each sample was treated with 1.5 ml of a mixed acid solution overnight at room temperature. Samples were then diluted to a final volume of 10 mL with deionized water, filtered through a 0.45 mm cellulose acetate filter, and analyzed by inductively coupled plasma (ICP) to determine the concentrations of heavy metals and essential elements as recommended by Stojsavljević et al. (2018). As for data analysis, statistical comparisons and correlations were carried out.

Results

Serum Heavy metals Levels

Asthma Patients Group

Data of Table (1) showed details of the serum concentrations of some heavy metals of Asthma patients from Basra city. Wide variations in the lead levels were seen as it varied between 5.3

µg/dL to 14.7 µg/dL. Narrow variations, however, was seen in nickel concentrations which ranged from 0.61 µg/dL to 1.98 µg/dL and cobalt which varied between 1.01 µg/dL 2.94 µg/dL The highest value of cadmium of Asthma patients was 2.97 µg/dL and the lowest 1.03 µg/dL. As foe chromium, values of serum concentrations ranged between 1.51 µg/dL – 3.98 µg/dL.

Table 1: Blood Levels of Heavy Metals in Asthmatic Patients (n=50)

Patient ID	Lead (Pb) µg/dL	Nickel (Ni) µg/L	Cobalt (Co) µg/L	Cadmium (Cd) µg/L	Chromium (Cr) µg/L
P1	8.75	1.96	1.06	2.82	3.11
P2	14.51	1.69	2.27	1.48	1.71
P3	12.32	1.92	1.63	1.29	1.9
P4	10.99	1.85	2.02	1.98	3.75
P5	6.56	1.44	2.82	2.97	3.02
P6	6.56	1.89	1.5	1.48	1.52
P7	5.58	0.72	1.82	2.34	1.75
P8	13.66	0.87	2.51	2.52	3.16
P9	11.01	0.66	1.46	1.48	1.51
P10	12.08	1.06	1.15	2.46	1.9
P11	5.21	1.14	1.58	1.74	2.87
P12	14.7	0.98	1.32	2.26	3.23
P13	13.32	1.76	2.86	2.27	3.13
P14	7.12	1.1	2.62	2.07	2.06
P15	6.82	0.99	2.27	1.18	3.28
P16	6.83	1.36	2.74	2.67	2.09
P17	8.04	0.8	2.61	1.64	2.31
P18	10.25	1.72	1.37	1.37	3.37
P19	9.32	0.7	2.79	1.08	3.12
P20	7.91	1.98	2.08	2.18	3.62
P21	11.12	1.68	2.61	2.36	3.14
P22	6.39	0.88	2.79	1.03	2.92
P23	7.92	0.61	1.64	2.02	1.73

P24	8.66	1.74	1.22	1.45	2.42
P25	9.56	1.59	1.46	2.29	2.16
P26	12.85	1.62	1.85	1.35	2.11
P27	7	1.68	2.64	2.38	3.93
P28	10.14	0.7	2.72	1.77	2.48
P29	10.92	1.1	1.01	2.87	3.73
P30	5.46	0.76	2.02	1.28	3.08
P31	11.08	1.81	1.83	1.68	3.49
P32	6.71	1.47	1.44	1.23	2.76
P33	5.65	1.06	1.24	2.85	2.94
P34	14.49	0.69	1.68	2.75	2.73
P35	14.66	1.04	2.89	1.52	1.99
P36	13.08	1.06	1.65	2.32	3.31
P37	8.05	1.62	2.04	2.63	2.2
P38	5.98	1.49	2.41	2.11	1.56
P39	11.84	1.84	1.73	2.06	3.11
P40	9.4	1.26	2.94	1.48	1.94
P41	6.22	0.77	2.92	1.19	3.85
P42	9.95	1.6	1.5	2.79	3.88
P43	5.34	1.67	1.99	2.8	3.79
P44	14.09	1.39	1.6	2.27	2.43
P45	7.59	1.68	1.57	1.68	1.54
P46	11.63	1.29	1.07	1.7	3.82
P47	8.12	1.33	2.22	2.45	2.57
P48	10.2	1.2	2.01	2.79	3.92
P49	10.47	0.64	1.1	2.77	3.91
P50	6.85	0.75	1.56	2.56	3.63

The detailed variations of the serum concentrations of each heavy metal in Asthma patients are shown in figures 1,2,3,4 and 5 for Pb, Ni, Co, Cd and Cr respectively. For Pb concentrations > 10 µg/dL occurred in half of the patients (25 patients). For Ni about 34 patients have a concentration > 1.0

µg/dL. Cobalt showed values > 2 µg/dL in 24 patients; others (26 patients) have lower values than 2 µg/dL. The same can be said for Cd in which 28 patients recorded > 2 µg/dL. Chromium concentrations showed 39 patients of more than 2.0 µg/dL and 11 patients of less than 2.0 µg/dL.

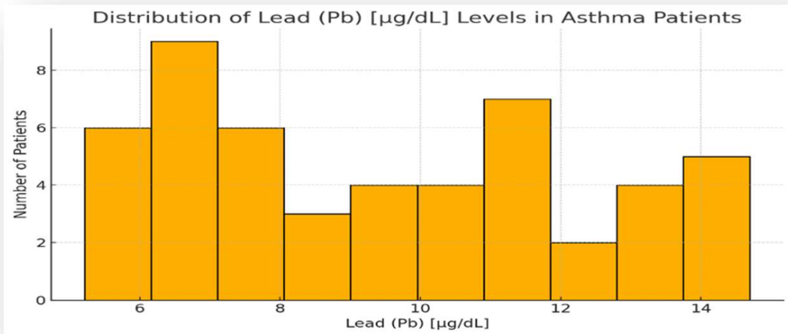

Figure (1): Distribution of Lead (Pb) [µg/dL] Levels in Asthma Patients

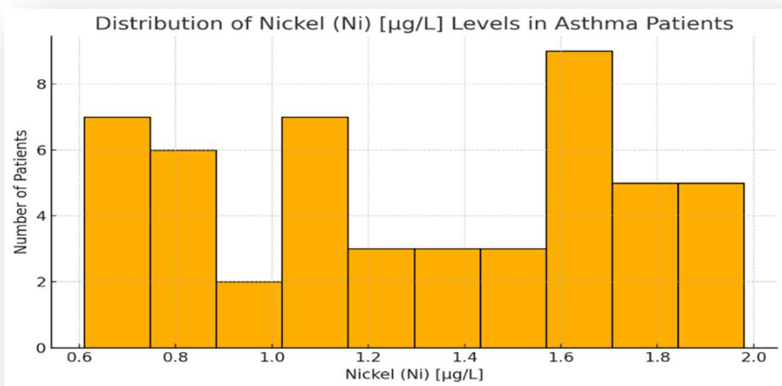

Figure (2): Distribution of Nickel (Ni) [µg/L] Levels in Asthma Patients

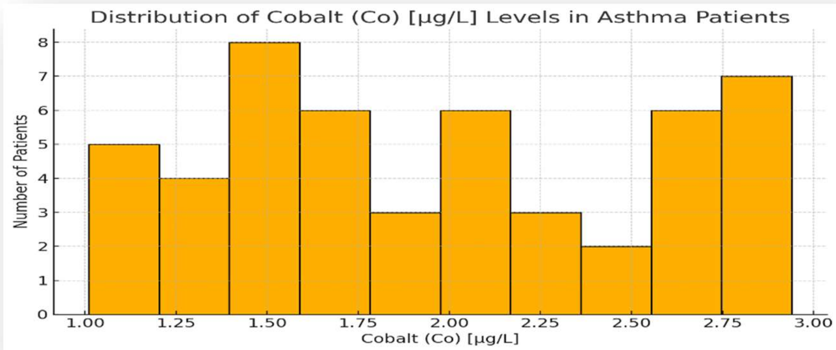

Figure (3): Distribution of Cobalt (Co) [μg/L] Levels in Asthma Patients

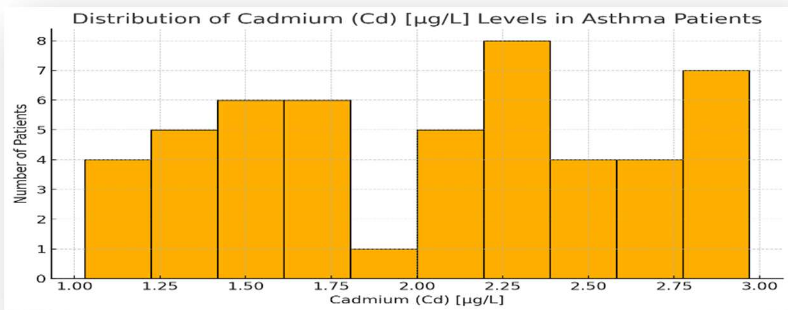

Figure (4): Distribution of Cadmium (Cd) [μg/L] Levels in Asthma Patients

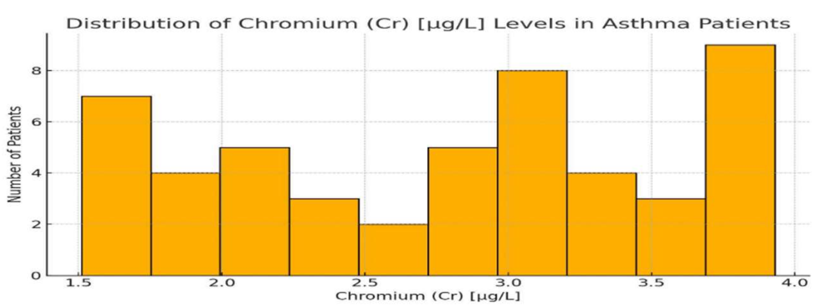

Figure (5): Distribution of Chromium (Cr) [μg/L] Levels in Asthma Patients

Control Group

Detailed serum concentrations of the same heavy metals for the control group are shown in Table 2. It is obvious that all levels in the control group are lower than those recorded for Asthma patients. Lead ranged between 0.70 – 4.6 μg/dL, Nickel between 0.05 – 0.45 μg/dL, Cobalt between 0.03 – 0.98 μg/dL, Cadmium between 0.15 – 0.95.

Table 2: Blood levels of heavy metals in healthy individuals (control group, n=20)

Control ID	Lead (Pb) µg/dL	Nickel (Ni) µg/L	Cobalt (Co) µg/L	Cadmium (Cd) µg/L	Chromium (Cr) µg/L
C1	1.472	0.405	0.031	0.439	0.534
C2	1.925	0.405	0.037	0.078	1.137
C3	4.256	0.434	0.823	0.025	0.022
C4	1.585	0.457	0.36	0.963	0.174
C5	0.847	0.256	0.127	0.836	0.069
C6	2.784	0.251	0.522	0.696	0.061
C7	4.681	0.399	0.77	0.409	1.283
C8	3.48	0.325	0.216	0.173	1.055
C9	2.85	0.351	0.623	0.156	0.711
C10	0.486	0.398	0.085	0.25	0.147
C11	3.075	0.445	0.052	0.549	0.737
C12	4.95	0.169	0.531	0.715	0.71
C13	0.7	0.188	0.541	0.66	0.26
C14	2.592	0.047	0.637	0.28	0.651
C15	4.387	0.289	0.726	0.955	0.598
C16	3.704	0.018	0.976	0.738	0.924
C17	3.485	0.233	0.516	0.554	0.953
C18	3.512	0.271	0.323	0.612	0.068
C19	1.797	0.143	0.795	0.42	0.562
C20	1.468	0.295	0.271	0.248	0.939

Comparisons of Patients and Healthy Groups

Comparison of five heavy metals levels in the sera of fifty asthmatic patients and twenty healthy control group along with the statistical t-test analysis of differences are shown in Table 3. Statistically significant differences ($P < 0.01$) were observed in all heavy metals between asthmatic patients and the healthy individuals.

Table 3: Comparison and statistical analysis of heavy metals of asthmatic patients and controls

This analysis revealed that the concentrations of lead (Pb), nickel (Ni), cobalt (Co), cadmium (Cd) and chromium (Cr), in the blood samples of patients with asthma were significantly higher ($p < 0.01$) than in the control group. Among these, chromium exhibited the most substantial difference, being approximately 381 % higher in the asthma patients respectively, followed by nickel, cobalt and cadmium which revealed 348 % and 335 % and 314 % higher values. While the concentrations of lead also significantly greater ($p < 0.01$) in the asthma group, but was lower than those of other

Metal (µg/dL)	Mean ± S.E Controls	Mean ± S.E Patients	Asthma Change	P-Value
Lead (Pb)	2.70 ± 0.98	9.46 ± 3.45	250 %	< 0.01
Nickel (Ni)	0.29 ± 0.03	1.30 ± 0.76	348 %	< 0.01
Cobalt (Co)	0.45 ± 0.07	1.96 ± 0.53	335 %	< 0.01
Cadmium (Cd)	0.49 ± 0.03	2.03 ± 0.65	314 %	< 0.01
Chromium (Cr)	0.58 ± 0.08	2.79 ± 0.28	381 %	< 0.01

metals (250 %). Furthermore, the concentrations of all measured metals showed a relative correlation with one another and with the severity of asthma.

Essential Elements

Asthma Patients Group

Data concerning blood concentrations of five essential elements in the healthy control group are shown in Table (4). Magnesium was the major element ranging from 1.54 to 1.99 mg/dL followed by Iron (61-169 µg/dL) and Copper (101-149 µg/dL). Zinc and Selenium being the lowest levels ranging between 60.8 -89.7 µg/dL and 42 – 96 µg/dL respectively.

Table 4: Blood Concentrations of essential elements in asthmatic patients (n = 50)

Patient ID	Zinc (Zn) µg/dL	Magnesium (Mg) mg/dL	Iron (Fe) µg/dL	Copper (Cu) µg/dL	Selenium (Se) µg/L
P1	75.09	1.55	145.49	134.91	71.21
P2	85.69	1.95	121.42	126.8	91.13
P3	79.76	1.75	106.66	115.48	73.11
P4	64.89	1.91	159.7	140.69	73.66
P5	62.12	1.66	72.23	134.24	92.6
P6	79.27	1.95	114.19	108.13	64.21
P7	60.8	1.69	61.25	145.55	48.04
P8	77.57	1.51	111.55	141.13	41.73
P9	88.21	1.95	66.19	147.49	85.31
P10	77.26	1.55	73.07	136.29	77.22
P11	71.65	1.66	72.93	130.67	82.24
P12	79.3	1.98	131.41	120.91	52.78
P13	73.75	1.98	142.06	146.64	48.18
P14	76.37	1.79	124.17	143.3	40.87

P15	88.24	1.82	165.84	102.26	61.04
P16	71.58	1.72	101.24	101.32	75.4
P17	88.84	1.65	91.43	118.82	63.53
P18	87.16	1.66	155.55	140.53	66.25
P19	65.87	1.84	84.6	149.36	94.25
P20	62.08	1.88	165.95	107.52	60.9
P21	63.02	1.9	61.34	129.71	70.84
P22	60.55	1.89	166.69	119.04	87.02
P23	62.83	1.55	64.75	148.5	63.79
P24	80.49	1.75	158.03	142.11	77.33
P25	62.14	1.53	118.05	141.92	91.74
P26	69.57	1.77	169.23	123.43	96.97
P27	85.35	1.72	68.12	120.74	48.82
P28	60.7	1.94	120.92	113.67	95.6
P29	84.43	1.68	166.62	102.82	69.53
P30	68.46	1.56	117.54	143.24	55.49
P31	63.54	1.57	129.23	140.65	67.55
P32	80.9	1.88	136.53	149.99	98.8
P33	78.87	1.81	110	149.83	69.56
P34	86.32	1.55	129.03	127.77	59.73
P35	82.05	1.54	124.27	138.45	78
P36	84.1	1.85	159.13	147.24	54.41
P37	68.46	1.54	65	142.48	44.55
P38	65.32	1.91	90.91	112.37	47.73
P39	82.52	1.85	164.55	122.53	47.68
P40	84.21	1.54	157.93	106.46	49.11
P41	89.72	1.54	110.12	147.7	48.33
P42	72.38	1.99	128.21	130.31	78.45
P43	71.16	1.69	90.51	111.43	50.91
P44	83.29	1.69	80.69	133.59	60.74
P45	70.22	1.91	111.01	130.91	93.81
P46	87.92	1.97	98.87	117.91	68.44
P47	85.75	1.99	124.2	105.68	80.05
P48	72.87	1.88	68.55	133.58	50.34
P49	82.53	1.69	167.18	126.02	51.54
P50	82.64	1.54	168.48	138.62	42.45

The detailed variations of the serum concentrations of each essential elements in asthma patients are shown in figures 6,7,8,9 and 10 for Zn, Mg, Fe, CU and Se respectively. For Zn concentrations > 70 µg/dL occurred in nearly half of the patients (27 patients). For Mg about 26 patients have a concentration > 1.75 mg/dL. Iron showed values > 100 µg/dL in 33 patients; others (17 patients) have lower values than 100 µg/dL. As for Cu in which 18 patients recorded < 125 µg/dL, while the majority 32 patients with concentrations more than 125 µg/dL. Concentrations of Selenium lower than 70 µg/dL were shown in 29 patients compared with 21 individuals with serum concentrations higher than 70 µg/dL.

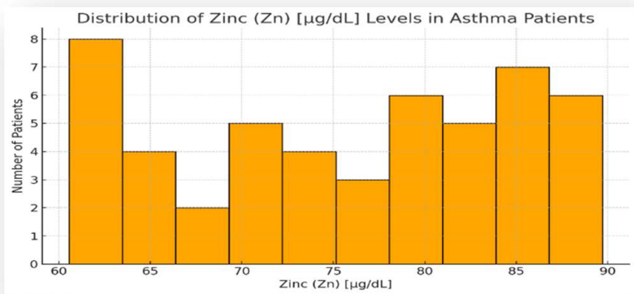

Figure (6): Distribution of Zinc (Zn) [µg/dL] Levels in Asthma Patients

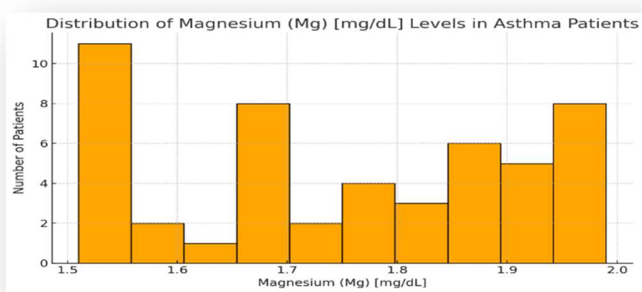

Figure (7): Distribution of Magnesium (Mg) [mg/dL] Levels in Asthma Patients

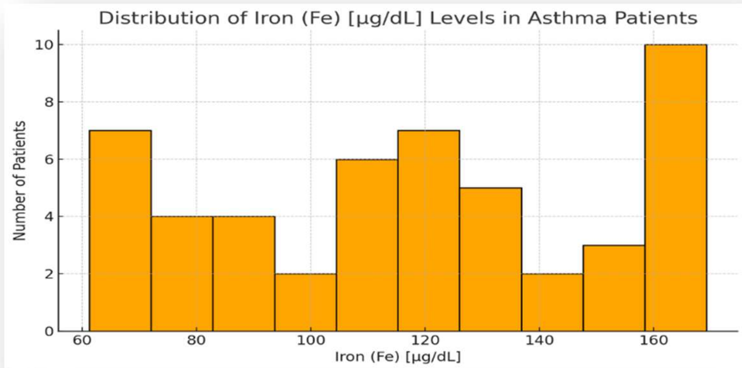

Figure (8): Distribution of Iron (Fe) [µg/dL] Levels in Asthma Patients

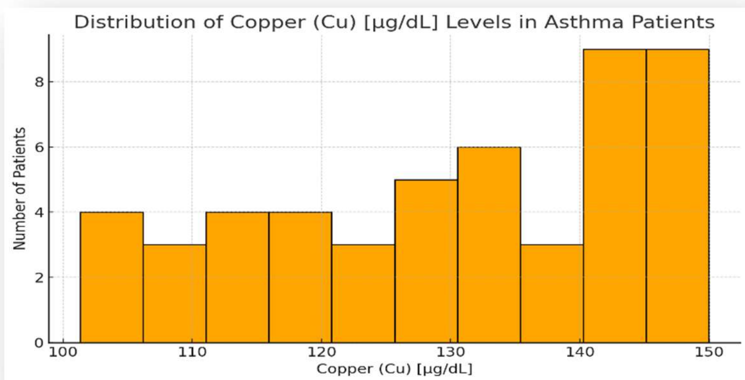

Figure (9): Distribution of Copper (Cu) [µg/dL] Levels in Asthma Patients

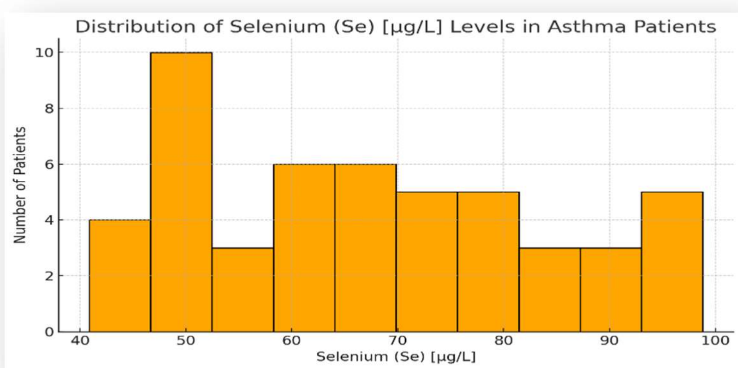

Figure (10): Distribution of Selenium (Se) [µg/L] Levels in Asthma Patients

Healthy Control Group

Detailed concentrations of some essential metals in the serum of healthy control individuals are shown in Table (5). Magnesium was the major constituents among other essential metals (nutrients) as it ranged between 1.72 – 2.15 mg/dL. It followed by Iron which ranged between 62 -158 µg/dL and Copper which ranged between 75 – 139 µg/dL. The other two metals, Zinc and Selenium revealed similar concentration in the healthy individuals being 90 and 86 µg/dL respectively.

Table 5: Blood concentrations of essential nutrients in healthy control group (n = 20)

Comparisons between Patients and Control Group

Table (6) presents the results of independent samples T-tests conducted to compare the blood concentrations of five essential nutrients (Zinc, Magnesium, Iron, Copper, and Selenium) between asthmatic patients (n = 50) and healthy controls (n = 20). Statistically significant differences (P < 0.01) were observed in the levels of Zinc, Magnesium, Copper, and Selenium, indicating that these nutrients were either significantly lower or higher in asthmatic patients compared to healthy individuals. No significant difference was found in Iron levels (P = 0.2492), suggesting that its concentration may remain within the normal range or vary between individuals.

Three elements, namely Zn, Mg and Se showed higher values in the control than in patients. Percentage changes varied between -16 % and 10% for Zn and Mg respectively and -22% for Se. On contrary, Cu and Fe showed higher values in the patients than in control. Percentage changes varied between -8.5% for Fe and 29% for Cu respectively It can be noted that Asthma patients have suffered from a significant reduction (P< 0.01) in the levels of zinc, magnesium and selenium, and a significant elevation of copper levels (P<0.01). However, iron showed slight insignificant elevation (P>0.05). These findings may reflect a potential role of nutrient imbalances in the pathophysiology or severity of asthma.

Table 6: Statistical analysis and comparison of essential elements levels between asthmatic patients and healthy people

Essential Elements	Mean Controls	Asthma Patients	Change in Asthma	P-Value

Zinc (Zn) µg/dL	90.74 ± 6.02	75.76 ± 4.11	-16.4 %	< 0.01
Magnesium (Mg) mg/dL	1.95 ± 0.25	1.75 ± 0.32	-10.3 %	< 0.01
Iron (Fe) µg/dL	108.57 ± 7.05	117.85 ± 9.72	+8.5 %	0.2492
Copper (Cu) µg/dL	100.56 ±4.42	129.82 ± 10.27	+29.0 %	< 0.01
Selenium (Se) µg/L	86.82 ± 6.65	67.26 ± 3.79	-22.5 %	< 0.01

Control ID	Zinc (Zn) µg/dL	Magnesium (Mg) mg/dL	Iron (Fe) µg/dL	Copper (Cu) µg/dL	Selenium (Se) µg/L
C1	78.45	1.81	62.21	94.93	109.02
C2	83.93	1.83	95.43	139.06	75.47
C3	78.85	1.92	83.26	112.4	70.25
C4	74.44	1.99	96.02	86.61	100.12
C5	76.03	2.07	73.17	77.12	115.76
C6	93.04	1.92	157.96	80.7	93.41
C7	80.32	1.98	125.3	87.22	94.3
C8	88.21	2.15	134.7	81.25	76.8
C9	95.17	1.72	146.81	83.06	106.17
C10	104.52	1.85	114.83	89.96	71.22
C11	71.97	2.13	69.56	82.14	79.42
C12	109.97	2.24	119.08	132.77	85.53
C13	101.4	2.01	124.55	75.62	90.46
C14	74.09	2.02	142	106.72	74.54
C15	113.68	1.76	107.48	98.73	66.89
C16	116.04	1.97	74.03	138.77	96.64
C17	73.05	2.02	91.22	77.84	77.32
C18	83.84	1.85	99.94	97.85	94.87
C19	110.31	1.86	131.05	137.86	69.26
C20	107.41	1.93	122.79	130.59	88.87

Discussion

Correlation of Heavy Metals to Asthma in Basra

Data of this research has highlighted substantial correlation between asthma severity and chromium, cadmium, nickel, cobalt and lead, all of which were identified as significant air pollutants influencing the severity of the disease in Basra city (Al-Fartusie et al., 2021 and Ariaee et al., 2016). The presence of trace metals in populations within large cities globally presents a significant public health issue, particularly in Basra city, southern Iraq, which experiences extensive contamination due to oil refineries, external conflicts, and wars.

The findings of the present study showed that serum lead concentration was significantly higher in Asthma patients in Basra. Lead is known to be is a harmful environmental pollutant which has high toxic effects to many body organs (Mahdi et al., 2021). Lead has also shown to renal and respiratory harmful effects. Pb-induced renal toxicity might lead to necrosis as stated by Kianoush et al. (2012). As for the effects of toxic metals on asthma, studies have shown that elevated blood lead levels correlate with reduced pulmonary function and increased asthma prevalence, particularly in children (Lanphear et al., 2005). Nickel in our study also showed elevated serum concentration in our Asthma sample. The result is contradictory to that of Al-Fartusie et al. (2021) who showed significantly lower levels of nickel in asthma patients with a reduction of 81%. Nickel exposure, especially in occupational settings such as Basra, is associated with induced asthma via immune-mediated mechanisms (Kim et al., 2005; Barcelos et al., 2020).

Chromium, also revealed higher concentration in the serum of Asthma patients in Basra. In the study of Al-Fartusie et al. (2021) and Ariaee et al. (2016), no significant differences were found in chromium levels between patients and healthy groups. The chromium primary route of exposure for human populations occurs via ingestion of chromium containing food and water (Nickens et al.,2010). According to Salama et al. (2016) and Fang et al. (2014) the intranasal potassium dichromate has resulted in the elevation of oxidative stress biomarkers and may cause lung injury. The study of Costa and Klein (2006) had shown that chromium is a potent respiratory irritant. Its inhalation exposure can lead to airway inflammation, bronchospasm, and even irreversible damage to lung tissue (Wang et al., 2011). Cobalt is commonly found in industrial environments such as Basra. It can cause hypersensitivity pneumonitis and occupational asthma through immune sensitization (Nemery, (1990; Skoczynska, et al., 1994). Cadmium exposure in Basra also caused an elevation of its concentration in Asthma patients due to inhalation of industrial fumes of refineries. Mendez-Arriaga, et al. (2020) have reported serious impact on lung function and inflammation due to exposure to cadmium. It is linked to emphysema and impaired lung function and in asthmatic individuals, it may exacerbate oxidative stress as seen by Jarup et al. (1998).

Essential Trace Elements in Asthma patients of Basra

Results of the present study showed clearly that there was a significant decrease in blood concentration of zinc, magnesium and selenium in asthmatic patients in Basra. On contrary iron and cobalt levels increased in the patients. The present findings are in agreement with previous reports by Al-Fartusie and Mohssan (2017) and Ali et al. (2021). Zinc is vital for immune function and has antioxidant properties (Bilan et al., 2014). Zinc deficiency is associated with increased susceptibility to respiratory infections and inflammation in asthma as recorded by Prasad (2008). Hypomagnesemia has been shown in individuals with severe or poorly controlled asthma in Basra. The present results are comparable with those obtained by Okayama, et al. (1987) and Al-Salhen et al. (2015). Reduction of blood selenium levels which has been recorded in asthmatic patients in Basra is in agreement with similar findings previously reported by Hoffmann & Berry (2008) who found low selenium levels in asthmatic patients causing impairment of airway antioxidant defenses.

Iron levels in the present findings have not changed significantly in asthma patients. It showed slight increase in the patients. The result is comparable to that of Ali et al. (2021) who stated that Iron is essential for oxygen transport and immune function. While iron deficiency may impair respiratory muscle function and exacerbate asthma symptoms, iron overload can contribute to oxidative stress (Ghosh, et al., 2006). Blood copper was the only element which shows significant increase in the serum of the patient samples. It acts as a cofactor in antioxidant enzymes such as superoxide dismutase (Al-Salhen et al., 2015). The imbalance in copper levels has been previously reported to affect oxidative stress pathways and influence asthma severity (Gaetke and Chow, 2003).

According to Al-Fartusie and Mohssan (2017) copper and iron were significantly higher in the serum of asthma patients compared to healthy controls. The increases were 20% (Cu), 54% (Fe). These results are comparable to the findings of the present study but with lower increase 8% for Fe and 29% for Cu. Zinc and magnesium were significantly lower in asthma patients, with reductions of 24% (Zn), 16% (Mg) (Ariaee et al., 2016).The present study reached similar findings as the zinc and magnesium were lower in asthma patients with a reduction of 16% for Zn and 10% for Mg. The increase in copper and decrease in zinc is notable, as a higher Cu/Zn ratio is often associated with inflammation and oxidative stress (Al-Fartusie et al., 2021). These changes may reflect the role of trace elements in inflammation, oxidative stress, and immune function in asthma pathogenesis.

Conclusions

1. Heavy metal contamination may significantly influence the onset and severity of asthma.
2. Exposure to environmental toxic metals such as lead, cadmium, and chromium poses a significant risk to respiratory health, especially in individuals with asthma through oxidative stress and immune dysregulation.
3. Adequate levels of essential trace elements (Zn, Mg, Fe, Cu, Se) play protective roles to support respiratory health by reducing inflammation and oxidative stress and modulating immune responses.
4. Monitoring and managing metal exposure and essential elements intake may be beneficial in asthma management.
5. Regular monitoring of metal exposure and public health assessments over time are crucial to mitigate environmental risk factors for asthmatic populations in Basra city.

References

Albadr, A. and Albadr, I. (2024). Knowledge, Attitudes, and Practices of Parents Regarding Antibiotic Use for Acute Upper Respiratory Tract Infections in Children in Basrah, Iraq. Cureus. Cureus, 7;16(10): e70996.

doi: 10.7759/cureus.70996. eCollection 2024 Oct.

Al-Fartusie, F. S. Manal J. A., Hassanain, K. Al-Bairmani, A. Mohammed, S. (2021). Evaluation of Some Trace Elements in Sera of Asthma Patients: a Case Control Study. Folia Medica 63(5):797-804. doi: 10.3897/folmed.63.e60506

Al-Fartusie FS, Mohssan SN. (2017). Essential trace elements and their vital roles in human body. IJACS 2017; 5(3):127–36.

Ali, A. A., et al. (2021). The role of iron in asthma: a double-edged sword. Journal of Trace Elements in Medicine and Biology, 67, 126780.

Al-Rubaye, A. A., & Al-Yassen, A. Q. (2023). Epidemiology and risk factors of atopic dermatitis among children in Basrah, Iraq. International Journal of Public Health, 12(2), 469-474.

Al-Salhen Kh. S, Mahmoud S.M, Omran S.M, Mohammed S.K. (2015). Role of Serum Trace Elements Magnesium, Copper and Zinc, Level in Libyan Patients with Bronchial Asthma. Journal of Biotechnology and Biochemistry.; 1(6):97-101.2015.

Ariaee N, Farid R, Shabestari F, Shabestari M, Jabbari Azad F. Trace Elements Status in Sera of Patients with Allergic Asthma. *Rep Biochem Mol Biol*. 2016;5(1):20-2534.

Barcelos, G. R., et al. (2020). Nickel-induced toxicity and the role of oxidative stress in asthma. Environmental Research, 188, 109731.

Bhaskar, N. Shikhaa, M. Jeevan, B. Kuldip, S. (2019) Assessment of Trace Elements Status in Bronchial Asthma. International Journal of Research & Review 6(1):109-114.

Bilan N, Barzeger M, Pirzadeh H, Saboktakin L, and Haghjo AG. (2014). Serum Copper and Zinc Levels of Children with Asthma. Internantional Journal of current Research and Academic Review, 2(8): 266-273.

Bousquet, J. Khaltaev, N. (2007). Global surveillance, prevention and control of chronic respiratory diseases, A Comprehensive Approach. Global Alliance against Chronic Respiratory Diseases, World Health Organization, 2007, pp. 1–98.

Malapati, B. R., Shaikh, M. N., Shah, M. M. (2020) Serum copper, zinc & magnesium levels in asthma patients. International Journal of Clinical Biochemistry and Research 2020;7(4):470–472

Chen, X., Wang, Z., Zhu, G., Nordberg, G. F., Jin, T., and Ding, X. (2019). The association between cumulative cadmium intake and osteoporosis and risk of fracture in a Chinese population. J. Expo. Sci. Environ. Epidemiol. 29 (3),435–443. doi:10.1038/s41370-018-0057-6.

Costa, M., & Klein, C. B. (2006). Toxicity and carcinogenicity of chromium compounds in humans. Critical Reviews in Toxicology, 36(2), 155–163.

Esra Akyüz Özkan , Ayşe Yeşim Göçmen , Yusuf Küçükbağrıaçık , Melike Akyüz .Serum Levels of Trace Elements, Vitamin D and Oxidant Status in Children with Asthma. J Basic Clin Health Sci 2019; 3:63-68.

Fang, Z., Zhao, M., Zhen, H., Chen, L., Shi, P., and Huang, Z. (2014). Genotoxicity of tri-and hexavalent chromium compounds in vivo and their modes of action on DNA damage in vitro. PloS One 9 (8), e103194. doi:10.1371/journal.pone.0103194

Gaetke, L. M., & Chow, C. K. (2003). Copper toxicity, oxidative stress, and antioxidant nutrients. Toxicology, 189(1–2), 147–163.

Ghosh, S., et al. (2006). Iron in lung inflammation and defense: from mechanism to application. Archives of Biochemistry and Biophysics, 452(2), 117–126.

Hoffmann, P. R., & Berry, M. J. (2008). The influence of selenium on immune responses. Molecular Nutrition & Food Research, 52(11), 1273–1280.

Jarup, L., et al. (1998). Health effects of cadmium exposure – a review of the literature and a risk estimate. Scandinavian Journal of Work, Environment & Health, 24(Suppl 1), 1–51.

Kianoush, S., Balali-Mood, M., Mousavi, S. R., Moradi, V., Sadeghi, M., Dadpour,B., (2012). Comparison of therapeutic effects of garlic and d-penicillamine in patients with chronic occupational lead poisoning. Basic Clin. Pharmacol.Toxicol. 110 (5), 476–481.

Kim, Y. H., et al. (2005). Occupational asthma caused by nickel sulfate. Allergy Asthma Immunol Res, 25(4), 272–277.

Landrigan PJ, Carlson JE, Bearer CF, et al. (1998). Children's health and the environment: a new agenda for prevention research. Environ Health Persp, 106: 787–794.

Lanphear, B. P., et al. (2005). Low-level environmental lead exposure and children's intellectual function: an international pooled analysis. Environmental Health Perspectives, 113(7), 894–899.

Luo, L., Wang, B., Jiang, J., Huang, Q., Yu, Z., Li, H., et al. (2020). Heavy metal contaminations in herbal medicines: determination. comprehensive risk assessments. Front. Pharmacol. 11, 595335.

Mahdi Balali-Mood , Kobra Naseri , Zoya Tahergorabi , Mohammad Reza Khazdair and Mahmood Sadeghi . (2021). Toxic Mechanisms of Five Heavy Metals: Mercury, Lead, Chromium, Cadmium, and Arsenic. Frontiers in Pharmacology. 12:1-18.

Mendez-Arriaga, F., et al. (2020). Exposure to cadmium and its impact on lung function and inflammation. Environmental Pollution, 263, 114573.

Nemery, B. (1990). Metal toxicity and the respiratory tract. European Respiratory Journal, 3(2), 202–219.

Nickens, K. P., Patierno, S. R., and Ceryak, S. (2010). Chromium genotoxicity: a double-edged sword. Chem. Biol. Interact. 188 (2), 276–288. doi:10.1016/j.cbi.2010.04.018.

Okayama, H., et al. (1987). Bronchodilating effect of intravenous magnesium sulfate in bronchial asthma. JAMA, 257(8), 1076–1078.

Prasad, A. S. (2008). Zinc in human health: effect of zinc on immune cells. Molecular Medicine, 14(5–6), 353–357.

Riedl, M.A. and Nel, A.E. (2008). Importance of oxidative stress in the pathogenesis and treatment of asthma. Curr Opin Allergy Clin Immunol, 8:49–56.

Salama, A., Hegazy, R., and Hassan, A. (2016). Intranasal chromium induces acute brain and lung injuries in rats: assessment of different potential hazardous effects of environmental and occupational exposure to chromium and introduction of a novel pharmacological and toxicological animal model. PLoS One 11 (12), e0168688. doi:10.1371/journal.pone.0168688

Shazia Q, Mohammad J, Rahman IT, Hossain U. Correlation of oxidative stress with serum trace element levels and antioxidant enzyme status in beta thalassemia major patients: A review of the literature. Hindawi publishing corporation, anemia 2012;7:20-23.

Skoczynska, A., et al. (1994). Occupational exposure to cobalt and its effect on the lungs. Journal of Occupational Medicine, 44(3), 274–279.

Stojsavljević, A., Trifković, J., Rašić-Milutinović, Z., Jovanović, D., Bogdanović, G., Mutić, J., & D. Manojlović, D. (2018). Determination of toxic and essential trace elements in serum of healthy and hypothyroid respondents by ICP-MS: A chemometric approach for discrimination of hypothyroidism.

Sveum R, Bergstrom J, Brottman G, Hanson M, Heiman M, Johans K, Malkiewicz J, Manney S, Moyer L, Myers C, Myers N, O Brien M, Rethwill M, Schaefer K, Uden D. Diagnosis and Management of Asthma. Institute for Clinical Systems Improvement. Updated July 2012.

Wang, X. Y., et al. (2011). Chromium exposure and the development of asthma in children. Environmental Science and Pollution Research, 18(5), 755–760.