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The Effect of Occupation on Heavy Metals Concentrations and the Their Relationship to Blood Cancer Incidenence rates in Diwaniyah

Duha Yahya Tawir[1],Haider Mashkoor Hussein[2]
[1,2] Department of Environment, College of Science, University of Al-Qadisiyah, Al-Qadisiyah, Iraq.
[1]E-mail: wjwdalghraby@gmail.com
[2]E-mail: haider.mashkoor.h@qu.edu.iq

ABSTRACT

"Heavy metal" describes a broad class of naturally occurring metallic elements with molecular weights and densities greater than those of water occur. These elements influence cells and livings beings in many manners; certain heavy metals possess important roles (such as iron, zinc, copper and manganese) and are harmful only in excessive amounts, while others are inherently highly hazardous (such as, arsenic, cadmium, lead and mercury). Consequently, all organisms and cells regulate metal homeostasis within physiological or sub-toxic and employ metal detoxification processes. Seventy-five samples from both gender were included in the present study with age range (15_70 years). 50 patients with blood diseases were selected from Teaching Al-Diwaniyah Hospital; and 25 participent apparently healthy control group. Heavy metals parameters measurement was performed on blood serum by use (Atomic absorption spectrophotometer), model Buck Scientific - 210VGP Atomic Absorption Spectrophotometer.The blood serum, were digestion to examine the heavy elements of the total study sample (treatment and control) As for occupation, employees constituted the highest percentage (36%), possibly reflecting the impact of work conditions on overall health. Studies have indicated that exposure to heavy metals can result in carcinogenic effects, disrupt various physiological processes, and increase cancer risk.Regarding diseases, the highest rate was among patients with Chronic Myeloid Leukaemia (CML) at 32%, emphasising the significance of this cancer type within the studied sample. Additionally, 60% of participants had no genetic diseases, which may suggest the influence of environmental or lifestyle factors the aim of study elevated the effect of occupation exposure on heavy metals concentrations among residents of diwaniyah Governorate and determine the relationship between this concentration and the incidence of Leukemia.

Keyword: Heavy metals, Leukaemia, meta-analysis

1. INTRODUCTION

Metallic elements with a density over that of water can be defined as heavy metals. (Duffus, 2002; Alexy *et al.*, 2022). Metals that are heavy (HMs) are elements of nature distinguished by a significant atomic weight and a density that is no less than five times that of the water. (Alloway, 2013; Abd Elwahed *et al.*, 2023). Assuming a correlation between toxicity and heaviness, Heavy metals also include metalloids that can trigger toxicity at minimal exposure stages, such as the arsenic (As). (Tchounwou *et al.*, 2012; Abd Elwahed *et al.*, 2023). Several types with heavy elements, such as chromium (Cr), metal cadmium (Cd), the element nickel (Ni), metallic copper (Cu), the element zinc (Zn), lead (Pb), mercury (Hg), and the arsenic (As), are acknowledged as physiologically unnecessary and harmful to aquatic ecosystems. (Jaishankar *et al.*, 2014; Abd Elwahed *et al.*, 2023).

At low concentrations, iron, zinc, copper, manganese, and other Metals that are heavy in weight are vital for human survival; yet, in elevated amounts, compounds can become poisonous. (Tchounwou *et al.*, 2012; Jomova & Valko 2011). The additional heavy metals that have no biological use include lead, thallium, mercury, arsenic, and cadmium. Nevertheless, because of their existence in the environment, they will unavoidably penetrate inside of humans (Jaishankar *et al.*, 2014; He *et al.*, 2021). Like critical metals, they become poisonous when certain amounts are attained (Lafta *et al.*, 2024; Bharti & Sharma, 2022).It might be difficult to confirm the diagnosis of elemental toxicity because its symptoms and indicators can be confused with those of several non-element-dependent illnesses (Fisher & Gupta, 2024).

Inorganic elements possessing a density above five g/cm^3 are categorised as heavy metals. (Alloway, 2013; Khalef *et al.,* 2022).

Elevated concentrations of heavy metals in the body can negatively impact haematological health. and raise the risk of developing hematologic disorders (Jomova&Valko,2011). Leukaemia is a malignant illness characterised by the excessive synthesis of immature white blood cells in the bone marrow, which disturbs normal haematopoiesis. From 2015 to 2019, the National Cancer Institute reported 14.1 new leukaemia cases and 6.1 leukemia-related deaths per 100,000 individuals year. Approximately 1.5% of individuals may receive a diagnosis of leukaemia in their lifetime, with a greater prevalence in men compared to women (Hassouneh *et al* ., 2019)

The prevalence of leukaemia in high-income nations was 1.5 times greater than in low-income ones (Huang *et al* ., 2022).The primary risk factors for leukaemia are radiation, prior treatment, chemical exposure, hereditary , haematological diseases, tobacco use, genetic syndromes, age, and sex (Bispo *et al*., 2020). The four primary classifications of leukaemia are acute lymphocytic leukaemia (ALL), acute myeloid leukaemia (AML), chronic lymphocytic leukaemia (CLL), and chronic myeloid leukaemia (CML), categorised by the pace of cancer progression and the nature of the aberrant cell types. Certain risk factors are strongly correlated with particular leukaemia subtypes. The Life Span Study (LSS) of Japanese survivors of the atomic bombing from 1950 to 2000 continuously demonstrates that radiation exposure elevates the incidence of leukaemia. Clear evidence indicates a dose-dependent risk of acute myeloid leukaemia (AML), acute lymphoblastic leukaemia (ALL), and chronic myeloid leukaemia (CML) has been identified [Richardson *et at*., 2009; Tsushima & Miyazaki, (2012).
Over time, exposure to specific metals has been linked to a heightened risk of leukaemia. and other malignancies due to their detrimental effects on hematopoietic cells (Goyer, 2001). It is well known that using heavy metals in certain industries or products, like alloys and colour pigments, can lead to workers being exposed to these metals. Exposure to drinking water tainted with heavy metals has been documented worldwide and has led to several detrimental consequences on human metabolism (Fu and Xi, 2008).

The main way that heavy metals are hazardous is by making reactive species of oxygen, which cause damage through oxidation and have negative health effects. (Zhang *et al.,* 2024). Using water that has metals that are heavy in it is connected to an elevated incidence of illness as well as mortality around the world. (Rehmn *et al*., 2018). Therefore, there is a strong motivation to express concerns about the role that certain heavy metals have in various health-related issues. (Khan *et al.,* 2023). While acute poisoning is caused by inhaling or coming into contact with dust, fumes, or vapors at work or by using some therapeutic procedures improperly, Metals that are heavy can get into the human body all the time via nourishment, air, water, or dermal absorption. (Lentini *et al*., 2017). Heavy metal poisoning may affect the brain, bloodstream, lung function, the renal system, liver function. And other organs of the body (Lentini *et al.,* 2017).

The baseline levels of necessary and harmful metals in leukemia patients, as well as the therapeutic significance of these metals, are unknown despite a wealth of epidemiological evidence connecting metals to leukemia and other diseases, Hospice care Civils de Lyon in northern France used inductively coupled plasma mass spectrometry compare serum samples from untreated AML patients and controls for trace metals as well as copper isotopic abundance ratios they produced a multi-metal score for those with AML, and survival analysis was conducted based on metal values. Ninety-four controls and sixty-seven untreated AML patients had their serum samples collected therefore, we aimed to measure metal levels in AML patients and controls, and find out how metal levels affected the survival of AML patients (Ohanian et al., 2020).

1.2 Sources of Heavy Metals

1.2.1 Natural Sources:

Natural geological Processes such as erosion result in the discharge of metals that are heavy into the ecosystem. These elements come from rocks and sediments that are naturally existent within the surrounding environment (Karamanis *et al.*, 2008; Dos Santos *et al.*, 2022).Minerals like these can be found in raindrops that collect on the ground or in the air and are carried by the wind. Volcanic activity is another natural source that contributes to ecological degradation (Everaarts, 1989; Garrett, 2000).It can release acid rain that contains high concentrations of heavy metals (Yücesoy and Ergin, 1992; NOAA, 2017).In most cases; the hazards of heavy metals are greater than the benefits (O'Neill *et al.*, 2023). For instance, hexavalent chromium has been found to be a carcinogen and can cause lung cancer if inhaled, although trivalent chromium is good for you (Sahli *et al.,* 2023).

1.2.2 Anthropogenic Sources:

Pollution with heavy metals originates from a wide range of sources, such as the oil and gas sector, oil refineries, iron and steel factories, glass and aluminum producers, tanneries, fertilizer and pesticide companies, gasoline, and many other types of businesses and industries (Asl *et al.*, 2019; Hussain *et al.*, 2019). Pollution from industrial or consumer waste can contaminate the water supply with heavy metals. The discharge of industrial waste into aquatic environments may elevate the amounts of certain components in water (Çapa *et al.*, 2022; Okoro *et al.,* 2020).

2. MATERIAL AND METHODS

2.1 Study design.

Seventy-five samples from both gender were included in the present study with age range (15_70 years). 50 patients with blood diseases were selected from Teaching Al-Diwaniyah Hospital; and 25-participant apparently healthy control group. The study samples were collected in the period from October 2024 to Janury 2025.

2.2 Sample collection.

The blood serum, were digestion to examine the heavy elements of the total study sample (treatment and control) included: One millilitre of blood serum was placed in a test tube, to which one millilitre of strong nitric acid was added and allowed to stand for 24 hours. Nitric acid concentrate and the peroxide of hydrogen are combined in a 1:2 ratio at an approximate temperature of 70 °C and allowed to react for up to two hours, until the solution clarifies.The samples were subsequently diluted with deionised water to a volume of 10 ml and filtered using a 0.45 µm pore filter paper.

2.3 Determination of heavy metal.

Using the 210 VGP Atomic Absorption Spectrophotometer (AAS), we looked at heavy metals like the metal zinc (Zn), the metal copper (Cu), the metal lead (Pb), the cadmium (Cd), and the element nickel (Ni). The atomic absorption apparatus looks at heavy metals like cadmium, lead, Nickel, the elements copper, and The element zinc, Based on the principle of flame atomic absorption , One of the analytical criteria for this apparatus is the existence of standard solutions, which contain these components in a quantities known to ascertain the percent of the sample., as each mineral has a light source. AAS technology relies on the principle that substances like minerals absorb light at wavelengths that are specific facilitating the full breakdown of metal ions in solution through a laminar flame. Light of the suitable wavelength is supplied, and the quantity of absorbed light is quantified in comparison to the standard the curve. (Walker et.al.,2016).

Utilising an open- flame absorption atomic apparatus, the models were removed from the freezer and allowed to equilibrate to a laboratory room temperature of 25°C. Subsequently, 0.5 ml was extracted from the sample and transferred to a volumetric vial. 1 ml of concentrated 70% HNO_3 were added, and the mixture was incubated in a water bath at 40°C for 30 minutes (Florez et al., 2016). Subsequently, the solution was transferred to the designated container, and the volume was adjusted to the mark. The concentration of the compounds in the blood samples was quantified using an AAS instrument.

2.4 Heavy metals analysis:

Heavy metals parameters measurement was performed on blood serum by use (Atomic absorption spectrophotometer), model Buck Scientific - 210VGP Atomic Absorption Spectrophotometer.The blood serum, were digestion to examine the heavy elements of the total study sample (treatment and control) included: One millilitre of blood serum was placed in a test tube, to which one millilitre of strong nitric acid was put in and allowed to stand for 24 hours. Nitric acid that is concentrated and peroxide of hydrogen are combined in a 1:2 ratio at a temperature of 70 °C and allowed to react for up to two hours, until the resulting solution clarifies. Then the samples were diluted with deionized water to 10 ml, and filtration with 0.45μ pore filter paper.Subsequently, samples that had been digested were analysed using an atomic absorption spectrometer to determine the concentration of heavy metals.

2.5 Statistical analysis :

The statistical program (SPSS Ver.25) was used in the statistical examination of the results of the current study under the level of significance (0.05) and the test of least significant difference (LSD) Least Significant Difference(Al-Rawi, , 2002), as well as according to the correlation coefficient between physical and chemical variables . While heavy metals were analyzed using a complete random design Complete Randomize Design (CRD) and averages were tested using (Duncan Test) multiple range depending on the method mentioned in Al-Rawi (2002), the results were assessed at a significant level ($p < 0.05$).

3. RESULT

3.1 Distribution of study samples by disease.

The findings of the current study indicated that 12% individuals had severe myeloid leukaemia, 4% had severe myeloid leukaemia, and 8% had acute lymphocytic leukaemia., 32% with chronic myeloid leukemia, 12% with myeloid, 12% with thalassemia while the control group was 20% from the total percentage, figure (3-1).

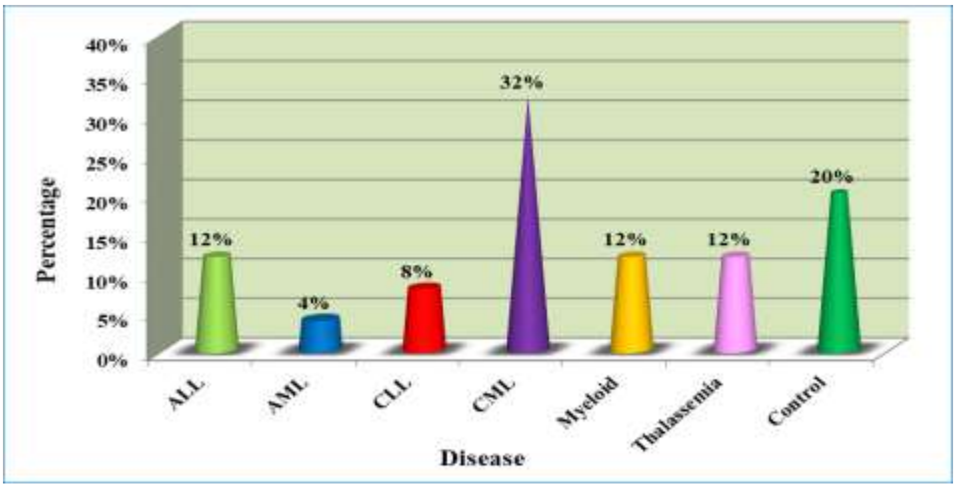

Figure (3-1) Distribution of study sample by disease.

3.2 Impact of heavy mental concentraction in the blood on the diseases.

The present study showed significan differences in the effect of ALL, AML, CLL, CML, myeloid and thalassamia regarding the concentrations of Pb ($p < 0.001$), Cd ($p < 0.001$), Zn ($p < 0.001$), Cu ($p < 0.001$), and Al ($p < 0.003$)in the blood, respectively. The significant differences may be due numerous health consequenses such as cardiovascular disease and carcinogenesis and other diseases (pan *et al* .,2024).

Table (3-1) Impact of heavy mental concentraction in the blood on the diseases.

Metals / Disease	Pb Mean±S.D.	Cd Mean±S.D.	Zn Mean±S.D.	Cu Mean±S.D.	Al Mean±S.D.
ALL (n=9)	0.0020^{a}±0.0013	0.2255^{a}±0.0389	0.1286^{bc}±0.0634	0.5568^{bc}±0.2225	0.0018^{a}±0.0006
AML (n=3)	0.0069^{b}±0.0001	0.2500^{a}±0.0100	0.0276^{a}±0.0002	0.2500^{a}±0.0100	0.0882^{ab}±0.0002
CLL (n=6)	0.0036^{a}±0.0027	0.2133^{a}±0.0081	0.0322^{a}±0.0017	0.1932^{a}±0.1245	0.1919^{b}±0.2086
CML (n=24)	0.0014^{a}±0.0006	0.2373^{a}±0.0447	0.1692^{c}±0.1287	0.6321^{c}±0.4284	0.0015^{a}±0.0007
Myeloid (n=9)	0.0030^{a}±0.0015	0.2990^{b}±0.0574	0.0873^{abc}±0.0464	0.4735^{abc}±0.0558	0.0016^{a}±0.0004
Thalassemia (n=9)	0.0087^{b}±0.0057	0.2507^{a}±0.0382	0.0387^{a}±0.0181	0.2462^{a}±0.0991	0.0022^{a}±0.0016
Control (n=15)	0.0030^{a}±0.0018	0.2387^{a}±0.0226	0.0548^{ab}±0.0104	0.2977^{ab}±0.0866	0.1071^{ab}±0.2185
P-Value	<0.001**	0.001**	<0.001**	<0.001**	0.003**

S.D. = Standard Deviation
Averages that share the same alphabet are not significantly difference between them according to the Duncan test.
** The differences are significant at the 0.01 level.

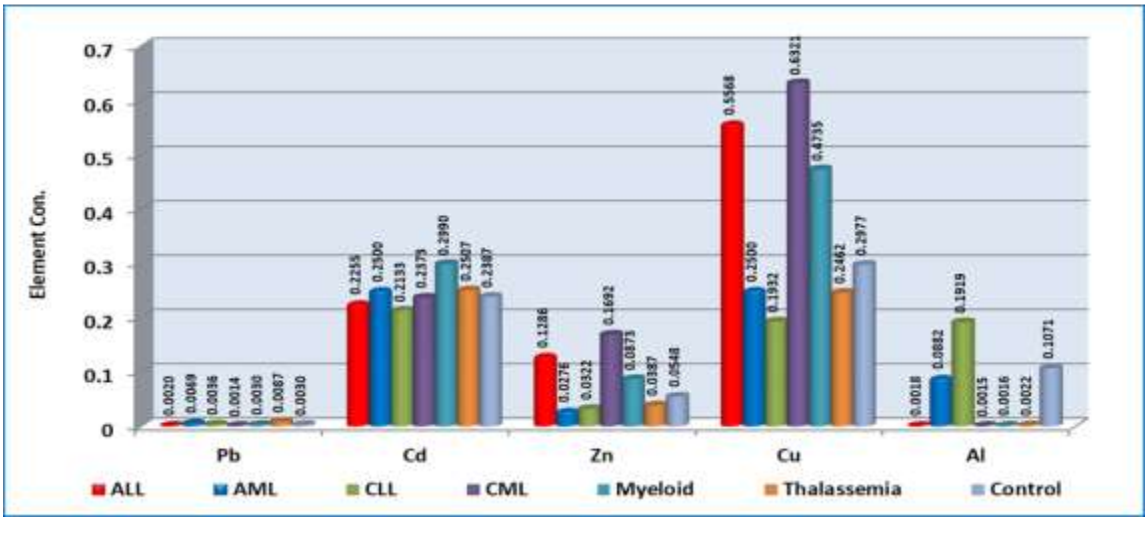

Figure (3-2) Impact of heavy mental concentraction in the blood on the diseases.

3.3 Distribution of study samples by family history

The findings of the current study indicated that 20% of patients with genetic disease, 60% of patients with non-genetic while the control group was 20% from the total percentage, figure (3-3).

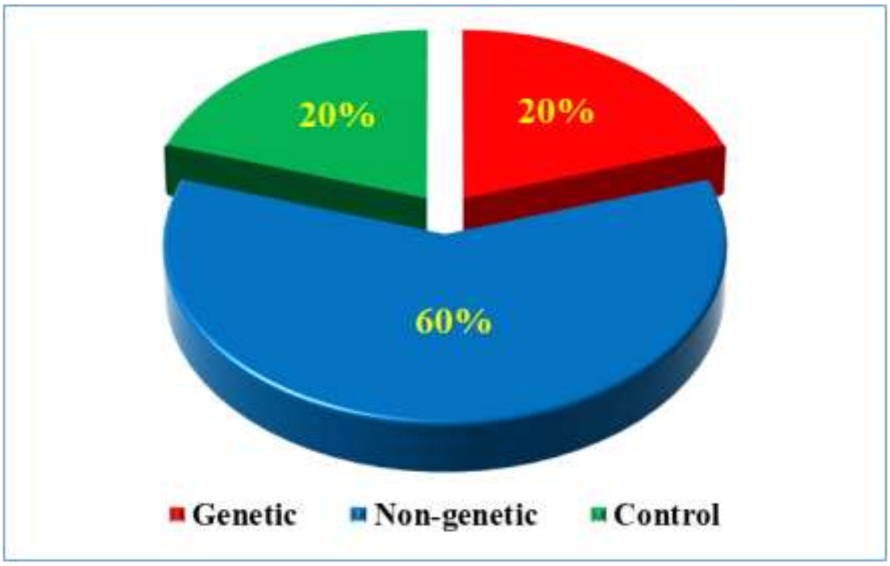

Figure (3-3) Distribution of study samples by family history

3.4 Impact of heavy metal concentration in to blood on the family history.

The findings of the present investigation indicated significant differences in the effects of hereditary, non-genetic, and control factors on blood lead concentration.(p value < 0.002), figure (3_4).While there were no significant differences of genitic, non genitic and control on the concentraion of Cd,Zn, Cu and Al in the blood. These result may be due to that even when the environmental stimulus is eliminated, epigenetic alterations that take place during the developing stage frequently continue, and this may have long-term consequences that result in illnesses.(Dutta and Ruden ,2024).

Table (3-2) Impact of heavy metal concentration in to blood on the family history.

Medical_history	Frequency	Percentage
Genetic	15	20%
Non-genetic	45	60%
Control	15	20%
Total	85	100%

3.5 Distribution of study sample by job

The findings of the current study indicated that 36% of participants were employees, 20% were freelancers, 20% were students, and 24% were housewives. (3-5).

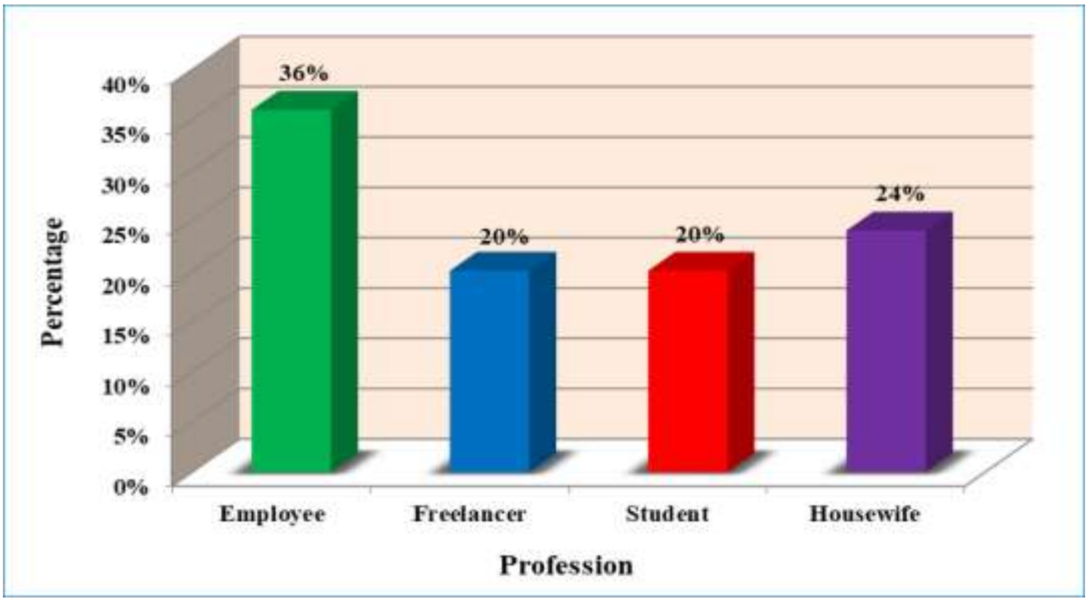

Figure (3-5) Distribution of study sample by job

3. 6 impact of job on the concentration of heavy metals blood.

The results both the present investigation revealed substantial differences in the impact of occupation on the concentrations of Pb and Al in the blood p-value < 0.001, p- value < 0.003, accordingly, as illustrated in figure (3-6).The significant differenses may be due toMetS risk may be increased by prolonged exposure to heavy metals, and adiponectin may be an early indicator of the disease.that workers' serum adiponectin levels are lowered by occupational exposure to heavy metals, such as lead. Of all the metal xposures, lead had the most detrimental effect on decreased adiponectin levels.(wu *etal*., 2023).

Exposure to lead, frequently from sources like paint, water pipes, and specific job settings, also leads to its accumulation in the body over time. Lead accumulates in bones and can be discharged into the blood.(zuo *etal* .,2025)

Table (3-3) impact of job on the concentration of heavy metals blood

Profession	Frequency	Percentage
Employee	27	36%
Freelancer	15	20%
Student	15	20%
Housewife	18	24%
Total	75	100%

4. CONCLUSIONS:

Statistically significant differences were found in the concentrations of heavy metals (Pb, Cd, Zn, Cu, Al) among patients with various hematological diseases such as ALL, AML, CLL, CML, and thalassemia, compared to the control group. A significant effect of family history (genetic vs. non-genetic) on lead levels was observed, while no significant differences were found for Cd, Zn, Cu, and Al. This may be due to lasting epigenetic changes that persist even after environmental stimuli are removed. There were significant differences in blood levels of Pb and Al based on the participants' jobs. Occupations involving direct exposure to heavy metals showed higher concentrations, highlighting the occupational health risks associated with certain work environments.

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