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Article

Assessment of Lead, Cadmium, Nickel, and Chromium Levels in the Blood of Street Beggars in Kirkuk Governorate, Iraq

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Abstract: Beggars constantly expose themselves to environmental pollutants, which pose significant health risks. Among these pollutants, heavy elements are important pollutants that this marginalized community in Kirkuk Governorate, Iraq in particular, and in the world in general is exposed to. Lead Pb, cadmium Cd, chromium Cr, and nickel Ni levels were estimated in the blood of beggars in the streets of Kirkuk Governorate, Iraq, and the results obtained were compared with the results of the control group. The study included 75 beggars and 75 control groups, all of whom were males and of the same age groups. Flameless atomic absorption technology was used to estimate the levels of all elements. The results showed a significant increase in the levels of all heavy elements under study in the blood of beggars, as the lead level was 14.2 micrograms/liter in beggars compared to 2.5 micrograms/liter in the control group. Cadmium was 3.1 µg/L versus 0.92 µg/L, chromium was 2.3 µg/L in beggars versus 0.67 µg/L in the control group, while nickel was 3.9 µg/L versus 0.86 µg/L. In general, the concentrations of heavy metals in the blood of adults were higher than in teenages and young children.

Keywords: Heavy Metals, Pollution, Beggars, Toxicity.

1. Introduction

Begging is a common social phenomenon all over the world. The most important reasons for the spread of this phenomenon are poor living conditions, lack of food, and lack of housing and medical treatment. Since beggars spend long hours in the streets, intersections, and in remote and industrial areas, they are constantly exposed to air, water, and soil pollution. Heavy metals are common pollutants that people in general and beggars in particular are exposed to. These elements include lead, chromium, cadmium, and nickel. Previous research and studies indicate that continuous exposure to these elements leads to many serious health problems [1]. The most important sources of lead pollution are car exhaust and industrial exhaust, and continuous exposure to lead leads to neurological problems and disorders [2]. As for cadmium, its direct effect is on kidney function and causes osteoporosis. Various industrial activities and cigarette smoke are common sources of pollution with this element [3]. Chromium is also one of the various industrial pollutants that primarily affects the competitive system in addition to causing cancer [4]. Nickel resulting from various industrial pollutants causes various skin diseases in addition to respiratory diseases [5]. Despite efforts to reduce environmental pollution, marginalized populations such as beggars are often ignored in public health assessments. As mentioned at the beginning, due to the living conditions that beggars suffer from in areas adjacent to industrial areas, landfills and traffic intersections, they are constantly and increasingly exposed to pollution compared to ordinary people [6]. (Table 1) shows the normal values of heavy elements in the blood. (Figure 1) shows the effects of heavy elements on humans [7].

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Table 1: normal values for some heavy elements in the blood

Element	Normal Value (µg/dL)	Ref.
Lead Pb	<5	CDC[8]
Cadmium Cd	<1	ATSDR[2]
Nickle Ni	<1	ATSDR[2]
Chromium Cr	<1	WHO[1]

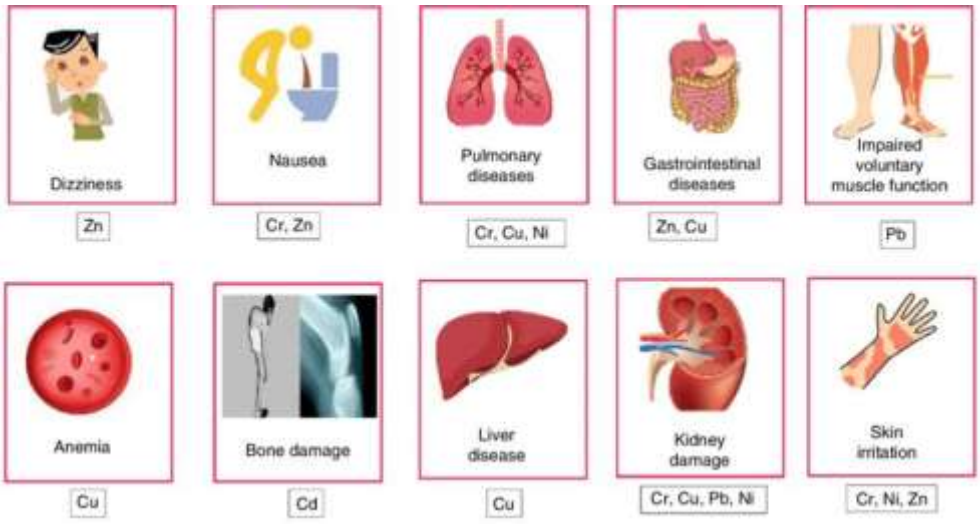


Figure 1: Adverse effect of different heavy metals in the human body

Previous studies have shown that beggars exposed to environmental pollution have higher concentrations of heavy metals. One study conducted in India found that lead levels were higher in child beggars than in the international standard [9]. In another study conducted in Cairo, Egypt, the researcher found that beggars had higher levels of both nickel and cadmium in their blood than in the control group [10]. In a similar study conducted in Brazil, the researcher found that beggars had significantly higher levels of chromium [11]. We conclude from these studies and other studies in the same scope that beggars are among the groups most exposed to heavy metals, and the reason is due to their difficult and harsh living conditions [12]. Understanding and studying the level of heavy metals in beggars in particular is of great importance to improve the health outcomes of this marginalized group and to assess the health risks they are exposed to. Therefore, this study aims to evaluate the levels of some common heavy metals (lead, chromium, nickel and cadmium) in the blood of beggars in Kirkuk Governorate in Iraq.

It is worth noting that the city of Kirkuk is considered an oil city, as it includes the Al-Shamal Refinery, which is the most important Iraqi refinery. In addition to the oil wells in Kirkuk, asphalt factories, and other factories, the city suffers from the accumulation of more than one million tons of waste in the streets of Kirkuk, according to figures published by unofficial organizations. Its emissions constitute an additional burden on what the city is suffering from as a result of oil pollution, especially in light of experts' warnings of Oil spills have increased the rate of toxic gas emissions and air pollution in the region throughout these years. On the other hand, the percentage of green spaces in Kirkuk Governorate does not exceed 2%, according to statistics from Kirkuk government departments published earlier by the Kirkuk Now website, while international standards indicate that this percentage should not be less than 15%. This caused great suffering to the people of the region, especially women, children and the elderly.

2. Materials and Methods

Study Site

Kirkuk, an ancient iraqian city dating back to 1600 BC, is located at latitude 35.47 degrees north and longitude 44.41 degrees east, 236 km north of the capital Baghdad (Figure 2). Historically built on a circular hill, it lies between the Zagros Mountains, the Tigris and Lesser Zab Rivers, and the Hamrin Mountains. The city is famous for its historic shrines, mosques, monuments, and artifacts. Kirkuk has a population of about 600,000 and is economically important due to its vast mineral resources, including Iraq's largest oil field, natural gas, and sulfur [13].

Sample Collection

The skin was cleaned using a sterile solution (isopropyl alcohol), and then a sterile needle was used to draw 5 ml of venous blood, and then the blood was placed in sealed collection tubes containing the anticoagulant (EDTA). The samples were then stored at (4-8 °C) until they were transported and stored at -20 °C until tests were carried out. The same steps were followed with healthy people. The number of beggars' samples was 75, and the number of control group samples was also 75, and for the same age groups and gender (all males).

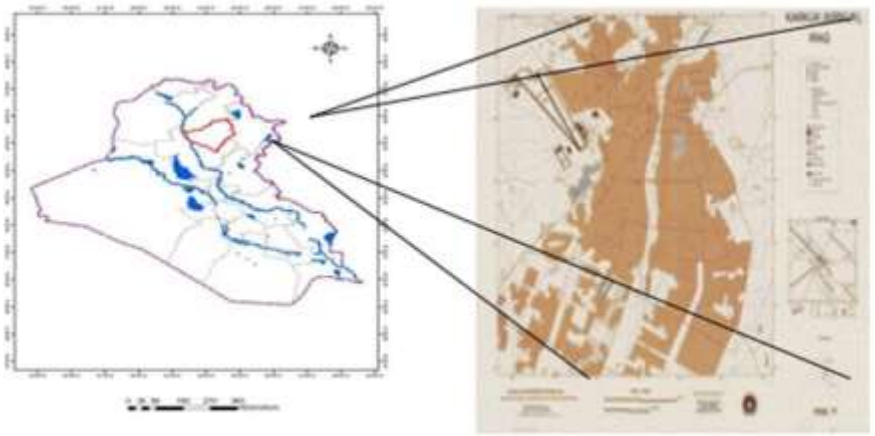


Figure 2: Study site

Analytical Techniques

Flameless Atomic absorption spectrophotometer method by the technique of Graphite Furnace (GFAAS) was used to determine Lead (Pb), Cadmium (Cd), Chromium (Cr) and Nickle (Ni). SHIMADZU AA7000 Atomic Absorption Spectrophotometer (Figure 3) was used for determination of these elements. GFAAS is one of the most important of the five techniques of atomic absorption spectrometry in which has the higher sensitivity which can be reach to the low detection limits (in ppb units) [20].

Figure 3: SHIMADZU AA7000 Spectrophotometer

Steps to analyze samples using GFAAS:

1. Sample preparation: Blood samples are processed, were acidified and diluted with 1N HCl.
2. Inserting the sample into the graphite oven: A small sample (20 µl) of the blood prepared in step 1 was injected into a graphite tube into the atomic absorption device.
3. Heating the sample: The graphite tube is heated gradually in several stages. It begins with the drying stage to remove solvents, then the calcination stage to remove organic materials, and finally the atomization stage to convert metals into free atoms.
4. Absorbance measurement: After atomizing the sample, a light beam passes through the graphite tube. Free atoms absorb light at specific wavelengths specific to each metal. The amount of absorbed light is measured using a sensitive detector. The amount of absorption is proportional to the concentration of the metal in the sample.
5. Analysis of results: Absorption values are compared with a calibration curve created using calibration solutions of known concentrations. The concentration of heavy metals (lead, cadmium, nickel, and chromium) in blood samples is calculated based on this comparison. (Table 2) Shows Operating conditions of Elements and (Figure 4) shows the calibration curves of the elements.

Table 2: Operating Conditions of Elements

Element	Wavelength (nm)	Lamp Current (mA)	Slit Width (nm)	Lighting mode
Pb	283.306	10	0.7	BGC-D2
Cd	228.801	12	0.7	BGC-D2
Ni	232.003	10	0.2	BGC-D2
Cr	357.868	10	0.7	BGC-D2

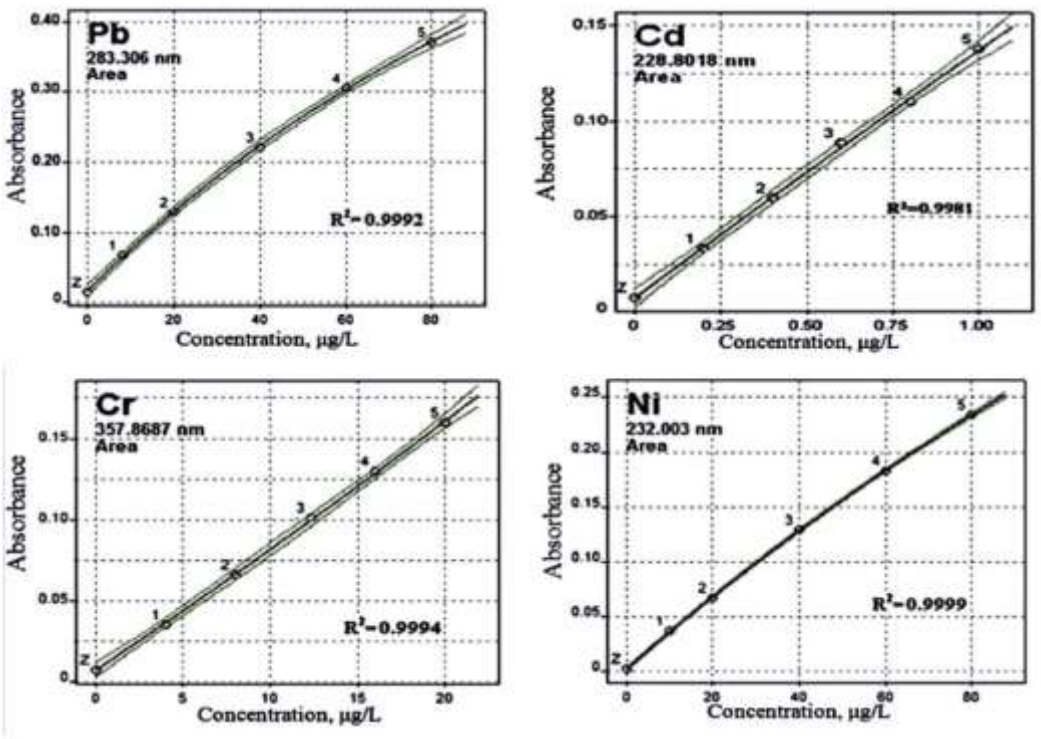


Figure 4: Calibration Curves of the Elements

Ethical Considerations

The consent of beggars and healthy people was obtained voluntarily before collecting samples, where the purpose of the study and the importance of participation were explained, while ensuring that no information about them such as name, race, and address was mentioned.

Statistical analysis

Statistical analysis of the data obtained from the study was performed using GraphPad Prism9 software and the data were statistically analyzed using T-test.

3. Results

The results obtained from this study can be illustrated in Tables 3. and Table 4. Where the T-test was used to verify statistical differences between the average concentrations of heavy metals in the blood of beggars and control group.

Table 3: The level of Elements Concentrations in the blood of both beggars group and control group

Element	Control (N=75) Mean ± SD	Beggars (N=75) Mean ± SD	P value
Lead Pb	2.5 ± 0.81	14.2 ± 3.41	<0.0001 ****
Cadmium Cd	0.92 ± 0.39	3.1 ± 0.79	<0.0001 ****
Nickle Ni	0.86 ± 0.36	3.9± 0.92	<0.0001 ****
Chromium Cr	0.67 ± 0.35	2.3 ± 0.73	<0.0001 ****

* (P ≤0.05)

Table 4: Distribution of results according to Age groups

Element	Age Group	Control Mean ± SD	Beggars Mean ± SD	P value
Lead Pb	Children (N=30) (0-12 Year)	2.0 ± 0.65	11.3 ± 2.91	<0.0001****
	Teenagers (N=25) (13-18 Year)	2.5 ± 0.86	13.4 ± 3.64	<0.0001****
	Adults (N=20) (>18 Year)	3.0 ± 0.88	17.8 ± 3.36	<0.0001****
Cadmium Cd	Children (N=30) (0-12 Year)	0.7 ± 0.33	2.2 ± 0.63	<0.0001****
	Teenagers (N=25) (13-18 Year)	0.84 ± 0.49	2.7 ± 0.72	<0.0001****
	Adults (N=20) (>18 Year)	1.21 ± 0.38	4.3 ± 0.78	<0.0001****
Nickle Ni	Children (N=30) (0-12 Year)	0.53 ± 0.29	3.1 ± 0.57	<0.0001****
	Teenagers (N=25) (13-18 Year)	0.82 ± 0.34	3.9 ± 0.81	<0.0001****
	Adults (N=20) (>18 Year)	1.2 ± 0.37	4.8 ± 1.2	<0.0001****
Chromium Cr	Children (N=30) (0-12 Year)	0.55 ± 0.29	1.9 ± 0.67	<0.0001****
	Teenagers (N=25) (13-18 Year)	0.62 ± 0.35	2.1 ± 0.70	<0.0001****
	Adults (N=20) (>18 Year)	0.82 ± 0.44	2.9 ± 0.82	<0.0001****

* (P ≤0.05)

Statistical analyzes showed statistically significant differences between beggars and healthy people in the levels of all heavy metals studied (P <0.05).

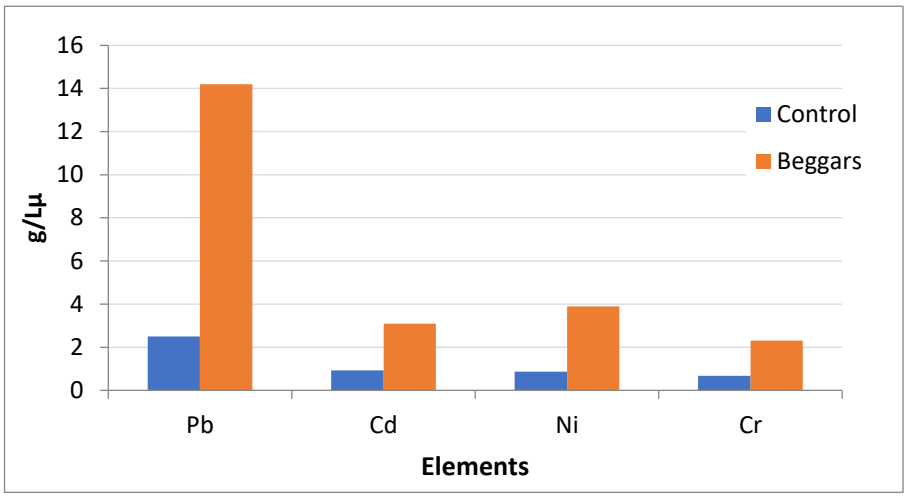
4. Discussion

Lead Pb

The mean blood lead level among urban beggars was found to be (14.2 μg/L), which is substantially higher than the average level observed in control group (2.5 μg/L) (Table 3) and (Figure 5). This finding is consistent with previous research indicating that urban environments, characterized by industrial activities and older housing with lead-based

paint, contribute to elevated lead exposure [8]. The implications of elevated blood lead levels include neurotoxicity, particularly affecting cognitive development in children and neurological function in adults [2]. This result is attributed to beggars' constant exposure to air pollution and street dust, as lead is one of the common pollutants in urban areas as a result of vehicle and industrial emissions.

Figure 5: The levels of Elements



Cadmium Cd

Urban beggars exhibited higher blood cadmium levels (3.1 μg/L creatinine) compared to control group (0.92 μg/L) (Table 3) and (Figure 5). Cadmium exposure, primarily through cigarette smoke and industrial emissions, poses significant health risks, including renal dysfunction and osteoporosis [14]. It is concluded from the high levels of cadmium that beggars are exposed to unhealthy and poor environmental and living conditions.

Chromium Cr

We conclude from Table 3 Figure 5 that the concentration of chromium was significantly higher in beggars when compared to the control group. The level of chromium in the blood of beggars was (2.3 μg/L), while its concentration in the blood of the control group was (0.67 μg/L). The industrial pollutants to which beggars are exposed and the polluted water that beggars use are the main cause of exposure to chromium [4]. The findings suggest that urban beggars, residing in areas with high industrial activity and environmental pollution, are at increased risk of chromium exposure through inhalation and dermal contact.

Nickel Ni

blood nickel levels among urban beggars (3.9 μg/L) were markedly higher compared to the control group (0.86 μg/L) (Table 3) and (Figure 5). Nickel exposure, commonly from industrial emissions and tobacco smoke, is known to cause dermatitis and respiratory issues [5]. The elevated nickel levels observed in urban beggars highlight their heightened exposure to environmental pollutants, which may be exacerbated by living conditions characterized by poor air quality and proximity to industrial zones.

In general, (Table 4) shows that the concentrations of heavy metals are higher in adults than in teenagers and children. (Figure 6) shows the concentration of lead for age groups; (Figure 7) shows the concentration levels of cadmium for age groups; (Figure 8) shows the concentration levels of nickel; and (Figure 9) shows the concentration levels of chromium.

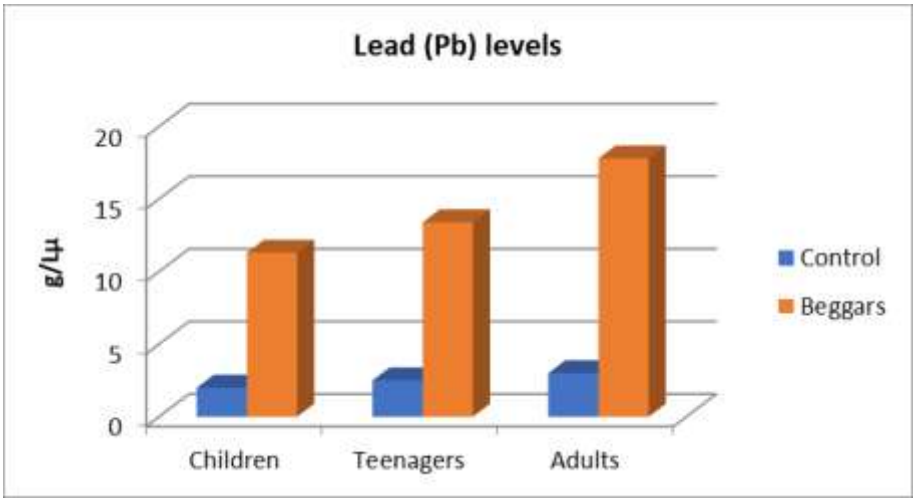


Figure 6: The levels of lead (Pb) for age groups

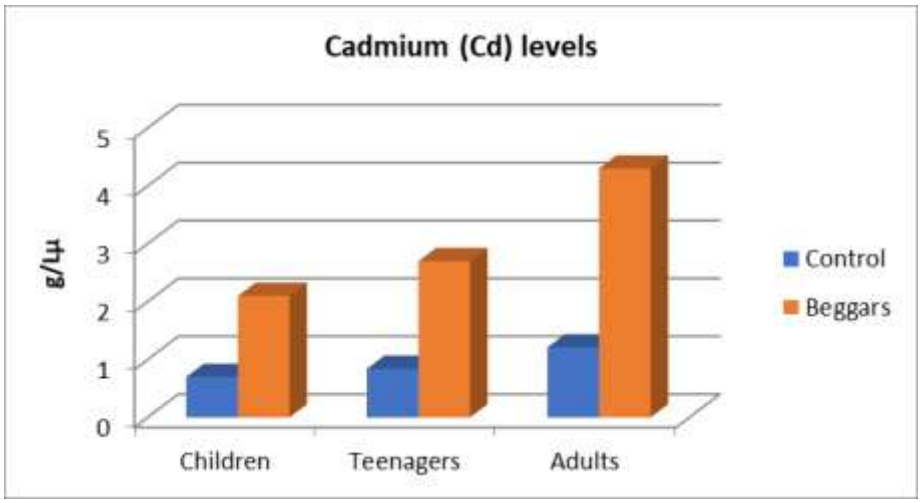


Figure 7: The levels of Cadmium (Cd) for age groups

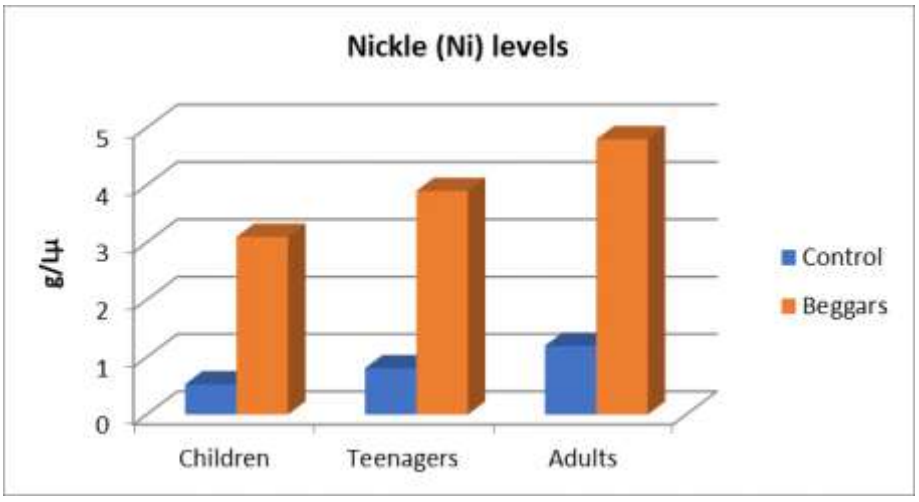


Figure 8: The levels of Nickle (Ni) for age groups

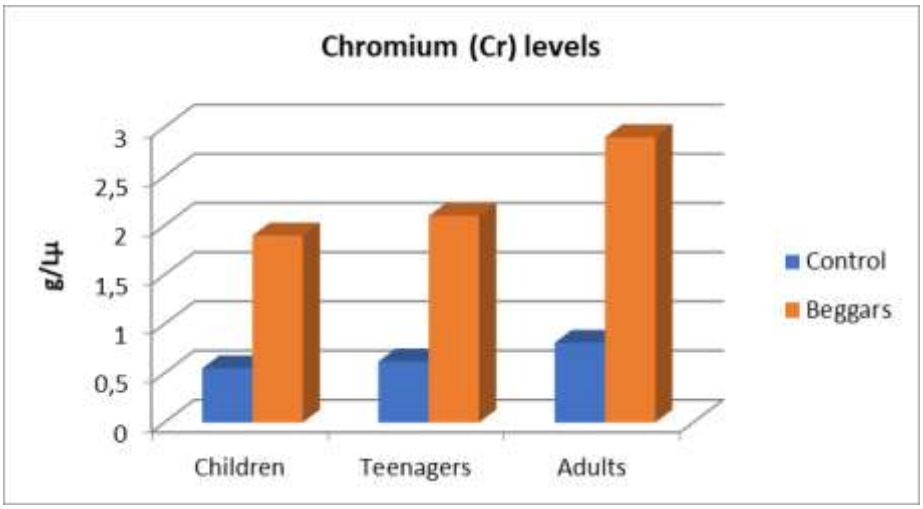


Figure 9: The levels of Chromium (Cr) for age groups

Factors associated with high concentrations of heavy metals in adults:

Higher concentrations of heavy metals in adults compared to children and adolescents can be the result of several factors related to age, growth, dietary behaviors, and environmental factors. Here are some possible reasons supported by scientific evidence:

1. Cumulative effects over time: Adults can have accumulated high levels of heavy metals over years of exposure, as a result of accumulation in tissues and organs such as bones, liver, and kidneys, which increases the availability of these elements in the body [15].
2. Use of tobacco products: Smoking and tobacco use can increase adults' exposure to heavy metals such as nickel and chromium, as tobacco products typically contain high levels of these elements and cause them to be effectively absorbed into the body [16].
3. Occupational exposure: The workplace can be a major cause of exposure of the elderly to heavy metals due to environmental pollution generated in their workplace. The most important workplaces causing this exposure are work related to mining, construction and manufacturing [17].

This study is a cross-sectional study of a specific group of people in a specific location, so other future studies should be conducted to understand the temporal changes and the amounts of pollutants to which people in general and beggars in

5. Conclusion

We conclude from this study that environmental pollutants have a direct impact on people exposed to them in general, especially those who are exposed continuously, including beggars, as a significant increase was found in the levels of the elements under study (lead, chromium, cadmium and nickel) among beggars when compared to the control group. This indicates a failure to reduce the causes of environmental pollution and a lack of health follow-up by the authorities responsible for the safety of public persons.

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