Determination of heavy metal concentrations in nails of car workshops workers in Baghdad

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Abstract: The increasing number and old models of cars in Baghdad city, Iraq leads to an increase in vehicles repair and maintenance workshops. These workshops are considered as highly polluted environments and the workers in these places are directly in contact with various pollutants and have different health problems. In this study, nail samples were taken from 60workers whom work includes cars maintenance, tires repairs, and welding. The present study is aimed to measure the concentrations of heavy metals which are associated with health hazards: Cd, Ni, Zn and Pb in nail samples of car workshops workers in Baghdad to provide some information about levels of these selective heavy metals. The concentrations of several heavy metals, such as (Cd, Ni, Zn, and Pb), in these nail samples, were determined by using flame atomic absorption spectrophotometer. The results of this study showed that welding workers recorded the highest concentration levels of heavy metals in their nail samples while car mechanics exhibited the lowest levels. Ni levels were found to be the highest in comparison to other heavy metals while Cd was recorded to be the lowest one. Results also revealed that the age of these workers might affect positively in heavy metals levels especially for Zn and Pb, 20.9, 6.8 µg/g, respectively, in age 41-50years old. In addition, Smoking among workers might contribute to increase metals concentrations, heavy metals levels were observed to be significantly higher ($p<0.05$) in smokers in comparison to non-smoking workers especially in terms of Zn and Pb. **Conclusion:** From these results this study conclude that the vehicle repairing workshop environments are regarded as important pollution sources for heavy metals and those workers in these places should be kept aware about the dangers relevant to these types of occupations to avoid health issues resulted from the continuous exposure to such dangerous pollutants.

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1. Introduction

Workers in auto shops (mechanics, auto welding, tires repair) are regularly exposed to toxic elements during performing their jobs. All workers in auto shops are exposed to a toxic release from vehicles and might also be exposed to oil leaks from storage tanks or gas spill.

Auto workers may get exposed to diesel fuel, gasoline, lead products, oil spills while in contrast vehicle painters exposed to lead and cadmium.

Previous studies indicated that the occupational exposure to heavy metals is straightly associated with different health hazards [Jarup, 2003].

Assessment of heavy metal concentrations for exposed workers is essential in order to monitor and reveal these metals impact on human health. The use of human nails as a biomarker of occupational exposure to pollutants is an alternative bioindicator of blood and urine [Wang *et al.,* 2009]. Nails are regarded as a good bioindicator for several toxic elements in which workers had been exposed to these elements for the duration of 2 to 18 months [Samanta, *et al*., 2004]. They also represent a useful tool for measuring the level of pollutants, regarding long-term exposure [Batista, *et al.*, 2008].

Metal body burden of trace/toxic elements is better reflected from trace elements contents in a nail, than those in the blood, the reason behind this is that nail gives records of relatively long periods, while blood shows transient levels that change with time. Determining trace/ toxic elements in human nails has importance in biological, medical and environment studies [Mehra and Jjuneja, 2004].

Nail tissue is rich with fibrous proteins that contain keratins as cysteine residues. Their roots are highly affected by the health status of the cells. Human nails provide a continuous record of element concentrations within the body. Nail growth in human is a continuous process during lifetime, with a range of 0.05-1.2 mm per week. The toenails growth is at a slower rate of 30-50 % and thus provide longer integration period for the metals. Moreover, nails are easier to sample [Abdulrahman *et al*., 2012].

The International Agency for Research on Cancer (IARC) classified (arsenic, cadmium, nickel, chromium, and beryllium) as human carcinogens. Heavy metals, even at a concentration less than 0.01% of body weight play an important role in the metabolism of living organisms [Mehra, R. and Jjuneja M. 2004]. Human exposure to heavy metal at

low levels could cause poisoning and diseases, while accidental exposure at a high level could cause serious effect immediately [Needham *et al*., 2005].

Occupational exposure to cadmium can lead to glomerular and bone damage and an increased risk of cancer [Jarup and Akesson, 2009]. Because metals are non-biodegradable, this makes it predictable in the environment and they cause serious ecotoxicological problems [Leblanc *et al*., 2000].

Researches shown that there are personal differences in trace element concentrations in human hair and nails according to human life or histories such as occupation, sex, age, food, habit, and social conditions [McCluggage, 1991].

Trace elements generally accumulate in the body during given periods of time and they reflect the biomedical and environmental history of the body as well as long term metabolic changes.

The importance of such examinations is related to the fact that there are several trace elements in the human body considered important in biochemical processes. Some researchers have been carried out such examination in the aim of correlating with various diseases. An excess or absence of these essential trace elements causes serious problems in the physiology of the body [Abdulrahman *et al*., 2012].

Previous studies have mentioned that the toxic effects of heavy metals, regarding the biochemical processes, includes competition for sites with essential metabolites and take the place of essential ions then reaction with SH groups and reaction with phosphate groups after the damage the cell membrane [ALLOWAY and AYRES,1997, Nikolic and Sokolovic, 2004].

Subsequently, some previous studies explained the mechanism via which heavy metal ions act by forming complexes with proteins where carboxylic acid (–COOH), amine (–NH2), and thiol (–SH) groups are involved. These modified biological molecules lose their ability to function properly and result in the malfunction or death of cells. When metals bind to these groups, they inactivate the vital enzymatic systems or affect the protein structure, which is linked to the catalytic properties of enzymes. This toxic effect may also cause the formation of radicals, dangerous chemicals that cause the oxidation of biological molecules [DHAR, 1973, Neal and Guilarte, 2012].

Cadmium is toxic at extremely low level; it is also associated with bone defects like osteomalacia, increased blood pressure and myocardial dysfunctions. In 1991, McCluggage reported that severe exposure to cadmium may result in pulmonary edema and death [McCluggage, 1991]. Smoking has also been reported to be a contributing factor to higher bioaccumulation of cadmium [Chattopadhyay and Samaddar, 1990].

The aim of the present study is to measure the concentrations of heavy metals which are associated with health hazards: Cd, Ni, Zn and Pb in nail samples of car workshops workers in Baghdad to provide some information about levels of these selective heavy metals. It is worth to mention that no previous studies concerned about this subject achieved in Baghdad.

2. Material and Methods

Sample collection

Before samples collection, all car workshops workers were subjected to a questionnaire to provide the following information: age, home address, nutritional habits, smoking and occupational exposure to heavy metals**.**

Afterward, nail samples of sixty workers were collected from different occupations in addition to nail samples of sixty control individual in Baghdad. Before sampling workers were asked to wash their hands with medicated soap and distilled water to avoid any metal contamination, then the workers were asked to dry their hands with a sterilized tissue paper to remove any external contamination. Fingernails were collected from the hand fingers of male subjects (11-50years) by using sterilized nail clippers. Samples of about 1g were collected from each worker and preserved in plastic bags till it was washed, dried, digested and converted into a water-clear solution.

Samples preparation

The followed procedure, mentioned previously [Mehra and Juneja, 2005], was applied for wet acid digestion.

Briefly, the digestion of dried nail samples were done by using 10 ml of 6: 1 mixture of concentrated nitric and perochloric acid (Bios, Europe), that kept at room temperature overnight to prevent excessive foaming, then samples were heated subsequently at temperature ranging between 160–180°C until the mixture become like clear water and less than 1 ml of the solution remained. The wet acid digestion process destroyed the organic matter and the metal in solution transformed to elemental form. After cooling each sample was quantitatively diluted up to 50mL using 0.1 N nitric and measured by Flame Atomic Absorption spectrophotometer (Sens AA, GBC Company).

Statistical analysis

Data were expressed as a mean and standard deviation and analyzed statistically using t-test.

3. Results

In the current study, table1 and Figure1 showed the effects of different types of occupations in mean

concentration of heavy metals workers nails that exposed to different levels of these pollutants.

Table 1. Mean ±SD of heavy metal concentrations in nails of occupations workers.

Occupation type	Heavy metal concentrations µg/g			
	Cd	Zn	Ni	Pb
Car mechanics	0.45±0.15*	15.7±11.10	5.7±0.39	5.5±3.77*
Repair car tires	0.38 ±0.12*	20.86±12.41	6.33±0.43*	5.6±4.058*
Auto welding	0.36±0.80*	16.2±2.74	6.5±0.60*	5.3±4.93*
Control	0±0	11.1±4.86	5.6±0.55	1.43±0.38

*significant at $p<0.05$

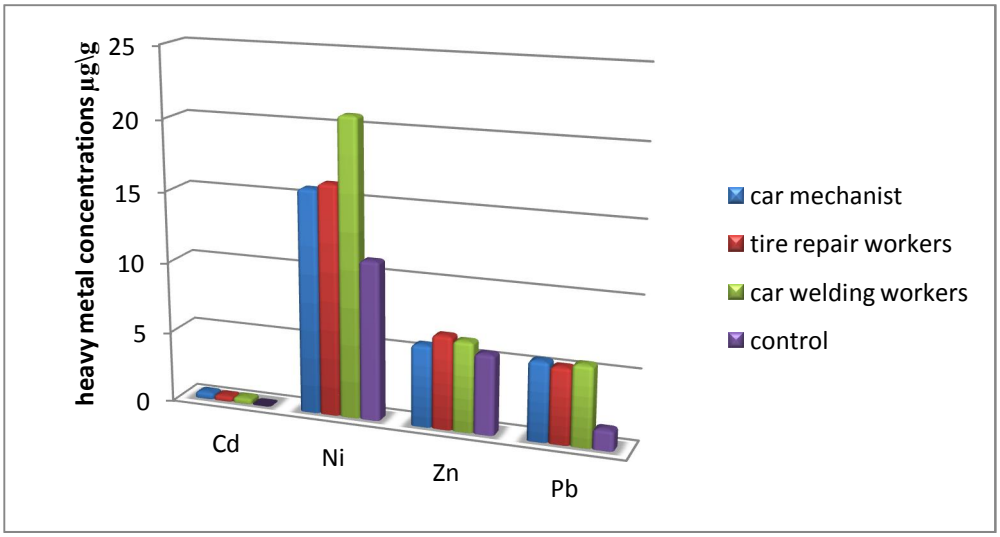

Figure 1. Effects of occupation types on heavy metals concentrations of worker nails

Regarding Cadmium (Cd) recorded concentrations in workers nails, the means of Cd were 0.45±0.15, 0.38±0.12 and 0.36±0.80µg/g for car mechanic, tires repair workers, and welding workers, respectively. The results of t-test show that the differences between mean concentrations of Cd in all types of occupations were significant at p<0.05 as they compared with mean Cd concentrations of the control group. It was indicated that the mean concentration of Zn was found to be 20.86±12.41µg/g in the nails of workers who repairing car tires and 16.2±2.74µg/g for welding workers, while car mechanic records the mean value of 15.7±11.10µg/g. T-test showed no significant differences as it compared these data with mean Zn of the control group 11.1±4.86µg/g.

Ni concentrations had the highest mean value for welding workers and found to be 6.5±0.60 µg/g followed by tires repairing workers 6.33±0.43 µg/g. Both occupations showed significant differences at p<0.05as they compared with mean Ni of the control group. Also, table 1 shows that mean concentration of Pb records high levels for all occupations and t-test results appears significant differences at p<0.05as they compared with control group.

The result shows that the concentrations of heavy metals in welding workers nails are the highest values among other occupations. This may produce by exposure to welding smoke which represents a mixture of very fine particles (fume) and gases, the fume contains toxic heavy metals such as (cobalt, cadmium, lead, zinc, nickel, chromium, manganese, beryllium) as it mentioned by the reference [Clausen and Rastogi, 1977].

The current study recorded that heavy metals concentrations were in order Ni> Zn>Pb>Cd. Antonini, refers that nickel is found inside the stream of welding fume and causes nasal lung cancer, also NIOSH classified Ni and Pb as a human carcinogen [Antonini, 2003].

Zinc oxide which emitted during welding may get inhaled to produce acute respiratory illness. Also, it may cause manifestations flue like symptom, appetite loss, nausea, vomiting, and slow digestion. Exposure to zinc by welders most often comes from the galvanized coating on metal, which is welded [Antonini, 2003].

A previous study recorded that Cd in welding fume cause inhalation lung injury. Welders use different instruments like oxyacetylene and electrical

arc welding machine to repair silencer and welding other parts of the car which produce harmful smoke. The inhalation of vapor of Nickel carbonyl by welding workers leads increasing Ni levels in their nails as it mentioned by reference [Nikolic and sokolovic, 2004].

In the current study, the car service workers ranked in the second occupation type which has a high heavy metal concentration in their nails. Their work includes changing a tire, repairing tire punctures, changing engine oil, cleaning carburetor filters, and changing oil filters, they exposed during their works to car exhaust and petroleum fuel smoke that comes from machinery operation [Caldwell *et al*., 2000] this may cause adverse health effects like eyes and respiratory injury as it mentioned in reference [Brosseau *et al*., 2014].

Results of the current study showed that the car mechanic records the lowest concentrations of heavy metals in their nails which may be produced by the type of their work. Their work includes dissembling and assembling parts such as car engine and other related vehicle parts. Oluwagbemi, refers that car mechanics workers exposed to heavy metals and polyaromatic hydrocarbons, resins and solvent. The risks in garages depend on many factors like individual susceptibility, the source of exposure, duration of exposure as well as the type of exposure [Oluwagbemi, 2007]. Car mechanics workers exposed to lead during dissembling car engine parts, lead poisoning and death cases were records by inhaled and ingestion of gasoline. Must of workers suck petrol and washed their hands with it, which leads to absorption of tetraethyl ad by mucosa and elevated blood levels [Oluwagbemi, 2007].

Table 2 and figure 2 summarize the mean and standard deviation values of heavy metals in nail samples taken from auto shop workers classified according to their age.

Table 2. Mean ±SD of heavy metal concentrations in nails classified according to their age.

Age groups/year	Heavy metal concentrations µg/g			
	Cd	Zn	Ni	Pb
11-20	0.44 ±0.14	10.8±4.06	6.04±0.53	4.2±2.17
21-30	0.45 ±0.20	21.05±18.66*	5.93±0.52	5.95±3.88
31-40	0.38±0.08	16.46±4.14*	5.76±0.25	6.46±4.00
41-50	0.40±0.08	20.9±15.61*	5.87±0.60	6.8±5.50

*significant at $p<0.05$

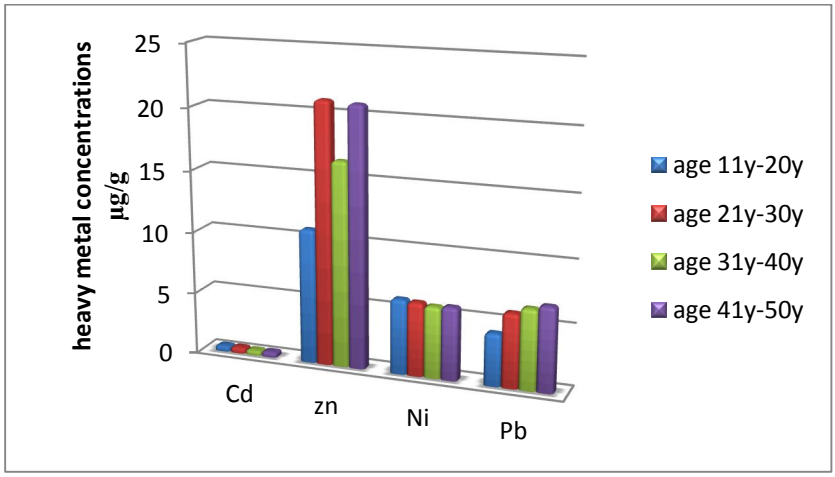

Figure 2. The relation between workers age and heavy metals concentrations in their nails.

The mean value of cadmium was the highest in age groups of 21-30 years with a mean of 0.45 ±0.20µg/g. Furthermore, a t-test showed no significant differences p>0.05 between all age groups. While the lowest mean value of Cd was in the age group of 31-40 years.

Concerning Zn, the age group of 21-30 years recorded the highest mean value of 21.05±18.66µg/g as it compared with other age groups and the results of t- test shows significant differences at p<0.05 among all age groups. While the mean concentrations of Ni appear to be with closed value in all experimental

groups and the results of t- test shows no significant differences p>0.05between these groups.

The mean concentrations of Pb were found to be 6.8±5.5µg/g in nails of workers with age group of 41-50 years this value represents the highest among other age groups while the lowest value of Pb found in age group11-20 years old, also t-test showed no significant differences p>0.05 between all age groups.

Results of the current study showed that there is a positive relationship between age groups and heavy metals concentrations in nails especially Zn and Pb. Car workshops workers exposed to lead and other heavy metals by inhaling car exhaust, welding fumes, petrol vapor, and grease. The risks increase by increasing the site and type of work as well as duration of exposure to these pollutants as it referred by reference [Clausen and Rastogi, 1977].

In Baghdad, most of the car worker shops are open and lay beside roads this make workers exposed continuously to heavy metal pollutants from different sources, which accelerate the accumulation of heavy metals in body tissue. The long-term exposure to these pollutants has enough to change physiological process in workers body [Ahmed, 2001]. Hasan *et al.*, mentioned in their study that the occupational exposure is very complex because many reasons contribute to absorption and depletion of metals like illness, poor diet as well as person susceptibility [Hasan *et al.*, 1995]. Or due to their specific metabolism processes which cause to different levels of intake and accumulation in workers body tissues [Wolfsperger *et al*., 1994].

Table 3 shows a comparison between smoking and non-smoking (control) groups concerning heavy metal concentrations. It was noticed that these concentrations are much higher than those of control groups. When compared the heavy metal concentrations in the smokers of car mechanic with non-smokers for Cd, Pb and Zn the means value appears high in smoker workers, while Ni shows closed value in each of smokers and non-smokers.

Table 3: Mean ±SD of heavy metal concentrations in nails of auto shop workers divided according to their smoking habit.

Occupation type with smoking habit	Heavy metal concentrations µg/g			
	Cd	Zn	Ni	Pb
Car mechanics				
Smoking	0.5±0.16*	18.4±15.67	5.7±0.54	6.9±4.80*
Non-smoking	0.43±0.14	14.1±7.3	5.7±0.2	4.69±2.85
Repair car tires				
Smoking	0.44 ±0.05*	45.2±26.3*	6.55±0.77*	12.6±0.77*
Non-smoking	0.36±0.15	8.7±3.78	6.22±0.26	4.65±1.67
Auto welding				
Smoking	0.42±0.02*	18.2±1.41*	7.5±2.12*	9.5±2.12*
Non-smoking	0.32±0.05	15.7±3.76	6.8±0.49	2.5±0.70
Control	0	11.19±4.68	5.61±0.55	1.43±0.38

*significant at $p<0.05$

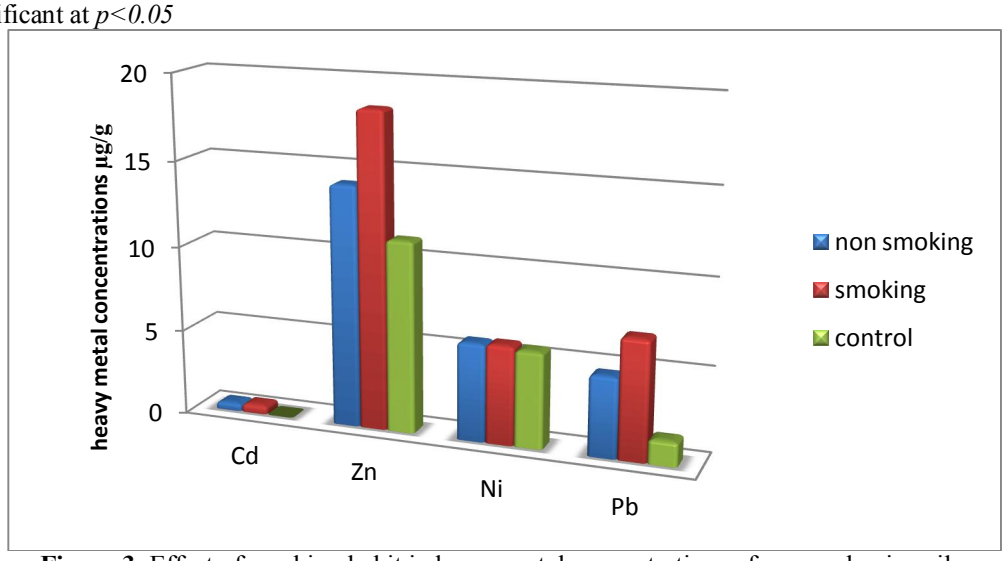

Figure 3. Effect of smoking habit in heavy metal concentrations of car mechanic nails.

When they compared with control groups, t-test shows significant differences at $p<0.05$ for the heavy metals Cd and Pb while for Zn and Ni there is no significant differences at $p>0.05$ as they compared with control group (figure 3).

The smoking tires repairing workers appears to have high concentration means in all examined heavy metal (Cd, Zn, Ni and Pb) as they compared with the mean concentration of the same metals in nonsmoking workers, (figure 4). Furthermore, t-test shows significant differences at $p<0.05$ between experimental groups and the control group (table 3).

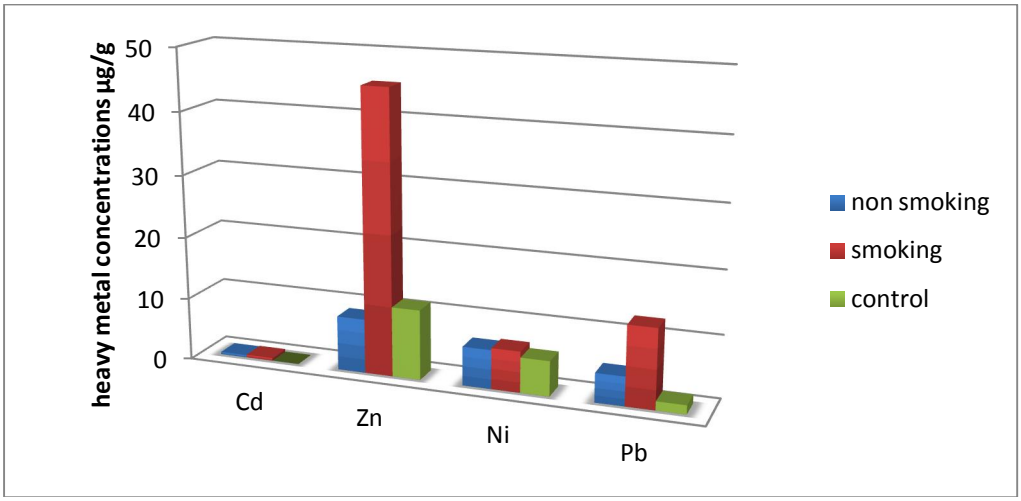

Figure 4. Effect of smoking habit on heavy metal concentrations of tires repairing workers

For welding occupation the smoking workers record high mean values in all examined heavy metals (Cd, Zn, Ni, and Pb) with (0.42, 18.2, 7.5 and 9.5 µg/g) respectively when they are compared with other heavy metal means values in non-smoking workers (fig. 5) and the differences between experimental groups and control group appears significant at $p<0.05$in all examined heavy metals (Table 3).

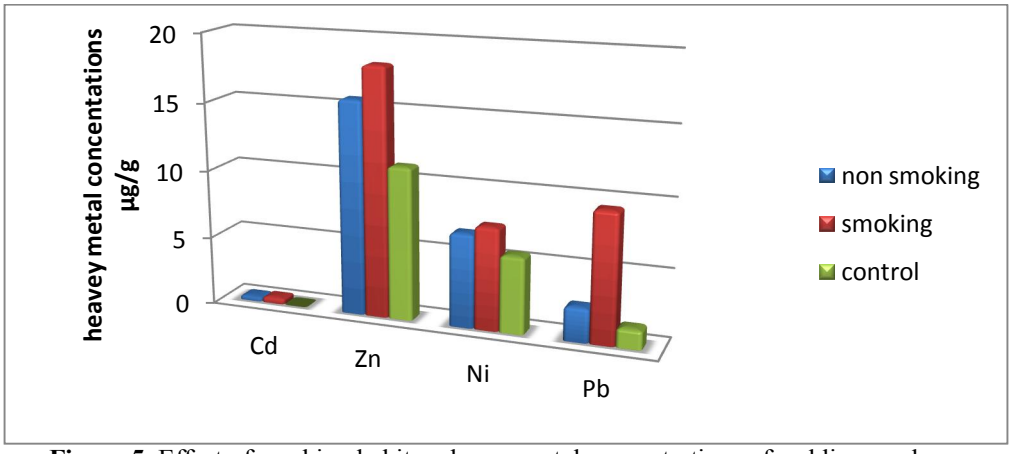

Figure 5. Effect of smoking habit on heavy metal concentrations of welding workers.

Our study found that smoking habit among workers of all type of tested occupations high leads to an increase in the levels of Zn and Pb concentrations in their nails. World health organization (WHO) refers in their reports that the concentrations of Pb in workshop workers nails is 0.2µg/g [Rashed and Hossam, 2007]. Results in the present study record high levels of Pb that reach to 9.5µg/g in smoking welding workers, 7.6µg/g in car services workers and 6.99µg/gin car mechanics. A Previous study referred that the higher cereal intake of Pb and Cd leads to elevations in workers nails tissue [Sera *et al*., 2002], while Ni concentrations elevated in nails due to great fast food consumption which is rich in hydrogenated oil [Ashraf *et al*., 1995].

4. Discussions

Nail samples for welding workers recorded the highest concentration levels of heavy metals while car mechanics showed the lowest levels.

Heavy metals levels increase with increase the age years of workers, especially for Zn and Pb. Smoking habit among vehicle workshop workers contributed to increased metal concentrations.

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