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# Heavy Metals concentrations in Mobile Phone Recharge Cards in Iraq.

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**ABSTRACT**

This work was designed to study the content of silver film materials on mobile recharge cards in Iraq, especially 79.17 % of the mobile users used their fingers nails to scratch the film in order to reveal the Personal Identification Number PIN as well as, about 7% of these users have different dermatological signs during the used of mobile cards, also, about 93%of the consumers wanted to know the chemical composition of coating materials. The concentrations of heavy metals Fe, Zn, Ag, Cu, Ni, Cd and Cr in mobile phone recharge cards of two major companies (designated as A and B).Coating materials were carefully scratched using a scraper into a special plastic tubes. The coatings were acid digested for total metals concentrations by Atomic Absorption Spectrophotometer (AAS) technique. The total metals concentrations (in part per million ppm) were as follow: Fe (142.803, 101.349 ppm), Zn (7.039, 9.126 ppm), Ag (4.706, 1.750 ppm), Cu (0.674, 0.303 ppm), Ni (0.380, 0.190 ppm), Cd (0.136, 0.075 ppm), and Cr (0.026, 0.003 ppm) for samples A and B respectively. For both the coatings analyzed, Iron and Silver elements had the highest concentration, while Cr metal had the lowest concentration. The content of metals was found to be in the order of Fe> Zn> Ag > Cu > Ni > Cd >Cr. Our results revealed that Iron and Silver concentrations were more than the recommended limit. As well as, it should be noted that Cu, Zn, Ni, Cr as well as Cd metals were present in the substances and despite their low concentrations; they may have a toxic effect when ingested frequently, with children being at higher risks. Therefore, the uses of silver coated recharge cards pose serious concern to humans and the environment through adhering of silver coatings on mobile cards on nails or under the fingers so, public awareness on proper handling and disposal of recharge scratch cards was recommended.

**Keywords:** Mobile phone, Recharge cards, Heavy metals, Silver coat, Iraq

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## INTRODUCTION

The term heavy metal refers to any metallic chemical element that has a relatively high density and is toxic or poisonous at low concentrations. Heavy metals are natural components of the Earth's crust. They cannot be degraded or destroyed. To a small extent they enter our bodies via food, drinking water and air. As trace elements, some heavy metals (e.g. copper, selenium, zinc) are essential to maintain the metabolism of the human body. However, at higher concentrations they can lead to poisoning (1).

Heavy metals have been shown to abound in several environmental matrices including water (2), plants (3),soil (4), air particulates (5), cosmetics(6) and even bio-logical tissues and organs such as Iron-hemoglobin, myoglobin, Cobalt coenzymes, Zinc in enzymes, Chromium Cr3+ in enzymes, Copper co-factor in enzymes(7).

The major routes of heavy metal uptake by man are food, water and air. Although some metals such as Cu, Zn and Mn are essential for growth and well-being of living organisms including man, they are toxic at higher concentrations (8). Infact, epidemiological evidence revealed that pollutants such as metals at even normal concentrations have adverse effects on human health. Other metals such as Pb, Cd and Hg are non-essential for metabolic activities and are toxic (9). Heavy metals such as Ag, Cd, Pb, Zn, Mn, Cu, Fe and Cr are found to be the major cause of nephritis, anuria and extensive lesions in kidneys (10). Since many people use their finger nails to scratch recharge cards, it becomes a route for entry of heavy metals into human body(11).

Mobile telephony such as the Global System Mobile (GSM) was introduced into Iraq over a decade ago, in 1983 (Zain Al-Iraq, Acia cell, Korek, Itsalona, Umniah..etc.). The principal method through which the subscribers of the various telephone companies credit their phones is through paper card vouchers (with dimensions varying from 3.7*0.7 cm for Asia Cell mobile cards 5$ and 3.7*0.5cm for Zain cards 5$) popularly called “recharge cards” in Iraq. An estimated 2 million spent paper vouchers cards are generated daily (12). The vouchers are either composed entirely of plain thin white paper, particularly the lower denomination vouchers, or are made up of cardboard-like compressed paper (hence the appellation “card”) as is the case with the higher denomination vouchers. These cards are coated with glossy water-resistant material, which protect the text printed in infrared ink from fading or being washed off easily. The card is layered with a 'silver' coating which when scratched off, reveal a PIN (Personal Identification Number) printed underneath. The silver coatings have been shown to contain heavy metals such as lead, copper, cobalt, nickel, and manganese (13).

Assessing the health risk associated with this metals is important since it is a common habit among people using recharged cards to use their finger nails to scratch the recharge card coating without proper washing of the nails thereby contributing a direct dermal contact with the heavy metal content of the coating films. Also in the course of removing the coating or scratching, the scratched particles are carelessly dispersed in the environment. Some of the particles contaminate the air around, while in most cases, larger percentage are returned into the ground where they are subjected to a number of processes that influences their mobility in the soil as well as their potential to contaminate ground water. Further transformations may lead to contamination of farm products and fresh water plants and animals, and finally get into the food chain (14).

**Aim of the study:**

One of the present day exposure routes to heavy metals is through the use of mobile phone recharge cards which are becoming increasingly popular among the young and the old, It has been observed that most people use their fingernails to scratch off the thin film opaque substance in order to reveal the PIN on the recharge cards for the recharging of their GSM lines. Mostly, these acts of scratching are done subconsciously or trivially without resorting to washing of hands with clean water and soap. Therefore, it becomes necessary to investigate the presence and levels of heavy metals Silver(Ag), Cadmium(Cd), Zinc (Zn),Iron(Fe),Copper(Cu),Chromium(Cr) and Nickel(Ni) in mobile phone scratch cards and compare the levels with permissible limits.

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## MATERIALS AND METHODS

**The present study was consisted from two parts:**

*I- A descriptive analytic study for using of mobile phone recharge cards in Iraq.*
*II- Elemental analysis of opaque thin film coating of mobile phone recharge cards.*

### A- Mobile telephone in Iraq:

A sample of 715 subjects (male 345 or 48.251% and female 370 or 51.748%) was randomly selected among population of Al-Najaf government as users for mobile telephone. A questionnaire with optional questions was designed for this study from April 2016 to March 2017. Questions forma was consisted of 8 parts related to using of recharged mobile telephone cards in Iraq.

1- Name of mobile phone companies (Zain Al-Iraq, Asia Cell, Omniah and Korek)
2- Number of mobile phone lines (1,2,3,4 and More)
3- Number of recharged mobile cards consumed per month? (1,2,3,4 and More)
4- The way of scratching off the coated film to reveal the PIN (Fingernails, Special part in mobile card and Special scraper)
5- Any epidemiological signs were found during the use of mobile researched cards? (Yes, No)
6- What are these signs?(redness and rashes, itch, pigmentations and scars and blisters)
7- Did you have any idea about the chemical nature of the film coated the PIN? (Yes, No)
8- Did you like to know the chemical nature and hazards of this coated film? (Yes, No)

### B- Elemental analysis of thin coating film of mobile recharge cards:

**Sample collection:**

Mobile phone recharge cards from two major recharge cards producing companies in Iraq were used for this study, the first one was Zain Al-Iraq and the second one was Asia Cell company. The companies are denoted as A and B, respectively. The recharge cards commonly and commercially available are in the price denominations of 5 and 10 $ respectively, with the 5$ denomination most purchased by a greater percent-age of the population. More than hundred (100) samples of each denomination were obtained from the recharge cards sellers and retail shops in Al-Najaf city –Iraq from March 2016 to March 2017. During the analysis, the silver coatings were carefully scratched off using a stainless steel scraper into a polythene bag. Adequate care was taken during sample collection to avoid cross contamination.

**Reagents used and treatment of containers:**

Reagents used were of analytical grade (Sigma, Merck and BDH chemicals) and include hydrochloric acid (HCl) and nitric acid ($HNO_3$). Solutions were prepared using doubly distilled-deionised water. All glassware used were washed in detergent solution, rinsed several times with distilled-deionised water and then soaked for 48 h in 10% $HNO_3$, after which they were rinsed further with distilled-deionised water and dried overnight in an oven at a temperature of 120◦ C before used(15).

**Sample digestion and analysis**

The samples were digested with a mixture of HNO3 and HCl for metal determination. 0.05 ± 0.0010 g of the silver coatings sample was placed in a digestion tube and predigested using 10 ml of concentrated HNO3 at 105°C until the liquor was clear. Then 5 ml of HCl was added and digested for 1 h until the liquor became colorless. The samples were evaporated slowly to almost dryness, cooled and dissolved in 5 ml of 1 M HNO3. The digested samples were filtered through Whatman's No. 1 filter paper and diluted to 50 ml with distilled-deionized water(15).

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**Total metals determination (AAS analysis):**

Metal determination using the procedure described by Okunola*et al*. (13). The sample solutions were analyzed for concentration of Ag, Cd, Ni, Fe, Cu, Cr and Zn using Flame Atomic Absorption Spectrophotometer AAS (Shimadzu). The equipment was calibrated using working standards 0, 2,4, 6, 8 and 10 ppm of each metal serially prepared from their 1000 ppm reference standards obtained from Fisher's AAS Inc., USA. Concentrations of the working ranges were obtained by diluting an appropriate volume of the stock solution with ultra -pure water. The equipment was previously standardized and corrected for background metal impurities using a blank determination. The samples were analyzed in triplicates.

## RESULTS AND DISCUSSION

**Descriptive study of mobile phone in Iraq:**

The results of mobile recharge cards obtained from the descriptive study are represented in Figures (1A-H).It was shown from Figure (1A)) that the Zain Al-Iraq and Asia Cell companies were the most common mobile phone companies in Iraq depending on number of users (78.18% and 46.85% respectively).On the other hand, Figure (1B) revealed that the most consumers of mobile phone have more than one mobile lines with higher percentage for double lines (43.64%).

In Figure (1C), we found that 34.55% of mobile users consumed about 1-2 mobile recharge cards in one month and 12.17%consumed more than four cards per month. It was discovered from the present work that there was a very high percentage of mobile cards using their nail fingers to remove the silver coating film to reveal the PIN with a percentage of 72.17%, whereas, only 34.41% of the mobile users used special part found within the mobile cards.

About 7.69% of the users notice the presence of some dermatological signs on their hands during the use of recharge cards (Figure 1D), which include 4.34% pigmentation , 3.36 % itch and 1.96% redness and rashes signs, while about 90.35% have no sings (Figures 1E&F).

The present research revealed that 79.30% of the mobile phone users didn't have any idea about the chemical nature of the silver coating layer (Figure1G), as well as, 93.01% of them like to know the chemical nature of this silver layer (Figure 1H), which giving a strong inducement to analyzed this coating film chemically in order to revealed its constituents.

**The concentrations of heavy metals in mobile phone rechargeable cards coating:**

The AAS results of the total metals concentration in different major silver coated recharge cards A for Zain mobile cards and B for Asia cell are presented in Table (1) and Figure(2).Amounts of elements (Ag, Cd, Zn, Fe, Cu,Cr and Ni ) expressed in part per million(ppm).

The bar chart shows that Iron metal was the most abundant element in the substances, the next abundant element found in the substance was Zinc metal while, Cadmium and Chromium metals have the lowest concentration for both samples A and B. The study revealed that the results for samples A and, B were very similar; it seems that the GSM companies make use of substance with same elemental composition on their respective scratch cards. Also, the distribution concentration of the metals were found to be Fe > Zn >Ag >Cu> Ni> Cd>Cr for Samples A and B in the order of decreasing magnitude. Very high Fe and Ag concentrations recorded in this work is not surprising as Ag and Fe itself is used as support for the electronic films coated on the recharge cards. Recently, its use in recharge cards coating has been discouraged due to the associated cancer related diseases (16, 17).

Presently, there is no set standard either locally or internationally for heavy metal concentration in recharge cards coatings; it is therefore difficult to ascertain if the values obtained in this study especially from the AAS results are too high or too low. Depending on the literatures, the allowable set standards were 0.1, 0.1, 50, 0.05, 1.0 and1.0 mg/L for Pb, Mn, Zn, Cr, Fe and Cu respectively in drinking water ; and 70 mg/ kg Pb, 1–10 mg /kg Cd, 200–600 mg/ kgZn and 100 mg/ kgCu in soil (18-20).

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The results showed that the concentrations of Iron (Fe) were the highest levels (142.803ppm and101.349 ppm in A and B samples, respectively) which were exceeded the recommended limit value (1.0 mg/l in drinking water), this implies that the recharged cards are sources of iron in the environment and its level pose health and environmental concern. On the other hand, Silver (Ag) level was highest in sample A(4.706ppm) and least in B sample (1.750ppm), the results reflected that Silver values were far above its allowable limits (0.1mg/l in drinking water).Heavy metals such as Ag, Cd, Pb, Zn, Mn, Cu, Fe and Cr are found to be the major cause of nephritis, anuria and extensive lesions in kidneys (10).

The concentrations of Zinc (Zn) were 7.039ppm in A and 9.126ppm in B, the results of Zn obtained were below their recommended level in soil ( 200-600mg/Kg ) and drinking water (50mg/l).Zinc can cause eminent health problems, such as stomach cramps, skin irritations, vomiting, nausea and anemia. However, zinc (Zn) is important for the physiological functions of living tissue and regulates many biochemical processes, but too much Zn can cause imminent health problems (21).

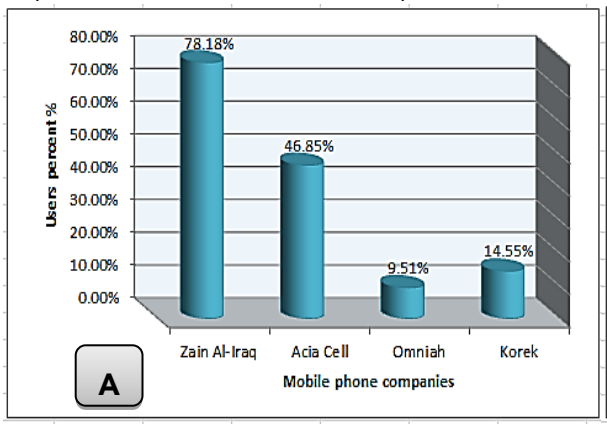
The levels of Copper (Cu) obtained from the analysis were 0.674ppm for A and at least level in sample B (0.303ppm), this shows that the values of Cu obtained was below the permissible values in soil (100 mg/kg) and drinking water(0.1 mg/l).Copper manifests at low concentrations and exposure to copper compound dust can cause dermatitis, discoloring of the skin, irritation of the nose and throat, while chronic exposure can cause brain damage. Copper (Cu) was essential work in animal metabolism but excessive ingestion of copper brings about serious toxicological concerns, such as vomiting, cramps, convulsions, or even death (22).

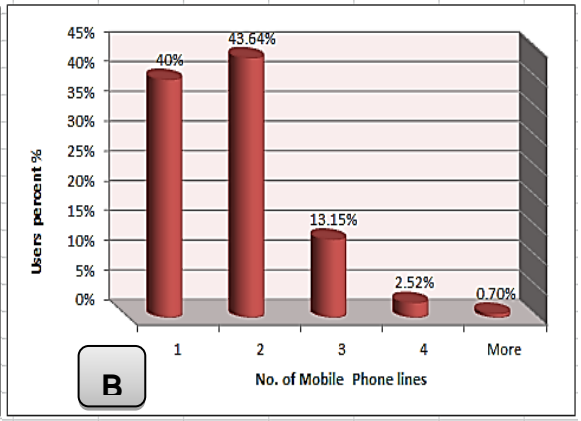
Nickel (Ni) values obtained were 0.380ppm in A and 0.190ppm in B, it's below than the recommended value in soil (1.05 mg/g).Nickel(Ni) exceeding its critical level might bring about serious lung and kidney problems aside from gastrointestinal dis-tress, pulmonary fibrosis and skin dermatitis; Ni is also known as a human carcinogen (23).

The concentrations of Cadmium (Cd) were about 0.136 ppm in A and 0.075ppm in B, showing that the levels were below the allowable limits in soil (1-10mg/kg) .Chronic exposure of cadmium (Cd) results in kidney dysfunction and high levels of exposure will result in death. Some of the metals like Cd and Pb are capable of injuring the kidney and cause symptoms of chronic toxicity, including impaired organ function, poor reproductive capacity, hypertension, tumors and hepatic dysfunction (24, 25).

The concentrations of Chromium (Cr) were 0.026ppm in sample A and 0.003ppm in sample B, these levels were below the permissible limit value (0.05mg/l) in drinking water, and 1.0 mg/kg in soil.Dermal exposures to chromium have been associated with skin rashes, kidney and liver damage, lung cancer, respiratory problems and even death (26).

At present, there are very scarce or limited literatures in Iraq on heavy metals in recharge cards silver coatings to compare results obtained in this study with, so, the results were compared with others available literatures. Different researches were investigated the elemental analysis for coating materials of mobile phone recharge cards in major brands in Nigeria, the results indicated the presence of Cd, Pb, Cu, Cr, Ni, Co, Fe, and Zn heavy metals in all brands (13,14,26), also Bichi *et al*., (11)showed that the substances used to cover the PIN in Nigeria contained metals such as titanium, potassium, iron, calcium, and zinc, they also found complete absence of radioactive isotopes in the substances.



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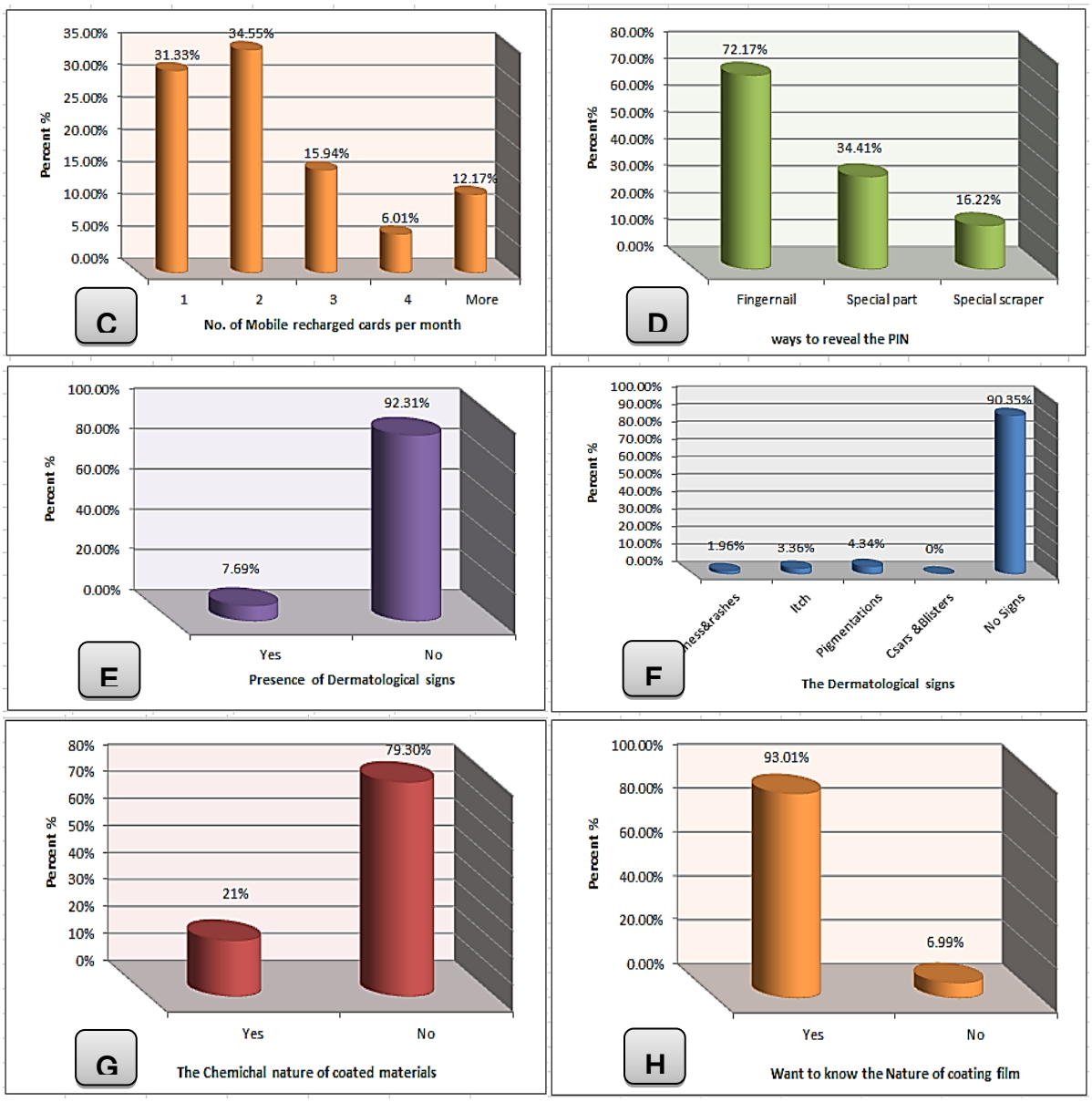


**Figure 1: Results of the descriptive study of mobile phone in Iraq.**

**Table 1: Concentration of heavy metals (ppm) in mobile recharge cards:**

| Heavy metals | Concentrations(ppm) | |
|---|---|---|
| | A(Zain mobile cards ) | B(Asia Cell mobile cards) |
| Fe | 142.803 | 101.349 |
| Zn | 7.039 | 9.126 |
| Ag | 4.706 | 1.750 |
| Cu | 0.674 | 0.303 |
| Ni | 0.380 | 0.190 |
| Cd | 0.136 | 0.075 |
| Cr | 0.026 | 0.003 |

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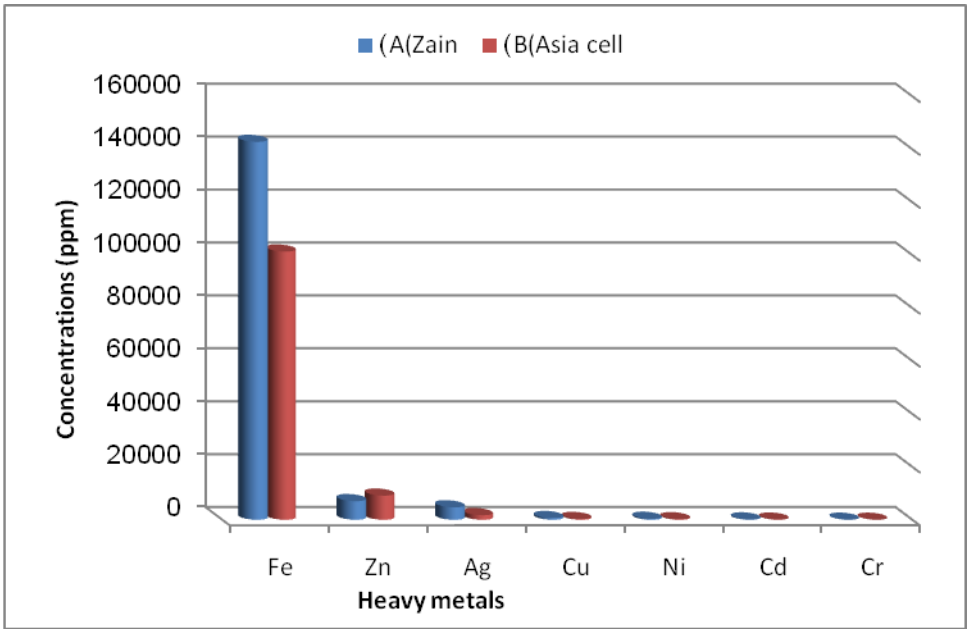


**Figure 2: Bar chart for the concentration of elements in mobile recharge cards in ppm.**

## CONCLUSIONS

- The presence of heavy metals, especially Fe, Ag, Cd, Cr, Zn, Cu as well as Ni in mobile phone recharge cards sold and used in Iraq.
- The recharge cards contain high levels of Fe and Ag metals which exceeded the recommended limits,however, levels of Cu,Zn,Cd,Cr, and Ni elements were within the allowable values, they may be toxic if ingested at higher concentrations.
- Generally, higher concentrations of heavy metals were found in sample A (Zain mobile cards) with the exception of Zn metal as compared with sample B(Asia cell mobile cards).
- The data obtained in thisstudy was relatively high and alarming to human health for a product like recharge cards that is consumed daily by many cell or mobile phones users in Iraq.

**Recommendations:**

- Using fingernails to scratch off the substance is not a safe practice. Blunt razor blade or any special scraper should be used instead.
- Care should be taken not to contaminate our foods and drinks with the substance to avoid ingestion of the substance.
- Warning statements concerning this opaque thin film coat should be clearly written on every recharge card by all service providers.
- Further studies should be carried out to evaluate the another elements such as Pb, Mn, Co and Al also another radioactive isotopes that lead to inducement of cancer and related ailments as well as some non-metal elements which may be toxic if ingested at a high concentration.
- Apart from that, using the printed numbers to top up the mobile phone account should be encouraged since this does not present metal exposure hazard and is economical.

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