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Evaluation of Health Risk Associated With Heavy Metals From Silver Coatings of Recharge Cards In Harare.

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ABSTRACT:*The study aimed to evaluate the health risk of the population that consume silver coatings of recharge cards of majortelecommunication companies designated as A and B. The silver coatings were scratched using a stainless steel spatula into a beaker and acid digested. Analysis of the samples was done using an ICP-MS to quantify the concentrations of Cr, As, Pb, Cd, Cu, Mn, Ni and Zn. The concentrations were in the range ND for Cd and As to 28.708ppm for Cu corresponding to recharge cards for company A whereas for B concentration range from not detected for Cd to 72.5073ppm for Cu. EDIvalues ranged from (1.65E-6 to 4.25E-9) and (4.17E-6 to 3.82E-10) for all the metals under study from recharge cardsof companies A and B respectively. EDIvalues follow the order: Cu > Zn > Mn > Ni > Cr > Pb > Cd = As for company A and Cu > Mn > Zn > Cr > Ni > Pb > As > Cd for company B. The hazard index of the metals under study wasbelow one for the two companies indicating that the exposure to these metals is not harmful to health.*

KEYWORDS -*estimated daily intake, health risk assessment, metal, hazard index, silver coatings*

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INTRODUCTION

Heavy metals behaviour, bioavailability and toxicity depends on their different forms[1]. This has resulted in this researcher getting interest in analysing the heavy metals in recharge cards coatings and their toxicity to human beings. Many telephone subscribers use their fingernails to scratch the silver coating of recharge cards. Because many of these people will not wash their hands thoroughly after this, they risk being contaminated by heavy metals contained in the coatings through ingestion [2].

Although some metals are essential to humans, if certain levels are exceeded they become detrimental [2]. They have been found in large amounts in water, plants, soil, air particles, cosmetics and biological tissues and organs [2], [3]. Due to their toxicity, persistence in the environment and bioaccumulation in human tissues, heavy metals have been regarded as most dangerous[4], [5].

Within acceptable limits, zinc is good for the physiological functioning of the tissues of living organisms though above the threshold values it causes stomach cramps, irritation of the skin, vomiting [2], oxidative stress[6]. Copper is essential at lower limits although at higher levels it causes anaemia, damage of liver and kidneys and irritation of intestines. Lead is not essential to human beings and it causes malfunctioning of the kidney, liver and the human brains[3], [5], [7], [8]. Intake of lead causes the inhibition of the synthesis of haemoglobin, reproductive system and cardiovascular system [5]. Cadmium bio-accumulates in the human body and causes malfunctioning of the kidney, while excessive contamination levels may result in death. Nickel causes gastrointestinal distress, lung and kidney damage and also cancer.Although chromium (III) is beneficial to the human body at low levels, Chromium (VI) is carcinogenic. According to Patrick Iwuanyanwu & Chinyere Chioma, (2017), deficiency of chromium causes poor growth and inefficiency in the metabolism of proteins and glucose[10]–[14].

Many people use their finger nails to scratch the airtime recharge cards but do not wash them afterwards. The finger nails becomes the route of exposure of metals in silver coatings of recharge cards. The objective of this study is therefore to evaluate the levels of heavy metals (Cu, Zn, Cr, Pb, As, Mn, Cd and Ni) in silver coatings of some recharge cards sold in Zimbabwe and subsequently assess their health risk on humans.

MATERIALS AND METHODS

2.1 Sampling and analysis

Mobile phone recharge cards of twomajor telecommunicationoperators were periodically bought from retail shops around Harare. The silver coatings of one dollar recharge cards of the two companies were scratched using a stainless steel spatula. The samples were stored in plastic bottle containers labelled A and B.

2.2 Sample digestion and analysis

The glassware and other materials used for the digestion and analysis of the samples were cleaned using liquid soap, rinsed with distilled water and subsequently soaked in 10 % nitric acid for 24 hours prior to rinsing with deionised water. Analytical reagents grade chemicals were used. Wet digestion method was used. To a sample of 0.0054 ± 0.0002 grams, 2 ml of concentrated hydrochloric acid was added followed by another aliquot of 2 ml concentrated nitric acid. The beaker was placed on the heat bank and regularly swirled. Heat was withdrawn just before dryness. A few drops of deionised water were added, the mixture was swirled again and transferred with filtration using Whatman No. 1filter paper into 50ml volumetric flasks before topping to the mark using deionised water. The sample was analysed using an ICP MS (Agilent Technologies 7800).

An assessment of the health risk associated with consumption of metals obtained from scratching recharge cards using bare hands was done using information about the metal daily intake (Di) and health risk index (HRI)[5], [9], [12], [15]. The EDI and HRI are given by the equations below:

$EDI = Cm * Di/BWav$[9][16] *Equation 1*

Where:

C*m* is concentration of metals in silver coatings of scratch cards in mg/kg,

D*i* is daily intake of metals in silver coatings of scratch card material in kg per person and,

BW*av* is average body weight in kg per person.

The average daily consumption of silver coatings of scratch card was estimated at 2.3 x 10^{-6} kg in this study. The value was adopted based on the fact that people add airtime of about ten dollars a day and at least ten percent of the material is retained on the finger nails on scratching and subsequently ingested. The average body weight was considered to be 40 kg.

$HRI = EDI/RD$ [16] *Equation 2*

Where RD is reference oral dose.

The health risk of a population is considered acceptable if HRI is less than 1[15].

RESULTS AND DISCUSSION

Table 0.1: Concentration of selected heavy metals in coatings of airtime recharge cards in ppm

Description	Cd	Cr	Pb	Zn	Cu	Ni	Mn	As
A	ND	0.0934	0.0741	3.1337	28.708	0.1111	0.2644	ND
B	ND	2.9711	0.1017	8.286	72.5073	1.0589	17.7153	0.0067

The results of different selected heavy metals found in airtime recharge cards coatings are shown in Table 3.1. The results of the study showed that recharge cards of company B have the highest amounts of heavy metals under study. Cadmium was not detected in recharge cards of the two sets of scratch cards. Recharge cards for company B had traces of arsenic (0.0067ppm) whereas those for company A had no arsenic detected. Though in very low concentrations, arsenic is associated with increased risk of cancer and blood circulatory problems[17], [18]. Consumers of recharge cards of company B need to exercise caution when scratching the cards.

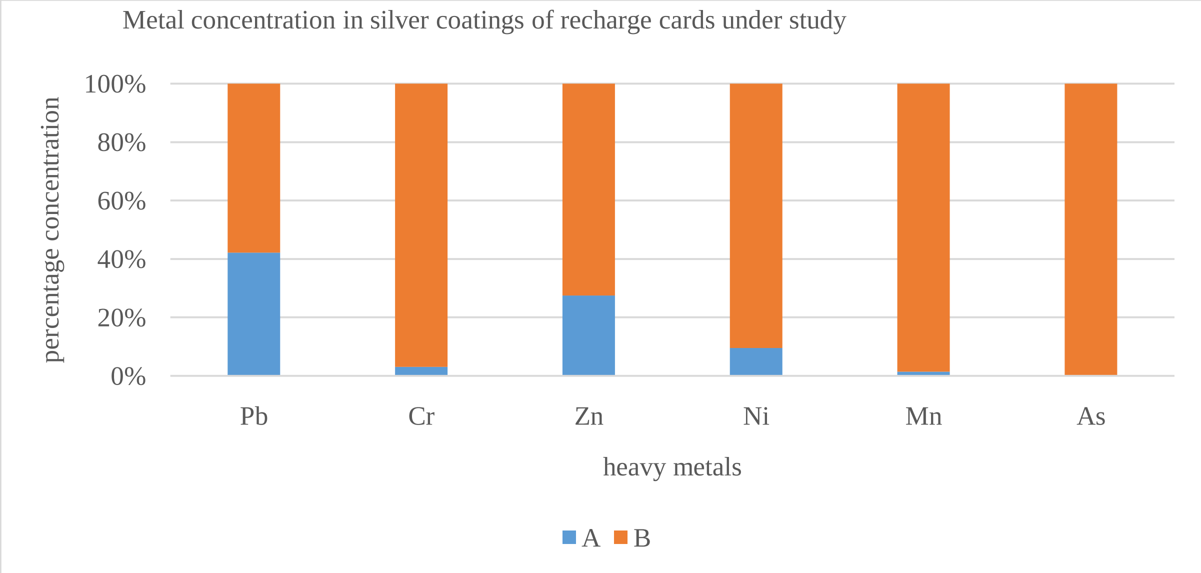

Figure 0.1: Variations in metal concentrations in silver coatings of recharge cards under study

3.1 Health risk assessment

3.1.1 Estimated daily intake

Table 0.2: Estimated daily intake of metals for adults from silver coatings of recharge cards

Element	Cr	Cd	Pb	Zn	Cu	Ni	Mn	As
EDI for A	5.37E-09	ND	4.25E-09	1.80E-07	1.65E-06	6.38E-09	1.52E-08	ND
EDI for B	1.71E-07	ND	5.85E-09	4.76E-07	4.17E-06	6.09E-08	1.02E-06	3.82E-10

The estimated amount of heavy metal concentration consumed by adults after scratching sliver coatings of recharge cards using finger nails is given by estimated daily intake, EDI and . Table 3.2 above shows results of EDI of metals from scratch cards. For the results of adults shown, the EDI values are significantly low, ranging from (1.65E-6 to 4.25E-9) and (4.17E-6 to 3.82E-10) for all the metals under study for companies A and B respectively. EDI of metals from scratch cards of company A follows the order: Cu > Zn > Mn > Ni > Cr > Pb> Cd = As where as those of company B follows the order: Cu > Mn > Zn > Cr > Ni > Pb > As> Cd. There have been grave concerns about the toxic effects of silver coatings on scratch cards. The relatively low concentrations (ND, 10^{-7}, and 10^{-10}) ppm of Cd, Cr, Pb and As will help dispel fears of the consumersin Zimbabwe that silver coatings of recharge cards have relatively less health risks. However, the practice of using finger nails to scratch recharge cards should be discouraged as additional concentration of these heavy metals may come from other sources such as food and polluted air[19] that will effectively increase the daily dosage. With bioaccumulation and many possible sources of heavy metals, the negative health effects are therefore possible. The results of the health risk assessment for this work compare slightly well with those of [2]for Nigeria (EDI of Pb, Cd and Cr are 10^{-10}, and 10^{-10} , and 10^{-11}) although Zimbabwean consumers are exposed slightly more than there Nigerian counterparts.

3.1.2 Hazard Index

Table 0.3: Hazard Index values of metals from silver coatings

Element	Cr	Cd	Pb	As
RI for A	2.00E-05	0	1.00E-06	0
RI for B	6.00E-04	0	2.00E-06	1.00E-06

The hazard index (HI) is a measure of likelihood of negative impacts by exposure to many pollutants. According to [5], [9], [20], if the health risk is greater than one (> 1) it indicates that there is a potential health risk associated with consumption of the metals that is not carcinogenic. The hazard index of the assessed metals are shown in Table 3.3. The results indicate that all of the metals under investigation had their HI less than 1. These metals do not pose a significant health effect on the consumers of airtime.

3.2 Analysis of the means to check the variance of the two sets of results

Statistical analysis of the mean concentrations of silver coating metals of the two mobile company recharge cards was done using t-test. It was observed that there is a significant difference between the means of the heavy metal concentration of silver coatings of recharge cards of the two main companies at $P<0.05$. The difference can be attributed to the use of totally different types of silver coating material by the two companies.

CONCLUSION

The results obtained from the study indicated the presents of heavy metals in silver coatings of recharge cards at elevated concentration levels though not high enough to cause negative health effects according to the hazard index. The study helps creates awareness to the consuming population that the recharge cards have the potential to cause negative health impacts on people and the environment they live in. It is therefore recommended that regulatory authorities carry out regular assessments of the levels of metals in the silver coatings of recharge cards to protect the health of the unsuspecting consumers.

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