

Serum Heavy Metals Level and OS among e-ic Waste Exposed

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Abstract

The current study is performed in Thi-Qar Province which included a collection of whole blood samples from e-ic repair workers. The survey questionnaire was used which is a standardized tool for this research and provides for grouping and processing of data and used standardized research instruments such as questionnaires and interviews of a larger group of subjects to get a clearer and richer examination of the data necessary for further analysis. A total of 100 whole blood samples were taken with different ages ranged from 16 years up to 56 years. Other study groups were 30 subjects from non-e-waste workers. Daily work time approximately about 6-8 hours for 1 year up to 30 years. The results showed that the percentage of diabetic patients among the e-waste population is only (6.5%) all of the diabetes cases were arise for workers whose exposure exceeded 10 years. The heavy metals concentrations in the serum were measured by using atomic absorption spectrophotometry and the levels of (Pb) were unexpected, the mean serum Pb levels ($24 \pm 54 \mu\text{g/L}$) of non-e-waste workers was near to that of e-waste workers ($24.6 \pm 34 \mu\text{g/L}$) at ($p \leq 0.05$), Cd results reported high concentrations in the serum workers of e-waste ($35.4 \pm 53 \mu\text{g/l}$) compared with workers as non-e-waste ($9.3 \pm 17.2 \mu\text{g/l}$) at ($p \leq 0.05$). The results of selenium showed an increase in serum Se levels in both groups, ($209.4 \pm 195.5 \text{ mg/L}$) for the exposed workers compares with ($178.2 \pm 29.5 \text{ mg/L}$) for unexposed workers. The other important aspect on which the study focused is the SOD1/catalase antioxidant system. As the study showed a decrease in SOD1 ($15.2 \pm 2.8 \text{ ng/ml}$) in workers of e-waste proportion in comparison to the comparison group ($36.8 \pm 60 \text{ ng/ml}$) at ($p \leq 0.05$). Also, the catalase concentration was lower in e-waste workers ($23.9 \pm 8 \text{ ng/ml}$) more than ($28.8 \pm 6 \text{ ng/ml}$) at ($p \leq 0.05$) in non-e-waste workers.

Keywords: Metals, OS, e-ic, Superoxide dismutase, Hypertension, Diabetic

Introduction

Products of e-ic and electrical have become an integral current economy part and, with newer technologies development, the life spans of such products are becoming shorter. Consequently, the e-ic waste volume is drastically increasing around the world⁽¹⁾. The hazards create from the e-waste from heavy metals presence (e.g. Cd, Pb, and Se, etc.).⁽²⁾

Pb: Pb is commonly used in electrical products as the main solder part (as a tin alloy) and as PbO_2 in cathode glass ray tube (monitors and televisions) along batteries of Pb-acid. Also, there compounds were utilized in cables of PVC and other materials as stabilizers.⁽¹⁾ Pb is utilized widely in goods as e-ic being a main solders

component (as tin alloy). Pb considered as extremely toxic for humans, plants and animals. It able to body-build up via recurrent acquaintance with irreversible properties on system of nervous, predominantly in children where nervous system is developing.⁽³⁾ Also, Pb has been utilized in solders in circuit printed boards and different components.⁽⁴⁾⁽⁵⁾⁽¹⁾

Cd is utilized in batteries of (Ni-Cd), surface mount resistors as devices chip, detectors as infrared, and chips of semi-conductor.⁽⁶⁾ Cd take place in specific components i.e., resistors of SMD chip, detectors of infra-red, and chips as semi-conductor. It is stabilizers for plastic where few older cathodes as ray tubes contain Cd. Compounds of Cd are bio-accumulative and toxic with irreversible health influences possible risk. Likewise, Pb and Cd might accumulate over time in the body, with exposure for a long-term leading to bone structure and kidneys damage. Compounds of Cd as well as Cd are

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well-known cause of carcinogens for human, principally via contaminated dust and fumes inhalation.⁽⁷⁾ Cd prompts OS in animals and cultured cells and minimizes antioxidant humans levels.⁽⁸⁾

Superoxide dismutase/ catalase: Exposure to toxic chemicals increases free radical formation.⁽⁹⁾ Free radicals (FR) are molecular fragments or molecules having a single unpaired e⁻. Generally, FR are chemically reactive, some (e.g. HO•)⁽¹⁰⁾. Mostly important FR in several disease conditions are derivatives of O₂, principally radicals of hydroxyl and superoxide. Due to its ability to lose e⁻, primarily a metal is thought to be toxic via ROS generation. Therefore, high concentrations exposure to a single metal being heavy may cause buildup and possibly, oxidative damage.⁽¹¹⁾ (Limón-Pacheco & Gonsebatt, 2009). Although ROS, might of negative side influences at high intensities, also they are vital biological molecules being signaling which employ protective and therapeutic influences in contradiction of diseases.⁽¹²⁾⁽¹³⁾⁽¹⁴⁾ Due to high ROS levels are implicated strongly in disease pathogenesis and progression, antioxidants (is in vivo molecule can prevent or slow FR oxidation) that exist in concentrations as low in comparison to the oxidizable substrate which able to scavenging such ROS following exerting useful signaling influences. For example, the mitochondrial-produced O₂⁻ is dismutation to H₂O₂ by superoxide dismutase, which is subsequently reduced to water via the glutathione peroxidase/reductases/NADPH system.⁽¹⁵⁾

An inequity between antioxidants and oxidants in oxidants favor, possibly causing damage, is termed of 'OS'. Oxidants are made as a normal aerobic metabolism product which might be yield at rates being elevated under conditions as pathophysiological.⁽¹⁶⁾ Oxidation is reaction chemically which transforms e⁻ from substance being specific into an agent of oxidizing which cause cells damage.⁽¹⁷⁾ Antioxidants terminate such reactions chain via removing completely the principal stray media and other oxidation reactions prevention from themselves oxidizing. As a result, antioxidants usually remove O₂.

Antioxidants of enzymatic activity (3 proteins) are considered as 1st defense line versus OS body: (SOD), (CAT), and glutathione peroxidase.⁽¹⁸⁾ (Ighodaro &

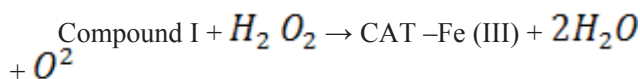
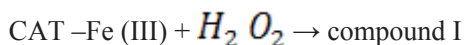
Akinloye, 2018). In this study we focused on SOD1/ CAT;

1. SOD catalyze the dismutation of O₂⁻ to H₂O₂:



CuZn-SOD is detected in all the virtually mammalian organelles cytoplasm.⁽¹⁹⁾ with 2 subunits of protein, every one having a catalytically active Cu and Zn atoms. SOD1 is highly present in the cytosol but is also partially localized in the mitochondrial matrix.⁽¹⁴⁾

2. CAT was enzyme as 1st antioxidant that characterized and catalyzes the 2-stage conversion of H₂O₂ to H₂O and O₂:



CAT comprises 4 subunits of protein, everyone having group as haem and NADPH molecule. CAT is located principally within peroxisomes of cells that also have most of generating capable enzymes of H₂O₂.⁽²⁰⁾

Methods

The study population was 100 E-ic repair workers who were exposed to e-ic waste asked them to take part in our study. Another group of evidently non-exposed e-waste is represented as the control group (50 individuals). After signature, the consent form, workers, and control groups followed the questionnaire include several clear questions; age, weight, length, working time, duration of exposure, diabetic or non-diabetic patients, and date of injury. Also, they were asked smoker or non-smoker, having daily drugs, endocrine diseased, if they have hypertension or other diseases. All metals being heavy were measured by Spectrophotometer of Atomic Absorption (AAS). Superoxide dismutase and catalase were measured by ELISA kits from MyBioSource / American.

The statistical case-control analysis of the current study was done with (SPSS) 24.0 and Microsoft Excel 2010. Data as numerical with normal distribution were designated as standard deviation and means, correlation used for finding the relationship between two groups.

Data as categorical were designated as % and count. Chi-square is utilized to compare the relationship between variables. To compare study groups used t-test.

Results

Table 1: Demographic characteristics for workers as e- and non-e waste workers.

Characteristics	Workers of e-waste	Non-e-waste worker	p-value
Age mean \pm SD	33.83 \pm 9.5	34 \pm 9	0.9
BMI Means \pm SD	26 \pm 4.5	27.3 \pm 4.5	0.5

Table 2: Clinical Characteristics for workers as e- and non-e waste workers.

Characteristics	Workers of e-waste	Non-e-waste worker	P-value
Diabetic	6.5%	0%	0.127 ^c
Diabetes family history	28.3%	35.3%	0.445 ^c
Smoking	4.3%	0%	0.217 ^c
Drugs	12.0%	17.6%	0.407 ^c
Endocrine disease	2.2%	5.9%	0.292 ^c
Hypertension	3.3%	11.8%	0.064 ^c
Another disease	8.7%	0%	0.076 ^c

^c .chi-square, P < 0.05

Table 3: Human CAT quantitative comparison between exposed and non-exposed workers.

Groups Test	Workers of e-waste	Workers of non e-waste	P- value
Catalase ng/ml	23.9 \pm 7.9))	28.8 \pm 6))	0.6
SOD1 ng/ml	15.2 (\pm 2.8)	36.8 (\pm 60)	0.05

*P < 0.05

Table 4 :Cd, Se, and Pb serum concentration for workers as e- and non-e waste workers.

study groups metal	Workers of e-waste Mean ($\pm SD$)	Workers of non e-waste Mean ($\pm SD$)	p-value
Cd(mg/l) Minimum maximum	35.4(± 53) 0.508 175.7	9.3 ± 17.2 0.51 72.3	0.000*
Se Minimum maximum	209.4 ± 195.5 1.07 893.5	178.2 ± 29.5 98.6 259.1	0.2
Pb Minimum maximum	24.6(± 34) 1.1 145.8	24.1 ± 53.9 1.8 231.4	0.95

*P < 0.05

Discussion

This study explores the effect of e-waste recycling on the health of e-waste repair workers and its linkage to diabetes and other diseases. Diabetes has been recorded in e-waste workers (6.5%) less than (49%) which is reported by. ⁽²¹⁾ All of them have a diabetes family history. Also, the rate of thyroid disease was (2.2%) dispute with ⁽²¹⁾⁽²²⁾. Hypertension rate was (3.3%), and other diseases were (8.7%).

The current study showed an increase in the levels of heavy in the e-waste population. Unexpectedly, the mean serum Pb non-e-waste workers levels were near to that of workers of e-waste. workers of e-waste will be unprotected to high levels of Pb by route of general followed by components being harmful which emerge from e-waste is either via ingestion, inhalation, or dermal contact. ⁽²³⁾ This convergence of Pb concentration in both study groups indicates the presence of other sources of Pb exposure. I have suggested the first major source is car exhaust fumes (A samples were taken from the city center). Pb-exposed might be happened via in Pb breathing dust or fumes.⁽²⁴⁾ Pb exposure might be happened via Pb dust ingesting, dust of Pb able to settle on clothes, water, food, and other objects. If Individuals smoke, drink, or eat in places in which Pb is being stored

or processed, they might ingest dust of Pb. Not cleaning hands prior to eating or touching mouths are ways also emight ingest Pb. Few studies proved that Pb via skin can be absorbed.⁽²⁵⁾ The second possible reason for Pb poisoning was smoking and passive smoking. ⁽²⁶⁾ Pbed gasoline and Pb paint and water was likely the primary source of Pb exposure for individuals living in regions with corrosive water supplies and Pb pipes. ⁽²⁷⁾

The results of serum Cd level reported high differences of significant in workers of e-waste compared with workers of non-e-waste. The present study results have an agreement with. ⁽²⁸⁾⁽²⁹⁾ E-waste is an important source of Cd. Cd is used in galvanized metal due to its inability to corrode, and also in the manufacture of pigments and the manufacture of negatively charged materials so it is frequently used in the battery industry. ⁽³⁰⁾ In the same way as Pb, (Cd) transports to humans. ⁽²³⁾ So, it was suggested three key routes to intake Cd; (1) inhalation: As soon as in the lungs, inhaled dose 10%-50% is absorbed, based on size of particle, specific Cd solubility of compound inhaled, and exposure duration. ⁽³⁰⁾ Leaves of tobacco accumulate as high Cd levels from soil, and smoke of cigarette is main exposure ources for tobacco smokers leaves accumulates high Cd levels from soil, and smoke of cigarette is the main exposure source

for smokers.⁽³¹⁾ (2) Ingestion: Mostly Cd ingested orally goes via GT unchanged being individuals normally absorb just almost 6% of Cd ingested, whereas up to 9% might be absorbed in those with deficiency of iron.⁽³²⁾ (ATSDR 1999). Cd also, in H₂O is easily absorbed compared to Cd in food (5% in H₂O compared to 2.5% in food).⁽³³⁾ The elevated Zn or Cr presence in diet declines Cd uptake.⁽³⁴⁾⁽³⁵⁾ (3) Dermal: skin absorption is not route of significant entry of Cd; just around Cd 0.5% is skin absorbed⁽³⁵⁾

On the other hand, for non-exposed workers, the Cd concentration was still above the maximum permissible limit by the WHO. It was suggested the first route “food is generally the largest source of Cd exposure. Cd levels in some foods can be increased by the application of phosphate fertilizers”.⁽³⁶⁾ The second route was passive smoking

The other important aspect in which the study focused on is the SOD1/catalase antioxidant system. As the study showed a decrease in SOD1 in workers of e-waste in comparison to the comparison group. Also, the concentration of catalase was lower in e-waste workers more than in non-e-waste workers. As it's known SOD1/CAT was increasing according to high ROS, but with high levels of ROS, the equation turns in favor of FR. On the other hand, Superoxide dismutases might be damaged only by few xenobiotics, such as cyanides, azide, HCl or diethyl-dithio-carbamate, and H₂O₂. Enzymatic activity increasing might be provoked via molecular activity enhancement vice versa. It is well-known that frequently SOD decrease or increase activity accompanies OS and an reactive O₂ increase formation of species.⁽³⁷⁾

Conflict of Interest – Nil

Source of Funding- Self

Ethical Clearance – Not required

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