Original Research Article

Influence of Alcohol intake on heavy metal accumulation in artisans from three locations in Port Harcourt, Rivers State, Nigeria

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ABSTRACT

Aim: The present study assesses the levels of some heavy metals in artisans in Rivers State, Nigeria

Study design: This is a Cross-sectional study

Place and Duration of Study: Automobile workshops, welding workshops, and painting workshops, located in Mile 3 mechanic garage, Elekahia and Rumuagholu., between June 2023 and January 2024.

Methodology: A total of 100 subjects were recruited for this study based on specific inclusion and exclusion criteria. The exposed group was made up of three different types of artisans (mechanics, welders, and painters) with a total of 75 exposed individuals, each group comprised of 25 artisans each, while the non-exposed (control) group were 25 individuals who were mainly students and office workers. All the participants for the study were asked to fast for 8 hours after which 10 ml of venous blood samples were collected into plain sample bottles. Separate serum samples were used to assay nickel, lead, mercury, arsenic, cadmium, and chromium. Statistical analysis was performed using GraphPad prism version 8.3. and p-values less than 0.05 were considered statistically significant.

Results: The results of the heavy metals showed significantly ($P<0.05$) high levels of arsenic in the mechanics, significantly ($P<0.05$) high levels of lead and chromium in the welders, and significantly ($P<0.05$) high levels of arsenic, lead, and cadmium in painters when compared to the control group. Some of the heavy and moderate consumers of alcohol artisans had significantly higher levels of arsenic, mercury and chromium when compared to non-consumers.

Conclusion: Automobile mechanics had significant higher levels of arsenic, the welders were exposed to lead, and chromium, while the painters had significant higher levels of arsenic and lead.

Keywords: Heavy Metals, Artisans, Alcohol intake, Port Harcourt, Rivers State, Nigeria

1. INTRODUCTION

Environmental pollution is one of the major causes of premature deaths globally [1]. Aerosol particles contain both solid and liquid chemical components like polycyclic aromatic hydrocarbons (PAHs) and heavy metals that can cause adverse health effects when inhaled [2]. Millions of people die every year due to diseases caused by the exposure to environmental contaminants [3]. Occupational exposure to heavy metals cuts across a lot of professions, these metals gain entrance into the human body either through inhalation of metal fumes in air, direct ingestion of contaminated food and water, environmental emissions from automobile or generator exhausts are also veritable sources of contact [4].

Heavy metals are natural elements that have high density and atomic mass, some of them are considered as essential trace elements needed for some biological processes, while others such as Mercury, lead, arsenic, cadmium etc., have been discovered to cause harmful effects

on human health even at very low concentrations. These metals are found dispersed in the earth's crust, but present at very low concentrations in the body. Heavy metals, even at very low concentrations in atmosphere, soil, and water, can induce health complications. Humans are mainly exposed to these metals either through environmental pollution like smoke from automobile exhaust, occupational exposure via inhalation of metal fumes or dermal deposition of these toxic metals, and the ingestion of contaminated food stuff and water obtained from soils with high levels of heavy metals [5].

The detrimental effect of heavy metals has been linked to the generation of free radicals causing an imbalance in antioxidant metabolism. Subsequently, this leads to lipid peroxidation and deoxyribonucleic acid (DNA) damage caused by oxidative stress and depletion of protein sulfhydryls (e.g., glutathione) [6].

Automobile technicians are among the group of people most vulnerable to occupational and environmental pollution, they include auto mechanics, automobile body repairers (panel beaters), auto painters, welders, vulcanizers, and auto electricians [19-21]. The most common pollutants in an automobile workspace is lead, cadmium, chromium and mercury which are usually deposited in car batteries, car paints, welding fumes, petroleum etc. It has been discovered that these groups of individuals experience low but continuous exposure to heavy metals which in the long term produces chronic toxicity [7]. The aim of this study as to assess the levels of some heavy metals in artisans in Rivers State, Nigeria.

2. MATERIALS AND METHOD

2.1 Experimental Design

All qualified subjects for this study were classified into four groups including the control group and it was based on their different occupations (automobile mechanics, painters, welders), and the control group. Alcohol consumption by the test participants was classified as heavy (consumes large amounts of spirits, and beer regularly), moderate (consumes small amounts of spirits, and beer sometimes), and (no) for those that do not consume alcohol at all.

2.2 Study Area

The subjects for this study were recruited from automobile workshops, welding workshops, and painting workshops, located in Mile 3 mechanic garage, Elekahia and Rumuagholu, Port Harcourt, Rivers State Nigeria.

3.3 Population of the Study (Sample Size)

The sample size was determined using the Cochran Formula; no = z2pq / e2 [8].

Z2= Confidence level (1.96)2
P= Prevalence rate (0.11),
Q = 1-P (0.89),
e2 (margin of error) = (0.05)2
(3.84) (0.11) (0.89) / 0.0025 = 100

A total of 100 apparently healthy male subjects aged (18 –65 years) were selected for this study. They were divided into 4 groups including the control group, with each group comprising 25 subjects each. The test groups were (automobile mechanics, welders, and painters) who have been working for at least two years either as workers or as apprentices and they were selected based on specific inclusion and exclusion criteria designed for this study using the well-structured questionnaire, while the control group was made up of 25 subjects who were mainly students, business owners, and office workers.

2.3.1 Test Group
The test group comprises of 3 subgroups with 25 subjects in each group

Sub-Groups
Group 1: Automobile mechanics.
Group 2: Painters.
Group 3: Welders.

2.3.2 Control Group
Group 4: Non-occupationally exposed individuals (25 subjects).

2.4 Sample Collection
Ten milliliters (10 ml) of venous blood (fasting samples) were collected from each subject into a plain bottle. The serum obtained after centrifugation was stored at -20°C until analysis.

2.5 Inclusion Criteria
• Only males aged 18-65 years were included in the study.
• Individuals who have been exposed for at least 2 years during their job, including apprentices with not less than 2 years working experience.
• Individuals that smoke and consume alcohol were also included in this study.

2.5 Exclusion Criteria
• Subjects less than 18 years of age were not eligible to participate in this study.
• Subjects with history of already existing cardiovascular or lung diseases like atherosclerosis, hypertension, chronic obstructive airway disease (COPD), and reactive airway disease are ineligible for the study.
• Subjects with less than 2 years of working experience in the listed vocations.

2.6 Determination of Heavy Metals by Atomic Absorption Spectrometry (AAS) Technique [9] (American Public Health Association)

2.6.1 Principle
The electrons within an atom exist at various energy levels. When the atom is exposed to its specific wavelength, it can absorb the energy (photons) and electrons move from a ground state to an excited state. The radiant energy absorbed by the electrons is directly related to the transition that occurs during the process. Heavy metals contain certain atoms and ions that can absorb light at specific wavelengths. When a sample containing heavy metals is exposed to light at the specific wavelength for each of the heavy metals, then only the specific metal will absorb the light. The amount of light absorbed at this wavelength is directly proportional to the concentration of the absorbing ions or atoms.

2.6.2 Procedure for Sample Digestion [10]
The sample was well mixed, 1 ml of the sample and nitric acid was measured and added to the AAS cuvette, the solution was mixed properly and boiled for 30 minutes at 100^{o}C. The solution was made up to 5 ml which was adequate for the analysis. The solution was measured with an atomic absorption spectrometer.

2.7 Statistical Analysis
The software used for the statistical analysis was GraphPad prism (version 8.3), the analytical tools used were Mean, Standard deviation (SD), ANOVA, Tukey's Multiple Comparison Test. The Results were expressed as mean± standard deviation.

3. RESULTS AND DISCUSSION

Table 1: Comparison of Heavy Metals of Controls, Mechanics, Welders, and Painters

Subjects	Arsenic (ppm)	Lead (ppm)	Mercury (ppm)	Chromium (ppm)	Cadmium (ppm)	Nickel (ppm)
Controls n=25	0.01 ± 0.00	0.01 ±0.00	0.03 ± 0.02	0.01 ± 0.00	0.02 ± 0.01	0.01 ± 0.01
Mechanics n=25	0.10 ± 0.05	0.02 ±0.00	0.03 ± 0.01	0.02 ± 0.01	0.02 ± 0.01	0.03 ±0.02
Welders n=25	0.01 ± 0.00	0.03 ±0.01	0.06 ± 0.02	0.03 ± 0.01	0.04 ±0.02	0.01 ± 0.00
Painters n=25	0.06 ± 0.03	0.03 ±0.01	0.06 ± 0.02	0.04 ± 0.01	0.11 ± 0.04	0.05 ± 0.02
p-values	0.0341	0.0097	0.2584	< 0.0001	0.0158	0.1888
F-Values	3.005	4.013	1.364	11.85	3.625	1.624
Tukey's Multiple Comparison Test	Summary	Summary	Summary	Summary	Summary	Summary
Control vs Mechanic	*	Ns	Ns	Ns	Ns	Ns
Control vs Welder	Ns	*	Ns	***	Ns	Ns
Control vs Painter	*	*	Ns	Ns	*	Ns
Mechanic vs Welder	Ns	Ns	Ns	***	Ns	Ns
Mechanic vs Painter	Ns	Ns	Ns	Ns	*	Ns
Welder vs Painter	Ns	Ns	Ns	*	Ns	Ns

Keys: *PPM=Parts Per Million, *=Significant (p<0.05), NS=Not Significant (p>0.05).*
Reference Range: Arsenic: <0.1 ppm, Lead: 0.05-0.25 ppm, Mercury: <0.02 ppm, Chromium: 0.10-0.16 ppm, Cadmium: 0.001-0.004 ppm, Nickel: <0.0003 ppm.

Table 2: Comparison of Heavy Metals to Heavy Intake of Alcohol by Controls, Mechanics, Welders and Painters

	Arsenic (ppm)	Lead (ppm)	Mercury (ppm)	Chromium (ppm)	Cadmium (ppm)	Nickel (ppm)
Mechanics n=5	0.21 ± 0.14	0.05 ± 0.02	0.02 ± 0.01	0.02 ± 0.01	0.01 ± 0.00	0.01 ± 0.01
Welders n=9	0.01 ± 0.0	0.06 ± 0.02	0.08 ± 0.02	0.02 ± 0.01	0.01 ± 0.00	0.03 ±0.02
Painters n=5	0.02 ± 0.01	0.10 ± 0.06	0.04 ± 0.01	0.08 ± 0.02	0.01 ± 0.01	0.01 ± 0.00
Controls	0.01 ± 0.00	0.01 ± 0.01	0.01 ± 0.00	0.03 ± 0.01	0.01 ± 0.00	0.05 ± 0.02
p-value	0.0339	0.1374	0.0009	0.0284	0.4795	0.1888
F-value	3.388	2.016	7.606	3.561	0.8495	1.624
Tukey's Multiple Test	Summary	Summary	Summary	Summary	Summary	Summary
Control vs Mechanic	*	Ns	*	Ns	Ns	Ns
Control vs Welder	Ns	Ns	Ns	*	Ns	Ns
Control vs Painter	*	Ns	Ns	Ns	Ns	Ns
Mechanic vs Welder	Ns	Ns	Ns	*	Ns	Ns

Mechanic vs Painter	Ns	Ns	***	Ns	Ns	Ns
Welder vs Painter	Ns	Ns	Ns	Ns	Ns	Ns

Keys: *PPM=Parts Per Million, *=Significant (p<0.05), NS=Not Significant (p>0.05).*
Reference Range: Arsenic: <0.1 ppm, Lead: 0.05-0.25 ppm, Mercury: <0.02 ppm, Chromium: 0.10-0.16 ppm, Cadmium: 0.001-0.004 ppm, Nickel: <0.0003 ppm.

Table 3: Comparison of Heavy Metals to Moderate intake of Alcohol by Controls, Mechanics, Welders and Painters

Subjects	Arsenic (ppm)	Lead (ppm)	Mercury (ppm)	Chromium (ppm)	Cadmium (ppm)	Nickel (ppm)
Mechanics n=15	0.09 ± 0.06	0.02 ± 0.00	0.03 ± 0.01	0.03 ± 0.01	0.02 ± 0.001	0.04 ± 0.03
Welders n=8	0.01 ± 0.00	0.03 ± 0.01	0.09 ± 0.03	0.08 ± 0.02	0.09 ± 0.04	0.02 ± 0.00
Painters n=14	0.04 ± 0.01	0.03 ± 0.01	0.04 ± 0.01	0.03 ± 0.01	0.16 ± 0.07	0.08 ± 0.04
Controls	0.004 ± 0.00	0.01 ± 0.00	0.02 ± 0.01	0.01 ± 0.00	0.03 ± 0.01	0.01 ± 0.00
p-value	0.3779	0.1691	0.0039	0.0002	0.0968	0.4227
F-value	1.056	1.76	5.163	8.137	2.244	0.9547
Tukey's Test	Summary	Summary	Summary	Summary	Summary	Summary
Mechanics vs Welder	Ns	ns	*	**	Ns	Ns
Mechanics vs Painter	Ns	ns	Ns	Ns	Ns	Ns
Mechanics vs Control	Ns	ns	Ns	Ns	Ns	Ns
Welder vs Painter	Ns	ns	Ns	**	Ns	Ns
Welder vs Control	Ns	ns	**	***	Ns	Ns
Painter vs Control	Ns	ns	Ns	Ns	Ns	Ns

Keys: *PPM=Parts Per Million, *=Significant (p<0.05), NS=Not Significant (p>0.05).*
Reference Range: Arsenic: <0.1 ppm, Lead: 0.05-0.25 ppm, Mercury: <0.02 ppm, Chromium: 0.10-0.16 ppm, Cadmium: 0.001-0.004 ppm, Nickel: <0.0003 ppm.

Table 4: Comparison of Heavy Metals to No Intake of Alcohol by the Controls, Mechanics, Welder and Painters

Subjects	Arsenic (ppm)	Lead (ppm)	Mercury (ppm)	Chromium (ppm)	Cadmium (ppm)	Nickel (ppm)
Mechanics n=5	0.03 ± 0.02	0.02 ± 0.01	0.04 ± 0.02	0.02 ± 0.01	0.03 ± 0.2	0.01 ± 0.00
Welders n=8	0.02 ± 0.00	0.03 ± 0.01	0.03 ± 0.02	0.05 ± 0.03	0.01 ± 0.00	0.01 ± 0.00
Painters n=6	0.15 ± 0.01	0.03 ± 0.01	0.06 ± 0.03	0.03 ± 0.01	0.02 ± 0.01	0.02 ± 0.01
Controls n=25	0.01 ± 0.00	0.01 ± 0.00	0.04 ± 0.03	0.04 ± 0.00	0.01 ± 0.00	0.01 ± 0.00
p-value	0.0557	0.0413	0.9254	0.1962	0.0735	0.7663
F-value	2.812	3.104	0.1554	1.662	2.56	0.3825

Tukey's Test	Summary	Summary	Summary	Summary	Summary	Summary
Mechanics vs Welder	Ns	Ns	Ns	ns	Ns	Ns
Mechanics vs Painter	Ns	Ns	Ns	ns	Ns	Ns
Mechanics vs Control	Ns	Ns	Ns	ns	Ns	Ns
Welder vs Painter	Ns	Ns	Ns	ns	Ns	Ns
Welder vs Control	Ns	Ns	Ns	ns	Ns	ns
Painter vs Control	Ns	Ns	Ns	ns	Ns	ns

Keys: *PPM=Parts Per Million, *=Significant (p<0.05), NS=Not Significant (p>0.05).*
Reference Range: Arsenic: <0.1 ppm, Lead: 0.05-0.25 ppm, Mercury: <0.02 ppm, Chromium: 0.10-0.16 ppm, Cadmium: 0.001-0.004 ppm, Nickel: <0.0003 ppm.

The result of this research recorded elevated levels of arsenic, lead and cadmium in painters, this finding correlates with that of Adejumo et al. [7] and Kaleem et al. [11] they both recorded high levels of lead and chromium in car spray painters, the increase in lead concentration in the blood of painters may be attributed to the fact that car spray painting requires the use of an equipment with the paint enclosed in a compressed air with very high pressure, as the paint is sprayed on the surface of the cars, some particles of the paints can be distributed in air trapped in air particles which may be inhaled, absorbed into the skin, or ingested following consumption of food without properly washing the hands after working. Lead may also be absorbed into the body during the process of painters trying to scrape off old paints from cars and metals before putting in a new coat of paint, the aerosols of the old paint dust may be inhaled or accumulate on the surface of the skin where they are later absorbed into the body. The increase in chromium concentration in painters may be attributed to the use of certain lubricants containing chromium, the treatment process and cutting of metals may release chromium particles into the air [12].

The result also showed that welders had higher levels of chromium when compared with the mechanics, this report correlates with that of Luqman & Hind [13] and Abdul et al. [14] the researchers reported a significant increase in chromium, lead, cadmium, iron and zinc in welders in Iraq. The process of welding involves heating up the metals under a very high degree temperature to enable the metals to melt so it can be fused together with another metal [15].This process releases fine and ultra-fine particles called welding fumes into the atmosphere as aerosols, the welding fumes are made up of a wide range of toxic heavy metals like cadmium, mercury, chromium, nickel, lead, and iron oxide, some of these metals also produces harmful gases like fluorine, and nitric oxide, the welding fumes can be inhaled by the workers or by dermal absorption following the deposition of these welding fumes on the skin in welders who do not adhere to safe practices and the use of standard personal protective equipment's like respirator mask, thick protective clothing's like standard coveralls for welders, eye goggles and hand gloves, when working, this explains the presence of heavy metal (chromium) detected in the serum of welders in this study. The metals may accumulate in the body where they begin to disrupt the normal function of various organs, since the welding fumes comprise various particles of different heavy metals, they may have multi-organ effects like causing respiratory distress, nervous system disturbance, cancer, and reproductive disorders [16].

When the heavy metals of the mechanics that consume heavy amounts, alcohol were compared with the controls that do not consume alcohol, lead and mercury levels were higher in the mechanics. The welders that consume heavy amounts of alcohol had higher chromium, while the painters had higher levels of arsenic when compared with the controls. The painters

that consume heavy amounts of alcohol had higher mean value of mercury when compared to the painters. Although they was not enough data linking the exposure of mechanics, welders, and painters to heavy metals and heavy alcohol consumption, but a research conducted by Jong et al. [17] who evaluated the effects of high alcohol intake on heavy metals and its effects in the lungs of smokers reported that the heavy consumption of alcohol together with the smoking of cigarette increases the concentration of heavy metals in blood, however, the researcher noted that the consumption of alcohol in non-smokers may be favorable in normal pulmonary function. AI-Min et al. [18] also reported that heavy alcohol intake and heavy metal exposure could increase the risk of developing Type 2 Diabetes Mellitus in male workers in China. The same effects on heavy metal concentration seen in the artisans that consume heavy amounts of alcohol were also similar with the artisans that consume moderate amounts of alcohol.

The result of this study showed that the artisans that did not consume alcohol had no significant difference in the concentration of heavy metals when compared with the controls. However, there is a lack of adequate information regarding alcohol consumption in artisans exposed to heavy metals. The comparison between the mechanics, and the welders, the welders and painters, and the welders and the control that consumes moderate amounts of alcohol showed that the welders had significantly higher levels of mercury and chromium [17]. The comparison of the heavy metal concentration in the artisans that do not consume alcohol with the controls showed no significant difference

4. CONCLUSION

This study revealed that automobile mechanics had significant higher levels of Arsenic, the welders were exposed to lead, and chromium, while the painters had significant higher levels of arsenic, lead, and chromium when compared with the control group, this implies that these groups of artisans are exposed to heavy metals which is an imminent factor to the onset of various disease conditions,

COMPETING INTERESTS

Authors have declared that no competing interests exist.

CONSENT

All authors declare that written informed consent was obtained from the patient (or other approved parties) for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editorial office/Chief Editor/Editorial Board members of this journal.

ETHICAL APPROVAL

The ethical approval for this study was obtained from the Health Research Ethics Committee, Rivers State Hospitals Management Board (RSHMB). The participants of the study were required to sign an approved informed consent form before their participation in the study, and identification numbers were assigned to each participant instead of their names to protect their privacy.

Disclaimer (Artificial intelligence)

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1.

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