



Assessment of Serum Levels of Some Heavy Metals in Carpenters Residing in Port-Harcourt in Relation to Their Lifestyle

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Authors' contributions

This work was carried out in collaboration between both authors. Author OI designed the study, performed the statistical analysis, wrote the protocol, wrote the first draft of the manuscript, and managed the analyses of the study. Authors OI and FCA managed the literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

Carpentry as an occupation involves the use of woods routinely on daily basis. However, these woods are preserved through the application of certain chemicals, some of which happens to be heavy metals. When these woods are processed, the heavy metals together with wood dust are released into the work environment, and when this is inhaled or involuntarily ingested over a period, it may result in bioaccumulation of the heavy metals. This study examined the serum levels of some heavy metals (chromium, nickel and arsenic) in carpenters residing in Port-Harcourt in relation to their lifestyle. A total of 180 apparently healthy male subjects were used for the study, out of which 90 subjects were carpenters (test subjects), while the other 90 subjects were non-carpenters (control subjects). Relevant information was collected using a structured questionnaire, written consent from each subject was obtained, and blood samples collected and analysed. The Solar Thermo-Elemental Atomic Absorption Spectrophotometer (AAS) Model SE-71906 was used to analyse the heavy metals. The results showed a significantly higher ($p < 0.05$) serum levels of

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chromium, nickel and arsenic in the carpenters as compared to the control subjects. Carpenters who were regular alcohol drinkers had a significantly higher ($p < 0.05$) serum levels of chromium, nickel and arsenic as compared to occasional drinkers and non-drinkers, while carpenters who were smokers had a significantly higher ($p < 0.05$) serum levels of chromium and nickel as compared to ex-smokers and non-smokers. These findings suggest that occupational exposure to wood dust may predispose carpenters and other wood workers to heavy metal intoxication, and that, drinking and/or smoking lifestyle may further predispose them to the heavy metal intoxication.

Keywords: Heavy metals; lifestyle; Port-Harcourt; carpenters.

1. INTRODUCTION

A carpenter is someone who uses woods to construct buildings or other structures. While working with woods, wood dust is released into the environment through activities such as milling, drilling and crushing of the woods. Wood dust is a by-product of wood processing or wood handling, and the sizes of wood dust particles depends on the activity from which they are generated [1]. Carpenters and sawmill workers are the subjects of wood dust exposure, which happens to be the oldest form of occupational exposure [2], with the potential of inducing nephrotoxicity [3] and other health conditions.

Woods are preserved by certain chemicals, some of which are heavy metals such as chromium, nickel, copper and arsenic; other chemicals include pentachlorophenol and creosote [4]. Nwajei et al., [5] carried out a study to determine the concentrations of some heavy metals (lead, cadmium, chromium, barium, arsenic and mercury) in wood dust particles collected in the environment of sawmill in Sapele, and concluded that wood dust particles contained elevated levels of these heavy metals.

When woods are processed through milling, drilling or crushing, the heavy metals together with the wood dust are released into the work environment. Inhalation or involuntary ingestion of the wood dust over a period, may result in bioaccumulation of the heavy metals, which may further result in an increased bioavailability (elevated serum concentration of the heavy metals), which in turn, may cause toxicity to the kidney, liver and other organs of the body [6]. Intoxication with chromium and nickel induces hepatotoxicity [7].

The alcohol-consumption and smoking lifestyle of the carpenters may be important factors in the determination of their serum heavy metal levels.

According to Centres for Disease Control and Prevention [8], a current smoker is someone who presently smokes and has smoked over 100 cigarettes in his/her lifetime, an ex-smoker is someone who no longer smokes and has smoked at least 100 cigarettes in his/her lifetime, a non-smoker is someone who has never smoked or who has not smoked more than one hundred cigarettes in his/her lifetime, and does not currently smoke. A regular alcohol drinker is someone who drinks alcohol at least three to four days weekly. An occasional alcohol drinker is someone who drinks alcohol once in a while. A non-alcohol drinker is someone who has never consumed an alcoholic drink in his/her lifetime. Therefore, this study is aimed at determining if wood dust exposure, as well as alcohol-drinking and/or cigarette-smoking lifestyle(s) has an impact on the serum levels of chromium, arsenic and nickel in carpenters.

2. MATERIALS AND METHODS

2.1 Study Design

A total of 180 apparently healthy male subjects within the ages of 18 to 60 were used for the study. This study was carried out in the month of February, 2018. Ninety (90) subjects were non-carpenters or non-wood workers (control subjects), and the other 90 subjects were carpenters (test subjects) who worked at different locations in Port-Harcourt (Marine Base, Mile 3 and Iloabuchi Carpentry Workshops) with a minimum of 4 years occupational exposure. The control subjects worked or resided within the study areas but were not exposed to wood dusts. Ethical approval for the study was obtained from the Ethical Committee of the Ministry of Health, Rivers State, Nigeria, and informed/written consent obtained from the subjects. Out of the 90 control subjects, 40 subjects were only drinkers, 40 subjects were only smokers, while the remaining 10 subjects were neither drinkers nor smokers. Also, out of the 90 test subjects, 40

subjects were drinkers, 40 subjects were smokers, while the remaining 10 subjects were neither drinkers nor smokers. Finally, out of the 40 carpenters who were drinkers, 20 were regular drinkers, while the remaining 20 were occasional drinkers. Also, out of the 40 carpenters who were smokers, 20 were current smokers, while the remaining 20 were ex-smokers.

2.2 Inclusion Criteria

All test subjects were apparently healthy carpenters with at least four years of occupational exposure. All control subjects were also apparently healthy.

2.3 Exclusion Criteria

Subjects who were exposed to burning woods daily in their surroundings, or those using firewood as a source of heat energy for cooking were also excluded.

2.4 Blood Sample Collection and Analysis

With the aid of sterile hypodermic syringes and needles, five millilitre (5 ml) of venous whole blood (random blood sample) was collected from each subject into plain bottles and spun, and the serum obtained, which was used in the analysis of the heavy metals using the Solar Thermo-Elemental Atomic Absorption Spectrophotometer (AAS) Model SE-71906.

2.5 Statistical Analysis

The generated data were expressed as Mean ± Standard deviation, and analysed using Microsoft Office Excel 2007 and Graph Prism Pad version 6.2. Comparisons of mean and standard deviation values were made for the various parameters for test and control subjects using the independent student's t-test and the analysis of variance (ANOVA). Schematic presentations of the data were expressed as aligned dot plots. Results were considered statistically significant at 95% confidence interval (p<0.05).

3. RESULTS

3.1 Comparison of the Chromium, Arsenic and Nickel Levels of Carpenters and Control Subjects

Details of the comparison of the mean chromium, arsenic and nickel levels of carpenters and control subjects are shown in Table 1 below. It shows that the mean chromium, arsenic and nickel levels of the carpenters were significantly higher (p<0.05) than those of the control subjects.

3.2 Serum Levels of Chromium, Arsenic and Nickel in Carpenters Based on Alcohol Consumption

The Serum levels of Chromium, Arsenic and Nickel of Carpenters in different alcohol groups: Non-, occasional and regular alcohol drinkers are shown in detail in Figs. 1-3 below using aligned dot plot. The figures showed that there were significant differences (p<0.05) in the mean Serum Chromium, Arsenic and Nickel levels amongst non-, occasional and regular alcohol drinkers. The regular alcohol drinkers had significantly higher serum levels of Chromium, Arsenic and Nickel than the non- and occasional alcohol drinkers.

3.3 Serum Levels of Chromium, Arsenic and Nickel in Carpenters Based on Smoking Habits

The Serum Chromium, Arsenic and Nickel levels of different smoking status: ex-smokers, non-smokers and smokers are shown in detail in Figs. 4-6 below using aligned dot plot. The figures showed that there were significant differences (p<0.05) in the mean Serum Chromium and Nickel levels amongst ex-smokers, non-smokers and smokers, with smokers having the highest levels amongst these groups, but there were no significant differences (p>0.05) in the mean Serum Arsenic levels amongst these groups.

Table 1. Serum levels of chromium, arsenic and nickel of carpenters and control subjects

	Chromium (PPM)	Arsenic (PPM)	Nickel (PPM)
Test (N=90)	0.59 ± 0.25	0.46 ± 0.17	0.01 ± 0.01
Control (N=90)	0.16 ± 0.07	0.09 ± 0.06	0.001 ± 0.003
P-Value	<0.001*	<0.001*	<0.001*

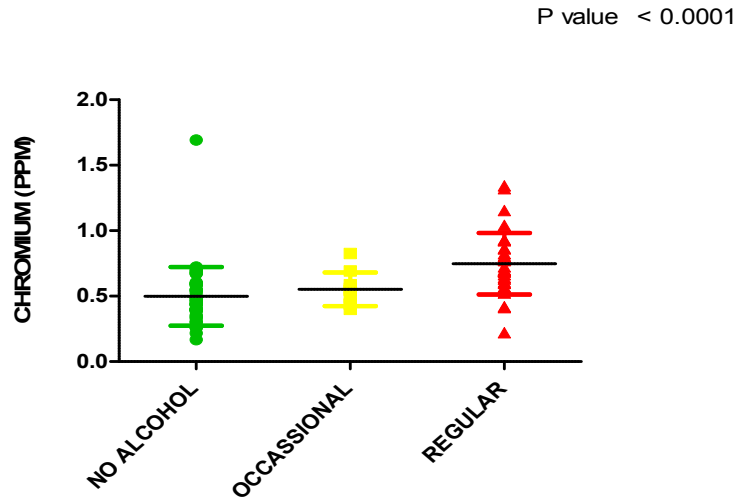


Fig. 1. Serum chromium levels in non-, occasional and regular alcohol drinkers

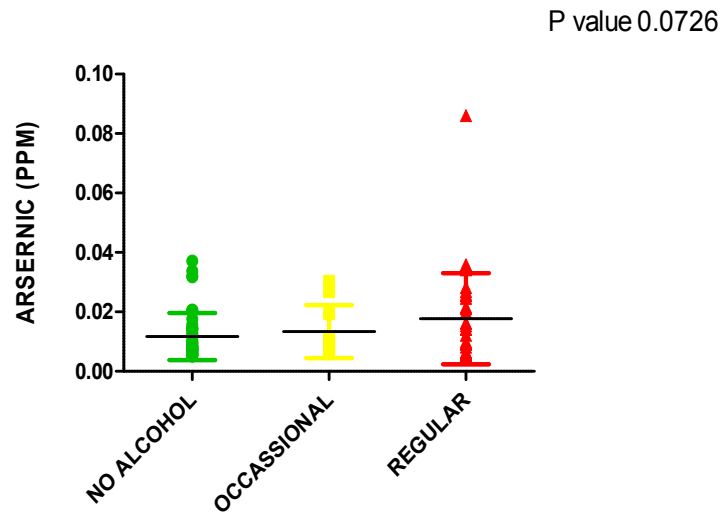


Fig. 2. Serum arsenic levels in non-, occasional and regular alcohol drinkers

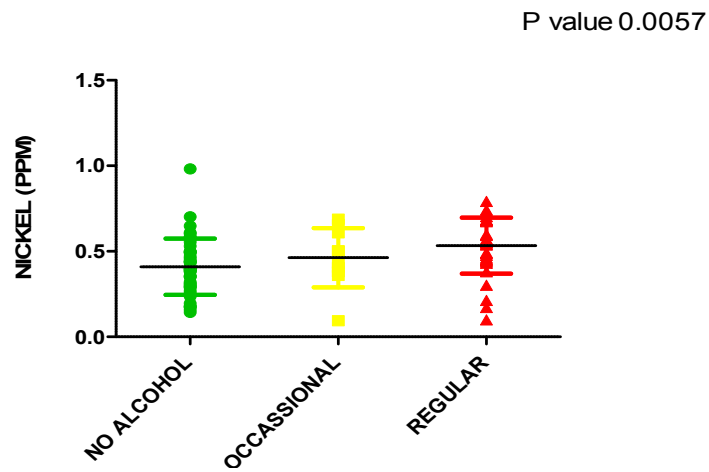


Fig. 3. Serum nickel levels in non-, occasional and regular alcohol drinkers

P value < 0.0001

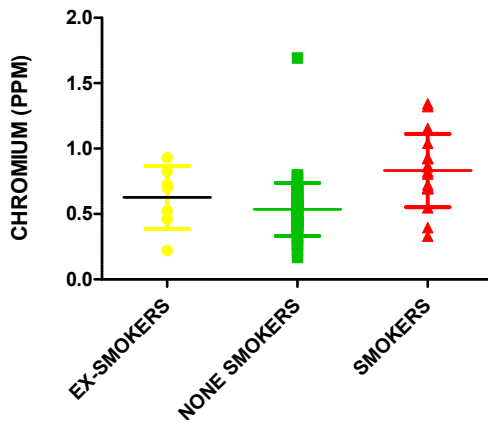


Fig. 4. Serum chromium levels in ex-smokers, non-smokers and smokers

P value 0.3172

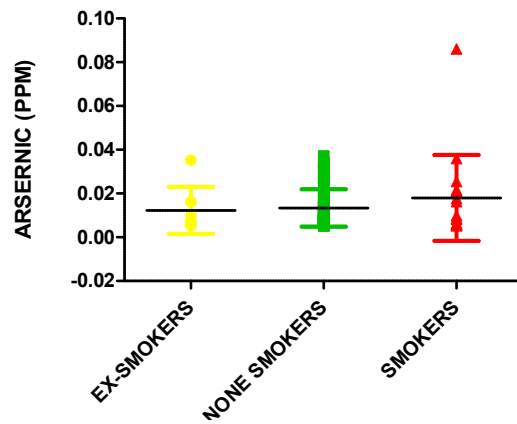


Fig. 5. Serum arsenic levels in ex-smokers, non-smokers and smokers

P value 0.0044

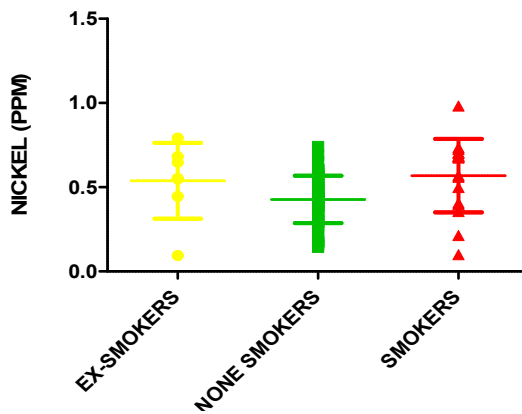


Fig. 6. Serum nickel levels in ex-smokers, non-smokers and smokers

4. DISCUSSION

The higher levels of serum chromium, arsenic and nickel levels as observed in the carpenters may be attributed to the heavy metal chemicals used in the woods as preservatives [4], which through processing of the woods, may have been inhaled alongside wood dust, bio-accumulated, and overtime led to an elevated serum levels. Similar report of elevated chromium, arsenic and nickel levels was reported by Nwajei et al. [5], in a study involving the analysis of these heavy metals in wood dust particles collected in the vicinity of wood sawmill in Sapele.

The higher serum chromium and nickel levels as observed in regular drinkers when compared to those of non-drinkers and occasional drinkers, may be attributed to the consumption of alcoholic drinks from chromium-plated and nickel-plated cans, in which these heavy metals may have leached out of the cans into the drinks, or contamination during processing of the alcoholic drink; consumption of such drinks overtime, may lead to bioaccumulation of the heavy metals. Soft drinks as well as acidic beverages are capable of dissolving nickel from pipes and containers [9], thus when such drinks or beverages are consumed, there is a possibility of the serum nickel to rise. About 68.9 percent of uncanned beverages and 76.2 percent of canned beverages in Nigeria had chromium levels greater than the maximum contaminant level of 0.10 mg/L [10].

The mean serum chromium and nickel levels for regular smokers were significantly higher when compared to those of non-smokers and ex-smokers. This report agrees with that of Tsuchiyama et al. [11], stating that regular smokers had a higher concentration of chromium and nickel than non-smokers. Chromium accumulates in tissues, particularly in lung, with its concentrations of about 4.3 mg/kg found in smokers compared about 1.3 mg/kg in non-smokers [12]. This report also agrees with that of Stojanovic et al. [13], stating that the nickel content in the blood of smokers was higher than in the blood of non-smokers. Chromium and nickel are naturally present in tobacco [14], as such when tobacco is consumed (through smoking), it may accumulate in the lung and enter the bloodstream, resulting in their elevation.

There was no significant difference in the mean arsenic levels among smokers, non-smokers and

ex-smokers, and this report contradicts that of Lindberg et al. [15], stating that the content of arsenic in biological samples of human population was higher in smokers than that in non-smokers. Tobacco plants take up arsenic from the soil and concentrate them in leaves, thus the arsenic content in tobacco may vary between countries [14], which could probably be the reason for the result from this study.

5. CONCLUSION

Occupational exposure to wood dust induced an increase in the serum chromium and nickel levels of carpenters. Regular alcohol consumption and cigarette smoking lifestyles also induced a further elevation in the serum levels of these heavy metals in the carpenters. Therefore, carpenters who regularly drink alcohol and/or smoke cigarettes are prone to having higher serum chromium and nickel levels. Increased serum levels of chromium and nickel may be associated with several health challenges. Therefore, the use of appropriate PPE such as dust masks, hand gloves, and regular medical check-ups in these artisans are highly recommended.

CONSENT

Written consent from each subject was obtained.

ETHICAL APPROVAL

Ethical approval for the study was obtained from the Ethical Committee of the Ministry of Health, Rivers State, Nigeria.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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