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Evaluation of some heavy metals concentration in body fluids of metal workers in Kano metropolis, Nigeria

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ABSTRACT

Metal workers in urban Kano constitute a major workforce with a considerable population. The present work was aimed at obtaining baseline data on the extent of metal ion concentration in body fluids (urine and blood) of sampled population in the area. The investigation involves interaction with sampled population as well as blood and urine sample collection for heavy metals analysis. The health problems associated with the practice identified by respondents include: metal fume fever; eye and skin irritation; dizziness and respiratory problems; lack of or inadequate protective devices during activity were also reported. Laboratory investigation of urine samples by Atomic absorption spectrophotometry indicated higher concentrations for Manganese (Mn), Lead (Pb) and Nickel (Ni); in blood samples, there were higher concentrations of Manganese (Mn), Lead (Pb), Chromium (Cr) and Nickel (Ni). Metal workers of urban Kano are at risk because of the concentration of Mn and Pb in particular. There is the need to monitor occupational activities that are responsible for pollution and with serious health risk.

1. Introduction

The processes of manufacturing metal from ores into final products are operations that require high temperature. During these operations metal fumes that are released into air contain both microscopic and sub microscopic particles. Metal fume is one of the most common sources of such particles. Metallic fume, which is a typical industrial aerosol referred to a complex mixture of materials of the welding rod and metal oxides [1,2].

Metal work is common activity in which up to two percent of the working populations in industrialized countries have been engaged in some forms of metal works [3].

Adverse health effects have resulted by the release of airborne particles into the environment through metal works. Higher incidence of pneumonitis, bronchitis and metal fume fever were reported by metal workers that were permanently exposed to high concentrations of metal fumes [4].

Metal fumes are solid particles that came from the base metal, coatings on the base metal and other metal consumables. These metal aerosols are oxidized and can form small particles made up of a complex mixture of metal oxides on contact with air. Metal workers are subsequently exposed to these complexes through respiration pathways. The fumes generated from the process of welding are composed of at least 13 metals that include cadmium (Cd), manganese (Mn), mercury (Hg), beryllium (Be), chromium (Cr), iron (Fe), lead (Pb), molybdenum (Mo), nickel (Ni), vanadium (V), zinc (Zn), cobalt (Co) and antimony (Sb) [5]. The chemicals contained in these gases and fumes depend on factors such as: the type of metal being welded, type of welding conducted, ingredients that forms electrode, time and intensity of exposure, presence of coatings on the metal and ventilation [6].

High risk of lung cancer has been associated with occupational exposures to metal fumes. However, the causal relationship is affected by the lack of a clear dose–response and exposure to other agents [7].

Determination of metal concentrations in body fluids is usually used as a biomarker of exposure. Atomic Absorption Spectrometry (AAS) is a suitable technique to monitor metals during occupational exposure with a sensitive and rapid screening method [8].

Metallic work is one of the widespread economic activities in urban Kano. Virtually, most houses, business premises and institutions use these metal products. Most of the workshops are situated either in open spaces or relatively enclosed setting so as to attract more customers. As such, the fumes and the dusts are released into the environment (atmosphere) while the workers are exposed directly to most of the metal dust/fume pollutants. The extent of

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exposure, the levels of metal contaminants in the body or body fluids or tissues of the workers is not documented or even understood in urban Kano. Obviously, these metal workers can have elevated concentrations of some heavy metals in their body which might consequently be above the set standard limit elsewhere.

Valuable data obtained from the present study would provide a baseline information for setting the standard limits to exposure by the relevant body in Kano (The state Ministry of Environment/Health) and would also assist in control measures. The significance of biological exposure to toxic compounds and their effects has become increasingly relevant for establishing occupational and environmental limits of harmful substances such as metals.

The aim of the study was to assess the metals concentration from body fluids of metal workers in Kano metropolis through**;** surveying the profile of metal workers in Kano metropolis; determination of the concentrations of metals, including cadmium, chromium, lead, manganese and nickel in blood and urine samples of experimental group workers and control group (non metal workers).

2. Materials and methods

2.1. Study area

The study area was Kano state which was located at the northern part of Nigeria. Kano metropolitan encompasses eight local governments. The sampling sites where along both Jakara and Gabari road all located at Kano Municipal.

2.2. Experimental design

Metal workers (n = 20) were sampled through random sampling from two major sites within Kano metropolis: Jakara and Gabari roads. The control group (n = 20) were selected randomly from the population with no history of exposure to metal fumes. Control groups do not differ from metal workers in gender, age and smoking habits [9].

All subjects were informed of the objective of the study and their consent was obtained. Ethical clearance from ethical committee of the state ministry of health was also obtained.

2.2.1. Questionnaire (design and administration of structured questionnaire)

An interviewer questionnaire was used for general population studies [10]. Data on sex, age, and social habits (e.g smoking and alcohol consumption) were collected. The questionnaire also included data on medical history, such as metal allergy as well as lifetime working experience in the industry, minimum daily working hours with the metals, use and type of exposure protective devices, the place of residence, number of years spent as a metal worker and presence of symptoms of metal contamination so as to ascertain that the effects are from metal works.

2.2.2. Blood samples collection

Blood samples were collected from test subjects in the morning around 7 and 8 am. 5 ml of blood samples were collected through venipuncture. Samples were collected in a royal blue EDTA tube. The collection site on the subject body was washed with soap and water, followed by alcohol (70%) swab. Blood was collected by venipuncture using a phlebotomy needle. EDTA tube was inverted about 8–10 times to prevent clotting. Each specimen tube was attached with an identification label. Specimens were stored at 4 °C [11].

2.2.3. Urine sample collection

Working clothes worn by the test subjects were removed prior to sample collection to prevent incidental dust from contaminating the sample. Subjects washed and dried their hands thoroughly with clean water prior to collecting urine. A clean plastic container for sample collection was used. Hand gloves were used during the collection process so as to prevent contamination. Urine was collected in a 10 ml aliquot tube, tightly covered and properly labeled. Specimens were maintained at 4 °C and taken to the laboratory for subsequent analysis [11].

2.2.4. Determination of metals concentration

Atomic Absorption Spectrometry (AAS) standard solutions for Cr, Cd, Mn, Ni and Pb (Titrisol grades) were used to build up the calibration curve. They were prepared from a stock solution of 1 g L^{-1} for each metal by successive dilutions with distilled water.

2.2.4.1. Digestion of whole blood. Concentrated nitric acid was added to the blood sample (5 ml) that was stored previously at 4 °C for analysis. Microwave was used for the digestion of the blood samples. For digestion of the samples, 4.0 ml of the sample and 10.0 ml of a mixture of concentrated hydrochloric acid and nitric acids in (5 ml conc. HCl +5 ml conc. HNO_3) were transferred into a 125 ml pressure-resistant bottle. The samples were digested for 4 min at 300 W. The digestion was stopped when a colourless solution was obtained and then it was evaporated to dryness. The solution was diluted to 25.0 ml with de-ionised water [12,13].

2.2.4.2. Digestion of urine. Concentrated nitric acid (1 ml of acid dL^{-1} of urine) was added to the aliquots that were stored previously at 4 °C for analysis. Microwave was used for the digestion of the urine samples. For digestion of the samples, 5.0 ml of the sample and 10.0 ml of a 1:1 mixture of concentrated hydrochloric acid and nitric acids (5.0 ml conc. HCl + 5 ml conc. HNO_3) were transferred into a 125 ml pressure-resistant bottle. The samples were digested for 4 min at 300W. The digestion was stopped when the solution became colourless. It was then evaporated to dryness and was diluted to 25.0 ml with de-ionised water [13].

2.2.4.3. Atomization atomic absorption spectrometry analysis

The procedure used was that of [14] using Atomic Absorption Spectrophotometer model 68000 Shimazu Japan.

2.3. Data analysis

Data analysis was performed using Sigma Stat 3.5 statistical software for Windows as follows: The metals concentrations of test subjects was compared with the control in both blood and urine samples. These were carried out using Students *t*-test. Correlation analysis was carried out to check whether there is a relationship between different variables. All analysis was performed at 5% confidence level.

3. Results and discussion

Table 1 shows the profile, duration of exposure and health history of both metal workers and control groups. The mean age and duration of exposure of the sampled population was highlighted. The protective device used was sun glasses and health problems that result from the work include eye, respiratory and metal fume fever.

Table 2 shows the mean concentration of metals in urine at different exposure rates of metal workers. Pb has the highest concentration while Cd has the least. Among the metals examined, only Mn showed a significant relationship with duration of exposure.