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Full Length Research Paper

Selected heavy metals and electrolyte levels in blood of workers and residents of industrial communities

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The study focused on the determination of the levels of lead, cadmium, sodium and potassium in the blood of selected industrial workers (n = 36), residents of the neighboring communities (n = 36) as well as the residents of the communities further away from any industrial setting (which controls) (n = 12). The subjects were recruited from the granite served as the, ceramic and cement industries at Ewekoro, Abeokuta North and South Local government areas of Ogun state, Nigeria. The blood lead (BPb) and cadmium (BCd) were determined by atomic absorption spectrophotometry, while blood sodium (BNa^+) and potassium (BK^+) were determined by flame photometry. The weight and height of all respondents were measured in addition to other information obtained through a structured questionnaire and their body mass indices computed. The mean BCd, BNa^+ and BK^+ for controls and the test subjects were not significantly different from each other. Significant difference was only observed in the level of BPb between the test and the control. This was also observed when comparing the mean of all the measurements in the blood of residents of the neighboring communities with that of the control subjects. These results revealed that workers and the residents of the neighboring communities are at the risk of lead poisoning to which they were exposed.

Key words: Industrial communities, heavy metals level, electrolyte levels.

INTRODUCTION

Industrialization is central to economic development and improved prospects for human well being. If proper abatement technology is not used, industry becomes a major source of air and water pollution, hazardous waste and noise. Industrial operations have the potential to affect the health of workforces and the general environment thereby impacting negatively on the health of nearby populations and sometimes the populations that are farther away (Sandoz, 1994).

The area of concern is the routine discharge of pollutants into the environment as well as accidents with serious environmental consequences. The variety of occupational health hazards makes quantification of their associated health risks and impacts at the global level very difficult (Mikheev, 1994). Some estimates have been based on the occupational injuries and diseases reported in official statistics (Leigh, 1996), but a large number of injuries and diseases caused by work place hazards are not reported, adjustment is therefore necessary. Making such adjustment, estimate that there might be as many as 125 million cases of occupational injuries and diseases each year, resulting in 220,000 fatalities. (ILO, 1997)

Working conditions, nature of work, vocational and professional status, and geographical location of industries and employment have a profound impact on the social status and social well- being of workers. In many countries, social policy and protection are closely linked with employment and unemployment.

As the mobility of workers increases leading to high numbers of migrant workers in some countries, their health, well being and social support require special attention which is the key issues for sustainable development (Silbergeld and Tonat, 1994).

This study therefore focused on the determination of the levels of lead, cadmium, sodium and potassium in the blood of selected industrial workers, residents of the neighboring communities as well as the residents of the distant communities away from the industrial settings and which served as the controls.

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Table 1. Comparison of anthropometric indices and levels of lead, cadmium, sodium and potassium in blood samples of control, workers of granite industry and their neighbours.

	$^{+}$Control (n=12)	$^{+}$GI(n=12)	t_1	P_1sig. level	$^{+}$ AGN (n=12)	t_2	P_2sig. level	t3	P_3 sig. Level
Age	34.67 ±11.87	34.33 ±5.31	0.103	NS	35.50±6.39	-0.223	NS	-.565	NS
Height (m)	1.65 ±0.08	1.62 ±0.07	1.162	NS	1.66±0.03	-0.339	NS	-.732	NS
Weight (kg)	62.42 ± 5.48	62.50 ±6.50	-0.036	NS	60.50±3.12	0.914	NS	-.042	NS
BMI (kg/m^{2})	22.99 ±1.75	23.45 ±2.52	-1.155	NS	21.92±1.57	1.954	NS	2.419	NS
BPb (µg/dL)	31.0 ±0.10	43.0 ±0.12	-3.148	0.009*	46.0±0.19	-3.046	0.011*	-.483	NS
BCd (µg/dL)	22.0 ± 0.07	22.0 ± 0.05	-0.011	NS	19.0± 0.05	0.774	NS	8.611	.000 *
BK^{+} (mM/L)	4.63 ± 0.50	4.66 ±0.30	-0.178	NS	4.53±0.29	0.702	NS	1.181	NS
Bna^{+}(mM/L	138.76 ±4.31	139.71 3.11	-0.532	NS	136.00±2.70	2.304	NS	2.792	NS

GI = Workers of granite industry, AGN = Neighbours of granite industry, BMI = Body mass index, BPb = Blood lead, BCd = Blood cadmium, BK+ = Blood potassium, BNa+ = Blood sodium. $^{+}$= Mean ± SD * significant p<0.05, t_1 and P_1 = Comparison between control and workers, t_2 and P_2 = Comparison between control and neighbours, t_3 and P_3 = Comparison between workers and neighbours.

MATERIALS AND METHODS

Study population

A total of 84 male adult subjects (age range between 23 and 50) were voluntary to participate in the study. Informal consents were obtained from respondents after which they were properly educated about the benefits of the study. Respondents with history of cigarette smoking and drug addiction were excluded from the study. In addition respondents with medical history of hepatic and renal pathology were also excluded from the study.

Eighty four (84) male adult subjects (age range between 23 and 50) were selected to participated in the study. These comprised of twelve respondents each from three different factories namely cement factory, granite industry and porcelain industry, all located within South-Western Nigeria. In addition, twelve respondents each living within the rural communities, 1 to1.5 km radius around each of these factories were randomly selected as residents of industrial communities. Another twelve respondents were selected as the control, who were living and working in a relatively clean environment within the government reservation area.

Anthropometric indices

The ages, body weights and heights of the subject were noted. Heights (m) and body weights (kg) were used to calculate the body mass index (BMI) (kg/m^{2}).

Collection of blood

10 ml of venous blood was obtained from the antecubital vein using disposable pyrogen-free needle and syringes. The blood samples were dispensed into plain vacutainer tubes containing EDTA to prevent coagulation. Samples were kept frozen at -70°C until analysed.

Determination of lead and cadmium from blood

samples Blood digestion

The blood samples were retrieved and allowed to thaw. 1 ml of the blood sample was pipetted using micropipette into conical flask. 10 ml conc. HNO_3 was added to the blood sample in the conical flask and then heated on a hot plate.

When the fume became clear and the solution was almost colourless, the solution was removed and allowed to cool. After this, the solution was made up to 25 ml by adding deionised water and stirring.

Determination of lead and cadmium from digested blood samples

The samples digested were analyzed using Alpha 4 AAS (CHEMTECH 4200) at wavelength 217 and 228.8 nm for lead and cadmium respectively at the Obafemi Awolowo University Central Laboratory, Ile-Ife.

Determination of sodium and potassium in blood plasma

Blood sodium (BNa^{+}) and potassium (BK^{+}) were determined by flame photometry (CORNING Clinical Flame Photometer 410C) at wavelength 589 and 768 nm for sodium and potassium respectively at the Obafemi Awolowo University Central laboratory, Ile Ife.

Statistical analysis

Using SPSS 10.00, results were expressed as mean ± standard deviation (SD), student's t-test was used to determine significant difference between means. The 5% ($p<0.05$) level of significant difference using two tailed 't' table was used to compare the calculated and critical 't' value from the table and thus statistical difference. Analysis of variance was also calculated using SPSS 10.00.

RESULTS

Table 1 showed the comparison of mean values of anthropometric indices and levels of leads, cadmium, sodium and potassium in controls and granite industry workers. There was no significant difference (P>0.05) between the means of age, height, weight, BMl, BCd, BK^{+} and BNa^{+} of the controls and granite industry workers. The mean value of the BPb 43.0 µg/dL of the granite industry workers was significantly different (P = 0.009, t = -3.148) from that of control (31.0 µg/dL).

Similarly there was no significant difference (P>0.05) in

Table 2. Comparison of anthropometric indices and levels of lead, cadmium, sodium and potassium in blood samples of control, workers of ceramic industry and their neighbours.

	$^+$Control(n=12)	$^+$Ceramic(n=12)	t_1	P_1sig.level	$^+$PN(n = 12)	t_2	P_2sig.level	t_3	P_3sig.level
Age	34.67±11.87	31.00 ±5.17	1.114	NS	32.83±6.19	0.411	NS	-1.379	NS
Height(m)	1.65±0.08	1.61 ±0.10	1.215	NS	1.64±0.05	0.699	NS	-.736	NS
Weight (g)	62.42 ±5.48	67.67 ±9.39	-1.961	NS	63.58±7.07	-.392	NS	1.872	NS
BMI (kg/m^2)	22.99 ±1.75	26.28±4.32	-2.195	NS	23.67±1.81	-.811	NS	2.153	NS
BPb (µg/dL)	31.0±0.10	44.0 ±0.12	-3.006	0.012 *	45.0± 0.06	-.314	0.00*	-.164	NS
BCd (µg/dL)	22.0±0.07	22.0 ±0.06	0.105	NS	23.0±0.04	-.294	NS	0.90	.NS
BK$^+$ (mM/L)	4.63± 0.50	4.87±0.41	-1.144	NS	4.72±0.27	-.473	NS	2.163	NS
Bna$^+$ (mM/L)	138.76 ±4.31	139.57 ±3.37	-0.585	NS	136.07±4.72	1.197	NS	1.126	NS

Ceramic = Workers of ceramic industry, PN = Neighbours of porcelein wares industry, BMI = Body mass index, BPb = Blood lead, BCd = Blood cadmium, BK+ = Blood potassium, BNa+ = Blood sodium. $^+$= Mean ± SD* significant $p<0.05$, t_1 and P_1 = Comparison between control and workers; t_2 and P_2 = Comparison between control and neighbours; t_3 and P_3 = Comparison between workers and neighbours.

Table 3. Comparison of anthropometric indices and levels of lead, cadmium, sodium and potassium in blood samples of control, workers of cement factory and their neighbours.

	$^+$Control(n=12)	$^+$Cement(n=12)	t_1	P_1sig.level	$^+$CN(n = 12)	t_2	P_2sig.level	t_3	P_3sig.level
Age	34.67±11.87	36.25±9.82	-0.660	NS	35.67±9.71	-0.233	NS	.816	NS
Height(m)	1.65±0.08	1.55±0.08	4.832	NS	1.64±0.07	0.422	NS	-2.484	NS
Weight(kg)	62.42 ±5.48	65.35±10.23	-1.047	NS	62.83±3.64	-0.277	NS	.184	NS
BMI(kg/m^2)	22.99 ±1.75	27.07±3.72	-3.126	0.010*	23.49±1.64	-0.763	NS	2.414	NS
BPb(µg/dL)	31.0±0.10	43.0±0.10	-4.461	0.001*	44.0±0.07	-3.979	0.002*	-.857	NS
BCd(µg/dL)	22 .0± 0.07	23.0±0.06	-0.458	NS	22.0±0.05	0.150	NS	.232	NS
BK$^+$(mM/L)	4.63 ± 0.50	4.37±0.54	1.017	NS	4.60±0.27	0.167	NS	-2.416	NS
Bna$^+$(mM/L)	138.76 ±4.31	139.53±2.50	-0.673	NS	137.43±4.00	0.679	NS	2.051	NS

Cement = Workers of cement company, CN = Neighbours of cement industry, BMI = Body mass index, BPb = Blood lead, BCd = Blood cadmium, BK+ = Blood potassium, BNa+ = Blood sodium. $^+$**=** Mean ± SD *significant $p<0.05$, t_1 and P_1 = Comparison between control and workers, t_2 and P_2 = Comparison between control and neighbours; t_3 and P_3 = Comparison between workers and neighbours.

age, height and weight, BMI, BCd, BK$^+$ and BNa$^+$, of the control and neighbours of granite industry but there was significant difference (P = 0.011, t =-3.046) in BPd.

Comparison of the mean values of measured parameters of granite industry workers and their neighbours also indicated a significant difference (P = 0.00, t = 8.611) in their Cadmium (Table 1)

For the ceramic industry respondents, there was no significant difference (P>0.05) between the mean values of age, height, weight, BMI, BCd, BK$^+$ and BNa$^+$ of control and ceramic industry workers. There was significant dif-ference (P = 0.012, t = -3.006) between the mean values of BPb of control and workers of the ceramic industry (Table 2).

There was not significant difference (P>0.005) in age, height, weight, BMl, blood Cd, blood K$^+$ and blood Na$^+$ of the control and neighbours of ceramic industry but there was significant difference (P = 0.0, t = -6.3.14) in their blood Pd (Table 2)

There was no significant difference (P>0.05) between the mean values of age, height, weight, BCd, BK$^+$ and BNa$^+$ of control and cement industry workers but there were significant difference (P = 0.01, t = -3.126 and P = 0.001, t = -4.461 respectively) for BMl and BPd. (Table 3)

DISCUSSION

In this study, occupational exposure to selected toxic heavy metals was investigated and exposure to lead has once again been identified as a major occupational hazard. This may be as a result of the increasing abundance of lead in our environment, and the consequences of industrialisation.

Lead toxicity is of great concern to public health due to its persistence in the environment and has been reported to affect many human organs. It has special affinity for bone and brain tissues (Granjean, 1975). All known effects of lead on biological system are deleterious. Many physiological system including those of the renal, nervous, heamopoietic, immune, reproduction and endocrine are principal targets of this environmental toxicant (Anetor et al., 2002)

Granite is said to contain lead and cadmium and during the process of breaking the rocks into smaller units, dust are released into the atmosphere. The majority of lead in rocks is present in silicate structures, for elements like calcium; it is unavailable until weathering breaks down the primary mineral (O,Nail, 1985). However, when rocks are being blasted for the production of granite and granite dust, lead is released into the atmosphere through dust. This may place the workers at the risk of exposure to these heavy metals. The residents of the neighbouring communities are at greater risk because the workers might be using some protective devices, which are not in place for the villagers around these industries. Moreover, the workers of these industries spent few hours at work and within the environment while the residents of the neighbouring communities spend almost twenty-four hours of the day around the industries. Hence the period of exposure to dust might be the reason for high level blood lead. Additionally many people are less knowledgeable about significance of lead exposure and preventive measures. Polivka (1999) also observed that there are gaps in lead poisoning prevention knowledge among rural residents. This may also be responsible for the high level of blood lead of the residents of the neighbouring communities

The most significant source of lead exposure is dust. Although dusts are complex in nature and might be categorized consistently into few categories relating to human exposure, household dust, soil dust, street dust and occupational dust (Gots, 1992). Occupational dust is the reason for the test carried out on these industrial workers and the residents of the neighbouring communities

In each case, the lead in dust arises from a complex mixture of fine particle of soil, flaked paint and airborne particles of industrial or automotive origin. Dust is deposited in windowsills from outdoor sources. The particles characteristically accumulate on exposed surface and also trapped in the fibres of clothing and carpets (USEPA, 1986). Lead-glazed pottery and lead pigment in toys and pencils is other route of exposure (Fincleman 1996). Lead silicate is used for the manufacture of glass and ceramic frits, which are used in introducing lead into glass and ceramic finish. This might be the major source of exposure in ceramic industries. When lead is released into the environment, it has along resident time compared with other pollutants. Lead and its compounds tend to accumulate in soil and sediments. They will remain bioavailable far into the future due to their low solubility and relative freedom from microbial degradation (Kataba-Pendias and Pendias, 1992). This also may be another major reason for the significant difference in blood lead. Another reason may be that, most of the arable crops being consumed by the residents of the neighbouring communities might have taken up lead from the soil. Lead from dust and gases from various industrial sources such as these factories can contaminate soil and plants.

Conclusively, there should be an appropriate control technology to eliminate or reduce pollution arising from industrial process and operations, both in and out of workplace, in order to protect the general environment and the health of workers and surrounding communi-ties. Full application of control technology comprises not only its design and implementation but also its operation, maintenance and management. Incorporating environmental considerations into design phase of products and processes can also do much to prevent and minimise pollution.

Workers in factories generally should be encouraged to observe workplace safety rules and follow procedures to protect themselves. When leaving the workplace, they should follow decontamination procedures to avoid wearing contaminated clothing that could potentially expose other persons. Measure should be taken to limit access to toxic products. Balance nutrition should be encouraged both in workers and neighbours that are exposed to pollution. Eating fresh fruits, vegetables, grains, lean meat and cold-water fish can do this.

Industrial workers should consider the use of supplemental antioxidants, herbs, minerals, amino acids, phyto-extracts, detoxifying agents, protective agents and fibre as adjuncts to a healthy diet to enhance vital organ functioning and to aid in body's natural detoxifying actions. Garlic, for example has been valued for centuries for its medicinal properties. Research has shown that garlic can protect us from various pollutants and heavy metals (Cha, 1987).

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