Network for Research and Development in Africa
International Journal of Pure and Applied Science Research
ISSN: 2384-5918. Volume 11, Number 5
Pages 28-38 (August, 2019)
www.arcnjournals.org

Determination and Health Implications of Heavy Metals on the Clothes of Mechanics in Buzaye Automobile Village, Sokoto

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Abstract: *The deposition of heavy metals on the clothes of local mechanics in Buzaye mechanic village of Sokoto was conducted using Atomic Absorption Spectroscopic method. Three samples of clothes were collected from fourteen workshops and samples were analyzed in triplicates. The assay revealed the present of heavy metals on the order of Zn>Ni>Cd>Pb. The same pattern was observed for average Zn concentration (µg/g) ranging from 16.5015 in sample K to 27.5777 in sample N. The average Zn concentration (µg/g) was in the order K (16.5015) > B (21.467) > L (23.3612) > I (24.4081) > D (25.8512) > M (26.1606) > A (26.3168). Other notable concentrations in an increasing order were samples H (26.9444) > C (26.9675) > F (27.1670) > E (27.4157) and lastly N (27.5777). The range and standard deviations of the metals is from 26.05±2.62 for Zn and 2.94±2.92. Analysis revealed a strong correlation of the metals from one automobile workshop to another. The study concluded that the interaction between the metals and the absorption ratio by body skin is highly probable.*
Key words: Workshops, Mechanics, Clothes, Health hazards and Heavy metals

1.0 Introduction

The dramatic increase in number of fairly used cars flying roads in most developing countries like Nigeria is alarming. These vehicles popularly known as Tokumbo cars in Nigeria pose serious environmental threat due to air pollution and in addition, automobile mechanic workshops had been established in recent years. During overhauling of these vehicle engines, metal fabrication and automobile panel beating, reasonable amount of spent engine oil and metals fillings are deposited on top soil while painting of vehicles and tyre vulcanizing are other activities that negatively affect the quality of soils around automobile workshops (Adewole and Uchegbu, 2010). Vehicle parts like break lining are known to contain copper which provides mechanical strength and assist in heat dissipation (Ukabiala *et al.,* 2009). Another author Cunningham *et al.,* (1975); reported that human activities such as metal smelting industries, coal combustion, auto emissions and application of commercial fertilizers, liming materials, sewage sludge, animal waste and irrigation water.

Like most of the developing cities in Nigeria, Sokoto is one of the are as were traffic density is increasing everyday. This is because of its closeness to the border region and a major entry route of these Tokumbo cars into the country. Buzaye is the biggest and the busiest automobile workshop in Sokoto metropolis and major mechanical workshop as a stop-over workshop. Table 1.0 presented the vehicular density of vehicles into the workshop. The workshop consisted of painters, mechanics, electric rewires, panel beaters, spare parts sellers and so on.

Table 1.0: Vehicles and Motorcycles tally entering the workshop in hours interval recorded during the sampling time of four hours (11:40 – 15:40 on 22nd Aug, 2017).

Sampling time	Motorcycle	Personal car	Bus and alike	Truck & van
0-60 mins	7	21	5	3
60-120 mins	9	28	1	6
120-180 mins	17	37	8	2
180-240 mins	5	26	3	0
Total	**38**	**112**	**17**	**8**

In most African countries, automobile mechanics are not using the needed safety kits such as eye goggles, uniform and so on. In fact, mechanics use the same cloth for a very long time without washing. In addition, these mechanics due to lack of equipment and working tools are using hands in most of their work resulting in deposition of different contaminants such as paints, PMS and used engine oils on their cloth and sweat as well. Hence, trace metal complex and dyes could be extracted from the fabrics by sweat solutions (Saracoglu *et al.,* 2003). In a complex mixture of different solvents as on the clothes of automobile mechanics there is a very high possibility of chemical leaching of heavy metals and their probable adsorption into the epidermal layer of the skin.

Occupational exposure to heavy metals has been widely reported by many authors (Nowak, 1994; Samanta *et al.,* 2004). Workers of the mining and production of cadmium, chromium, lead, mercury, gold and silver have been reported to be thus exposed; also inhabitants around industrial sites of heavy metal mining and processing, are exposed through air by suspended particulate matters (Heyer, 1985; Ogwuegbu and Muhanga, 2005). Most literature work on automobile workshops were based on the availability of heavy metals in soils of automobile workshops for example, the chemical fractionation of heavy metals in soils around the vicinity of automobile mechanic workshops in Kaduna metropolis, Nigeria was investigated by Achi *et al.*, (2011); and discovered that the highest percentage of metals were concentrated in the residual fractions.

To effectively predict the degree and magnitude of health risk it is important to studies the inherent hazards of a pollutant, exposure levels and population characteristics are very essential in drawing a final conclusion of the health risk of any pollutant. Studies from the field and laboratory experiments showed that accumulation of heavy metals in a tissue is mainly dependent on media concentration of in which metals are exposed and exposure period; although some other environmental factors such as pH and temperature play significant roles in metal accumulation (Jeffree *et al.,* 2006; Singh, R.K. *et al*., 2006).

The fear of this entry root of heavy metals into the body system of this group of automobile mechanics instigated this study to provide baseline information on the contamination of heavy metals (Zn, Ni, Pb and Cd) on the clothes of local automobile mechanics and to further highlight some health risk associated with this attitude.

2.0 Materials and methods

All the reagents used were analytical grade (AnalaR) chemicals and all the glassware, containers and tools were washed with liquid detergent first, rinsed with 20% (v/v) nitric acid and finally rinsed with distilled water. The containers and glassware were kept in oven until needed. Distilled water was used throughout the work (Tsafe *et al.,* 2012). Fourteen samples from different workshops were collected irrespective of the nature of work of the mechanics and for each of the samples it was divided into three parts and treated as a separate sample without any treatment.

2.1 Materials Digestion

1 g of each of the pieces of cloth from mechanics was digested with using nitric acid and hydrochloric acid in a ratio of 3:1 in digestion vessels until a clear solution was obtained. The digested clothes were filtered and made up to 100 ml with distilled water. Each sample was treated in triplicates and analyzed for heavy metals (Zn, Ni, Pb and Cd) using a Shimadzu AA 6800 Atomic Absorption Spectrophotometer at the National Research Institute for Chemical Technology-Zaria. Statistical analyses of the data was conducted and presented.

Fig. 1: Sample collected before digestion

3.0 Results and Discussion

The concentration of Zn (µg/g) was presented in table 2.0 showing, the average and the standard deviation of each sample. The range of the results for Zn (ppm) was from 16.38 in sample K to 27.87 in sample N. The same pattern was observed for average Zn concentration (µg/g) ranging from 16.5015 in sample K to 27.58 in sample N. The average Zn concentration (µg/g) was in the order K (16.50) > B (21.467) > L (23.36) > I (24.41) > D (25.85) > M (26.16) > A (26.32). Other notable concentrations in an increasing order were samples H (26.94) > C (26.97) > F (27.17) > E (27.412) and lastly N (27.58). Zinc, Cd, Pb, Cu are fuel additives and can easily be released into the atmosphere and carried to the soil through rain and wind (Mohammed *et al.,* 2005) as well can be deposited on automobile parts such as exhaust system even at much higher concentrations. Zn can be considered as one of the heavy metals which are components of tyre and engine and can be released during abrasion and wears (Odoh et al., 2011). The little variation in the results of Zn could be attributed to the period of exposure of the materials to contamination, since its expected that the longer the period of exposure, the higher the accumulation of trace metals not only in Zn.

Generally, toxic heavy metals such as Cd and Zn pose health hazards, if their concentrations exceeds the maximum permissible limits. However, the tendencies of accumulation over a long period of time is enormous. Akan (2009); discovered high concentrations of Zn in tissues of different categories of fishes with highest concentrations in the liver, gills, stomach, kidney and bone in descending order. Zinc oxide is the major cause of zinc shakes or Monday morning fever as is popularly called, a disease that is associated with acute occupational heavy metal exposure (Samara and Richard, 2006). The recommended Daily intake of Zinc is 150 ug/day (WHO, 1987), even though zinc deficiency facilitates effects of some toxic metals like lead.

Lead concentration on the clothes of local mechanics is presented in table 3.0. The concentration of lead was lowest in sample K (16.38 ppm) and highest was found in sample N (27.87 ppm), with an average concentration ranging from 16.50 ppm to 27.58 ppm. A comparative studies on nonoccupationally exposed residents showed higher in concentration in elements such as Pb, being 20 times higher and Cd being 10 times higher (Rodushkin and Axelsson, 2000) and thus the content of toxic metals suggested high levels of exposure to heavy metals (Elijah *et al.,* 2010). Lead toxic effects are vary in human from central nervous system in children, shortening the gravity, decrease in birth weight and, retardation of mental development when concentration is ≥ 500ug/l in blood ((Atanaskova, 2011; Mukesh *et al*., 2008). The effects of lead are manifested primarily in nervous haemopietic, urinary and genital systems and the kidney gets damaged due to decrease in blood hemoglobin (Ch.Subba 2010; Baykov *et al.,* 1996). In addition, lead to paints, dyes, and gasoline have created an epidemic of lead poisonings. Lead in its organic form is better absorbed through the skin (Samara and Richard, 2006). Toxicological effects of lead on man include inhibition of haemoglobin formation, sterility, hypertension and mental retardation in children.

Cadmium

The kidney is considered the critical target organ for the general population as well as for occupationally exposed populations resulting to renal failure while chronic obstructive airway disease is associated with long-term high-level occupational exposure by inhalation (FAO/WHO, 2011).

Cadmium, lead, copper and zinc are the major metal pollutants of the auto-mechanical workshop and are released from fuel burning, wear out of tyres, leakage of oils and corrosion of batteries and metallic parts such as radiators (Dolan *et al*., 2006). Refined foods are the major sources of Cd and the Daily dietary intake of Cd ranges from 40-50ug/day (WHO, 1987).

Other means of direct internal contamination include ingestion of food during routine work and dermal from dust that are likely to settle on sweat prone skin surfaces due to high temperature environment and heavy exercises (Arogunji 2007).

Sexuality, weight, age, (3), concentration, physicochemical properties, chemical bonds and their solution on absorption, accumulation, distribution in the body and physiological effects on metals (Dharib *et al*., 2003). Cd in chronic accumulation in the kidneys where it causes dysfunction if the concentration in the kidney cortex exceeds 200 mg/Kg fresh weight (Oyedele *et al.,* 2006) the amount of absorption and assembling depends on ecological, physical, chemical and biological condition and the kind of element and physiology of the body (Agbozu *et al.,* 2007). Chronic inhalation of cadmium causes both fibrotic and emphysematous lung damage, bone and Kidney resulting into renal failure. Itia-itia disease. (Samara and Richard, 2006).

Nickel

The concentration (µg/g) was presented in table 4.0 showing a range of nickel contents on the clothes of auto mechanics in buzaye was low. Nickel is used for nickel alloys, electroplating, machinery parts, stainless-steel, spark plugs and also as a catalyst while Nickel dermatitis, consisting of itching of the fingers, hands and forearms, it is the most common effect in human from chronic skin contact with nickel (Rajappa *et al.,* 2010). Nickel has been reported to be present in fuels as additives in low quantity and as trace metal in steel products. Heavy metals are toxicities are relatively uncommon but failure to recognize and treat heavy metal toxicities can result in significant morbidity and mortality (Samara and Richard, 2006). Genetics is an important factor because a higher incidence of heavy metal toxicity occurs in the African American population in the US because of delays in removing lead sources from lower socioeconomic areas (Samara and Richard, 2006).

4.0 Conclusions

The assay for the evaluation of heavy metals in pieces f mechanics clothes was conducted to acertain the level of possible exorsure to these metals. Metals including Zn, Ni, Cd and Pb were evaluated using atomic absorption spectroscopic technique. Results suggested the prevalence of these metals ranges from K (16.5015) to K (27.5777). Analysis revealed a strong correlation of the metals from one automobile workshop to another.

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Table 1: Total Zn Concentration (µg/g)

Sample No	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Sample A	26.4122	21.2414	26.7651	25.7644	27.3087	27.2336	27.1497	27.0022	24.3561	27.5459	16.5767	23.4335	26.2416	27.3695
Sample B	26.5395	21.7851	27.2393	25.9351	27.3377	27.1526	27.381	26.8692	24.6366	27.4129	16.3771	23.2774	26.0131	27.8727
Sample C	25.9987	21.3773	26.8981	25.8512	27.6037	27.1121	27.7744	26.9617	24.2288	27.4157	16.5478	23.3728	26.2243	27.4938
Average	26.3168	21.467	26.9675	25.8512	27.4157	27.167	27.436	26.9444	24.4081	27.4591	16.5015	23.3612	26.1606	27.5777
%RSD	1.0744	1.318	0.9072	0.33	0.5931	0.2277	1.1511	0.2531	0.8548	0.2767	0.6535	0.337	0.4862	0.9504
SD	0.009777	0.009784	0.008459	0.00295	0.005623	0.002139	0.01092	0.002358	0.007214	0.002627	0.003729	0.002722	0.004398	0.009063

Table 2: Total Ni Concentration (µg/g)

Sample No	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1st Sample	26.4122	21.2414	26.7651	25.7644	27.3087	27.2336	27.1497	27.0022	24.3561	27.5459	16.5767	23.4335	26.2416	27.3695
2nd Sample	26.5395	21.7851	27.2393	25.9351	27.3377	27.1526	27.381	26.8692	24.6366	27.4129	16.3771	23.2774	26.0131	27.8727
3rd Sample	25.9987	21.3773	26.8981	25.8512	27.6037	27.1121	27.7744	26.9617	24.2288	27.4157	16.5478	23.3728	26.2243	27.4938
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%RSD	1.0744	1.318	0.9072	0.33	0.5931	0.2277	1.1511	0.2531	0.8548	0.2767	0.6535	0.337	0.4862	0.9504
SD	0.009777	0.009784	0.008459	0.00295	0.005623	0.002139	0.01092	0.002358	0.007214	0.002627	0.003729	0.002722	0.004398	0.009063

Table 3: Total Pb Concentration (µg/g)

Sample No	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1st Sample	26.4122	21.2414	26.7651	25.7644	27.3087	27.2336	27.1497	27.0022	24.3561	27.5459	16.5767	23.4335	26.2416	27.3695
2nd Sample	26.5395	21.7851	27.2393	25.9351	27.3377	27.1526	27.381	26.8692	24.6366	27.4129	16.3771	23.2774	26.0131	27.8727

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
3rd Sample	25.9987	21.3773	26.8981	25.8512	27.6037	27.1121	27.7744	26.9617	24.2288	27.4157	16.5478	23.3728	26.2243	27.4938
Average	26.3168	21.467	26.9675	25.8512	27.4157	27.167	27.436	26.9444	24.4081	27.4591	16.5015	23.3612	26.1606	27.5777
%RSD	1.0744	1.318	0.9072	0.33	0.5931	0.2277	1.1511	0.2531	0.8548	0.2767	0.6535	0.337	0.4862	0.9504
SD	0.009777	0.009784	0.008459	0.00295	0.005623	0.002139	0.01092	0.002358	0.007214	0.002627	0.003729	0.002722	0.004398	0.009063

able 4: Total Cd Concen ration (µg/g)

Sample No	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1st Sample	26.4122	21.2414	26.7651	25.7644	27.3087	27.2336	27.1497	27.0022	24.3561	27.5459	16.5767	23.4335	26.2416	27.3695
2nd Sample	26.5395	21.7851	27.2393	25.9351	27.3377	27.1526	27.381	26.8692	24.6366	27.4129	16.3771	23.2774	26.0131	27.8727
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%RSD	1.0744	1.318	0.9072	0.33	0.5931	0.2277	1.1511	0.2531	0.8548	0.2767	0.6535	0.337	0.4862	0.9504
SD	0.009777	0.009784	0.008459	0.00295	0.005623	0.002139	0.01092	0.002358	0.007214	0.002627	0.003729	0.002722	0.004398	0.009063

Table 4: Average Zn, Ni, Pb and Cd Concentrations (µg/g)

Sample No	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Average Zn (ppm)	26.3168	21.467	26.9675	25.8512	27.4157	27.167	27.436	26.9444	24.4081	27.4591	16.5015	23.3612	26.1606	27.5777
Average Ni (ppm) Average	26.5395	21.7851	27.2393	25.9351	27.3377	27.1526	27.381	26.8692	24.6366	27.4129	16.3771	23.2774	26.0131	27.8727
Pb (ppm) Average	25.9987	21.3773	26.8981	25.8512	27.6037	27.1121	27.7744	26.9617	24.2288	27.4157	16.5478	23.3728	26.2243	27.4938
Cd (ppm)	26.3168	21.467	26.9675	25.8512	27.4157	27.167	27.436	26.9444	24.4081	27.4591	16.5015	23.3612	26.1606	27.5777

Table 5: Two-tailed Correlations

		A	B	C	D	E	F	G	H	I	J	K	L	M	N
A	Pearson Correlation	1	.487	.458	.216	-.950	.589	-.824	-.434	.873	.275	-.578	-.347	-.631	.489
	Sig. (2-tailed)		.677	.697	.862	.201	.599	.383	.714	.325	.823	.608	.774	.565	.675
	N	3	3	3	3	3	3	3	3	3	3	3	3	3	3
B	Pearson Correlation	.487	1	.999*	.958	-.191	-.419	.094	-.998*	.851	-.706	-.994	-.988	-.985	1.000**
	Sig. (2-tailed)	.677		.021	.185	.878	.725	.940	.038	.352	.501	.069	.098	.111	.002
	N	3	3	3	3	3	3	3	3	3	3	3	3	3	3
C	Pearson Correlation	.458	.999*	1	.967	-.158	-.449	.126	-1.000*	.834	-.729	-.990	-.993	-.979	.999*
	Sig. (2-tailed)	.697	.021		.164	.899	.704	.919	.017	.373	.480	.090	.077	.132	.023
	N	3	3	3	3	3	3	3	3	3	3	3	3	3	3
D	Pearson Correlation	.216	.958	.967	1	.099	-.662	.375	-.973	.665	-.880	-.921	-.991	-.894	.957
	Sig. (2-tailed)	.862	.185	.164		.937	.539	.755	.148	.537	.315	.254	.088	.296	.187
	N	3	3	3	3	3	3	3	3	3	3	3	3	3	3
E	Pearson Correlation	-.950	-.191	-.158	.099	1	-.811	.959	.132	-.677	-.560	.295	.038	.358	-.194
	Sig. (2-tailed)	.201	.878	.899	.937		.398	.182	.916	.526	.622	.809	.976	.767	.876
	N	3	3	3	3	3	3	3	3	3	3	3	3	3	3
F	Pearson Correlation	.589	-.419	-.449	-.662	-.811	1	-.943	.472	.120	.939	.319	.553	.255	-.416
	Sig. (2-tailed)	.599	.725	.704	.539	.398		.216	.687	.924	.224	.793	.627	.836	.727
	N	3	3	3	3	3	3	3	3	3	3	3	3	3	3

G	Pearson Correlation	-.824	.094	.126	.375	.959	-.943	1	-.152	-.443	-.771	.014	-.245	.081	.091
	Sig. (2-tailed)	.383	.940	.919	.755	.182	.216		.903	.708	.440	.991	.843	.949	.942
	N	3	3	3	3	3	3	3	3	3	3	3	3	3	3
H	Pearson Correlation	-.434	-.998*	-1.000*	-.973	.132	.472	-.152	1	-.819	.747	.986	.996	.973	-.998*
	Sig. (2-tailed)	.714	.038	.017	.148	.916	.687	.903		.389	.463	.106	.060	.149	.040
	N	3	3	3	3	3	3	3	3	3	3	3	3	3	3
I	Pearson Correlation	.873	.851	.834	.665	-.677	.120	-.443	-.819	1	-.230	-.903	-.761	-.929	.853
	Sig. (2-tailed)	.325	.352	.373	.537	.526	.924	.708	.389		.852	.283	.449	.241	.350
	N	3	3	3	3	3	3	3	3	3	3	3	3	3	3
J	Pearson Correlation	.275	-.706	-.729	-.880	-.560	.939	-.771	.747	-.230	1	.626	.806	.573	-.704
	Sig. (2-tailed)	.823	.501	.480	.315	.622	.224	.440	.463	.852		.569	.403	.612	.503
	N	3	3	3	3	3	3	3	3	3	3	3	3	3	3
K	Pearson Correlation	-.578	-.994	-.990	-.921	.295	.319	.014	.986	-.903	.626	1	.966	.998*	-.994
	Sig. (2-tailed)	.608	.069	.090	.254	.809	.793	.991	.106	.283	.569		.167	.042	.067
	N	3	3	3	3	3	3	3	3	3	3	3	3	3	3
L	Pearson Correlation	-.347	-.988	-.993	-.991	.038	.553	-.245	.996	-.761	.806	.966	1	.947	-.988
	Sig. (2-tailed)	.774	.098	.077	.088	.976	.627	.843	.060	.449	.403	.167		.209	.100
	N	3	3	3	3	3	3	3	3	3	3	3	3	3	3
M	Pearson Correlation	-.631	-.985	-.979	-.894	.358	.255	.081	.973	-.929	.573	.998*	.947	1	-.985
	Sig. (2-tailed)	.565	.111	.132	.296	.767	.836	.949	.149	.241	.612	.042	.209		.109
	N	3	3	3	3	3	3	3	3	3	3	3	3	3	3
N	Pearson Correlation	.489	1.000**	.999*	.957	-.194	-.416	.091	-.998*	.853	-.704	-.994	-.988	-.985	1
	Sig. (2-tailed)	.675	.002	.023	.187	.876	.727	.942	.040	.350	.503	.067	.100	.109	
	N	3	3	3	3	3	3	3	3	3	3	3	3	3	3

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).