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SERUM LEAD, CADMIUM AND MERCURY LEVELS IN NIGERIAN BATTERY REPAIR WORKERS: CORRELATIONS WITH PLASMA LIPIDS.

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ABSTRACT
Background: Lipid and lipoprotein abnormalities play a major role in the pathogenesis and progression of atherosclerosis as well as other cardiovascular diseases. These have been associated with an increased blood lead, mercury and cadmium levels. This study was therefore designed to determine the association between chronic occupational exposure to lead, cadmium and mercury on plasma lipids. **Subjects and Methods**: Sixty battery repair workers who have been on the job for at least 5 years and sixty apparently healthy, age and sex matched controls were consecutively enrolled for the study. Serum was extracted from 6mls of venous blood collected from subjects and controls after an overnight fast. Demographic and anthropometric parameters were obtained using semi-structured questionnaires. Serum levels of lead (Pb), cadmium (Cd) and mercury (Hg) were measured by atomic absorption spectrophotometer. Total Cholesterol (T-Chol), Triglycerides (Tg) and High Density Lipoprotein-Cholesterol (HDL-Chol) were measured using commercially prepared reagents manufactured by Randox Laboratories Limited, United Kingdom. Low Density Lipoprotein – Cholesterol (LDL-Chol) was calculated using Friedewald equation **Results*:*** The serum levels of Cd (0.36 ±0.11 µg/dl vs 0.25±0.05µg/dl), Pb (0.09±0.14µg/dl vs 0.03±0.01µg/dl) and Hg (0.06±0.05µg/dl vs 0.02±0.01µg/dl) were significantly higher among battery repair workers than control subjects, p<0.01 respectively. Furthermore, there was statistically significant increase in LDL-Chol (2.60±1.17mmol/L vs 1.73± 0.45 mmol/L), Total Cholesterol (4.35± 0.81 mmol/L vs 3.70 ±.38 mmol/L) and Triglyceride (0.63± 0.43 mmol/L vs 0.37± 0.22 mmol/L) with corresponding decrease in HDL-Chol (1.35±0.81 vs 1.67±0.33 mmol/L) among battery repair workers When compared with controls. Significant negative association was observed between HDL-Chol and Cd (r = -0.328, p<0.05) among battery repair workers. **Conclusion*:*** Increased serum levels of Cd, Pb and Hg among battery repair workers may potentially increase the risk of having dyslipidaemia and its associated complications.

KEYWORDS: Battery repair workers, plasma lipids, Cadmium, Lead and Mercury.

INTRODUCTION
Occupational exposure to trace metals still persists in unorganized small scale battery repair workshops.[1] World Health Organization has reported chronic high level exposure of heavy metals invariably causes serious adverse health problems and this has contributed to approximately 800,000 premature deaths per year.[2]

Cadmium (Cd) is important in the production of Nickel-Cadmium(Ni-Cd) rechargeable batteries. Cadmium and its compounds are highly toxic on exposure. It has been established that human exposure to this metal predisposes to cancer.[3]

Mercury (Hg) evaporates to form a mercury vapor in the atmosphere. This increases its risk of exposure and it can cause adverse effects. Mercury is also a know constituent of commonly used car battery. An experimental study has shown deleterious effects of mercury such as tremors, impaired cognitive skills, and sleep disturbance in workers with chronic exposure to mercury vapour even at low concentration.[4]

Lead is widely used in Lead- acid batteries and it is highly toxic when there is any form of exposure. Lead's toxicity was recognized and recorded as early as 2000 BC and the widespread use of lead has been a cause of endemic chronic plumbism (Lead poisoning) in several societies.[5,6]

Occupational exposure to cadmium and lead has been linked to increased generation of free radicals with their increased attacks on membrane lipids as well as the evidences of dyslipidaemia.[7] Furthermore, the effects of exposure to these toxic chemicals may go beyond the expected because free radical attack is multisystemic in nature.

Batteries containing mercury are being discouraged in developed countries but not yet in developing countries like Nigeria.[6] Batteries are being used in automobiles, power generating sets and power generating inverters. With this, there is an increased load of batteries to repair by battery repairers which in turn may increase their level of exposure. In view of these, this study was designed to look into the serum levels of Hg, Cd and Pb and their possible effects on plasma lipids in battery repair workers.

METHODOLOGY

Study Design and Study Site

This is a cross-sectional prospective study that was carried out in the city of Osogbo, the capital city of Osun State, Nigeria. Sixty battery repair workers who had been on the job for at least 5 years were recruited for the study. Each Subject was recruited in a consecutive manner after their informed consent was obtained until total of sixty was achieved. Sixty age and sex matched controls were enrolled as well after their informed consent was obtained, they were apparently healthy volunteers who lived within Osogbo metropolis and have no history suggestive of exposure to lead, cadmium and mercury in the past. The control subjects have not, at any time lived close to factory or shop of battery repair workers. A semi-structured questionnaire was used to obtain information on demographic data, career history such as length of engagement in battery repair and clinical history including history of hypertension, diabetes, recent blood transfusion. Blood pressure, weight, Body Mass Index (BMI), waist and hip circumferences were carried out using standard calibrated instruments.

Ethical approval was sought and obtained from Ladoke Akintola University of Technology Teaching Hospital Ethical Committee, in Osogbo, Osun State.

Sample Collection, Preparation and Storage

Following an overnight fast of 10 – 12 hours, 6mls of venous blood sample was collected from the antecubital vein of each subject and control using aseptic procedure of venepuncture. Three milliliters each was dispensed into clean, dry plain bottles and Na^+ EDTA specimen bottles. Each sample in the plain bottles was allowed to clot and retract for between 30 mins and 1 hour. This was later centrifuged at 2,500g for 5 minutes. The serum was harvested into another dry plain specimen bottle and immediately stored frozen till analysis. Venous blood that was dispensed into Na^+ EDTA bottles was also centrifuged for 5 minutes at 2,500g and the plasma constituent was harvested into plain bottle and stored frozen prior to analysis. Serum and plasma samples were stored for the maximum period of three months and they were respectively used for the analysis of trace metals (Pb, Cd and Hg) and lipid profile.

All samples including standards and controls were analyzed in batches (on the same day). **S**erum concentrations of lead (Pb), cadmium (Cd) and mercury (Hg), were measured by flamed atomic absorption spectrophotometer (AAS) using Beck Model 200 SN115874824D (Beckman, Germany) using direct method as described by Kaneko *et al.*[8] Parameters of lipid profile were analyzed using commercially manufactured ready to use kits by Randox Laboratories Limited, United Kingdom. Low Density Lipoprotein – Cholesterol was calculated using Friedewald equation.[9]

Statistical analysis was done using Statistical Package for Social Sciences (SPSS) version 16.0. Results were reported as mean ± standard deviation. Pearson's correlation coefficient (r) was used to determine the relationship between mean of the variables. Results were regarded as significant at $p<0.05$.

RESULTS

Table 1: **Age distribution of study population versus control.**

Age distribution (Years)	Subject (n)	Percentage (%) Subjects	Control (n)	Percentage % Control
21- 30	6	10	5	8.33
31 – 40	14	23.33	15	25
41 – 50	14	23.33	12	20
> 50	26	43.33	28	46.67
Total	60	100	60	100

Table 1: shows age distribution of study population. Ten percent of subjects were between the ages of 21-30. Fourteen percent each were between the ages of 31-40 and 41-50 while 26% were > 50 years of age.

Table 2: Anthropometric parameters of study population versus control.

	Subject	Control	P value
	N = 60	N = 60	
Age (Years)	46.77 ± 11.85	46.60 ± 11.93	0.957
BMI(Kg/m^2)	26.10 ± 4.26	23.83 ± 1.78	*0.011
Systolic B.P(mmHg)	142.13 ± 25.22	133.27± 13.42	0.095
Diastolic B.P(mmHg)	85.13 ± 16.49	80.80± 11.08	0.237
Waist/hip ratio (Inches)	1.13 ± 0.18	1.10± 0.15	0.505

*P < 0.05 considered significant.

As shown in table 2 above. There was no statistical significant difference in mean values of blood pressure and waist-hip ratio except body mass index between the subjects and controls. The mean values of systolic and diastolic blood pressure in subjects were 142.13 ± 25.22 mmHg and 85.13 ± 16.49 mmHg respectively. The mean values of systolic and diastolic blood pressure in control group were 133.27± 13.42 mmHg and 80.80± 11.08 mmHg respectively Body mass index was significantly higher in subjects than controls (26.10 ± 4.26 Vs 23.83 ± 1.78 Kg/m^2 ; p=0.011).

Table 3: Trace metals and Lipid fractions in study population and controls.

Parameters	**Subjects**	**Controls**	**P values**
	N = 60	N = 60	
Cd (µg/dL)	0.36 ± 0.11	0.25 ± 0.05	*0.000
Hg (µg/dL)	0.06 ± 0.07	0.02 ± 0.01	*0.010
Pb (µg/dL)	0.09 ± 0.14	0.03 ± 0.01	*0.003
Total Chol (mmol/L)	4.35 ± 0.81	3.70 ± 0.38	*0.000
HDL-Chol (mmol/L)	1.35 ± 0.81	1.67 ± 0.33	*0.000
LDL-Chol (mmol/L)	2.60 ± 1.17	1.73 ± 0.45	*0.007
Tg (mmol/L)	0.63 ± 0.43	0.37 ± 0.22	*0.000

*P < 0.05 considered significant.

In table 3 above, Pb, Cd, Hg, T-Chol, LDL-Chol and Tg were significantly higher in the subjects than the control group. HDL-Chol was observed to be significantly lower in the subjects than in the control group.

Table 4: Pearson Correlation of analytes in test subjects.

	TG	**HDL-C**	**TC**	**LDL-C**	**Cd**	**Hg**	**Pb**
Tg mmol/l rp	1	0.023 0.862	0.103 0.434	-0.060 0.649	0.178 0.173	0.082 0.0534	0.157 0.232
HDL-C mmol/l rP	0.023 0.862	1	-0.375** 0.003	-0.727** 0.000	- 0.328* 0.011	0.000 0.997	0.148 0.258
T-C mmol/l rp	0.103 0.434	-0.375** 0.003	1	0.856** 0.000	-0.162 0.217	-0.129 0.324	-0.196 0.133
LDL-C mmol/l rP	-0.060 0.649	-0.727** 0.000	0.856** 0.000	1	0.212 0.105	-0.089 0.501	-0.196 0.134
Cd µg/dL rP	0.178 0.173	-0.328* 0.011	0.162 0.217	0.212 0.105	1	0.379** 0.003	0.571** 0.000
Hg µg/dL rP	0.082 0.534	0.000 0.997	-0.129 0.324	-0.089 0.501	0.379* 0.003	1	0.617** 0.000
Pb µg/dL rP	0.157 0.232	0.148 0.258	-0.196 0.133	-0.196 0.134	0.571** 0.000	0.617** 0.000	1

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2- tailed).

Table 4 shows correlation of biochemical parameters in the studied subjects. Following the correlation, negative association was observed between HDL-chol and Total Chol (r = -0.375, p<0.05), HDL and LDL-Chol (r = -0.727, p<0.05). Also, negative correlation was observed between HDL and Cadmium (r = -0.328, p<0.05). Moreover, positive correlation was observed between LDL- Chol and Total Chol (r = 0.856, p<0.05). Furthermore, there was a positive correlation between Cadmium and Mercury (r = 0.379, p<0.05), Cadmium and Lead (r = 0.571, p<0.05).

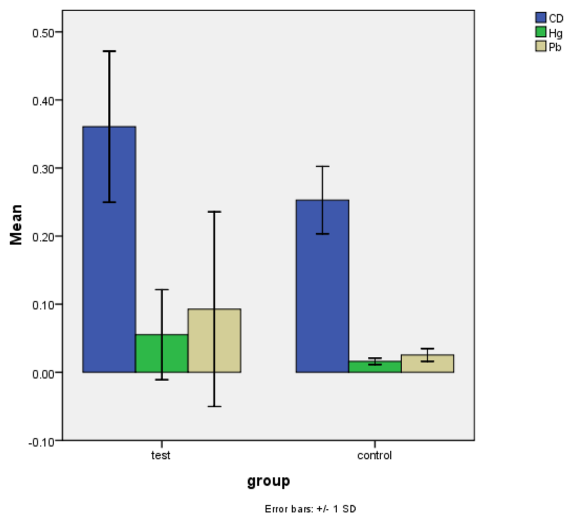

Figure 1: Histogram of Trace Metals in Subjects versus Controls.

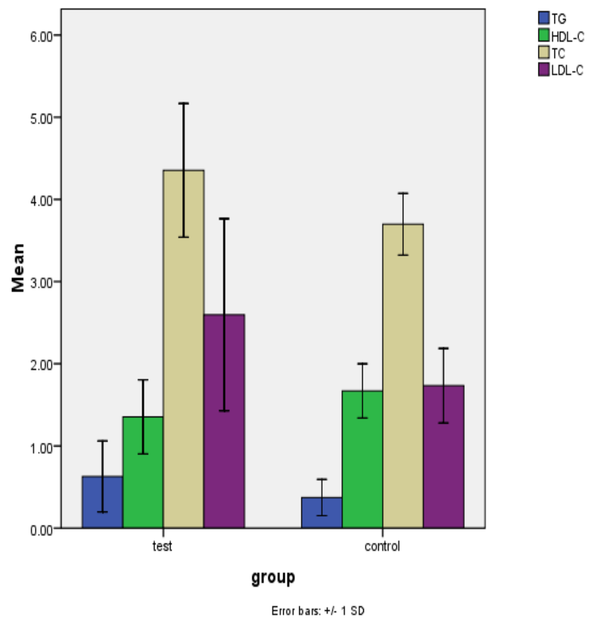

Figure 2: Histogram of Lipid Fractions in Subjects versus Controls.

No subject was found to have any features suggestive of Cd, Hg and Pb poisoning. No subject engaged in the use of any protective measure like face mask.

DISCUSSION

The similar statistical distribution of age and sex of the subjects and controls observed in this study makes the study to eliminate influence of these on our measured biochemical parameters. Ageing and gender have been observed in the past to influence serum levels of some biochemical parameters.[10,11] Systemic blood pressure, body weight and waist/hip ratio found to be similar in subjects and controls also show to the conclusion of no influence of these on our measured parameters. Studies have shown significant influence of hypertension and obesity on some parameters, especially lipids considered in this study.[12,13] These are as illustrated in tables 1 and 2 Decreased serum levels of Cd, Hg and Pb in subjects when compared with controls may be due to the fact that our subjects were occupationally exposed to these toxic metals. Our findings furthermore are not different from the work of Shazia *et al.*, 2009.[14] These may happen because most batteries in use in our environment contain these metals and there is increase in batteries for repair. People presently in our environment use batteries for various activities more than it is used in the automobile. In fact in some neighboring villages batteries are the only sources of power. However, the work of Anetor *et al*[15] does not agree with our finding. They observed no significant differences between subjects and controls of these trace elements despite the exposure. However, the duration of subjects at work recruited was shorter than in this present study. This may also reflect the importance of using protective measures with any other safety precautions as none of our subjects was found using this. Their knowledge of occupational safety was poor and this may definitely increase the exposure.

The mean values of Low Density Lipoprotein Cholesterol (LDL-Chol) among battery repair workers observed to be significantly higher compared to control subjects may also be related to the exposure of these toxic metals. The exposure to toxic metals like these has been related to generation of free radicals with their accomplished complications.[16,17] Evidence of dyslipidaemia has been observed in patients with suspected free radical injury[18] This was in agreement with the works of Kristal *et al* in 1999.[19] He observed that higher LDL-Chol among battery repair workers could be caused by lipid peroxidation. Epidemiological findings suggested that abnormal increase in LDL-Chol is a major risk factor for atherosclerosis.[20]

It was observed from the present study that serum cadmium level was negatively correlated with the risk of decreased HDL-Chol among battery repair workers. Consequently, as the serum level of cadmium increases the level of HDL-Cholesterol tend to decrease. This observation was consistent with earlier epidemiological study by Kim Kiosok, *et al*[21] who found lower HDL-Chol concentration among battery repair workers in Korean population. HDL-Chol has been documented to be involved in the removal of lipid peroxides, promote uptake of cholesterol from peripheral tissues and subsequent delivery of cholesterol to the liver.[21]

No significant correlation observed between serum Lead and Mercury on plasma HDL-Chol, LDL-Chol, T-Chol and Tg among battery repair workers is in accordance with the findings of Lee *et al.* in 2005.[22] However, Chuang *et al.* in 2012[23] found significant correlation between serum mercury and plasma lipids among battery repair workers in China population. They attributed this to oxidation of lipid by mercury to lipid peroxides e.g cholesterol is converted into cholesterol oxidation products (COPs) which have deleterious effects on the cardiovascular system.[23]

Findings from previous studies suggested that there is concurrent exposure to different heavy metals among battery repair workers; exposure to one heavy metal predisposes battery repair workers to other heavy metals used in production of batteries[24] This was in agreement with our findings because there was positive correlation between serum cadmium, Lead and mercury levels. Therefore, as serum cadmium levels increases, the serum levels of other heavy metals such as Lead and mercury tend to increase. These affirm to the point of view by Liang *et al.*, 1993[24] that battery repair workers are at increased risk of having effect of exposure to different other heavy metals used in the production of batteries.

In this study, all participants' serum lead, cadmium and mercury concentrations were below the suggested level of concern according to criteria of Centre for Disease Control (CDC)[25] and Agency for Toxic Substance and Disease Registry (ATSDR)[26] This report is consistent with the report of Lee *et al.*, 2005[22] who also observed that serum heavy metal concentration among battery repair workers in developing countries such as Pakistan, Azerbaijan, India and Bangladesh were below the suggested toxic range of CDC and ATSDR. Conversely, Perry *et al* in 2011[27] observed abnormal increase in serum heavy metal concentration among battery repair workers in United States of America (U.S.A) population above the CDC and ATSDR toxic ranges. They attributed this astronomical increase in serum heavy metal concentration to over dependent on Lead-Cadmium batteries among developed countries such as U.S.A, Canada, Germany and France. Considering conflicting reports above, standard safety precaution should still be adhered to in other to break or prevent the toxic trend already observed in this study.

CONCLUSION AND RECOMMENDATION

There is increased risk of Cadmium, Mercury and Lead poisoning and their correlation with dyslipidaemia in battery repair workers. This is evidenced as there are increased serum levels of these metals with corresponding dyslipidaemia in battery repair workers.
Battery repair workers may in feature come down with clinical features of Cadmium, Mercury and Laed poisoning if the present tread of exposure is not checked. We recommend health education for battery repair workers in the use of standard precaution measures.

REFERENCES

1. Arun, J.P., Nilma, N.D., Adinath, N.S., Dilip, B.R. Biochemical effect of occupational lead exposure to workers small scale automobile workshops of North Karnataka India. *Environ. Health Perspect.*, 2011; 132: 142-99.
2. World Health Organization. Prevention of diseases through healthy environments exposure to cadmium: a major public health concern. Geneva, switzaland., 2002; 5.
3. Occupational Safety and Health Administration (OSHA). occupatonal exposure to cadmium. 2010; *Newsletter* section V.
4. Liang, Sun R.K, Chen Z.Q. Chronic neurobehavioral effects of elemental mercury indentist.1993; *British journal of Industrial Medicine*, 49(11): 782-90.
5. Ogunseitan, OA. and Smith, TR. The cost of environmental lead poisoning in Nigeria. *African J. Environ. Sci. Technol. 2007; 1*(*2*): 027–036.
6. Ademuyiwa, O, Arowolo, T., Ojo, D.A., Odukoya, O.O., Yusuf, A.A. and Akinhanmi, T.F. Lead levels in blood and urine of some residents of Abeokuta, Nigeria. *Trace Elem Electro., 2002;* 2(19): 63-69.
7. Kristal Boneh, Coller, D., Froom P., Harari G. and Ribak, J. (1999). The association between occupational lead exposure and serum cholesterol and lipoprotein levels. *American journal of public health., 1999;* 89(7): 1083-1087.
8. Kaneko, Clinical Biochemistry of Animal. 4th Edn. *Academy press inc.*, 1999; 932.
9. Seth SM, Michael JB, Mohamend BE, Peter PT, Peter OK, Roger SB *et al.* Comparison of a Novel Method vs the Friedewald Equation for estimating Low-density lipoprotein Cholesterol Levels from the Standard Lipid Profile. *JAMA*., 2013; 310(19): 2061-2068.
10. Shumaila K, Arif MB, Bakhtyawar AK, Sobia D, Muhammad A, Mohammad A, *et al*. Effect of age and gender on some blood biochemical parameters of apparently healthy small ruminants from Southern Punjab in Pakistan. *Asian Pac. J Trop Biomed*., 2012; 2(4): 304-306.
11. Lawan A, Mohd AN, Abdullah R, Ahmad B. Effect of age and Performance on Physical, haematological and Biochemical Parameters in Endurance Horse. *Journal of Equine Veterinary Science*., 2013; 33(6): 415-420.
12. Salahuddin M, Sayed AA Syed SR, Badam KM. effect of Ramadan Fasting on Body Weight, (BP) and Biochemical Parameters in Middle Aged Hypertensive Subjects: An Observational Trial. *Journal of Clinical and Diagnostic Research*., 2014; 8(3): 16-18.
13. Bertram L, Michael PO, William C, William FK. Lipids and the Kidney. *Hypertension*., 1990; 15(5): 443-450.
14. Shazia, k., Iqbal, N.M, Tom, K.(2009).Toxic effects of heavy metals on lipids . *Prev Med*., 2009; 44: 166-7.
15. Anetor GO, Nsonwu AC, Adeniyi FAA, Fukushima S. Mixed chemical-induced oxidative stress in occupationally exposure in Nigerians. *African Journal of Biotechnology*., 2009; 8(5): 821-826.
16. Patra RC, Rautray AK, Swarup D. Oxidative stress in Lead and Cadmium Toxicity and its Amelioration. *Veterinary medicine International*. 2011; Article ID 457327, 9.

17. Jhuli KA, Camila ACP, Thais deOliveira F, Ivanita S, Alessandra SP, Dalton VV. Cadmium exposure induces vascular injury due to endothelial oxidative stress: the role of local angiotensin II and COX-2. Free Radical Biology and Medicine., 2013; 65: 838-848.
18. Regina NU, Beno OO, Demilade AO. Lead induced dyslipidaemia: The comparative effects of ascorbate and chelation therapy. African Journal of Biotechnology., 2013; 12(15): 1845-1852.
19. Kristal Boneh, Coller, D., Froom P., Harari G. and Ribak, J. (1999).The association between occupational lead exposure and serum cholesterol and lipoprotein levels. *American journal of public health, 1999;* 89(7): 1083-1087.
20. Musail J, Undas A, Syslo K. Lipid metabolism abnormalities and atherosclerosis in patients on maintenance hemodialysis. Przegl Lek., 1994; 51(6): 264-7.
21. Kim Kisok, (2012). Blood Cadmium Concentration and Lipid profile in Korean adults, *Environs Res.*, 2012; 112: 225-9.
22. Lee T.H. Effects of Lead and Mercury on Lipid fractions *American journal of industrial medicine*, 2005; 314-317.
23. Chuang, H.Y., K.Y., Chao, and J.D. Wang. Estimation of burden of lead for offspring of female lead workers: A quality adjusted life year (QALY) assessment. *Journal of Environmental Health., 2012;* (17–18): 1485–1496.
24. Liang, Sun R.K, Chen Z.Q. Chronic neurobehavioral effects of elemental mercury indentist. *British journal of Industrial Medicine,* 1993; 49(11): 782-90.
25. Centre for Disease Control (CDC). Heavy metal poisoning and Cardiovascular disease. 1991; (www.hindawi.com/journals/jt/2011/870125/).
26. Agency for Toxic Substances and Disease Registry (ATSDR) (2011). Public Health Awareness, 2011; (http://www.atsdr.gov/public/statement/phs.asp?id=46&tid=15).
27. Perry G, Amod, P. Utilization of cadmium and lead in battery manufacturing and it impending danger on public health., 2011; 45.