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Environmental pollutants in pregnancy and neonates in the population of Ogoni, Rivers State

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ABSTRACT

Environmental pollutants of petroleum origin are emerging health, safety and environment issues. Randomly selected 50 pregnant women between aged 18 to 50 years each from each region volunteered to participate in the study. They were resident of petroleum impacted and non-petroleum impacted environments in Ogoni and Ogoja for at least a period of ten years respectively. Serum samples in pregnancy and umbilical cord blood were used to evaluate the content of environmental pollutants (heavy metals) using atomic absorption spectrophotometry. Blood samples were collected from neonate cord during delivery at the point of separation of the umbilical cord from the placenta. Likewise, potable drinking water and soil samples from the studied populations were also subjected to heavy metal analysis. This study indicated a high level of exposure of petroleum heavy metal pollutants in the population of Ogoni pregnant women, especially for vanadium > lead > cadmium and for neonates, lead > vanadium > cadmium in relation to control; indication of variation in the differences of exposed; as well, heavy metals can be transferred from mother to child during pregnancy. Importantly, neonates being more vulnerable, especially for lead. Furthermore, the study also revealed a high level of exposure pollutants in the population of Ogoni in soil, as cadmium > lead; in shallow surface drinking well water, as lead; and in deep underground bore hole drinking water as lead > cadmium compared to the control. Our studies are suggestive that chronic exposure to petroleum environmental pollutants (heavy metals) in air, water and soil can present toxic effects which can negatively affect both mother and new born baby.

INTRODUCTION

Human exposure to environmental pollutants is emerging health, safety and environment issues. Human exposure to environmental pollutants associated with industrial activities such as petroleum exploitation and exploration or oil and gas flaring in the Niger Delta has been suggested to be largely responsible for impaired cardio-metabolic (Nworah et al., 2011; Chuemere et al., 2015; Mmom and Chuemere, 2016; Uvoh et al., 2021; Nwafor et al., 2011; Uvoh et al., 2021; Egwurugwu and Nwafor, 2013; Egwurugwu et al., 2013; Akangbou et al., 2018) respiratory (Obianime et al., 2017; Uvoh et al., 2021; Joffa et al., 2013) haematological (Nwafor, 2013; Adienbo and Nwafor, 2010; Egwurugwu et al., 2013; Nwafor et al., 2013) reproduction (Nwafor et al., 2013), neurological (WHO, 2011; Nwafor and Maduako, 2001; Ilochi and Chuemere, 2021; Stanley et al., 2008) renal (Egwurugwu et al., 2013; Uvoh et al., 2021) functions and many more. Cement dust induces systemic toxicity via respiratory perturbation and body/organ weight discordance mediated by heavy metal bioaccumulation. (Owonikoko et al, 2021).

Hitherto such human activities have been suggested to

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result in the accumulation of toxic environmental pollutants such heavy metals in the environment, including air, water and soil (Obianime et al., 2017; (Idodo-Umeh and Ogbeibu, 2010; Uvoh et al., 2021; Tchounwou et al., 2012; Martin and Griswold, 2009; Egwurugwu et al., 2013; Nwankwo and Ogagarue, 2011; Chuemere et al., 2018). Heavy metals are metallic elements are highly soluble in aquatic environments and can be absorbed easily by living organisms and once it enters the food chain it ends up negatively affecting the body (Obianime et al., 2017; Idodo-Umeh and Ogbeibu, 2010; Tchounwou et al., 2012; Martin and Griswold, 2009; Chuemere et al., 2018). Indeed residents of the Niger Delta Region of Nigeria have been exposed for decades to the hazards of the petroleum industry operations associated environmental pollutions of air, soil and water yet the correlation between the increases in environmental pollutants and that of the chronic diseases prevalence is poorly understood.

The aim of this study was to assess the content of environmental pollutants (heavy metals) in serum samples collected form pregnant women and umbilical cord blood detached from the placenta after childbirth from volunteers, belonging to petroleum and non-petroleum production environments in the population of Ogoni and Ogoja respectively. In addition, soil and portable drinking water samples in the population were also collected for analysis for heavy metals. To the best of our knowledge, this is the first study reporting on heavy metal pollutants in serum, water, and soil in the pollution of Ogoni as well as in that of the Niger Delta.

MATERIALS AND METHODS

Sample collection and analysis

Prior to be enrolled, participants who were predominately local farmers were informed about the study merits and were submitted to assist self-reporting questionnaire to record their age, occupation, biometrics, and duration of exposure or resident in the study environment. Volunteers attending the public health centre clinics were randomly selected throughout the course of the study. Blood samples were collected from 50 pregnant women volunteers each, were recruited in the population of Ogoni and Ogoja respectively, with ages ranging from 18 to 50 years.

Each pregnant woman volunteer was requested to give about 5 mL of whole blood, kept in a plastic tube (with heparin), 5 mL of whole blood to prepare the serum, 5 ml cord blood, kept in a plastic tube (without heparin). 5 ml of cord blood was collected immediately after delivery at the point of separation of the placenta from the umbilical cord. These samples were collected between 2019 and 2020, placed immediately in a dry ice enclosure, facilitating their transport, for proper storage, to Asa Quest Global Concept Limited Laboratories, Environmental and Engineering Services, Road 4, plot 7 Eliminigwe Estate, Elelenwo. Blood samples collected were allowed to clot, retract and centrifuged at 5000 rpm for 5 min. The collected supernatants were kept in a freezer at -20°C, ready for use. Toxicological analyses were carried out using atomic absorption spectrophotometry (AAS), at Asa Quest Global Concept Limited Laboratories, Environmental and Engineering services, Road 4, Plot 7 Eliminigwe Estate Elelenwo, Port Harcourt, Rivers State. The procedure employed was as detailed according to the specifications of the manufacturer.

Soil samples were collected as previously described (Obianime et al., 2017) and subjected to AAS analysis following the procedure of the manufactures. Portable drinking water samples collected from untreated shallow or surface well water and deep underground borehole drinking sources respectively were also subjected to AAS analysis according to the procedures specified by the manufacturer. This study was approved by the Government health research ethical committees of Rivers state, and Cross River State and the Institutional ethical research committee, University of Port Harcourt, and carried out in strict compliance to the guidelines of the National Committee for Research Ethics in Science and Technology.

Ethical approval

Ethical approval was obtained from University of Port Harcourt Research Ethics Committee before the investigation. UPH/CEREMAD/REC/MM67/019, 22/11/2019. Cross Rivers State Health Research Ethics Committee. 26/02/2020. REC NO. CRCMOH/REC/2020/113

Statistical analysis

Analysis was carried out using Statistical Package for Social Science (SPSS) version 22.0. Data analysis were expressed as mean ± SEM. Data were analysed using Independent Samples Test. Percentages for independent variables were calculated; $p<0.05$ was considered statistically significant.

RESULTS AND DISCUSSION

The observation of high concentrations of heavy metals in this study is consistent with the previous studies reported for the Niger Delta Region of Nigeria (Idodo-Umeh and Ogbeibu, 2010; Uvoh et al., 2021; Nwankwo and Ogagarue, 2011). More so, surface and underground waters in the petroleum exploration environments tend to have more concentrations of heavy metals than non-

Table 1. Heavy metals in pregnancy and neonates (range in parentheses).

Heavy metals	Concentration in pregnancy (µg/L)		Concentration in neonates (µg/L)		P value
	Control (Ogoja)	Test (Ogoni)	Control (ogoja)	Test (ogoni)	
Vanadium	0.04±.00 (0.01-0.16)	0.29±.02 (0.07-0.96)	0.03±.01 (0.01-0.07)	0.21±.04 (0.03-1.33)	0.001
Lead	0.65±.02 (0.23-1.39)	3.47±.13 (0.98-6.67)	0.30±.01 (0.11-0.5)	3.26±.21 (1.31-7.48)	0.001
Cadmium	0.15±.00 (0.07-0.29)	0.40±.14 (0.19-0.81)	0.10±.01 (0.07-0.14)	0.24±.01 (0.16-0.33)	0.001

Table 2. Heavy metals in soil sample (range in parentheses).

Heavy metals	Concentration (mg//kg)		Percentage difference
	Control (Ogoja)	Test (Ogoni)	
Lead,	0.0015 (<0.001-0.002)	1.925 (1.840-2.010)	12843.33
Cadmium,	0.0085 (<0.001-0.007)	2.278 (1.981-2.575)	26900
Vanadium,	<0.001 (<0.001-<0.001)	<0.001 (<0.001-<0.001)	0

petroleum production areas (Egwurugwu et al., 2013; Nwankwo and Ogagarue, 2011). Heavy metals disrupt cellular events including growth, proliferation, differentiation, damage-repairing processes, and apoptosis (Mahdi et al., 2021). Young children are particularly vulnerable to the toxic effects of lead and can suffer profound and permanent adverse health impacts, particularly on the development of the brain and nervous system (WHO, 2021). However, the results of the present study clearly indicate variations in the differences in the concentrations of the exposed investigated environmental pollutants, the population of Ogoni being exposed to high level of lead, vanadium and cadmium from the air; lead and cadmium from the soil and water respectively compared to the control group. There was also variation in the differences in the level of exposed heavy metals in the portable drinking water supply, the borehole drinking water supply having more concentrations of heavy metals than the shallow well drinking water supply. The participants were mainly peasant farmers whose main source of portable drinking water were untreated surface or shallow well water and underground borehole water, and invariably, might not only be exposed to environmental air pollutants but also from drinking water pollutants and eating soil-contaminated food crops.

Table 1 describes the heavy metal content in pregnancy and cord blood (neonates) and showed significantly ($p<0.05$) high level of exposure for the population of Ogoni compared with Ogoja (control content) of vanadium (625%), lead (433%) and cadmium (166%) for the pregnant and for the cord blood, vanadium, lead and cadmium content of 600, 986.7 and 140% respectively.

Besides, there were variations in the differences of the investigated environmental pollutants, lead, cadmium and vanadium content of the cord blood given as 127, 15.7 and 4% respectively, in relation to the pregnant content and showed that neonates are more vulnerable to lead toxicity. The preponderance of lead content of cord blood, and by inference, neonate, might be suggestive plausibly to its potency in adversely modulating plasma membrane diffusion potential and cellular uptake (Nwafor, 2001; Nwafor and Coakley, 2003; Nwafor and Coakley, 2003) of high concentration of lead, consequently, leading to lead-induced toxicity – a possible cellular mechanisms of lead poisoning.

Figures 1–3 describes the scattered plot for the heavy metals in pregnancy and cord blood and showed positive strong relationships for cadmium, and lead, the points been evenly distributed, an indication that increase in pregnant cadmium and lead brings about an increase in cord cadmium (Figures 1 and 2). In contrast, in the case for vanadium, the plot showed a positive weak relationship (Figure 3).

Correlation coefficient analysis between the heavy metals in pregnancy and cord blood revealed strong positive significant correlations for lead (R-value = 0.798, p-value = 0.000) and cadmium (R-value = 0.795, p-value = 0.000) but weak positive correlation for vanadium which was not significant (R-value = 0.112, p-value = 0.209).

Tables 2 and 3 depicts heavy metal content in soil and portable drinking water samples and showed that the pregnant women in Ogoni, Niger Delta region, are exposed not only to air and soil pollutants but also to water heavy metals contaminants in agreement with previous reports (Egwurugwu et al., 2013; Nwankwo and Ogagarue, 2011).

Conclusion

The current study provides data on environmental pollutants, lead cadmium and vanadium in serum samples

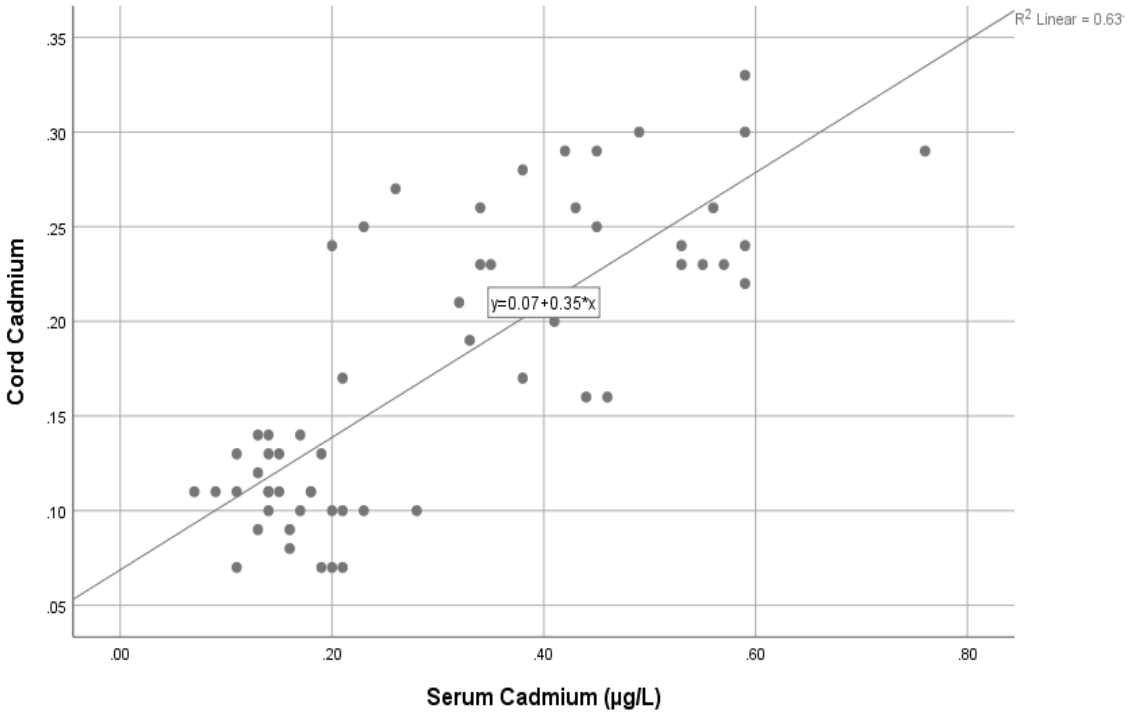

Figure 1. Relationship between cadmium in pregnancy and neonate.

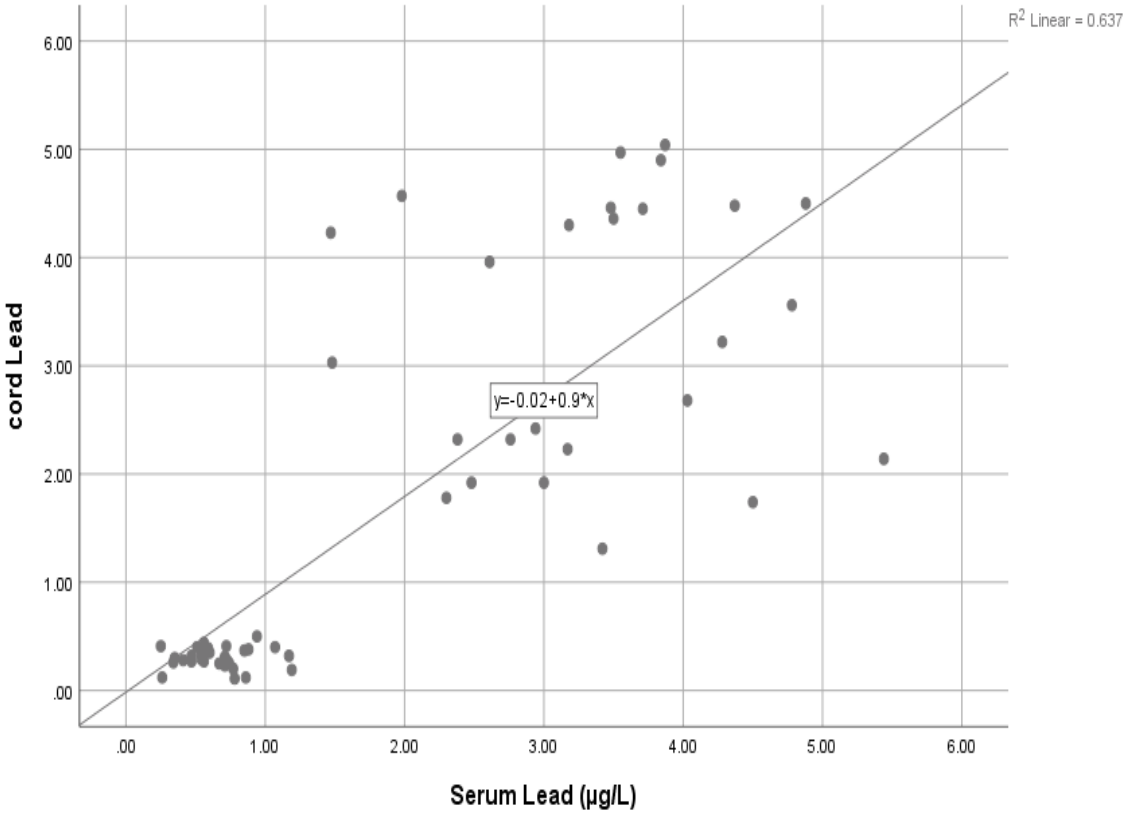

Figure 2. Relationship between lead in pregnancy and neonate.

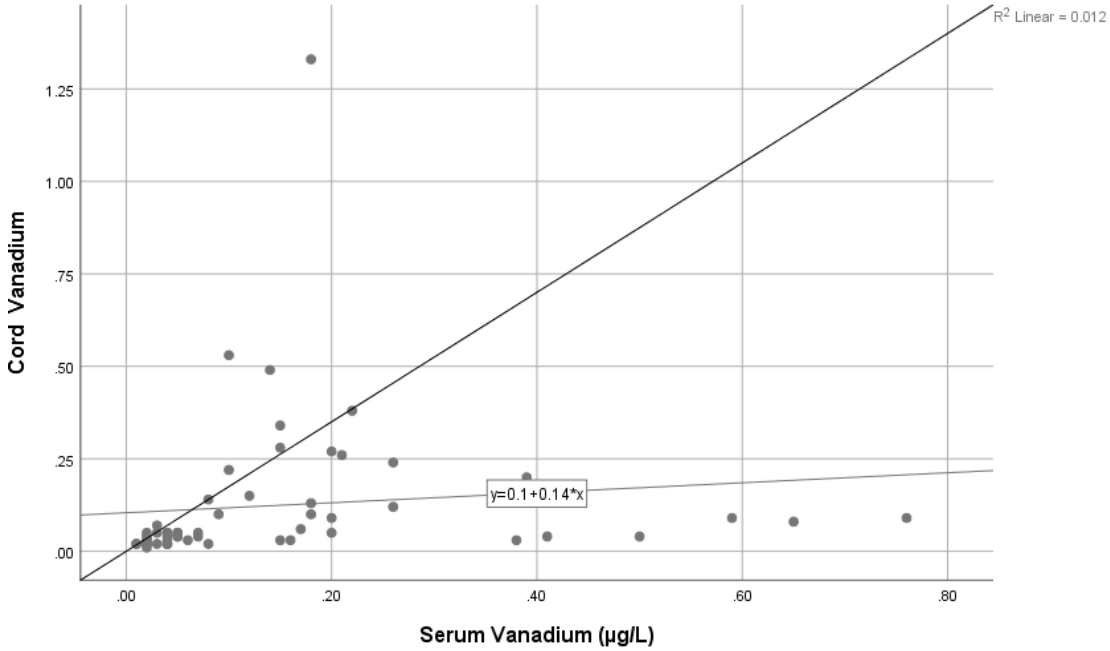

Figure 3. Relationship between vanadium in pregnancy and neonate.

Table 3. Heavy metals in the portable drinking water.

Portable drinking water sources	Heavy metals	Concentration (mg/kg)		Percentage difference
		Ogoja(control)	(Test)Ogoni	
Well water (shallow/surface)	Lead	<0.001 (<0.001-<0.001)	0.006 (0.004-0.008)	500
	Cadmium,	<0.001 (<0.001-<0.001)	<0.001 (<0.001-<0.001)	0
	Vanadium,	<0.001 (<0.001-<0.001)	<0.001 (<0.001-<0.001)	0
Bore hole water (underground)	Lead,	<0.001 (<0.001-<0.001)	0.0485 (0.040-0.057)	4.950
	Cadmium,	<0.001 (<0.001-<0.001)	0.0025 (0.002-0.003)	350
	Vanadium	<0.001 (<0.001-<0.001)	<0.001 (<0.001-<0.001)	0

collected from pregnant volunteers and cord blood (neonates) in the population of Ogoni, form 2019 to 2020; and from soil and water samples. These were the first data on persistent organic pollutants from both human, water and soil sources in Ogoni as well as in the Niger Delta, partly filling the gap of insufficient data on environmental pollution in the populations exposed to prolonged petroleum production. In comparison with pregnant women, high contents were observed with respect to lead, cadmium and vanadium in neonates (cord blood) indication that there is transfer of heavy metals from mother to child through maternal neonatal cord blood in the pregnant population in Ogoni, Rivers State. Additionally, the findings of this study has shown also that there is disproportionate distribution of heavy metals in the portable drinking water, the deep underground borehole water being highly contaminated with high levels of heavy metals (lead and cadmium) than the surface/shallow well water that has lead burden. The results of the present report are consistent with the view that the population of Ogoni is exposed to the investigated environmental pollutants from air, soil and water. From the findings of this study, it is therefore, possible to explore potential associations between the environmental contaminants and the prevalence of some chronic diseases in the population of Ogoni in particular and the Niger Delta at large.

Study limitation

The challenge of this study was that limited number of

volunteer pregnant women participated due to the fetish belief of the use of blood for experimentation. Furthermore, delivery was sparingly because of the adoption of the traditional rather than the orthodox method for maternity healthcare.

REFERENCES

Adienbo O. M. & Nwafor A. (2010). Effect of prolong exposure to gas flaring on some haematological parameters of humans in the Niger Delta region of Nigeria. J. Appl. Sci. Environ. Manage. 14(1):13-15.

Akangbou P. C., Chuemere A. N. & Ogadinma I. (2018). Impairment of cardiovascular function indices in male rats induced by aluminum-tainted water: atherogenic indices and predictorratio assessment. Discovery. 54(275):442-446.

Chuemere A. N., Akangbou P. C. & Ogadinma I. (2018). Evaluation and predictor ratio of toxicity of aluminum-tainted drinking water impact in male rats: oxidative stress in heart and kidney. Sci. Technol. 4:183-188.

Chuemere A. N., Olorunfemi O. J., Nwogu J. U., Mmom O. F., Agbai E. O. & Vurey V. V. (2015). Correlation between blood group, hypertension, obesity, diabetes, and combination of prehypertension and pre-diabetes in school aged children and adolescents in Port Harcourt. International Organisation of Scientific Research Journal of Dental and Medical Sciences 14(12):83-89.

Egwurugwu J. N. & Nwafor A. (2013). Prolonged exposure to oil and gas flares ups the risks for hypertension. Am. J. Health Res. 1(3):65-72.

Egwurugwu J. N., Nwafor A. & Ezekwe A. (2013). Impacts of prolonged exposure to gas flares on some blood indices in humans in the Niger Delta Region, Nigeria. Arch. Appl. Sci. Res. 5(1):98-104.

Egwurugwu J. N., Nwafor A., Chinko B. C., Olorunfemi O. J., Iwuji S. C. & Nwankpa P. (2013). Effects of prolonged exposure to gas flares on the lipid profile of humans in the Niger Delta region, Nigeria. Am. J. Res. Comm. 1(5):115-145.

Egwurugwu J. N., Nwafor A., Olorunfemi O. J., Iwuji S. C. & Alagwu E. A. (2013). Impact of prolonged exposure to oil and gas flares on human renal functions. Int. Res. J. Med. Sci. 1(11):9-16.

Egwurugwu J. N., Nwafor A., Olorunfemi O. J., Nwankpa P. & Okwara J. E. (2013). Prolonged gas flaring and water quality in Obiakpu Egbema, Imo State, Nigeria. Int. Res. Environ. Sci. 2(4):1-5.

Idodo-Umeh G. & Ogbeibu A. E. (2010). Bioaccumulation of the heavy metals in cassava tubers and plantain fruits grown in soils impacted with petroleum and non-petroleum activities. Res. J. Environ. Sci. 4:33-41. Ilochi O. N. & Chuemere A. N. (2021). Progressive changes in gait, kinematic, horizontal and vertical activities in response to oleic acid and heavy metal exposure. Asian J. Adv. Med. Sci. 3(4):232-241.

Joffa P. K. P., Nwafor A. & Adienbo M. O. (2013). Correlation between body mass index and peak expiratory flow rate of an indigenous Nigerian population in the Niger Delta Region. Res. J. Rec. Sci. 2(2): 28-32.

Mahdi B.-M. K. N., Zoya T., Mohammad R. K. & Mahmood S. (2021). Toxic mechanisms of five heavy metals: mercury, lead, chromium, cadmium, and arsenic. Front. Pharmacol. 12:1-19. https://doi.org/10.3389/fphar.2021.643972

Martin S. & Griswold W. (2009). Human health effects of heavy metals. Environmental Science and Technology Briefs for Citizens. 15: 1-76.

Mmom F. C. & Chuemere A. N. (2016). A study of incidence and prevalence of hypertension, diabetes and obesity with blood type in postmenopausal females in Port Harcourt. Saudi J. Biomed. Res. 1(1):22-29.

Nwafor A. & Coakley W. T. (2003). Membrane potential change effects on cationic and neutral drug induced erythrocyte shape change and cellular uptake of drugs. Afr. J. Biomed. Res. 6(1):9-14.

Nwafor A. & Coakley W. T. (2003). The effect of diffusion potential change on anionic drugs indomethacin and barbitone induced red blood shape change. Afr. J. Biomed. Res. 6(2):95-100.

Nwafor A. & Maduako K. O. (2001). Visual acuity of Nigerians in two distinct and contrasting environments in Rivers State in the Niger Delta. Afr. Appl. Sci. Environ. Manage. 5(2):47-50.

Nwafor A. (2001). The effect of salt and sugar loading on human Erythrocyte plasma and urinary sodium and potassium as a function of time and membrane potential. Afr. J. Appl. Zool Environ. Biol. 3:22-25.

Nwafor A. (2013). Life under assault: Nowhere to hide. Inaugural lecture series No. 102: March 14, 2013, University of Port Harcourt.

Nwafor A., Asiegbu L. N., Adienbo M. O. & Mmom F. C. (2013). Anti-fertility activity of ingestion of Nigerian Bonny light crude oil contaminated feed in male reproduction: A possible hyothamo-pituitary axis mechanism. Am. J. Res. Comm. 1(7):210-218.

Nwafor A., Nworah D. C., Chike C. P. R. & Egwurugwu J. N. (2011). Relation of serum total cholesterol, body mass index and blood pressure as cardiovascular risk conditions among normotensive and hypertensive type 2 diabetes mellitus females in Port Harcourt. Afr. J. Med. Sci. 4(1):1-6.

Nwankwo C. & Ogagarue D. (2011). Effects of gas flaring on surface and ground waters in Delta State, Nigeria. J. Geol. Mining Res. 3(5):131-136.

Nworah D. C., Chike C. P. R., Akpa M. R., Nwafor A. & Dapper D. V. (2011). Prevalence of left ventricular hypertrophy in hypertensive and normotensive type 2 diabetes females in Port Harcourt. Niger. J. Physiol. Sci. 26(1):7-10.

Obianime A. W., Odili O., Olorunfemi O. J., Wokoma T. O. & Chuemere A. N. (2017). Toxic air and soil in automobile workshop impact negatively on the health status of automechanics: The Nigeria environment. Inter. J. Pharm. Pharm. 1(3):1-7.

Owonikoko M. W., Emikpe B. O. & Olaleye S. B. (2021). Standardized experimental model for cement dust exposure; tissue heavy metal bioaccumulation and pulmonary pathological changes in rats Toxicol. Report. 8:1169-1178.

Stanley P. C., Gasekomeh E. G., Osika U. M., Nwafor A., Mokwunye O. & Ozor I. B. (2008). Pattern of serum electrolytes changes among non-psychotic depressives on amitriptyline. Niger. J. Psych. 6(1):37-39.

Tchounwou P. B., Yedjou C. G., Patlolla A. K. & Sutton D. J. (2012). Heavy metal toxicity and the environment. Experientia Supplementum. 101:133-164.

Uvoh S. M., Chuemere A. N. & Asara A. A. (2021). Evaluation of some cardiovascular parameters of apparently healthy pregnant women in gas flaring communities: A baseline study in Bayelsa State, Nigeria. J. Res. Med. Med. Sci. 2(6):104-108.

Uvoh S. M., Chuemere A. N. & Obia O. (2021). Impact of gas flares on anthropometric indices of pregnant and non-pregnant women in selected gas flaring communities in Bayelsa State Nigeria. Int. J. Biol. Med. Sci. 1:15-21.

Uvoh S. M., Chuemere A. N. & Onyebuchi O. (2021). Assessment of consistent exposure to gas flares on renal indices during pregnancy: A baseline study in Bayelsa State, Nigeria. Int. J. Med. Appl. Sci. 10(2): 54-60.

Uvoh S. M., Chuemere A. N., Kiridi E. G. E. & Nnandi C. N. (2021). Toxic air and respiratory indices among pregnant women in Bayelsa State, Nigeria. J. Res. Med. Med. Sc.s. 2(5): 99-103.

Uvoh S. M., Chuemere A. N., Ngaikedi C. N., Emily K. & Gabriel E. (2021). Determination of blood serum lead and cadmium level during pregnancy in gas flaring communities of Bayelsa State, Nigeria. Int. J. Med. Appl. Sci. 10(2):54-60.

WHO (2011). Adverse health effects of heavy metals in children. Children's health and the environment; WHO Training Package for the Health Sector, October.