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Assessment of Some Heavy Metals and Iron Parameters amongst Dumpsite Scavengers in Port Harcourt, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Author EON designed the study. Author HB performed the statistical analysis and author ASG managed the analyses and the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aim: The aim of the study was to determine the levels of some heavy metals, namely Cadmium (Cd), Lead (Pd), and Iron (Fe) in waste scavengers in port-Harcourt, Nigeria
Study Design: This study is a cross-sectional observational study.
Place and Duration of Study: This study was conducted in Port Harcourt, Rivers State, Nigeria, between March, 2019 and October, 2019.
Methodology: A total of 170 subjects of ages between 16 to 43 years. Of this, 100 were dumpsite scavengers while 70 were apparently healthy control subjects. The subjects involved in this study gave their informed consent and had no history of diabetes mellitus, hypertension, and renal and hepatic disorders, and have been in scavenging activity for at least one year. Three milliliters (3ml) of blood was taken from each subject and put in plain bottles. The serum obtained was put in plain bottles and stored at -20^{0}C prior to analysis. The heavy metals were assayed using the Atomic Absorption Spectrophotometry (AAS) while the hepatic parameters were assayed using Mindray Biochemistry auto analyzer (Model BS120, Shenzhen, China). Serum ferritin was assayed using enzyme immunoassay while serum transferrin was done using colorimetric method. Data obtained were analyzed using Student's t test and Pearson's correlation.

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Results: The body mass index (BMI) of the scavengers were significantly lower than that of the control subjects (*p=.0001*). The activities of the liver enzymes AST, ALT and ALP were significantly higher in the scavengers compared to the control subjects (*p=.0001*). The levels of total proteins, albumin and globulin of the scavengers were significantly lower than those of the control subjects (*p=.0001*). The levels of serum iron, transferrin and ferritin were similarly lower in the scavengers compared to the control subjects (*p=.0001*). However, the levels of cadmium and lead were significantly higher in the scavengers compared to the control subjects (*p=.0001*).
Conclusion: These findings indicate possible biochemical derangements in the scavengers due to their exposure to the hazards associated with the scavenging activity.

Keywords: Assessment; heavy metals; iron; dumpsite; scavengers; Port Harcourt; Nigeria.

1. INTRODUCTION

For many years, there has been a fast upsurge in the generation of municipal solid waste (MSW) in metropolitan cities, which may be attributed to increased population of humans and animals, and increased production and consumption of food and other items [1]. One of the problems related to the quality of waste generated is increased population and consumption [2]. Municipal solid waste also called a refuse, garbage, trash or rubbish results from things that are disposed daily by the population, which may vary from one country to another; it is usually classified into biodegradable waste (such as food and kitchen waste, green waste], recyclable waste, inert waste, composite waste, hazardous waste, toxic waste and biomedical waste [3,4] defined wastes as things which have been considered unfit and unwanted, and are therefore, disposed of, due to economic reasons or lack of the knowledge of alternative technologies to recycle them. The Environmental Protection Agency (U.S. Federal Government Agency) developed a waste management hierarchy ranking strategy for municipal solid was based on environmental friendliness, which is made up of four levels from the most to the least preferred methods which include: source reduction and reuse, recycling or composting, energy recovery, treatment and disposal. However in most developing countries proper waste management seem to be inefficient due to negligence from environmental stakeholders, and thus poor funding of the sanitary agencies and lack of organization [5,3] stated that solid waste management is a major challenge in developing countries due to urbanization, industrialization increasing population of animals and humans and their increased demand for food.

Out of the various methods of disposing waste such as composting, landfill and incineration and open dumping the latter happens to be the most available method here in Nigeria [6]. In many cities of African countries, wastes are usually dumped on the streets, road sides or abandoned buildings [7] where they produce heaps of trash with foul or offensive odour, obstruct traffic and pose serious health challenges on humans [8]; Some of which may get into drainages and overtime cause flooding, and blockage of drainage systems in the city [1]. Lorentz et al. [9] stated that dumping of waste is a global threat, and that this waste imposes several health challenges such as the transmission of infectious diseases to humans and animals residing within that vicinity.

Unavoidably, faeces from humans and animals, paint containers, pesticides, batteries, are most times components of municipal solid waste, and when these wastes wash into the surface and ground water, they cause contamination, thus posing serious public health problems [10], also stated that solid waste has the potential of causing stagnation in the environment by inducing global warming, which in turn poses negative effect on humans and their environment. When micro-organisms present in openly-dumped waste act on the degradable materials [6], they cause the soil, air and water to be polluted [11].

Scavengers are often found collecting recyclables without any protective measures, or even scavenging for food leftovers. In this sense, dumpsites pose significant health and environmental threats both to the scavengers and the wider general public living close by. They are exposed to toxic substances, including heavy metals. Toxicity due to heavy metals most commonly affects the brain and the kidneys. There are over twenty different heavy metals released into the surrounding naturally and by anthropogenic means [12]. Heavy metals gain access into biological systems of the scavengers either through inhalation or ingestion, where they

cause the cells to malfunction, by displacing original metals from their natural binding sites, and binding to such sites which are not actually made for them [13] For the purpose of this study, the following three (03) heavy metals cadmium (Cd), Lead (Pd) and Iron (Fe) are considered.

It is an established fact that wastes at dumpsites pose several challenges on the environment and health of people living or working within that environment, therefore, the need to study the levels of some heavy metals which are known to be abundant in the wastes.

2. MATERIALS AND METHODS

2.1 Study Population and Design

The study was carried out in 100 male subjects who were in active scavenging activity at three dumpsites namely Ada George, Iwofe Station and Rumuokoro/Tank Road areas of Port-Harcourt, Rivers State. The number of years of the occupation, and the use or non-use of personal protective equipment (PPE) were put into considerations as well as the smoking and alcohol consumption lifestyle of these scavengers. The demographic data, Social data and Bio-data of the study subjects were obtained using a well-structured questionnaire to obtain relevant information. A control group consisted of 70 apparently healthy male subjects not scavenging or residing within the vicinity of the dumpsites were used for this research work.

2.2 Eligibility Criteria

The study subjects for this research work gave their informed consent, and did not have history of diabetes mellitus, kidney disease, hypertension, heart disease, or any other disorder. Subjects who are alcoholics or smokers, exposed to wood dusts or burning woods daily in their surroundings, or use fire wood as a source of heat energy for cooking were also excluded from both the control and test groups. The subjects were within the age range of (16-43) years and have been a scavenger for at least one year.

2.3 Blood Sample Collection

Three milliliters (3ml) venous bloods were collected from each subject using vein puncture. The blood samples were put into plain bottles and spun for 5 minutes at 3000 rpm using a centrifuge. The serum obtained was transferred into other plain bottles and stored in the freezer compartment of a refrigerator till the time of assay.

2.4 Laboratory Methods and Principles

2.4.1 Determination of cadmium, lead and iron

The first stage in the analysis of these heavy metals involved the acid digestion of the plasma samples. Therefore the serum was digested. The acid digestion was determined using, Atomic Absorption spectrophotometer (AAS). Atomic absorption spectrophotometry is based on free atoms (gas) generated in an atomizer can absorb radiation at specific frequency. The atoms absorb ultraviolet or visible light and make transitions to higher electronic energy levels. The analyte concentration was determined from the amount of absorption.

2.4.2 Determination of serum ferritin levels

Serum ferritin levels was determined by using enzyme immunoassay. The principle is based on antigen-antibody binding. Specific anti-ferritin anti-bodies are coated into micro-titration wells. The test sera are applied. Then monoclonal anti-ferritin labeled with Horseradish peroxidase enzyme (conjugate) was added. If human ferritin is present in the sample, it will combine with the anti-body on the well and the enzyme conjugate resulting in the ferritin molecules being sandwiched between the solid phase and the enzyme linked anti-bodies. After, incubation, the well are washed with distilled water to remove unbound labeled anti-bodies. On addition of the substrate (TMB), a color was develop only in those wells in which enzyme are present, indicating the presence of ferritin. The reaction was stopped by the addition of dilute hydrochloric acid and the absorbance was then measured at 450 nm. The concentration of ferritin was directly proportional to the color intensity of the test sample.

2.4.3 Determination of serum transferrin levels

Serum Transferrin level was determined using colorimetric method. Transferrin reacts with its specific antibody to yield insoluble immune complexes. Turbidity due to these immune complexes is directly proportional to the concentration of transferring present in the sample, the absorbance of which may be

determined spectrophotometrically at a wavelength of 340 nm. The final absorbance for each sample was calculated using the formula: Abs1 – Abs2. The concentration of serum transferrin (in mg/dl) was then determined on the calibration curve.

2.5 Statistical Analysis

Data generated from this study was analyzed using Graph pad Prism Version 6.2. Student's T-Test was used to compare means of parameters between Scavengers and Control subjects. Results were considered statistically significant at less than 0.05 ($p<.05$).

3. RESULTS AND DISCUSSION

This study evaluated the levels of some biochemical parameters in dumpsite scavengers. The details of the demographic variables of the test group are shown in Table 1.

The results obtained indicate that the scavengers had significantly lower Body Mass Index, BMI ($p=.0001$) compared to the control subjects (Fig. 1). This finding agrees with the work of Ukachi et al. [14], who reported a significantly lower BMI among waste dumpsite scavengers. Waste scavengers carry out their activities manually and most often they walk long distances as they move from one dumpsite to another.

This and other intense physical activity among this group of workers may be responsible for their reduced BMI [15] as seen in this study. There are basically two major types of scavengers in this study namely: Active scavengers or they are called Permanent scavengers, which are mostly the foreigners that came from the Northern parts of the country (Nigeria) to earn for a living.

While the other group of scavengers are called Non-Active or Temporary scavengers. These group of scavengers are also called Part time scavengers who are the locals or the native people of the dumpsites. These group of scavengers have other job such as Gardener, Student and others out there. In both groups of scavengers, most of them are relatively young people.

The result from this study also indicated that waste scavengers have significantly higher levels of cadmium ($p=.001$) and lead ($p=.0001$) than the control subjects (Figs. 2 and 3 respectively). The levels of iron ($p=.0001$), ferritin ($p=.001$) and transferring ($p=.001$) were significantly lower in the scavengers than the control subjects (Figs. 4, 5 and 6 respectively). The significantly high levels of cadmium agree with the work of Adeoye et al. [16]. Heavy metals are found in electrical waste materials, and other solid wastes, agricultural wastes contaminated with the cadmium and among smokers [17].

Table 1. Demographic information of study participants

Demographic Variables	Values
Number of participants	100
Age Range (years)	16-43
Marital Status(Married/ Separated/Single)	49/6/45
Range of Duration on the Job (years)	1-6
Type Scavenger (Active/Non-active)	96/4
Educational Level (primary/None)	18/82

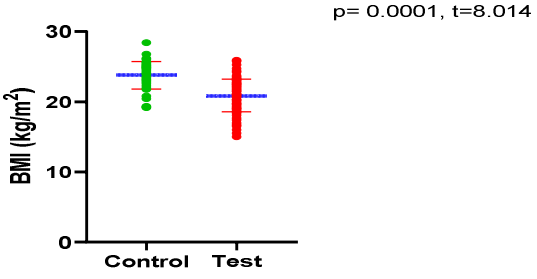

Fig. 1. Comparison of BMI of subjects

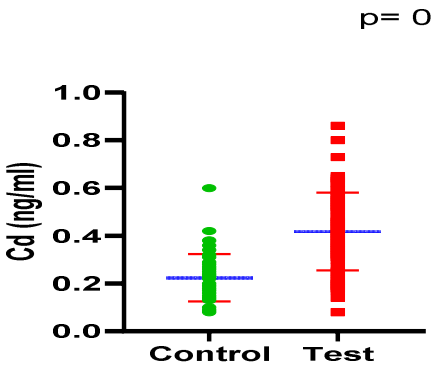

Fig. 2. Comparison of cadmium levels of subjects

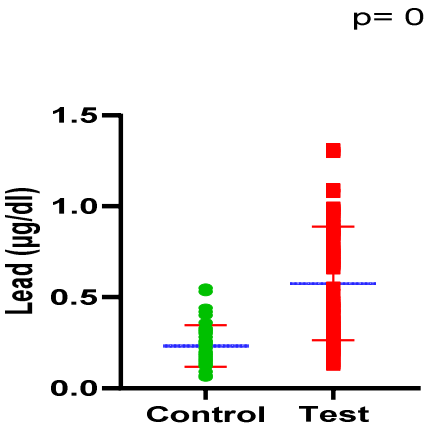

Fig. 3. Comparison of lead levels of subjects

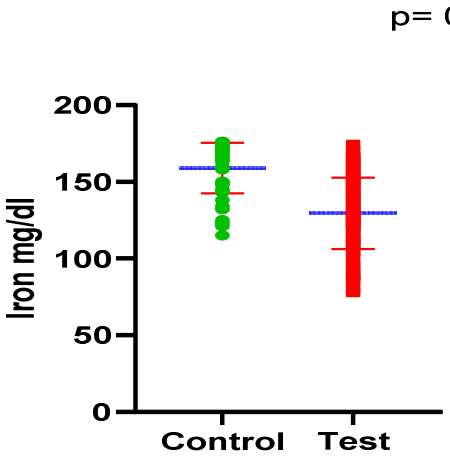

Fig. 4. Comparison of iron levels of subjects

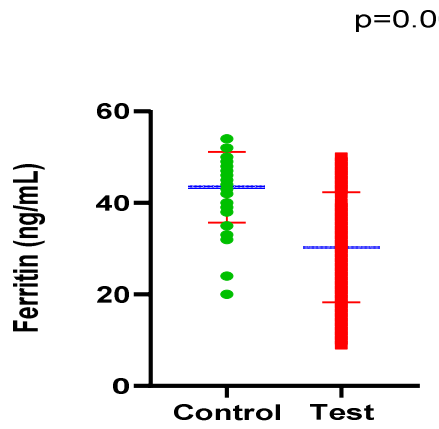

Fig. 5. Comparison of ferritin levels of subjects

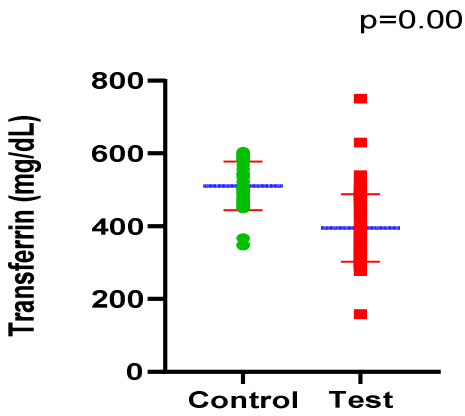

Fig. 6. Comparison of transferrin levels of subjects

Several researchers have reported high levels of iron in dumpsites [18]. Solid waste dumpsites are a major source of metals that contaminate the soil. Leachate is produced, which carries the metals into the soil and surrounding environment thereby causing pollution [19]. The scavengers get exposed to these metals, because most of them do not use any form of Personal Protective Equipment (PPE) [16].

This study indicates that the levels of lead were significantly higher in the scavengers compared to the control subjects. This finding is in agreement with the finding of Adeoye et al. [16]. They have reported that the levels of lead in dumpsites are higher than allowable limits. Lead is also component of waste material that are found at dumpsites, such as lead accumulators and soldering wires [20]. Scavengers sustain sharp injuries from their activities [21], and such wounds could be a channel for absorption of lead in the leachate into the body. They also store food and water among the wastes and consume these items [21].

This study indicates that the scavengers had significantly low levels of serum iron, ferritin and transferrin. Scavengers sustain sharp injuries [21] and this can lead to loss of iron in the blood. Again, iron absorption is usually inhibited by lead by way of competitive inhibition [22]. Since lead levels are significantly raised in scavengers in our study it may lead to the low levels of iron seen in the scavengers.

Serum ferritin was significantly low in the scavengers compared to the control subjects. Ferritin is an iron-storage protein and when iron

levels are high, ferritin levels will also be high [23] and vice versa. Thus, the significantly low level of ferritin could be as a result of the reduced levels of iron among the scavengers.

Transferrin is the major protein that transports iron in the body, and therefore plays a role in the homeostasis of iron [24]. Transferrin is synthesized in the liver and under normal physiological conditions, iron in the blood is bound to transferrin [25].

Thus, the low level of transferrin in this study may be due to liver impairment or due to the reduced iron level or both. In general, there is low level transferrin in the presence of low level of iron [26].

There were significant correlations among the parameters measured in this research work.

Cadmium correlated positively with iron levels of the test group (*R=.3352, P=.0007*) but negatively with lead (Fig. 7), ferritin and transferrin levels of the test group (*R=.3734, P=.0001*), (*R=.3616, P=.0002*), and (*R=.3914, P=.00002*) respectively, (Figs. 8 and 9 respectively).

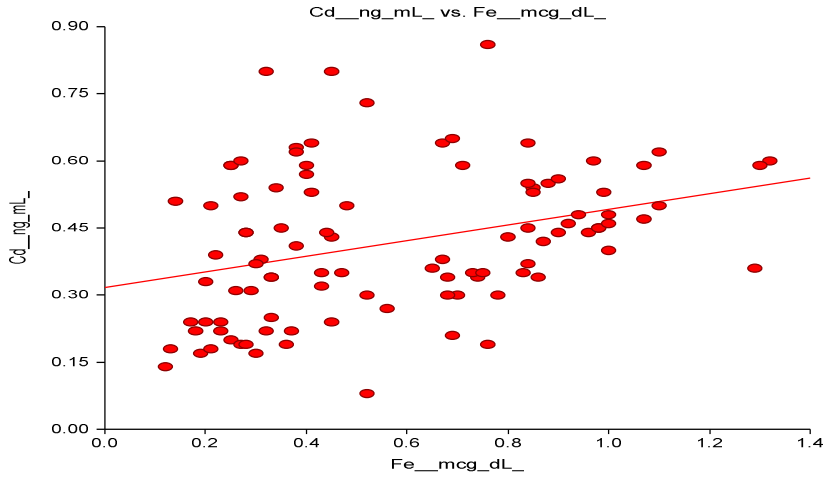

Fig. 7. Correlation plots of cadmium and iron levels of scavengers

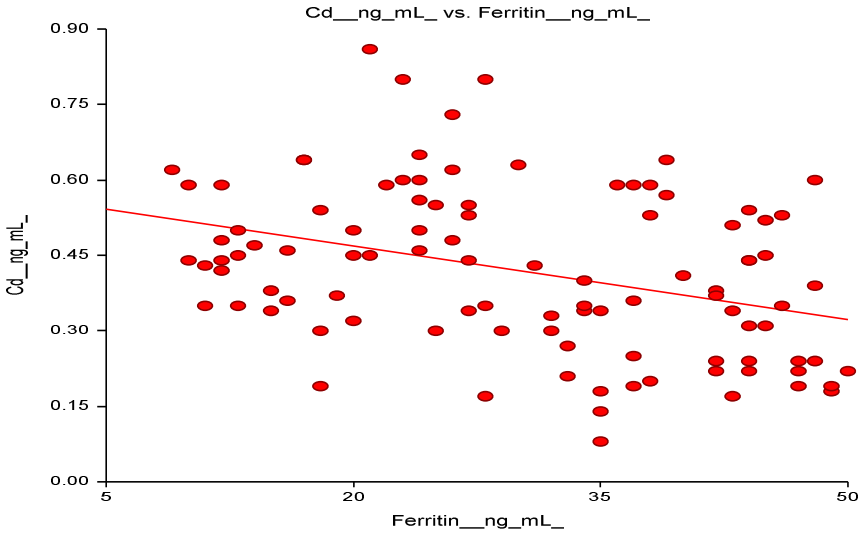

Fig. 8. Correlation plots of cadmium and ferritin levels of scavengers

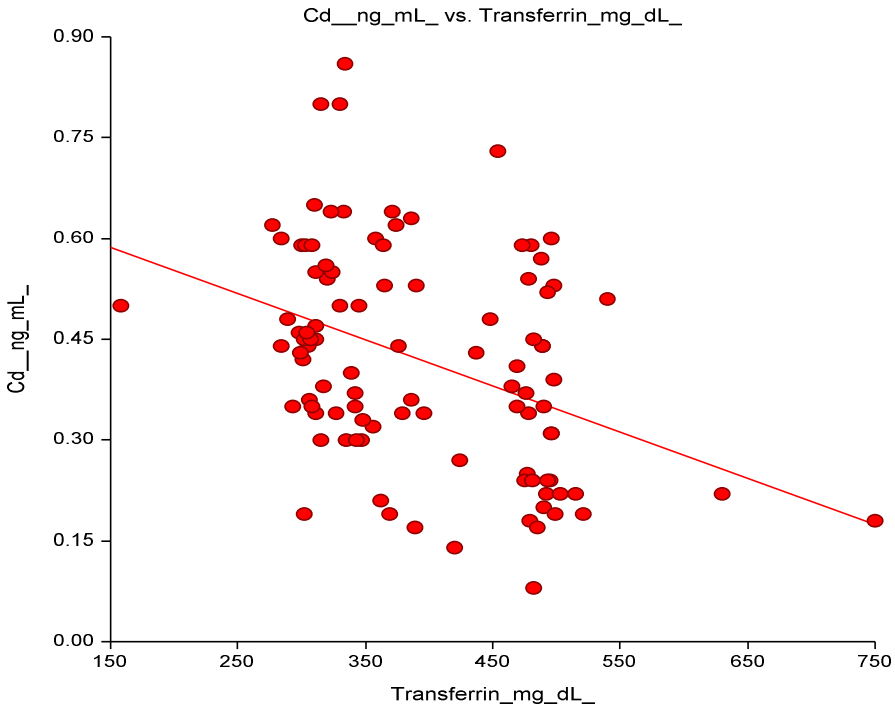

Fig. 9. Correlation plots of cadmium and transferrin levels of scavengers

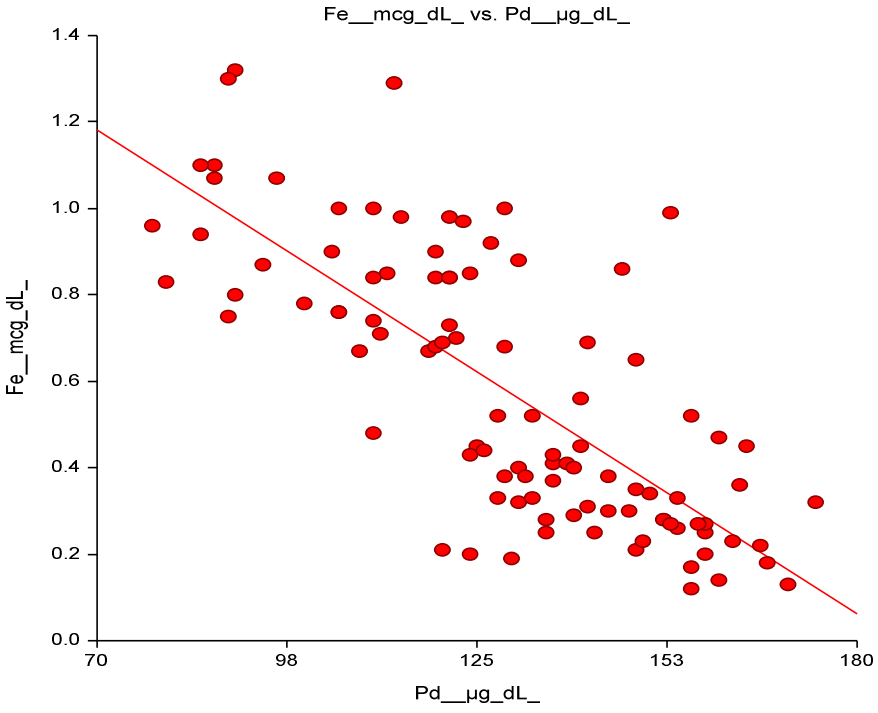

Fig. 10. Correlation plots of iron and lead levels of scavengers

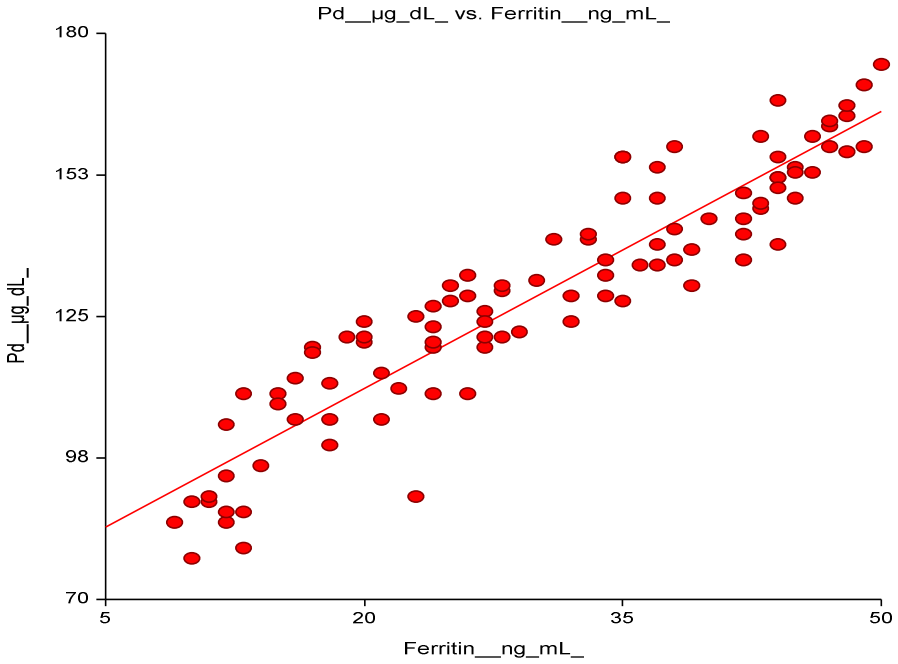

Fig. 11. Correlation plots of lead and ferritin levels of scavengers

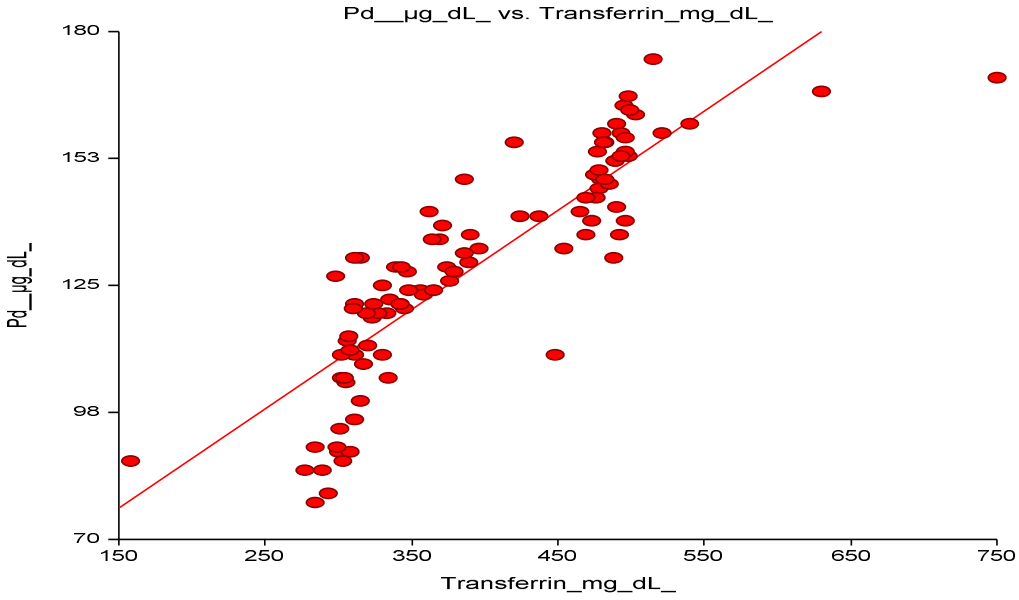

Fig. 12. Correlation plots of lead and transferrin levels of scavengers

4. CONCLUSION

Waste dumpsite scavengers are exposed to greater risk of infection and other health problems by virtue of their occupational exposure. From this study they had significantly higher levels of heavy metals especially cadmium and lead. They also had lower levels of iron and iron parameters, such as ferritin and transferrin. There were also higher levels of liver

enzymes and low levels of protein, albumin and globulin. The scavengers are at a greater risk of liver impairment, heavy metal toxicity and possibly other health challenges. These infections may be transmitted to members of their families and eventually to neighbors and associates.

Since the scavengers were exposed to these due to their occupation, it can also be stated that there is need to improve on waste management in our society. In addition, they should be encourage the use of PPE during scavenging activities.

CONSENT

All authors declare that 'written informed consent was obtained from the patient (or other approved parties) for publication of this case report and accompanying images. The subjects were informed about the study, and both informed and written consent were obtained from each subjects, an informed consent of the study participants was obtained and the subjects were free to withdraw from the study at any time.

ETHICAL APPROVAL

All authors hereby declare that all experiments have been examined and approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki. Ethical approval for this study was obtained from the Health Ethics Research Committee of the Rivers State Hospital Management Board.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Ibama O, Konne FE. Determination of haematocrit, sedimentation rate (ESR) and haemoglobin levels in municipal solid waste collectors (Sanitation Workers) in Port-Harcourt, Nigeria. J Adv Med Pharm Sci. 2018;19(2):1-6.
2. Zimring CA. Cash for your trash: Scrap recycling in America. New Brunswick, New Jersey. Rutgers University Press. 2005; 83-134.
3. Karshima SN. Public health implications of poor municipal waste management in Vom, Nigeria. J Vet Sci. 2016;11:142–148.
4. Adeyemi AO. Waste scavenging in third world cities: A case study in Ilorin City. Inaugural lecture, University of Ilorin, Ilorin, Kwara State, Nigeria; 2001.
5. Burntley SJ. A review of municipal solid waste composition in the United Kingdom. J Waste Mgt. 2007;27(10):1274-1285.
6. Wachukwu CK, Mbata CA, Nyenka CU. The health profile and impact assessment of waste scavengers (Rag Pickers) in Port Harcourt, Nigeria. J Appl Sci. 2010;10: 1968–1972.
7. Efe SI. Waste disposal problems and management in Ughelli, Nigeria. J Env Prot. 2013;4:4-11.
8. Falase A. Waste management practices in Nigeria: A welcome address at the opening of the based convention, Africa regional conference, Ibadan, Nigeria; 2004.
9. Lorentz J, Hill L Samimi B. Occupational needle stick injuries in a metropolitan police force. Am J Prev Med. 2000;18(2): 146-150.
10. Ayotamuno JM, Gobo AE. municipal solid waste management in Port-Harcourt, Nigeria: Obstacles and prospects. Mgt Env Qual. 2004;15:389-398.
11. Nwaokwe T. National report of hazardous waste management in Nigeria: Proceedings of the based convention, Africa regional conference, Ibadan, Nigeria. 2004;20-26.
12. Ezejiofor TIN, Ezejiofor AN, Udebuani AC, Ezeji EU, Ayalogbu EA, Azuwuike CO, Adjero LA, Ihejirika CE, Ujowundu CO, Nwaogu LA, Ngwogu KO. Environmental metals pollutants load of a densely populated and heavily industrialized commercial city of Aba, Nigeria. J Tox Env Heal Sci. 2013;5(1):1-11.

13. Jaishankar M, Tseten T, Anbalagan N, Mathew BB, Beeregowda KN. Toxicity, mechanism and health effects of some heavy metals. Interd Tox. 2014;7(2):60–72.
14. Ukachi EE, Wachukwu CK, Ollor AO. Amuh FU. Invoices of cardiovascular diseases and malaria parasitaemia among solid waste disposal workers in Port Harcourt, Nigeria. BrJ Medic Med Res. 2016;12(6):1–3.
15. Suleiman OS, Niyi AW, Bolanle AF, Adebisi AC, Abolape IA. Lipid profile, blood pressure and body mass index of male waste pickers in Osogbo, Nigeria. GSC Bio Pharm Sci. 2019;06(01):030-035.
16. Adeoye AC, Akindele FB, Adebisi WN, Olunle SS, Iyanda AA. Lead and cadmium in serium of Nigeria Rag pickers. Intl J Adv Sci Res. 2019;4(3):01–05.
17. Asgele T, Gebrehedhin K. Heavy metal analysis in solid municipal wastes. Intl J Tech Enhanc Emer Eng Res. 2015; 3(2): 2347–2389.
18. Olakunle IA, Olarenwaju TS, Olumuyiwa AO. Investigation of heavy metal content on dumpsites soil and vegetables grown: A case study of Ilesha Metropolis, Nigeria. Intl J AdvSci Res Eng. 2018;4(12):178–184.
19. Kanmani S. Gandhimathr R. Assessment of heavy metal contamination in soil due to leachate migration from an open dumping site. App Water Sci. 2013; 3:193–205.
20. Amadi AN. Nwankwoala HO. Evaluation of heavy metals in soils from enyimba dumpsite in Aba, Southeastern Nigeria using contamination factor and geo-accumulation index. E Env Res. 2013; 3(1):125–134.
21. Nyathi S, Olowoyo JO, Oludara A. Perception on scavengers and occupational hazards associated with scavenging from a waste dumpsite in Pretoria, South Africa. J Env Public Health. 2008;1–7.
22. Abbaspour N, Hurrell R, Kelishadi R. Review on iron and its importance for human health. J Res Med Sci. 2014;19(2): 164–174.
23. Daru J, Colman K, Stanworth SJ, Salle BDL, Wood EM, Pasricha S. Serum ferritin as an indicator of iron status: What do we need to know? American J Clin Nutr. 2019; 106:16345–16395.
24. World Health Organization. Serum transferrin receptor levels for the assessment or iron status and iron deficiency in populations; 2014. Retrieved on 11th April, 2020.
25. Asmamais B. Transferrin in fishes: A review article. J Coastal Life Med. 2016; 4(3):176–180.
26. Tolosano E. Increasing Serum transferrin to reduce tissue iron overload due to ineffective erythropoiesis. Haematological. 2015;100(5):565-566.

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