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Lead and cadmium levels in serum of Nigerian Rag-Pickers

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Abstract
Rag-picking otherwise known as solid waste scavenging involves being in contact with harmful materials some of which may contain toxic metals, hence the need to assess heavy metal levels in rag-pickers. Participants consisted of 30 rag-pickers and 30 age/gender-matched individuals that served as control. Estimation of Cd and Pb was carried out by Atomic Absorption Spectrophotometry (AAS) in the serum obtained from 5 mL of blood collected from each participant. Questionnaire was administered to obtain information on demographic characteristics as well as occupation related factors. Statistical analysis was carried out using Student's t test and Pearson's correlation co-efficient. The level of significance was $p \leq 0.05$. Results of the study revealed significantly high levels of cadmium and lead in rag-pickers compared with control. A positive correlation between serum Cd and Pb was observed among rag-pickers but no correlation was observed in control subjects. Eighty-three percent of the rag-pickers were found not to be using personal protective equipment. In addition, 30% of rag- pickers possess Secondary School Certificate or higher education, 77% put in more than 35 hours per week, and 90% were living below poverty line. Results of the study indicate that when the use of personal protective gear is disregarded by rag-pickers, elevated concentrations of serum Cd and Pb may occur. Furthermore, results suggest high level of poverty and under-employment among Nigerians who hold rag-picking as full time job.

Keywords: lead, cadmium, rag-picking

1. Introduction
Many metals have distinct physiologic roles but others without any biologic function can impact negatively on human health even at low levels; examples of which include Pb, Cd, Cr, and Ni [1]. The concentrations of heavy metals in human body vary considerably with life-style, geographical location, occupation, etc. Rag-picker (also known as solid waste scavenger) is a term used for an individual that makes a living by rummaging through refuse in the streets to collect material for salvage. The occupation (rag-picking) has been linked with metal exposure in different parts of the world, this occurs from high heavy metal contents at dumpsites [2-5]. Jung *et al.* [6] identified Cd, Pb, and Cr as important metal contents of solid waste in Japan. Cd, Cr, Cu, Hg, Ni, Pb, and Zn have also being identified as components of waste by Sørum *et al.* [7]. In Nigeria, Anake *et al.* [8] documented the presence of the following metals; Cd, Pb, Cr, Ni in municipal waste in solid waste dumpsites. Yet their study was not extended to solid waste scavengers; i.e. to investigate whether such metals would reflect in any biological specimens of those involved in waste management. Meanwhile, it is not unlikely that waste pickers because of their close proximity to waste, may have high body burden of toxic metals, hence the need for a study of this nature. The aim of the study is to determine whether contact with solid waste is capable of elevating toxic/heavy metals in serum of male Nigerians.

2. Materials and Methods
Ethical Considerations
Before the study was embarked upon, ethical approval was obtained from the Ethical Committee of the Ladoke Akintola University of Technology Teaching Hospital, Osogbo. Informed consent was also obtained from each participant.

The Study Area
The study was conducted at two locations (Ajegunle and Sabo) in Olorunda Local Government Area, Osun state. These are the two most prominent spots where scavenged materials are deposited before salvaged items are sold off. Since, rag-pickers must report at the locations daily to deposit recovered items, therefore, the two locations were chosen as recruitment centers.

Study Design
This study was designed as a cross-sectional comparative study.

Instrument of data collection
Structured questionnaire was adopted and utilized to collect the variables of interest from the respondents. Information was obtained on lifestyle (smoking, alcohol intake), duration of contact to waste; use of personal protective equipment, and socio-economic status, educational status, age, gender and other demographic features.

Population, Sampling Technique and Sample Size
The Nigerian rag-pickers used for the study was obtained through a multi-stage sampling technique. Of the states of the (Nigerian) federation, Osun state was chosen, of the local government areas in the state, Olorunda Local

Government Area was selected, after which simple random sampling technique was employed. Moreover, as suggested by Hertzog [9] sample size of 30 participants was adopted, this being a pilot study. Therefore, 30 rag-pickers were recruited for the study. The control group also consisted of 30 participants- age and gender matched. As it is commonly found in most parts of Nigeria, solid waste scavengers are mostly males [10] hence male participants were recruited for the study.

Collection and separation of sample

From the ante-cubital vein, five millimeters of blood was collected from each participant after the site had been sterilized using the 70% alcohol (methylated spirit). It was collected into anti-coagulants free bottles and left to clot for 4 hours. The sample of each participant was centrifuged at 3000 rpm for 5 minutes and the serum obtained stored at -20 ^{o}C prior to the time of analysis.

Assessment of heavy metals

The determination of the levels of heavy metals (Cd, Pb) in serum samples of solid waste scavengers was achieved using Atomic Absorption Spectrophotometer (AAS)- A Analyst 400 (manufactured by Perkin Elmer, United States of America).

Statistical Analysis

Descriptive statistics was used for qualitative data and were presented in pie charts. The level of significant difference between Pb and Cd levels of solid waste scavengers and control group was carried out using Student's t test. Pearson correlation co-efficient was used to determine association between Pb and Cd. All data were analyzed using Statistical Package for Social Sciences (SPSS) version 23. P≤0.05 was considered significant.

3. Results

The Levels of serum Pb and Cd were significantly higher in rag-pickers than in control (P<0.05) as shown in Table 1. Results of the demographic and occupational characteristics as well as lifestyle of the rag-pickers are summarized in pie charts below (Figures 1-6). Lead showed positive correlation with cadmium among solid waste scavengers r= 0.663; p<0.000). However, there was no significant correlation between lead and cadmium in the control subjects (r= 0.001; p>0.05). Results revealed that 90% of the scavengers were observed to be poor. According to United Nations, individuals that earn income in which their family members live on less than 1. 90 USD a day are considered to be living under poverty line. Concerning use of protective wears, CC

Table 1: Comparison Trace Element Parameters Among Study Subject

Parameters	Test subjects (n=30)	Control subjects (n=30)	p-value
Lead (µg/L)	19.0±0.0.7	0.17±0.0.4	0.000*
Cadmium (µg/L)	3.1±1.0	0.2±0.04	0.000*

Data presented as mean ± standard deviation; * Significant at p-value <0.05

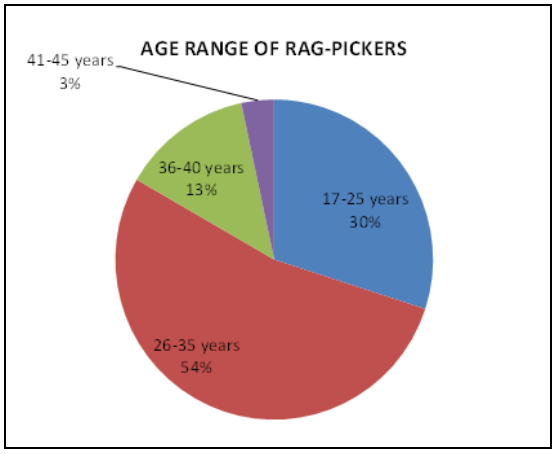
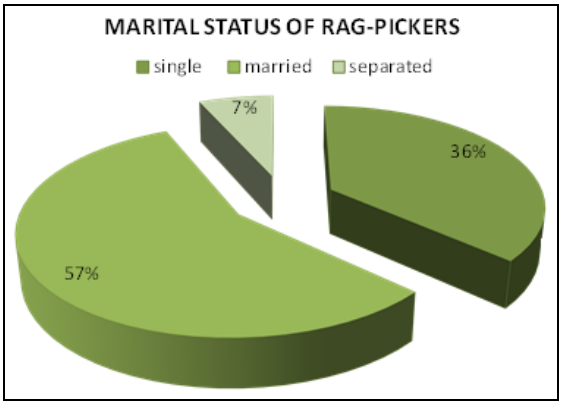


Fig 1



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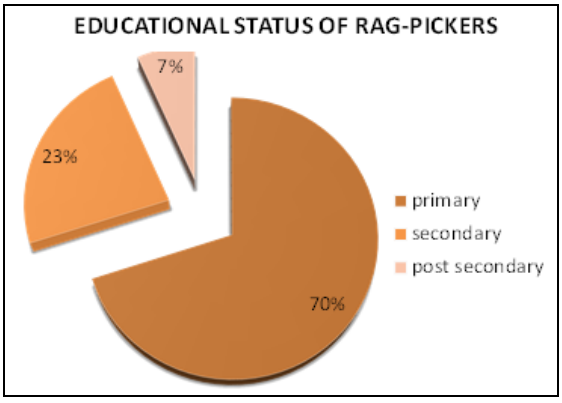

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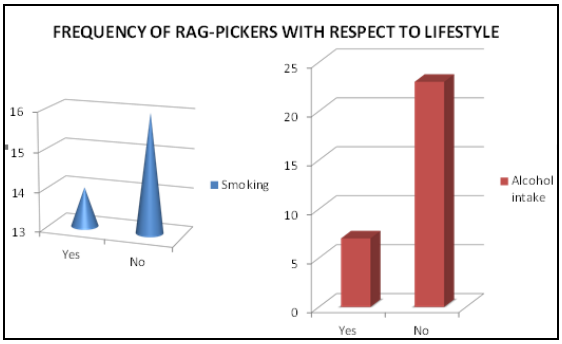

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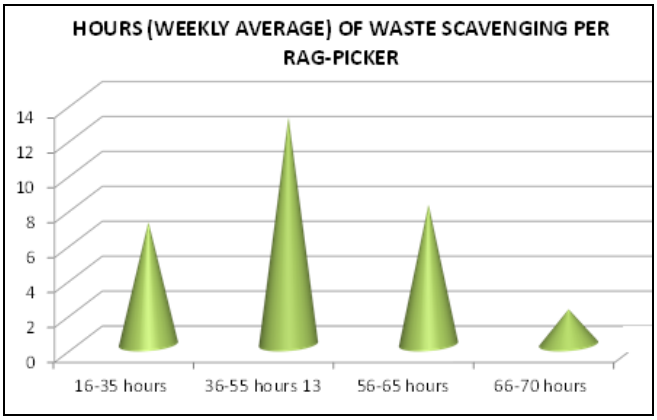

Fig 5

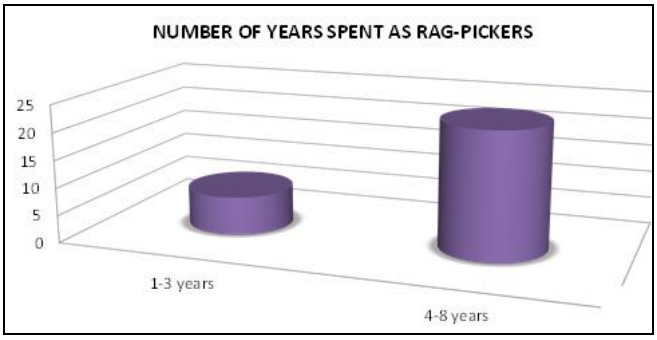

Fig 6

4. Discussion

That the significantly higher level of Cd and Pb observed in rag-pickers (compared with control) may be linked to occupational exposure can be deduced from the submission of Esakku *et al* [11]. According to them electronic goods, electroplating waste, painting waste, used batteries, etc. which are dumped constantly with municipal solid wastes increase heavy metals in dumpsites. The fact that neither apron nor boot was used by most rag-pickers recruited makes this a possibility. In addition, in most parts of the developing world, since solid waste dumping occurs without sorting hazardous waste from non-toxic one, it makes it difficult for rag-pickers to avoid contact with hazardous materials (like heavy metals) and raises overall toxic environmental effects.

While for this study, the heavy metal content of solid waste (in this environment) was not carried out and therefore could not be correlated with the degree of exposure in rag-pickers. Various studies in Nigeria showed that slow leaching of these heavy metals under acidic environment during the degradation process results in formation of leachates with high metal concentrations. By not using gloves, the studied subjects might have touched waste, soaked in leachates.

The result of the study of Wachukwu and Eleanya [12] which showed that mean lead concentration was higher for the solid waste workers than control subjects is in agreement with this study. Study of Odewabi and Ekor [13] have also raised the possibility that toxic neuropathies common among waste management workers (WMW) may be linked with heavy metals present in municipal solid wastes. These researchers showed that while essential element- iron- was significantly lower, Pb and chromium levels were significantly higher in waste management workers, an observation which is also in accord with the results of the present study especially with respect to serum Pb level.

The significantly high level of Pb and Cd in rag-pickers (when compared with control) will no doubt alter physiologic processes [14,15]. In other words, the significant increase in Cd may have far-reaching effects on various body parts. For example, approximately 50% of cadmium absorbed is rapidly accumulated in the liver, although this means that there is reduced availability of cadmium to other organs such as the kidneys and testes, but since they are more sensitive to Cd exposure [16], its harmful effects can still be felt in these extra-hepatic tissues. Much of the cadmium-induced organ toxicity has been linked with generation of reactive oxygen species (ROS) and oxidative stress [17,18].

"Interaction Profiles" compiled by the United States Agency for Toxic Substances and Disease Registry report [19] that renal toxicities of mixtures of lead plus cadmium are greater than would be predicted knowing the toxicity dose response of the individual elements, and that of lead plus cadmium are particularly supra-additive. Presence of cadmium in another biologic fluid (i.e. urine) has been reported in municipal waste operators [20]. It is important to note, the mechanistic basis of Cd toxicity is similar to that of Pb.

Although data from the study of Devi *et al.* [21] showed that 18% of rag-pickers possess Secondary School Certificate (SSC) or higher education, a much higher proportion (30%) of rag-pickers for present study were holder of such qualifications. Undoubtedly, this may be one of the reasons why rag-picking is associated with lack of job satisfaction [22,23], since holders of SSC who serve as rag-pickers and are grossly under-employed. Especially as it is their main employment, 76% of the rag-pickers put in more than 35 hours per week. According to International Labour Organization [24] work-hours more than 35 hours/week is considered full-time job.

Poverty and/or lack of job satisfaction has been linked with unstable family condition and harmful lifestyles, yet only less than 7% were separated from their spouses indicative that the socio-economic effects of rag-picking on family stability was minimal. Unlike mild effects of rag-picking on stability of family life, as much as 23% and 46% respectively, smoke cigarette and consume alcohol, two common harmful lifestyle choices in their environment.

The results of the study taken in association with past ones indicate lackadaisical attitude to the use of personal protective equipment (PPE) by rag-pickers across the world. For example, while data from the present study revealed a compliance rate of 17%. Ahmed *et al.* [25] put adherence to practice of protection, through use of PPE at 39%. Both are in agreement with the observation of Gebremedhin *et al.* [26] who reported that 37% of waste scavengers adopted certain measures for their personal safety or protection. A much higher disregard for this very important measure was observed by Konya *et al.* [27], they identified that majority of the collectors had no access to personal protective gears, although Hoefel *et al.* [28] reported of non-compliance of 52%. This indicates that there is need for training program as well as health instructions to be made available for all rag-pickers from the start of work, so as to provide educative basis for effective use of PPE. Moreover, supervision of waste handlers on appropriate use of PPE is deemed necessary.

5. Limitations of the study

Due to small sample size, the results of the study cannot be generalized to all rag-pickers across the country. Other important information (on awareness about adverse health effects, job stress, etc) was not obtained which could have shed more light on possible role they play on the overall effects on rag-pickers so as to facilitate a more robust approach to the impact of the these salient issues on rag-pickers. Moreover, since the heavy metal content of waste in Olorunda local government area was not determined, the cause of elevated serum Cd and Pb levels could not be conclusively established.

6. Conclusion

The results of the study indicate that solid waste scavenging may predispose people to heavy metal toxicity. The study also provides evidence for many serious socio-economic problems among Nigerian rag-pickers. Rag-pickers definitely seem ignorant on the importance of PPE, since many of them did not use any of the gears. That only 5 out of 30 solid waste scavengers avail themselves of the use of protective gears suggests that there is need for thorough enlightenment about personal protection for rag-pickers by government or non-governmental organizations (NGO). It is being suggested that an undertaking of a comprehensive health status assessment of rag-pickers is paramount; this will provide more information to all stakeholders about the danger posed to rag-pickers who disregard the use of protective gears.

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