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URBAN WASTE MANAGEMENT AND CONCENTRATION OF HEAVY METAL AMONG WASTE WORKERS IN PORT HARCOURT METROPOLIS

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Heavy Metal, Waste Worker, Health, Hazard, Contaminant, Urban Waste Management.

ABSTRACT

Rapid urbanization, industrial growth, and increased environmental activities in cities like Port Harcourt Metropolis have led to a significant rise in the generation of municipal solid waste. This surge has not only burdened waste management systems but has also heightened the exposure of waste workers—both formal and informal to harmful contaminants, including heavy metals. These metals, such as lead (Pb), cadmium (Cd), chromium (Cr), mercury (Hg), and arsenic (As), are commonly found in various components of solid waste, including batteries, electronic devices, paints, and industrial byproducts. When handled without adequate protective measures, these substances pose serious health risks due to their toxic, non-biodegradable, and bioaccumulative properties. This study examines concentration of heavy metal among waste worker in Port Harcourt Metropolis. . The study was guided by two objectives and two research questions. Using experimental and survey research design, the population for the study constitutes the ninety-five (95) service providers to Rivers State Waste Management Agency (RIWAMA). The study used both primary and secondary data for analysis. The sample for the study was 30 service providers from where the sample population for the study was collected from the different parts of Port Harcourt metropolis. To get the sample for the study, multi-stage sampling technique was adopted to obtain a sample of one hundred and seventy five (175) waste workers. For method of data collection, One hundred and seventy-five (175) copies of questionnaire was administered to the sampled waste workers of the different service providers to RIWAMA. The study reveals that all the respondents were conscious of the fact that poor waste disposal is harmful to human health. This is because 100 percent of the respondent indicated that they are aware. The study highlight the need for The Rivers State Waste Management Agency (RIWAMA) should ensure all workers are equipped with quality personal protective equipment (PPE) such as gloves, masks, boots, and overalls. Enforcement policies should penalize non-compliance by contractors.

I. INTRODUCTION

Over the years, there have been rising issues of emission waste particles including unhealthy gaseous substance into the atmosphere in Rivers State and Port Harcourt Metropolis due to rapid population growth, industrialization, and urbanization. Port Harcourt Metropolis, a major urban center in the Niger Delta region, generates large volumes of solid waste daily, much of which is handled by both formal and informal waste workers under unsafe and poorly regulated conditions. These waste

workers are exposed to a wide range of occupational hazards, including physical injuries, biological infections, and most notably, chemical contaminants such as heavy metals (Otitoju et al., 2019).

Heavy metals such as lead (Pb), cadmium (Cd), mercury (Hg), chromium (Cr), and arsenic (As) are frequently found in municipal waste due to their widespread use in batteries, electronics, paints, and other household and industrial materials. These metals are non-biodegradable and bioaccumulative, making them particularly hazardous when they enter the human body through inhalation, ingestion, or dermal contact (Adewuyi & Aderemi, 2016). Waste workers in Port Harcourt, many of whom operate without personal protective equipment (PPE), are particularly vulnerable to these exposures. Over time, bioaccumulation of heavy metals can lead to chronic illnesses such as neurological disorders, kidney damage, liver dysfunction, and cancers (Nduka & Orisakwe, 2010).

Studies have shown that blood samples of waste handlers in other parts of Nigeria contain elevated levels of toxic heavy metals compared to non-exposed populations (Ideriah et al., 2013). This is largely attributed to direct contact with unsegregated waste, poor occupational safety practices, and lack of regular medical screenings. In Port Harcourt, where open dumping and informal handling of waste are common, such exposures may be even more pronounced. Yet, there is a dearth of localized data on the actual concentration levels of these toxic substances in the bodies of solid waste workers.

Furthermore, beyond toxicological concerns, the health hazards faced by waste workers are compounded by poor working conditions, low social status, lack of access to healthcare, and irregular remuneration. These conditions have been linked to increased vulnerability to occupational diseases, psychological stress, and poor health-seeking behaviors (Afon, 2012; Ekpu & Archibong, 2007).
Moreover, many waste workers lack adequate protective gear, proper training, and access to medical examinations, thereby increasing their risk of long-term exposure and adverse health outcomes (Adewuyi & Aderemi, 2016). Despite their indispensable service, these workers remain marginalized and unprotected by formal occupational health and safety frameworks. The health implications of such exposures—ranging from skin rashes and hearing loss to kidney damage and cognitive dysfunction—pose a serious public health concern, not only for the workers but also for their families and communities (Ekpu & Archibong, 2007).

Given the socio-economic and environmental nature of Port Harcourt Metropolis, where informal waste handling is prevalent and regulatory enforcement is weak, the likelihood of hazardous exposure is particularly high. Yet, there is insufficient empirical data to inform targeted interventions, especially regarding heavy metal contamination. Therefore, this study is necessitated by the urgent need to evaluate the concentration of heavy metals in the blood samples of solid waste workers and to understand the associated health hazards they face. The findings are expected to contribute significantly to occupational health policies and practices in Nigeria.

Objectives of the Study

To analyses the concentration level of heavy metals in blood samples of waste workers in the study area.

To examine the nature of health hazards on solid waste workers in the study area.

Research Questions

In addressing the problems highlighted above, we asked the following questions:

What is the concentration of heavy metals in the blood samples of Solid Waste Workers in the study area?

What are the major health risks affecting solid waste workers in the study area?

Study Area

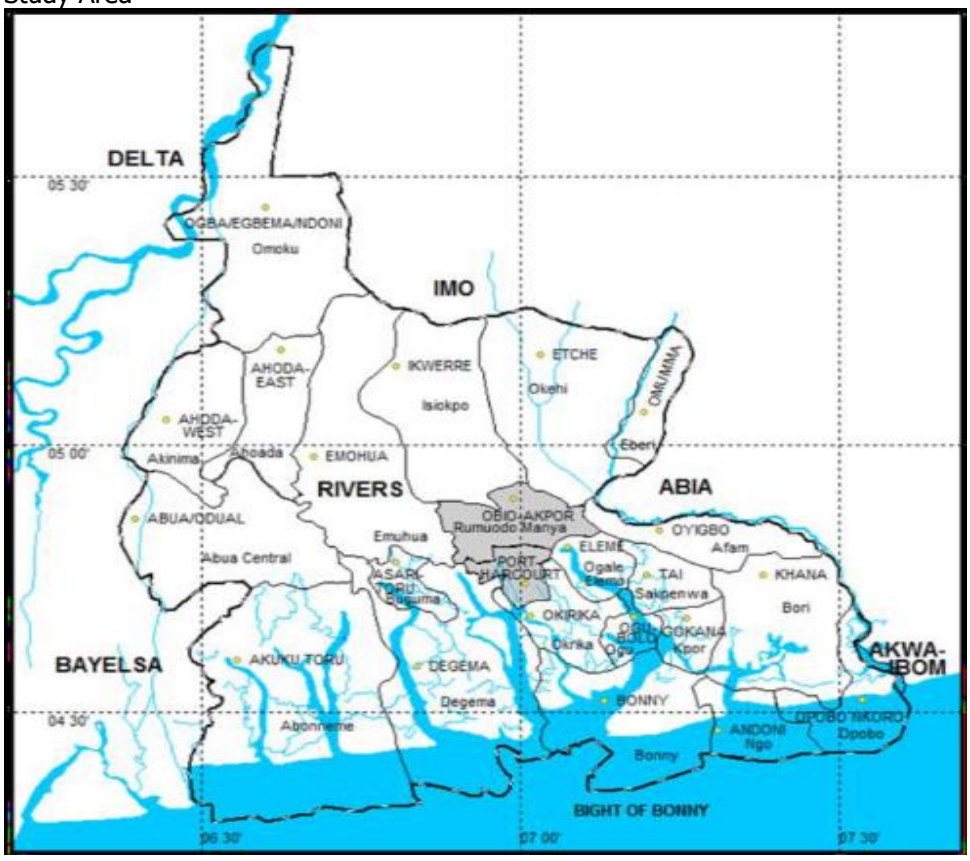

Fig. 1.1: Rivers state showing both Port Harcourt and Obio/Akpor Local Government Areas
Source: River State Ministry of Lands and Survey

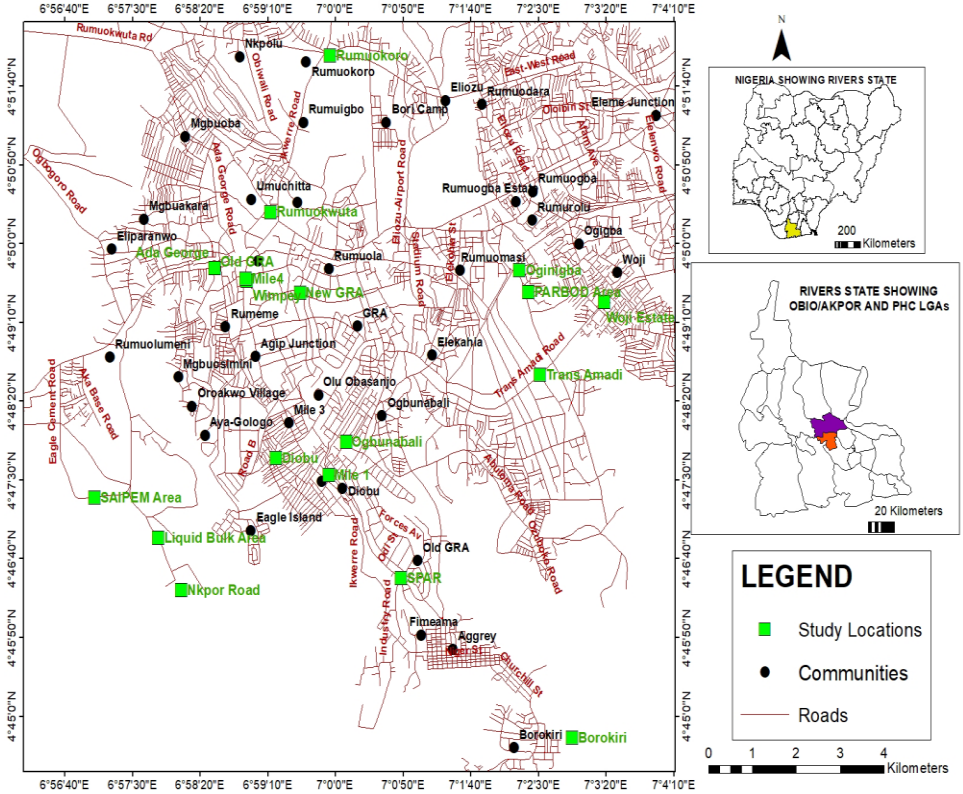

Fig 1.2: Port Harcourt Metropolis showing Locations used for sampling
Source: Rivers State ministry of Lands and Survey – Digitized in the GIS Lab UNIPORT

II. METHODOLOGY

This study employed an experimental and survey research design. The sample frame for this study comprises ninety-five (95) service providers to the Rivers State Waste Management Agency (RIWAMA). The research employed both primary and secondary data for analysis. The primary data sources were derived from a structured questionnaire, interviews, field observations, and laboratory analyses, particularly of the blood serum samples from solid waste workers. The secondary data sources were acquired from the RIWAMA clinic, textbooks, online resources, both published and unpublished academic papers, journals, and government gazettes.

The study sample comprised 30 service providers selected from various locations within the Port Harcourt metropolitan. A multi-stage sampling strategy was employed to get a sample of one hundred seventy-five (175) trash workers for the study. One hundred seventy-five (175) questionnaires were distributed to the sampled trash workers from various service providers to RIWAMA for data collection. The research tool was explicit and unambiguous.

Table 1: Waste dump and sampled locations of waste workers, GPS Coordinates and land-use pattern in the study Area.

S/N	Location name	Geographical coordinates	Land-use description
1	Rukpokwu	N 04º 55' 42.9", E 007º 00'	Residential area at Egbelu new road, Rukpokwu
2	Mile 1	N 04º 47'22.8", E 007º0'15"	Market and residential
3	Rumuagholu	N 04º 53' 21.5", E 006º 58	Residential/school area, off SARS road, Rumuagholu
4	Wimpey	N 04º 49' 36", E 006º59'10"	Residential and commercial area
5	Rumuokwuta	N 04050'20", E 6059'10"	Residential/ area by Ardova filling station Ikwere road
6	Rumuokoro	N 04º 51' 43.4", E 006º 59'	Residential area around Akwaka phase 3, Rumuodomaya
7	Ogbunabali	N04047'70", E 007º 0'35"	Residential area aound eastern By-pass junction
8	Rumuola	N 04º 49' 36", E 007º1'10"	Residential by Y- junction Rumuadaolu
9	Rumuigbo	N 04º 50' 70", E 006º 59	Residential area about MCC 2nd gate.
10	Ozuoba	N 04º 52' 04.5", E 006º 56	Residential area opposite Provil School, Ozuoba
11	Eligbolo Road	N 04º 51' 58.8", E 007º 00'	Residential/school area by Eligbolo road.
12	Oroigwe	N 04º 52' 21.8", E 007º 02'	Residential area by Oroigwe, Elimgbu
13	Rumuokwurushi	N 04º 52' 05.2", E 007º 04	Residential area before Nzor hotel, Rumuokwurushi
14	Diobu	N 04º 47' 50", E 006º59'20"	Residential and Market area by Iroabuchi
15	Elioparanwo	N 04º 50' 07.8", E 006º 57'	Residential area around 27, Royal Avenue, Elioparanwo Town
16	Ada George	N 04º 50' 08.5", E 006º 58'	Commercial area at Rumuepirikom by Ada George Road.
17	Rumuigbo	N 04º 50' 25.4", E 007º 00	Residential area behind PHWC, Psychiatric Rd, Rumuigbo
18	Woji Estate	N 04º 53' 17.2", E 007º 02'	Residential area by Temple Ejekwe Street, Woji Road
19	Elelenwo	N 04º 50' 07.3", E 007º 04'	Church premises/residential area at Elelenwo
20	Rumuolumeni	N 04º 48' 40.4", E 006º 57'	Church Premises (St Mark's Ang. Church, Rumuolumini)
21	Eliozu	N 04º 50' 52", E 007º 1'39"	Residential and commercial area near St Peter Claver
22	Diobu	N 04º 47' 28.3", E 007º 00'	Church Premises (CKC church, mile 1,

			Diobu).
23	Trans-Amadi	N 04º 48' 10.5", E 007º 02'	School premises (Tago Int'l Sch., off Odili Rd, T/Amadi)
24	Gbalajam	N 04º 48' 39.5", E 007º 04	Residential area at Gbalajam, Woji (close to a creek).
25	Liquid Bulk Area	N 04º 47' 00.9", E 006º 58'	Residential area around 38D, Collin Owonda Str., Eagle Island
26	SPAR	N 04º 45' 52.6", E 007º 01'	Residential area around Hospital Road, PH Township.
27	Abuloma	N 04º 46' 50.9", E 007º 02'	Hotel/residential area at Abuloma
28	Borokiri	04º 45' 01.6", E 007º 02'	Commercial area at UPE, Borokiri.
29	Borokiri	N 04º 44' 07.7", E 007º 01'	Commercial area (petroleum) close to Borokiri Sand Fill
30	Eagle Island	N 04º 46' 67", E 6058' 80"	Residential area Along Christmas village road

Source: Researcher's fieldwork and Analysis (2022)

In order to determine the sampling frame and sample size for this study, the total number of service providers was obtained from RIWAMA. To determine the representative sample size, 30 percent of the service providers were chosen based on their area of operation representing the thirteen demarcated areas selected for the study. The service providers and number of staff are shown in table 1.2 below:

Table 1.2: Zones and Number of Service Providers and sample size.

S/N	Location/ Zone	Service Providers	Number of staff	Sample size (30%)	Zone codes
1	Township-Borikiri axis	Passion blade Nig. Ltd	40	12	A
2	Township-Borikiri axis	Fracon Enterprises	34	10	A
3	Township-Borikiri axis	High Five PLC	26	8	A
4	Township-Borikiri axis	Winner Word Enterprises	37	11	A
5	Township-Borikiri axis	Numac Nig. Ltd	23	7	A
6	Township-Borikiri axis	Jendev Nig. Ltd.	40	12	A
7	Township-Borikiri axis	Osidenco Nig. Ltd.	33	10	A
8	Township-Borikiri axis	Emachar Global	21	6	A
9	Trans-Amadi-Oroigwe axis	Sedafeco Nig. Ltd.	13	4	B
10	Trans-Amadi-Oroigwe axis	Ken Global	24	7	B
11	Trans-Amadi-Oroigwe axis	Boboo Sweepers Enterprises	15	5	B
12	Trans-Amadi-Oroigwe axis	Paco Nig. Ltd.	16	5	B
13	Trans-Amadi-Oroigwe axis	Benvic Enterprises	23	7	B
14	Trans-Amadi-Oroigwe axis	Pellob Global	14	4	B
15	Trans-Amadi-Oroigwe axis	Emma Group Ltd.	23	7	B
16	Rumuokoro-Mile one axis	Flenc Holding	12	4	C
17	Rumuokoro-Mile one axis	Grace Loc Nig. Ltd.	10	3	C
18	Rumuokoro-Mile one axis	Citizen Global	13	4	C
19	Rumuokoro-Mile one axis	Panafricano Nig. Ltd.	14	4	C
2	Rumuokoro-Mile one axis	Beats Global Ltd.	15	5	C

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21	Rumuokoro-Mile one axis	Integrity and Son Ltd.	15	5	C
22	Rumuokoro-Mile one axis	Wakog Global Nig. Ltd.	16	5	C
23	Rumuokoro-Mile one axis	Basil Nig. Ltd.	12	4	C
24	Ozuoba -Rumuolumeni axis	Epiphanie Enterprises	13	4	D
25	Ozuoba -Rumuolumeni axis	Tatiana group	17	5	D
26	Ozuoba -Rumuolumeni axis	Ste Nina Nig. Ltd.	10	3	D
27	Ozuoba -Rumuolumeni axis	Gullaume Enterprises	11	3	D
28	Ozuoba -Rumuolumeni axis	Gildas Nig. Ltd.	15	5	D
29	Ozuoba -Rumuolumeni axis	Avent group Nig. Ltd.	12	4	D
30	Ozuoba -Rumuolumeni axis	Gilgal Envt. Services Ltd	19	6	D
		TOTAL	586	175	

Source: Computed from RIWAMA Document, 2022.
A – Township-Borikiri axis; B - Trans-Amadi - Oroigwe axis; C -Rumuokoro-Mile one axis;
D – Ozuoba -Rumuolumeni axis,

III. RESULTS

Demographic Characteristics of Respondent

Table 1: Distribution of Solid Waste Handlers of different service providers according to their job description

Job Task	Number of employees (N=175)	(%)
Truck Drivers	35	20
Refuse Collector	48	27.4
Street sweepers	45	25.7
Waste Pickers	47	26.9
Total	175	100

Source: Researcher's Field Work, 2022

Table 1 above shows distribution of Solid waste handlers at RIWAMA according to their job task. It reveals that most respondents under survey 45(25.7%) were street sweepers, 47 (26.9%) were waste pickers, 48 (26.9%) were refuse collector and least 35 (20%) are truck drivers. The implication of this result is that most respondents have overview of the issue discussed based on their experience in the handling of solid waste in course of their job description.

Sources and Composition of Solid Waste in the Study Area

The data collected with section B of the questionnaire which dwelt on sources and composition of solid waste in the study area was used to answer research question 1. Data were analysed using frequency and percentage. Summary of the results were presented in table 4.6. To examine the source and composition of solid waste in the study area, two categories of questions were asked; they included what are the sources of Solid waste and what are the types of Solid waste generated.

Heavy metals concentration in blood of solid waste workers and non-waste workers sampled at different zones of the study area (mg/l).

Specimen numb	Lead (Pb)	Zinc (Zn)	Cadmium (Cd)	Chromium (Cr)	Arsenic (As)	Nickel (Ni)	Mercury (Hg)

er and zone code							
1A	0.04(0.00)*	2.41(1.73)*	0.06(0.03)*	0.03(0.69)*	0.02(0.00)*	0.04(0.13)*	0.00 (0.0)*
2A	0.04(0.02)*	1.91(3.82)*	0.09(0.10)*	0.04(0.00)*	0.00(0.01)*	0.04(0.01)*	0.00 (0.0)*
3A	0.45(0.01)*	3.06(2.05)*	0.10(0.00)*	0.04(0.13)*	0.01(0.00)*	0.03(0.00)*	0.00(0.0)*
4A	0.45	1.49	0.08	0.05	0.00	0.05	0.00
5A	0.46	2.56	1.43	0.05	0.00	1.05	0.00
1B	2.32(0.0)*	1.69(1.38)*	1.62(0.01)*	0.06(0.01)*	0.02(0.04)*	0.05(0.05)*	0.00(0.0)*
2B	2.20(0.03)*	3.91(3.69)*	0.11(0.06)*	0.63(0.37)*	0.00(0.01)*	0.07(0.02)*	0.00(0.0)*
3B	1.11(0.03)*	2.35(2.81)*	0.12(0.00)*	0.50(0.02)*	0.00(0.00)*	0.05(0.00)*	0.00(0.0)*
4B	1.13	0.71	0.15	0.05	0.00	1.05	0.00
5B	1.13	1.44	0.22	0.06	0.01	0.06	0.00
1C	1.33(0.01)*	2.60(2.91)*	0.21(0.07)*	0.06(0.00)*	0.01(0.01)*	0.07(0.03)*	0.00(0.0)*
2C	1.54(0.01)*	2.60(1.67)*	0.28(0.00)*	0.08(0.14)	0.01(0.01)*	1.07(0.13)	0.00(0.0)
3C	1.56(0.13)*	1.03(3.12)*	0.28(0.31)*	0.08(0.07)*	0.02(0.01)*	0.08(0.01)*	0.00(0.0)*
4C	2.56	3.41	0.32	0.08	0.00	0.06	0.00
5C	2.57	1.10	0.31	0.08	0.01	0.09	0.00
1D	2.90(0.04)*	2.75(1.00)*	0.34(0.00)*	0.09(0.02)*	0.00(0.00)*	1.07(0.00)*	0.00(0.0)*
2D	3.05(0.01)*	0.61(2.33)*	1.43(0.00)*	0.09(0.02)*	0.03(0.00)*	0.81(0.02)	0.00(0.0)*
3D	3.15	1.40	1.49	0.09	0.01	0.30	0.00
4D	3.55	2.20	1.65	0.13	0.00	0.60	0.00
5D	3.98	0.58	1.65	0.62	0.00	1.07	0.00

*( ) – Data from non-waste workers (used) as control.
Source: Research medical examination field data, 2022.

The data in table 4 showed that Lead (Pb) concentration in the blood samples of waste workers in the Township-Borikiri, zone A axis ranges between 0.04-0.45Mg/l with control ranging between 0.0-0.02mg/l; Zinc concentration was between 1.91-3.06Mg/l and control having values between 1.73-3.82mh/l; Cadmium ranges between 0.06-1.43Mg/l and control ranging from 0.00-0.10mg/l; Chromium ranges between 0.03-0.05Mg/l with control having values between 0.00-0.69mg/l; Arsenic was between 0.00-0.02Mg/l with control having values ranging between 0.00-0.01mg/l; Nickel ranges between 0.03-1.05Mg/l with control as 0.00-0.13mg/l and Mercury had concentration level of 0.00-0.00Mg/l with non-waste workers having no values for Mercury in zone A.

At the zone, B area, which comprises of Trans-Amadi-Oroigwe axis showed elevated concentration of Lead which ranges between 1.11-2.32Mg/l with control ranging between 0.00-0.03mg/l; Zinc ranges between 0.71-3.91Mg/l while control ranges between 1.38-3.69mg/l; Chromium had a range of 0.05-0.63Mg/l with control having concentration values between 0.01-0.37mg/l. There was no Mercury seen in the blood samples of waste and non-waste workers alike at zone B, but Cadmium and Nickel which were seen had concentration values ranging from 0.11-1.62mg/l and 0.05-1.05Mg/l respectively. The values for non-waste workers accordingly were 0.0-0.06mg/l and 0.00-0.05mg/l for Cadmium and Nickel respectively.

For the Rumuokoro - Ikwerre road axis denoted as zone C had Lead concentration in the blood as ranging from 1.33-2.57mg/l and control as 0.01-0.13mg/l; Zinc ranges between 1.03-

3.41Mg/l with control values ranging between 1.67-3.12mg/l; Cadmium ranges from 0.21-0.32Mg/l with its control ranging between 0.00-0.31mg/l; Chromium ranges between 0.06-0.08 and control having concentration values ranging from 0.00-0.14mg/l; Arsenic ranges between 0.00-0.02 and control values ranging between 0.01-0.01mg/l; Nickel had concentration level ranges from 0.06-1.07Mg/l with control having values between 0.01-0.13mg/l . However, Mercury was not seen in the blood samples of both waste and non-waste workers at zone C.

At the zone, D, which comprises of Ozuoba-Choba-Ogbogoro-Rumuolumeni axis, Lead (Pb) concentration ranges between 2.90-3.98Mg/l with control having 0.01-0.04mg/l; Zinc ranges between 0.58-2.75Mg/l and control with values ranging between 1.0-2.33mg/l; Cadmium concentration was between 0.34 -1.65mg/l and control with no significant values; Chromium concentration ranges between 0.09-0.62mg/l with control values ranging between 0.02mg/l in all cases; Arsenic had concentration levels ranging between 0.00-0.03mg/l with control showing zero concentrations. Nickel ranges between 0.30-1.07mg/l and control with values ranging between 0.00-0.02mg/l. Mercury was not seen in the blood samples of both waste and non-waste workers in this Zone.

Table 4: Knowledge of harmful Consequences of Poor Waste Disposal to waste handlers

Items	Frequency	Percentage (%)
Yes	175	100
No	-	-
I don't know	-	-
Total	175	100

Source: Researcher's Fieldwork, 2022

Data analysis as seen in Table 4 reveals that all the respondents were conscious of the fact that poor waste disposal is harmful to human health. This is because 100 percent of the respondent indicated that they are aware.

Table 5: Health Symptoms reported by Respondents

Items	Frequency	Percentage (%)
Malaria	15	8.5
Diarrhea	25	14.2
Typhoid	12	6.8
Acute Back pain	10	5.7
Painful joints and other musculoskeletal disorders	12	6.8
Possible Liver and Kidney damage	23	13.1
Reduced sense of smell, skin diseases (rashes) and hearing impairment	78	44.5
Total	175	100

Source: Research Fieldwork, 2022

Table 5 shows respondents opinion on the health symptoms of poor waste disposal, 6.8% (12) of respondents indicated that when waste are not properly handled it could make them vulnerable to typhoid, 8.5% (15) respondents had opinion that they could be vulnerable to malaria; 14.2% (25) respondents had opinion that they could be vulnerable to Diarrhoea, 25 % (67) respondents had opinion they could be exposed to experiencing painful joints and other musculoskeletal disorders; 21% (56) respondents had opinion that they could be exposed to experiencing acute back pain; 9% (23) had opinion that they could experience a possible liver and kidney damage and 67% (178) respondents had opinion that they could experience other symptoms not mentioned

IV. CONCLUSION

The study underscores the significant occupational health risks faced by solid waste workers in Port Harcourt Metropolis. High concentrations of heavy metals—particularly lead (Pb), cadmium (Cd), nickel (Ni), and chromium (Cr)—were detected in the blood samples of waste workers, exceeding those found in non-waste workers. This indicates chronic exposure likely caused by poor waste segregation practices, lack of protective equipment, and frequent contact with contaminated waste materials. Moreover, a wide range of health symptoms reported by workers, including skin diseases, respiratory issues, hearing impairment, and potential kidney or liver damage, reinforces the hazardous nature of their work environment. Although waste workers showed a good level of

awareness regarding the harmful consequences of poor waste handling, systemic factors—such as inadequate health policies, informal employment structures, and weak enforcement of occupational safety standards—continue to place them at risk.

V. RECOMMENDATIONS

Government health agencies in Rivers State should implement routine medical screening for all waste workers to detect early signs of heavy metal poisoning and other related health conditions.

The Rivers State Waste Management Agency (RIWAMA) should ensure all workers are equipped with quality personal protective equipment (PPE) such as gloves, masks, boots, and overalls. Enforcement policies should penalize non-compliance by contractors.

Training workshops should be periodically organized to educate waste workers on safe handling practices, recognition of hazardous waste, and emergency response procedures.

Many workers are employed informally without access to health insurance or job security. State authorities should integrate them into formal systems that guarantee minimum wage, health benefits, and legal protection.

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