Direct Research Journal of Chemistry and Material Science

Vol. 12(2), Pp. 27-, December 2024,

https://journals.directresearchpublisher.org/index.php/drjcm

Research Article
ISSN: 2354-4163

Determination of Heavy Metals from Laboratory Dusts in Science Village, Ignatius Ajuru University of Education, Port Harcourt, Rivers State, Nigeria

[1]Amesi, O. H. and [2]Edori, O. S.

1Department of Chemistry, Faculty of Science, Rivers State University, PMB 5080, Port Harcourt
[2]Department of Chemistry, Ignatius Ajuru University of Education Rumuolumeni, P.M.B. 5047, Port Harcourt, Rivers State, Nigeria. *
Corresponding Author: email: okobuezeh@gmail.com

ABSTRACT

Dust particles are of great importance and of public health concern in the laboratory environment since students spend a long time in the laboratory conducting experiments and research. The exposure of students to heavy metals in the laboratory could expose them to certain health risks associated with heavy metals. Therefore, this research was carried out to determine the concentrations of heavy metals from laboratory dusts in Science Village, Ignatius Ajuru University of Education, Port Harcourt, Rivers State, Nigeria. Dust samples were collected from three different laboratories (Integrated Science, Biology and Chemistry Laboratories) to ascertain the concentrations of some heavy metals. After due laboratory pretreatment methods, the heavy metals were analyzed using Atomic Absorption Spectrophotometer (Model SE-71906). The mean concentrations (mg/Kg) of the heavy metals studied were in the range Fe (1.1425±0.001-1.5403±0.024), Cu (0.4549±0.002-1.1906±0.018), Zn (0.2180±0.009-0.3582±0.009), Pb (0.1257±0.043-1.1057±0.029), Cd (0.0002±0.000-0.0086±0.000), Co (not detected-0.4933±0.009), Cr (0.6538±0.028-0.8813±0.053), Mn (not detected-0.4677±0.010) and Ni (0.0028±0.000-0.0845±0.000).The findings showed the order of occurrence of heavy metals in the laboratories were Integrated Science > Biology > Chemistry. The investigation also showed that all the heavy metal concentrations at various laboratories were lower than the background values given by DPR. Contamination factor analysis revealed that the heavy metals are at no risk or very low risk of occurrence. Appropriate measures should be put in place within the laboratory environment to keep the heavy metal concentrations low as in the case of this work in other to prevent any possible rise on the part of students or workers that make use of the laboratories.

Keywords *Contamination, contamination factor, dust, laboratories, heavy metals*

Article information
Received 17 November 2024;
Accepted 15 December 2024;
Published 19 December 2024
DOI:
https://doi.org/10.26765/DRJCMS345984223

Citation: [1]AMESI, O. H. and [2]EDORI, O. S. (2024). Determination of Heavy Metals from Laboratory Dusts in Science Village, Ignatius Ajuru University of Education, Port Harcourt, Rivers State, Nigeria.. *Direct Research Journal of Chemistry and Material Science*. Vol. 12(2), Pp. 15-19.

INTRODUCTION

The contamination and eventual pollution of the environment by heavy metals due to human activities is of utmost concern and calls for critical analysis as a result of possible adverse effects it causes to the environments, plants animals and humans that occupy the space. Heavy metals are widespread and are well known environmental contaminants due to their prevalent occurrence and persistent in the environmental setting results in both chronic and acute toxicity to living organisms and humans. Heavy metals are naturally present in the environments (air, soil and water) and have the ability to cause pollution on any given environment. Heavy metals have the propensity to accumulate in the cells and organs of living organisms and are carcinogenic and nature (Chopra et al., 2008).

Certain heavy metals like Ag, Hg, Cd, Pb, and Cr, even at very low concentrations are very poisonous (Opaluwa et al., 2012). As a result of the thermal stability of heavy metals, and accumulation possibilities, they pose serious health challenges which could result in damaging effects on animals and humans, for they are not readily removed from the body (Yusuf & Oluwole, 2009; Abdulhamid et al., 2015). Heavy metals like manganese can bring about health problems such as reproductive system abnormalities (Zhu et al., 1999), Parkinson-like symptom (Erikson & Aschner, 2003) and also could also affect the immune system (Li & Yang, 2008). The occurrence of heavy metals in any given environment can negatively affect water and food quality, growth of plants, animals and that of microorganisms (Antoaneta, 2010; Nwankwoala & Ememu, 2019).

Heavy metals (HMs) are more common in greater quantities in a variety of ecological settings due to their stability and lack of ability to degrade (Chen et al., 2014). Organic pollutants and dangerous heavy metals have been spread into the air, dust, soil, and water because of the fast process of urbanization and industrialization (Han et al., 2020; Yu et al., 2021). Dust is defined as a solid substance or particulate that settles as a fine powder (less than 100 mm) on the surface of an object or the ground (Adekola & Dosumu, 2001; Al-Rawi et al., 2024). Due to its components and properties, dust serves as a key connection in the air, soil, and water ecosystems and serves as a monitor of environmental quality (Yu et al., 2021; Pan et al., 2017). The dust pollution level of indoor environments (homes, buildings, classrooms, campuses, offices … etc.) is 2-5 times higher than in outdoor environments (USEPA, 2021). Over 90% of a person's lifetime is exposed to indoor dust and its pollutants (Tan et al., 2018). In educational institutions, investigations relating to heavy metal concentrations, pollution degree, source identification and origin has mostly engrossed on kindergartens and primary schools (Tan et al., 2018; Agarwal et al., 2019; Hashemi et al., 2020). There are very few studies on heavy metals pollution in universities campuses. Campus dust heavy metals pollution is a major issue, with possible effects on college students (Fan et al., 2020).

Air pollution is one of the environmental challenges or difficulties that most countries in the world are facing today. Over the past decade, economic growth in developing countries has been accompanied by deteriorating air pollution, and great heights of air pollution and increased menace of mortality (Huang et al., 2018). Dust is not only a significant connection between the atmosphere, water and soil, but also act as a carrier of heavy metals (Fan et al., 2021; Zhou et al., 2022). Heavy metals in dust are identified to be of particular interest since they are poisonous and non-degradable, and long-term contact or exposure might have hostile effects on human health. Heavy metals like lead, mercury, cadmium and arsenic account for 40% of the 10 major substances of public health worry, according to the World Health Organization reports (WHO). Men et al. (2020) revealed that two heavy metals, nickel and chromium, were categorized as Level-1 carcinogens. These heavy metals when present in dust could come in to the human body by means of direct inhalation, ingestion and dermal contact absorption Chen et al., 2014).

Humans are open to heavy metals through many paths since these metals are everywhere in the environment, and originate from both natural and anthropogenic activities (Wilson & Pyatt, 2007).

One of the imperative pathways of contact to metal for humans is through dust. Dust is a solid material composed of soil, anthropogenic metallic compositions and natural biogenic constituents (Ferreira-Baptista & De Miguel, 2005). Both indoor and outdoor dust contributes significant to heavy metal pollution in the environment. Lately, there is a collective unease about heavy metal contamination in indoor environment since most of the people spend as much as 80 to 90% of their time indoor (Klepeis et al., 2001; Sharpe, 2004). These percentages could be easily exceeded especially for children, infant and elderly.

Settled dust is existing in the indoor environment as a combination of particulate matter resulting from interior and exterior sources (Butte & Heinzow, 2002). Settled surface dust frequently functions as a reservoir of harmful particulate pollutants including trace metals.

The metals in the dust could be accumulated in human body through direct inhalation, ingestion and dermal contact absorption, and might pose potentially poisonous effects on the environment and human health.

Children specifically are at greater risk in comparison to adults, since they are more involve in greater hand to mouth activity, while their neurological system is still undergoing development and they having much higher absorption rate of heavy metal than adults (Wahab et al., 2012).

Tactlessly, these investigations in most cases ignore a distinctive functional area, which is, the university campus. It might be that the public generally believes that university students are already adults, but ignores the fact that their bodies are still growing up.

Additionally, physical and cultural actions further increase the hazard of contact to campus dust. Consequently, the degree of heavy metals in dust on university campus is a vital environmental concern or issue, and the potential damage it could be caused to university students ought to be taken seriously.

MATERIALS AND METHODS

Description of study area

The Ignatius Ajuru University of Education is situated in Rumuolumeni, Obio/Akpor Local Government Area, Port Harcourt, Rivers State, Nigeria. The university is close to a notable waterside or waterfront area known as Iwofe. The Science Village is at the rear side of the university close to the swamp which is an offshoot from the tidal waters of the New Calabar River. The Science village houses some buildings in which one of them which is at Geographical position (GPS) latitude N4°48'32.924" (4.809146) and longitude E6°55'47.893" houses the different laboratories used in the study.

Collection of dust samples for heavy metals

The dust collection approach was adapted the method of Zhong et al. (2014), Latif et al. (2014), and Sulaiman et al. (2017). Dust samples were collected from three laboratories, namely Integrated Science Laboratory, Biology Laboratory and Chemistry Laboratory within the same building in in Science Village in the Ignatius Ajuru University of Education, Port Harcourt with the aid of paintbrush and polyethylene container. Samples were collected twice a month for three months, between 9.00 A.M and 5.00 P.M during academic activities for all sampling locations. The dust samples were collected from windows, fans, fume hoods, laboratory bench air conditioners and even the laboratory floors. For each sampling point and sampling event, a new paintbrush and polyethylene container was used and labelled to avoid cross-contamination.

Preparation of dust samples for the determination of heavy metals

The collected dust samples were first air-dried to a constant weight and then transferred into an oven and dried at 105° C for about 24 hours. Then, 5 g of the fine portion of the dust was weighed into a ceramic crucible and then added 25 cm^3 of deionized water. The sample was digested using 10 cm^3 of three-concentrated acid mixture of HNO_3, HCl and H_2SO_4 in the ratio 5:3:2 (Benson et al., 2016) and then heated using a steam bath until a clear colour was obtained. The digested sample was then filtered into a previously cleaned 50 cm^3 plastic laboratory bottles and was again made up to the 25 cm^3 mark. The solution was filtered and the filtrate was then stored at a temperature of 4°C in the freezer, awaiting determination and analysis.

Heavy metal analysis

The heavy metal analysis was achieved for the filtered digest by the usage of a thermo Atomic Elemental Absorption Spectrophotometer (model SE-71906). Different wavelengths were used for the determination of different metals and dependent on the type of the hollow cathode lamp appropriate for that particle heavy metal to be examined. The digested samples were aspirated directly into an air–acetylene flame for each of the heavy metals to be determined**.** The instrument was calibrated by analyzing known concentration of heavy metals (Sehgal et al., 2012).

After the determination and analysis of every 10 samples, there was a re-run of blank sample so that errors could be reduced in the progression of analysis and determination. This technique checkmated the performance and efficiency. Each heavy metal was tested thrice for a given sample and the results were then shown as mean ± standard deviation (Sehgal et al., 2012).

Contamination factor

The contamination factor or index was estimated by using the mathematical formula of Lacatusu (2000). The mathematical formula for estimating contamination factor is given as:

$CF = Cn/Bn$,

Where, Cn = the concentration of the metal and Bn = background concentration of the metal taken from DPR (1991). Contamination index classification of contamination by heavy metal first used by Hakanson (1980) and also adopted by El-Sherbiny *et al*., (2019), are $CF < 1$ = low degree of contamination, $1 < CF < 3$ = moderate degree of contamination, $3 < CF < 6$ = considerable degree of contamination and $CF > 6$ = high degree of contamination.

RESULTS

Concentrations of heavy metals from laboratory dust samples in Science Village at Ignatius Ajuru University of Education

The results for the concentration of heavy metals in the dust samples in the studied laboratories in Science Village at Ignatius Ajuru University of Education in March shown in (Table 1) indicated that Fe ranged from 1.1422 to 1.5232 mg/Kg, Cu; 0.4527 to 1.2016 mg/Kg, Zn; 0.2073 to 0.3499 mg/Kg; Pb; 0.0926 to 1.0813 mg/Kg; Cd; 0.0002 to 0.0089 mg/Kg, Co; not detected to 0.4810 mg/Kg, Cr; 0.6311 to 0.8102, Mn; not detected to 0.4812 mg/Kg and Ni; 0.0027 to 0.0845 mg/Kg.

The results for the concentration of heavy metals in the dust samples in the studied laboratories in Science Village at Ignatius Ajuru University of Education in May shown in (Table 2) indicated that Fe ranged from 1.1421 to 1.5241 mg/Kg, Cu; 0.4537 to 1.1656 mg/Kg, Zn; 0.2171 to 0.3226

Table 1: Concentration of heavy metals (mg/Kg) from dust samples in the studied laboratories in Science Village at Ignatius Ajuru University of Education in March

Heavy Metals	Sample Location		
	Integrated Sc. Lab	Biology Lab.	Chemistry Lab.
Fe	1.5232	1.3625	1.1422
Cu	1.2016	0.8310	0.4527
Zn	0.3499	0.2661	0.2073
Pb	0.0926	1.0813	0.2195
Cd	0.0089	0.0036	0.0002
Co	ND	0.4810	ND
Cr	0.8102	0.6311	0.8102
Mn	ND	0.4467	0.4812
Ni	0.0845	0.0028	0.0027

Table 2: Concentration of heavy metals (mg/Kg) from dust samples in the studied laboratories in Science Village at Ignatius Ajuru University of Education in May.

Heavy Metals	Sample Location		
	Integrated Sc. Lab	Biology Lab.	Chemistry Lab
Fe	1.5241	1.5104	1.1421
Cu	1.1656	0.8364	0.4537
Zn	0.3526	0.2941	0.2171
Pb	0.0974	1.0894	0.2276
Cd	0.0084	0.0045	0.0002
Co	ND	0.5004	ND
Cr	0.8955	0.6610	0.8856
Mn	ND	0.4548	0.4614
Ni	0.0843	0.0028	0.0029

Table 3: Concentration of heavy metals (mg/Kg) from dust samples in the studied laboratories in Science Village at Ignatius Ajuru University of Education in July.

Heavy Metals	Sample Location		
	Integrated Sc. Lab	Biology Lab.	Chemistry Lab
Fe	1.5735	1.3625	1.1433
Cu	1.2046	0.8767	0.4584
Zn	0.3710	0.3081	0.2297
Pb	0.1870	1.1463	0.2520
Cd	0.0085	0.0038	0.0002
Co	ND	0.4984	ND
Cr	0.9382	0.6994	0.9328
Mn	ND	0.4471	0.4606
Ni	0.0848	0.0028	0.0028

Table 4: Mean concentration of heavy metals in (mg/Kg) from dust samples in the studied laboratories in Science Village at Ignatius Ajuru University of Education during the study period.

Heavy Metals	Sample Location			DPR Limit
	Integrated Sc. Lab	Biology Lab.	Chemistry Lab	
Fe	1.5403±0.024	1.4312±0.061	1.1425±0.001	38,000.00
Cu	1.1906±0.018	0.8480±0.020	0.4549±0.002	36.00
Zn	0.3582±0.009	0.2894±0.017	0.2180±0.009	140.00
Pb	0.1257±0.043	1.1057±0.029	0.2330±0.014	85.00
Cd	0.0086±0.000	0.0040±0.000	0.0002±0.000	0.8
Co	ND	0.4933±0.009	ND	20.00
Cr	0.8813±0.053	0.6538±0.028	0.8762±0.050	100.00
Mn	ND	0.4495±0.004	0.4677±0.010	850.00
Ni	0.0845±0.000	0.0028±0.000	0.0028±0.000	35.00

mg/Kg; Pb; 0.0974 to 1.0894 mg/Kg; Cd; 0.0002 to 0.0084 mg/Kg, Co; not detected to 0.5004 mg/Kg, Cr; 0.6610 to 0.8955, Mn; not detected to 0.4614 mg/Kg and Ni; 0.0028 to 0.0843 mg/Kg.

The results for the concentration of heavy metals in the dust samples in the studied laboratories in Science Village at Ignatius Ajuru University of Education in July shown in (Table 3) indicated that Fe ranged from 1.1433 to 1.5735 mg/Kg, Cu; 0.4584 to 1.2046 mg/Kg, Zn; 0.2297 to 0.3710 mg/Kg; Pb; 0.2297 to 1.1463 mg/Kg; Cd; 0.0002 to 0.0085 mg/Kg, Co; not detected to 0.4984 mg/Kg, Cr; 0.6994 to 0.9382, Mn; not detected to 0.4606 mg/Kg and Ni; 0.0028 to 0.0848 mg/Kg.

Mean concentrations of heavy metals from laboratory dust samples in Science Village at Ignatius Ajuru University of Education

Iron (Fe)

The mean concentrations of Fe recorded in the different laboratories located at Science Village of the Ignatius Ajuru University of Education varied from 1.1425±0.001 to 1.5403±0.024 mg/Kg. The lowest mean concentration was recorded in the Chemistry Laboratory while the highest mean concentration was recorded in Integrated Science Laboratory during the study period (Table 4).

Copper (Cu)

The mean concentrations of Cu recorded in the different laboratories located at Science Village of the Ignatius Ajuru University of Education varied from 0.4549±0.002 to 1.1906±0.018 mg/Kg. The lowest mean concentration was recorded in the Chemistry Laboratory while the highest mean concentration was recorded in Integrated Science Laboratory during the study period (Table 4).

Zinc (Zn)

The mean concentrations of Zn recorded in the different laboratories located at Science Village of the Ignatius Ajuru University of Education varied from 0.2180±0.009 to 0.3582±0.009 mg/Kg. The lowest mean concentration was recorded in the Chemistry Laboratory while the highest mean concentration was recorded in Integrated Science Laboratory during the study period (Table 4).

Lead (Pb)

The mean concentrations of Pb recorded in the different laboratories located at Science Village of the Ignatius Ajuru University of Education varied from 0.1257±0.043 to 1.1057±0.029 mg/Kg. The lowest mean concentration was recorded in the Integrated Science Laboratory while the highest mean concentration was recorded in Biology Laboratory during the study period (Table 4).

Cadmium (Cd)

The mean concentrations of Cd recorded in the different laboratories located at Science Village of the Ignatius Ajuru University of Education varied from 0.0002±0.000 to 0.0086±0.000 mg/Kg. The lowest mean concentration was recorded in the Chemistry Laboratory while the highest mean concentration was recorded in Integrated Science Laboratory during the study period (Table 4).

Cobalt (Co)

The mean concentrations of Co recorded in the different laboratories located at Science Village of the Ignatius Ajuru University of Education varied from not detected to 0.4933±0.009 mg/Kg. During the period of study Co was not detected in both Chemistry Laboratory and Integrated Science Laboratory but was only recorded in Biology Laboratory (Table 4).

Chromium (Cr)

The mean concentrations of Cr recorded in the different laboratories located at Science Village of the Ignatius Ajuru University of Education varied from 0.6538±0.028 to 0.8813±0.053 mg/Kg. The lowest mean concentration was recorded in the Biology Laboratory while the highest mean concentration was recorded in Integrated Science Laboratory during the study period (Table 4).

Manganese (Mn)

The mean concentrations of Mn recorded in the different laboratories located at Science Village of the Ignatius Ajuru University of Education varied from not detected to 0.4677±0.010 mg/Kg. During the period of study Mn was not detected in the Integrated Science Laboratory while the highest mean concentration was recorded in the Chemistry Laboratory (Table 4).

Nickel (Ni)

The mean concentrations of Ni recorded in the different laboratories located at Science Village of the Ignatius Ajuru University of Education varied from 0.0028±0.000 to 0.0845±0.000 mg/Kg. Biology Laboratory and Chemistry Laboratory recorded the same mean concentration while the highest mean concentration was recorded in Integrated Science Laboratory during the study period (Table 4).

Contamination factor analysis of heavy of heavy metals from laboratory dust samples in Science Village at Ignatius Ajuru University of Education

The contamination or accumulation factors of the studied heavy metals from the different laboratory dust samples in in Science Village at Ignatius Ajuru University of Education for Fe ranged from 3.0066×10^{-5} to 4.0534×10^{-5}, Cu; 1.1971×10^{-5} to 0.0331, Zn; 0.0016 to 0.0026, Pb; 0.0015 to 0.0130, Cd; 0.0003 to 0.0108, Co; not recorded to 0.0247, Cr; 0.0065 to 0.0088, Mn; not recorded to 0.0006 and Ni; 0.0001 to 0.0024 within the different laboratories used in the study (Table 5). Using the interval of classification initiated by Hakanson (1980), indicated that the dusts from the different laboratories used in the study within Science Village of Ignatius Ajuru University of Education showed that all fell within the category <0.1 which is for very slight contamination.

Table 5: Contamination factor (C_F) analysis of heavy metals from the different laboratory dust samples.

Heavy Metals	Sample Locations		
	Integrated Sc. Lab	Biology Lab.	Chemistry Lab
Fe	4.0534×10^{-5}	3.7663×10^{-5}	3.0066×10^{-5}
Cu	0.0331	0.0236	1.1971×10^{-5}
Zn	0.0026	0.0021	0.0016
Pb	0.0015	0.0130	0.0027
Cd	0.0108	0.0050	0.0003
Co	-	0.0247	-
Cr	0.0088	0.0065	0.0088
Mn	-	0.0005	0.0006
Ni	0.0024	0.0001	0.0001

DISCUSSION

Concentrations of heavy metals in dusts of the studied laboratories

The concentrations of the different heavy metals in dusts studied from the three laboratories in Science Village of the Ignatius Ajuru University of Education are discussed below. Due to the absence of guidelines for the amounts of heavy metals in the dust, the mean levels of the heavy metals in the indoor dust of the laboratories were compared with their guidelines in the soil given by Directorate of Petroleum Resources (DPR) 1991.

Iron (Fe)

The mean variations in the concentrations of iron (Fe) in the three different laboratories in Science Village from Ignatius Ajuru University of Education fall between the ranges of 1.1425±0.001 to 1.5403±0.024 mg/Kg within the months under investigation. The order of occurrence in the different laboratories were Integrated Science Laboratory > Biology Laboratory > Chemistry Laboratory. The concentration values obtained from the different laboratories were far lower than the value recommended by DPR (1991) for Fe in the soil which is 38,000.00 mg/Kg. The mean concentrations of Fe obtained in this work for the different laboratories were far lower than that which was obtained in the work of Sulaiman et al. (2017) which was recorded in UITM, Malaysia which was 37591.67

mg/Kg and also that which was recorded in the work of Al-Rawi et al. (2023) which had a mean concentration of 13622.41 mg/Kg which was obtained from indoor dust from College of Science, University of Anbar Campus, Iraq.

Copper (Cu)

The mean variations in the concentrations of copper (Cu) in the three different laboratories in Science Village from Ignatius Ajuru University of Education fall between the ranges of 0.4549±0.002 to 1.1906±0.018 mg/Kg within the months under investigation. The order of occurrence in the different laboratories were Integrated Science Laboratory > Biology Laboratory > Chemistry Laboratory. The concentration values obtained from the different laboratories were far lower than the value recommended by DPR (1991) for Cu in the soil which is 36.00 mg/Kg. The mean concentrations of Cu obtained in this work for the different laboratories were far lower than that which was obtained in the work of Kun et al. (2023) which had a mean value of Cu (129.2 mg/Kg) from road dust from University Campus of Xicheng, Southwest China and that obtained from campus dust samples in Wuhan city (Liu et al., 2022) which was 70.20 mg/Kg but were higher than that which was recorded by Sulaiman et al. (2016) which was not detected in roofing tiles in Tezpur, India.

Zinc (Zn)

The mean variations in the concentrations of zinc (Zn) in the three different laboratories in Science Village from Ignatius Ajuru University of Education fall between the ranges of 0.2180±0.009 to 0.3582±0.009 mg/Kg within the months under investigation. The order of occurrence in the different laboratories were Integrated Science Laboratory > Biology Laboratory > Chemistry Laboratory. The concentration values obtained from the different laboratories were far lower than the value recommended by DPR (1991) for Zn in the soil which is 140.00 mg/Kg. The mean concentrations of Zn obtained in this work for the different laboratories were far lower than that which was obtained in the work of Kun et al. (2023) which had a mean value of Zn (831.8 mg/Kg) from road dust from University Campus of Xicheng, Southwest China and that which was recorded in UITM, Malaysia which was 1253.33 mg/Kg (Sulaiman et al., 2017) but was higher than the value reported in Makurdi, Nigeria which was not detected (Kadili et al., 2017).

Lead (Pb)

The mean variations in the concentrations of lead (Pb) in the three different laboratories in Science Village from Ignatius Ajuru University of Education fall between the ranges of 0.1257±0.043 to 1.1057±0.029 mg/Kg within the months under investigation. The order of occurrence in the different laboratories were Biology Laboratory > Laboratory Chemistry > Integrated Science Laboratory. The concentration values obtained from the different laboratories were far lower than the value recommended by DPR (1991) for Pb in the soil which is 85.00 mg/Kg. The mean concentrations of Pb obtained in this work for the different laboratories were far lower than that which was obtained in the work of Al-Rawi et al. (2023) which had a mean concentration of 147.42 mg/Kg which was obtained from indoor dust from College of Science, University of Anbar Campus, Iraq and also that which was reported in a study undertaken by Kadili et al. (2017) in Makurdi Nigeria that had concentration of 225.50 mg/Kg.

Cadmium (Cd)

The mean variations in the concentrations of cadmium (Cd) in the three different laboratories in Science Village from Ignatius Ajuru University of Education fall between the ranges of 0.0002±0.000 to 0.0086±0.000 mg/Kg within the months under investigation. The order of occurrence in the different laboratories were Integrated Science Laboratory > Biology Laboratory > Chemistry Laboratory. The mean concentration values obtained from the different laboratories were far lower than the value recommended by DPR (1991) for Cd in the soil which is 140.00 mg/Kg. The mean concentrations of Cd obtained in this work for the different laboratories were lower than that which was obtained in the work of Javid et al. (2021) for Cd which ranged from 0.001 to 0.007 mg/Kg with a mean value of 0.003 mg/Kg and also that which was recorded in the work of Han et al. (2017) which ranged from 0.10 to 0.60 mg/Kg with a mean concentration of 0.30 mg/Kg.

Cobalt (Co)

The mean variations in the concentrations of cobalt (Co) in the three different laboratories in Science Village from Ignatius Ajuru University of Education fall between the ranges of not detected to 0.4933±0.009 mg/Kg within the months under investigation. The concentrations of Co was only detected in the Biology Laboratory. The concentration values obtained from the different laboratories were far lower than the value recommended by DPR (1991) for Co in the soil which is 20.00 mg/Kg. The mean concentrations of Co obtained in this work for the different laboratories were lower than that which was obtained in the work of Han et al. (2017) which ranged from 25.10 to 112.4 mg/Kg with a mean concentration of 52.9 mg/Kg and also lower than the value obtained by Al-Rawi et al. (2023) with mean concentration of 44.74 mg/Kg but was within the same range with that which was obtained in the work of 0.011 to 0.464 mg/Kg with a mean concentration of 0.145 mg/Kg but was higher than that which was reported in the work of Sulaiman et al. (2016) which was not detected in Tezpur, India.

Chromium (Cr)

The mean variations in the concentrations of chromium (Cr) in the three different laboratories in Science Village from Ignatius Ajuru University of Education fall between the ranges of 0.6538±0.028 to 0.8813±0.053 mg/Kg within the months under investigation. The order of occurrence in the different laboratories were Integrated Science Laboratory > Chemistry Laboratory > Biology Laboratory. The concentration values obtained from the different laboratories were far lower than the value recommended by DPR (1991) for Cr in the soil which is 100.00 mg/Kg. The mean concentrations of Cr obtained in this work for the different laboratories were lower than that which was obtained in the work of Al-Rawi et al. (2023) which varied from 73.65 to 239.64 mg/Kg with a mean concentration of 141.37 mg/Kg in indoor dust from College of Science, University of Anbar Campus, Iraq and also that which was recorded in the work carried out by Han et al (2017) which varied from 103.90 to 379.80 mg/Kg with a mean concentration of 154.10 mg/Kg in dusts from parks and squares of an industrial city in semi-arid area of China but were higher than that which was obtained in an investigation carried out by Javid et al. (2021) which varied from 0.129 to 0.485 mg/Kg with a mean value of 0.286 mg/Kg.

Manganese (Mn)

The mean variations in the concentrations of manganese (Mn) in the three different laboratories in Science Village from Ignatius Ajuru University of Education fall between the ranges of not detected to 0.4677±0.010 mg/Kg within the months under investigation. The order of occurrence in the different laboratories were Chemistry Laboratory > Biology Laboratory > Integrated Science Laboratory. The concentration values obtained from the different laboratories were far lower than the value recommended by DPR (1991) for Mn in the soil which is 850.00 mg/Kg. The mean concentrations of Mn obtained in this work for the different laboratories were far lower than that which was obtained in the work of Han et al. (2017) which varied from 336.90 to 1148.40 mg/Kg with a mean concentration value of 504.40 mg/Kg in dusts from parks and squares of an industrial city in semi-arid area of China.

Nickel (Ni)

The mean variations in the concentrations of nickel (Ni) in the three different laboratories in Science Village from Ignatius Ajuru University of Education fall between the ranges of 0.0028±0.000 to 0.0845±0.000 mg/Kg within the months under investigation. The order of occurrence in the different laboratories were Integrated Science Laboratory > Biology Laboratory = Chemistry Laboratory. The concentration values obtained from the different laboratories were far lower than the value recommended by DPR (1991) for Ni in the soil which is 35.00 mg/Kg. The mean concentrations of Ni obtained in this work for the different laboratories were far lower than that which was obtained in the work of Han et al. (2017) which varied from 17.60 to 32.4 mg/Kg with a mean concentration value of 25.1 mg/Kg in dusts from parks and squares of an industrial city in semi-arid area of China.

Contamination factors of heavy metals from the different laboratories

The contamination factors for heavy metals recorded in this work indicated that the dusts from the different laboratories used in the study within Science Village of Ignatius Ajuru University of Education showed that all fell within the category <0.1 which is for very slight contamination or no contamination. The contamination factors obtained for the different heavy metals in this study were far lower than that which was reported in the work of Al-Rawi et al. (2023) where contamination factor values of heavy metals in indoor dusts were up to a factor of 7.50 and 7.37, respectively. According to Hakanson (1980), the classification of the indoor dust had a very high pollution with Cd and Pb and moderate contamination with Co, Cr, Cu and Zn. The high level of pollution in the indoor dust of the research area studied by Al-Rawi et al. (2023) could be linked to the traffic emissions due to the proximity of the College of Science to the entrance of University of Anbar and the parking lot. This observation disagreed with this work in which the studied laboratories are far away from traffic congestion and the regular cleaning of the different laboratories must also have contributed to the low contamination of the laboratories. The values recorded in this work were also lower than the mean values recorded by Nwankwoala and Ememu (2018) in a research conducted at Okpoko and environs and also that recorded by Ojo et al (2012).

Conclusion

This research work investigated the concentrations of heavy metals from laboratory dusts in Science Village, Ignatius Ajuru University of Education, Port Harcourt, Rivers State, Nigeria. Dust samples were collected and analyzed using appropriate laboratory methods to ascertain the concentrations of different heavy metals in dust samples from three laboratories in Science Village of Ignatius Ajuru University of Education Port Harcourt. The study showed that the studied heavy metals were present in the dusts of the different laboratories in different degrees, varying from Laboratory to laboratory. The study indicated that heavy metal concentrations were generally in the order Integrated Science Laboratory > Biology Laboratory > Chemistry Laboratory.

Overall, the metal concentrations in indoor laboratories' dust were lower compared to the values given by Directorate of Petroleum Resources (DPR) for surface soils. Perhaps the metal concentrations in indoor dusts of the laboratories were far lower due to the regular sweeping, mopping and washing of the laboratories. The presence of the studied heavy metals in the different laboratories even though very low might pose health challenges on the users of the laboratories since they are always in regular contact with the dusts as it is a place used regularly for experiments and researches. All laboratories have different nature of chemical usage, where Biology and Chemistry Laboratories use more chemicals than the Integrated Science Laboratory. It is expected the metal concentrations in indoor dust from both laboratories would be higher than the Integrated Science Laboratory. Surprisingly, that is not true as seen due to the fact that the Chemistry Laboratory is cleaned more often followed by Biology Laboratory and then lastly by Integrated Science Laboratory. The contamination factor index revealed that the degree of contamination of the studied heavy metals as at the time of study is low and therefore the users of the different laboratories are at the level of no risk or low risk of heavy metals' contamination.

REFERENCES

Abdulhamid, Z., Agbaji, E. B., Gimba, C. E., & Agbaji, A. S. (2015). Physicochemical parameters and heavy metals content of soil samples from farms in Minna. *International Letters of Chemistry, Physics and Astronomy*, *58*, 154-163.

Adekola, F., & Dosumu, O. (2001). Heavy metal determination in household dust from Ilorin City, Nigeria. *Journal of Nigeria Society for Experimental Biology, 3*, 217 – 221.

Agarwal, N., Nagendra, S., Peter, A., & Yarpala, D. (2019. Microanalysis of the floor dust particles in the classrooms of tropical urban environment. *Journal of Instrumentation and Engineering, India Series A, 100*, 447-458.

Al-Rawi, A. S., Aljumialy, A. M., Saod, W. M., & Al-Heety, E. A. (2023). Pollution level and sources of heavy metals in indoor dust from College of Science, University of Anbar Campus, Iraq. 3rd Scientific Conference of Iraqi Desert Geology (IDGC 2023) IOP Conference Series: Earth and Environmental Science 1300 (2024) doi:10.1088/1755-1315/1300/1/012019.

Antoaneta, E. (2010). Determination of heavy metals in soil using XRF technique. *Roman Journal of Physics*, *55*(2010), 815-820.

Benson, N. U., Asuquo, F. E., Williams, A. B., Essien, J. P., Ekong, C. I., Akpabio, O., & Olajire, A. A. (2016). Source evaluation and trace metal contamination in benthic sediments from equatorial ecosystems using multivariate statistical techniques. *PLUS ONE, 11*(6), 1–19.

Butte, W., & Heinzow, B. (2002). Pollutants in house dust as indicators of indoor contamination. *Reviews of Environmental Contamination and Toxicology, 175*, 1–46.

Chen, H., Lu, X. W., Chang, Y. Y., & Xue, W. Z. (2014). Heavy metal contamination in dust from kindergartens and elementary schools in Xi'an, China. *Environmental Earth Sciences, 71*(6), 2701-2709.

Chopra, A. K., Pathak, C., & Prasad, G. (2009). Scenerio of heavy metal contamination in agricultural soil and its management. *Journal of Applied and Natural Science*, *1*(1), 99-108.

Directorate of Petroleum Resources (DPR) (1991). Environmental guidelines and standards for petroleum industry in Nigeria.

Eneji, I. S., Adams, I. U., & Julius, K. A. (2015) Assessment of heavy metals in indoor settled harmattan dust from the University of Agriculture Makurdi, Nigeria. *Open Journal of Air Pollution, 4*, 198-207

Erikson, K. M., & Aschner, M. (2003). Manganese neurotoxicity and glutamate-_GABA interaction. *Neurochemical International*, *43*, 475-480.

Fan, X. Y., Lu, X. W., Yu, B., Zuo, L., Fan, P., Yang, Y. F., Zhuang, S. K., Liu, H. M., & Qin, Q. (2021). Risk and sources of heavy metals and metalloids in dust from university campuses: A case study of Xi'an, *China. Environment Research*, *202*, 111703, 2021.

Ferreira-Baptista, L., & De Miguel, E. (2005). Geochemistry and risk assessment of street dust in Luanda, Angola: A tropical urban environment. *Atmospheric Environment, 39*, 4501-4512.

Han, Q., Wang, M., Cao, J., Gui, C., Liu, Y., He, X., He, Y., & Liu, Y. (2020). Health risk assessment and bio accessibilities of heavy metals for children in soil and dust from urban parks and schools of Jiaozuo, China. *Ecotoxicology and Environmental Safety,* 191, 110157. https://doi.org/10.1016/j.ecoenv.2019.110157.

Han, X., Lu, X., Qinggeletu, & Wu, Y. (2017). Health Risks and Contamination Levels of Heavy Metals in Dusts from Parks and Squares of an Industrial City in Semi-Arid Area of China. *International Journal of Environmental Research and Public Health*, 14, 1-12.

Hashemi, S., Fazlzadeh, M., Ahmadi, E., Parand, M., Ramavandi, B., Taghizadeh, F., & Arfaeinia, H. (2020). Occurrence, potential sources, in vitro bio accessibility and health risk assessment of heavy metal in indoor dust from different microenvironment of Bushehr, Iran. *Environmental Geochemistry and Health*, https://doi.org/10.1007/s10653-020-00598-z.

Huang, J., Pan, X. C., Guo, X. B., & Li, G. X. (2018). Impacts of air pollution wave on years of life lost: A crucial way to communicate the health risks of air pollution to the public. *Environment International, 113*, 42-53.

Javid, A., Nasiri, A., Mahdizadeh, H., Momtaz, S. M., Azizian, M., & Javid, N. (2021). Determination and risk assessment of heavy metals in air dust fall particles. *Environmental Health Engineering and Management Journal, 8*(4), 319-327. doi: 10.34172/EHEM.2021.36.

Kadili, J. A., Itodo, A. U., & Eneji, I. S. (2017). Toxic metals in office dust as geochemical indicators of indoor contamination. *FUW Trends in Science & Technology Journal, 2*,101– 105.

Klepeis, N. E., Nelson, W. C., Ott, W. R., Robinson, J. P., Tsang, A. M., Switzer, P., Behar, J. V., Hern, S. C., & Engelmann, W. H. (2001). The National Human Activity Pattern Survey (NHAPS): a resource for assessing exposure to environmental pollutants. *Journal of Exposure Analysis and Environmental Epidemiology, 11*, 231- 252.

Kun, Y., Chen, L., Xian, Y., Zhang, W., Wang, X., & Wang, J. (2023). Levels, risk and sources of heavy metals in road dust from university campus - A case study of Xicheng, Southwest China. *Pollution Journal Environmental Studies, 32*(3), 2171-2180

Lacatusu, R. (2000). Appraising levels of soil contamination and pollution with heavy metals. *European Soil Bureau Research Report*, 4, 393-402.

Latif, M. T., Yong, S. M., Saad, A., Mohamad, N., Baharudin, N. H., & Mokhtar, M. B. (2014). Composition of heavy metals in indoor dust and their possible exposure: a case study of preschool children in Malaysia. Air Quality and Atmospheric Health, 7(2), 181–193.

Li, M. S., & Yang, X. S. (2008). Heavy metal contamination in soil and phytoaccumulation in a manganese mine wasteland, South China. *Air, Soil and Water Research, 1*, 31-41.

Liu. S., Zhang, X. H., Zhan, C. L., Zhang, J. Q., Xu, J., Wang, A. L., Zhang, H. D., Xu, J. Y., Guo, J. L., Liu, X. L., Xing, X. L., Cao, J. J., Xiao, Y. L. (2022). Evaluating heavy metals contamination in campus dust in Wuhan, the university cluster in Central China: distribution and potential human health risk analysis. *Environmental Earth Sciences. 81*, 210-223.

Men, C., Liu, R. M., Xu, L. B., Wang, Q. R., Guo, L. J., Miao, Y. X., & Shen, Z. Y. (2020). Source-specific ecological risk analysis and critical source identification of heavy metals in road dust in Beijing, China. *Journal of Hazardous Materials. 388*, 121763, 2020.

Nwakwoala, H. O., & Ememu, A. J. (2018). Contamination indices and heavy metal concentration in soils in Okpoko and environs, Southeastern Nigeria. Journal of Environmental Science and Public Health, 2(2), 77-

95.
Ojo, O., Jegede, R. O., Ajayi, M. C., & Osibanjo, O. (2012). Heavy metals and some physicochemical parameters in soil of major domestic dumpsites in Akure Township, Ondo State, South-Western Nigeria. *International Journal of Engineering Technologies and Management Research, 4*(10), 26-30.
Opaluwa, O. D., Aremu, M. O., Ogbo, L.O., Abiola, K. A., Odiba, I. E., Abubakar, M. M., & Nweze, N. O. (2012). Heavy metal concentrations in soils, plant leaves and crops grown around dump sites in Lafia Metropolis, Nasarawa State, Nigeria. *Advances in Applied Science Research*, *3*(2), 780-784.
Pan, H., Lu, X., & Lei, K. (2017). A comprehensive analysis of heavy metals in urban road dust of Xi'an, China: contamination, source apportionment and spatial distribution. Science of Total Environment, 609, 1361–1369.
Sehgal, M., Garg, A., Suresh, R., & Dagar, P. (2012). Heavy metal contamination in the Delhi Segment of Yamuna basin. *Environmental Monitoring and Assessment*, *184*, 1181–1196.
Sharpe, M. (2004). Safe as houses? Indoor air pollution and health. *Journal of Environmental Monitoring, 6,* 46 – 49.
Sulaiman, F., Brimblecombe, P., & Grossi, C. (2016). Mobilisation of trace elements on roofing tiles. *Indoor Built Environment, 25*, 329-339.
Sulaiman, F. R., Bakri, N. I. F., Nazmi, N., & Latif, M. T. (2017). Assessment of heavy metal in indoor dust of a university in tropical environment. *Environmental Forensics, 18*(1), 74-82
Sulaiman, F. R., & Suratmin, M. A. (2020). Composition of metal in indoor dust from university laboratories. *Malaysian Journal of Medicine and Health Sciences, 16*(SUPP11), 28-32.
Tan, S., Praveena, S., Abidin, E., & Cheema, M. (2018). Heavy metal quantification of classroom dust in school environment and its impacts on children health from Rawang (Malaysia). *Environmental Science and Pollution Research, 25*, 34623–34635.
United States of Environmental Protection Agency (USEPA) (2021). Why indoor air quality is important to schools. Resource document. https://www.epa.gov/iaq-schools/why-indoor-air- quality-important schools.
Wahab, N. A. A., Darus, F. M., Isa, N., Sumari, S. M., Hanafi, N. F. M. (2012). Heavy metal concentration of settled surface dust in residential building. The Malaysian *Journal of Analytical Sciences, 16*(1), 18 – 23.
Wilson, B., & Pyatt, F. B. (2007). Heavy metal dispersion, persistence and bioaccumulation around an ancient copper mine situated in Anglesey, UK. *Ecotoxicology and Environmental Safety, 66*, 224-231.
Yu, B., Lu, X., Fan, X., Fan, P., Zuo, L., Yang, Y., Wang, L. (2021). Analyzing environmental risk, source and spatial distribution of potentially toxic elements in dust of residential area in Xi'an urban area, China. *Ecotoxicology and Environmental Safety, 208*, 111679. https://doi.org/10.1016/j.ecoenv.2020.111679.
Yusuf, K. A & Oluwole, S. O. (2009). Heavy metal (Cu, Zn, Pb) contamination of vegetable in urban city: A case study in Lagos. *Research Journal of Environmental Science*, *30*, 292-298.
Zhong, J. N. M., Latif, M. T., Mohamad, N., Abd-Wahid, N. B., Dominick, D., & Juahir, H. (2014). Source apportionment of particulate matter (PM10) and indoor dust in a university building. *Environ Forensics, 15*(1), 8–16.
Zhou, L., Liu, G. J., Shen, M. C., & Liu, Y. (2022). Potential ecological and health risks of heavy metals for indoor and corresponding outdoor dust in Hefei, Central China. *Chemosphere. 302*, 134864, 2022.
Zhu, C. C., Zhang, B. Y., Ye, F. L., Zhu, G. X., & Yang, J. Q. (1999). Effects of manganese exposure on male sexual hormone. *Chinese Public Health*, *15*, 63-64.