*Sahel Journal of Life Sciences FUDMA (SAJOLS)*
**September 2025 Vol. 3(3): 251-260**
**ISSN: 3027-0456 (Print)**
**ISSN: 1595-5915 (Online)**
**DOI: https://doi.org/10.33003/sajols-2025-0303-31**

*Research Article*

# Assessment of Heavy Metal Concentrations and the Pollution Level in Dust Samples around the Vicinity of Motor Parks in the Kaduna Metropolis, Northwestern Nigeria

***Muktar Babagana[1], Fatima Abubakar[1], Ali Bakari[2], and Auwal Ibrahim[1]**

**[1]Department of Applied Chemistry, College of Science and Technology, Kaduna Polytechnic, Kaduna State, Nigeria**
**[2]Faculty of Earth and Environmental Sciences, Bayero University, Kano State, Nigeria**
***Corresponding Author's email*: bgmuktar77@gmail.com; Phone: +23408034281195**

## ABSTRACT

This study assessed the pollution status of environmentally relevant heavy metals cadmium (Cd), nickel (Ni), lead (Pb), and chromium (Cr), in surface dust collected from four major motor parks in Kaduna, Nigeria: Kawo, Mando, Sabon Tasha, and Command Junction motor parks. Composite dust samples were randomly collected from three points, spaced 10 meters apart within each motor park, as well as from a control site, on a weekly basis over an eight-week period. The concentrations of Cd, Ni, Pb, and Cr were analyzed using Atomic Absorption Spectroscopy (AAS). The average concentrations (mg/kg) of Cd, Ni, Pb, and Cr in the motor park dust samples were 0.05 ± 0.001, 0.63 ± 0.31, 3.13 ± 0.02, and 4.17 ± 1.17, respectively, compared to control site values of 0.12 ± 0.01, 0.63 ± 0.30, 1.13 ± 0.02, and 1.80 ± 0.79. When compared with the maximum permissible concentrations (MPC) set by the World Health Organization (WHO) and the National Environmental Standards and Regulations Enforcement Agency (NESREA), all measured levels were within acceptable limits. Pollution indices, including the enrichment factor (EF), contamination factor (CF), and geo-accumulation index (Igeo), were used to evaluate the extent of contamination. The results indicated varying degrees of contamination, with some metals showing signs of moderate pollution, likely attributable to both anthropogenic activities and natural weathering processes. Overall, while heavy metal levels remain below regulatory thresholds, the study underscores the need for continuous environmental monitoring and enhanced pollution control strategies in and around Kaduna motor parks.

**Keywords:** Enrichment factor; Geo-accumulation Index; Kawo; Mando; Pollution index; Sabon Tasha

**Citation**: Babagana, M., Abubakar, F., Bakari, A., & Ibrahim, A. (2025). Assessment of Heavy Metal Concentrations and the Pollution Level in Dust Samples around the Vicinity of Motor Parks in the Kaduna Metropolis, Northwestern Nigeria. *Sahel Journal of Life Sciences FUDMA*, 3(3): 251-260. DOI: https://doi.org/10.33003/sajols-2025-0303-31

## INTRODUCTION

Motor parks in urban centers like Kaduna Metropolis serve as hubs for transportation and commerce. However, these areas are often characterized by high vehicular traffic, mechanical activities, and inadequate waste management practices, leading to significant environmental pollution. Dust generated in such environments can accumulate heavy metals, which are toxic and pose serious health risks to humans and the ecosystem. Dust, which is made up of tiny solid particles, has the ability to absorb heavy metals and other contaminants from both natural and artificial sources (Žibret *et al*., 2013; Moreno *et al*., 2013). The primary source of human exposure to heavy metals is through surface dust, which is found both indoors and outdoors (Sahakyan *et al*., 2016). The three main ways that people can be exposed to heavy metal-contaminated surface dust are by ingestion, inhalation, and skin contact (Mohmand *et al*., 2015). Surface dust pollution in motor parks is a serious threat to both the environment and human health worldwide, especially in urban areas such as Kaduna metropolis. Human activities have a significant impact on densely populated cities due to industrial pollution, transportation, waste generation, and urban development. These urban environmental issues get worse every day (Shah *et al*., 2020). Heavy metals like lead (Pb), copper (Cu), cadmium (Cd), and chromium (Cr) are frequently contained in vehicle emissions in parking lots. These metals are often emitted by the vehicle's exhaust, brake dust, tire wear, and other components. The emissions, like those from chimneys, do not diffuse well since they are emitted close to the ground level and hence readily settle on dust (Obanijesu and Olajide, 2007). Dust produced during the operation of vehicles is derived from a lot of sources, such as wearing of braking systems, tires, and clutch plates; degradation of the catalytic converter's active layer; or resuspension of road dust (Adamiec *et al*., 2016). It has also been demonstrated that heavy metal contributed pollutants in road dust are much increased in cities with high braking activity due to lead wear on brake pads (Adamiec *et al*., 2016).

Due to their persistent nature, non-biodegradability, high toxicity, and detrimental effects on human health, heavy metals in dust have gained attention from all over the world (Nag and Cummins, 2022; Zhao *et al*., 2019; Zhou *et al*., 2021). Owing to their persistent and hazardous characteristics, the American Environmental Protection Agency (US EPA) has identified seven heavy metals as priority control pollutants: As, Cr, Cu, Ni, Pb, Zn, and Cd (Luo *et al*. 2015; Huang *et al*. 2016; Jin *et al*. 2019; Khanoranga, 2019). With a high specific density (>5 g/cm$^3$), these metals often referred to as heavy metals, can enter the body through ingestion, inhalation and skin contact (Lian *et al*. 2019; Sahu and Gurjar 2021). According to studies, long-term exposure to heavy metals through dust can cause cancer, kidney damage, respiratory problems, and neurological diseases (Ihedioha *et al*., 2017). The United States Environmental Protection Agency (USEPA) and the World Health Organization (WHO) have set permissible limits for these metals, yet many environments—particularly in developing countries—lack routine monitoring and enforcement of these standards (WHO, 2021).

In Nigerian and other cities, studies have highlighted the presence of elevated levels of heavy metals in dust samples from motor parks (Henry *et al*., 2023; Okunola *et al*., 2015). Similarly, a study conducted by Magaji *et al*. (2020) evaluated heavy metal concentrations in soils around major parks in Gombe Town, Nigeria. The study found varying levels of metals such as (Mn, Ni, Pb, Cr, Zn, Fe) in soils around two main motor parks (Gombe Terminus and Tashan Dukku) and found elevated concentrations near the motor parks, decreasing with distance. Another study by Imam *et al.* (2021) assessed the levels of heavy metals in groundwater samples from selected motor parks in Kaduna. The study found that lead and cadmium concentrations exceeded the World Health Organization's recommended limits, suggesting potential contamination of water sources due to activities in the motor parks. These findings underscore the need for comprehensive studies focusing on dust samples from motor parks to assess the extent of heavy metal contamination and associated health risks.

## MATERIALS AND METHODS

### Description of the Study Areas

Four (4) notable motor parks in Kaduna State (Kawo, Mando, Sabon Tasha, and Command junction motor parks) were considered and selected for this study. Both Kawo and Mando Motor Parks are located in Kaduna North, while Sabon Tasha and Command junction motor parks were located in Kaduna South local government areas. Figure 1 shows the map of Kaduna State showing where these samples were collected and their coordinates. These motor parks serve as transportation hubs, serving as major entry and departure points for people and goods traveling to various destinations across northern and southern parts of Nigeria. These parks operate daily from 6:00 am to 6:00 am, facilitating both intra-city and interstate travel.

**Kawo Motor Park** (7.44826°E, 10.5855°N) also known as Alhaji Dr. Ahmad Muhammad Makarfi Central Motor Park, is a prominent public transportation hub located in Kawo, Kaduna North, Kaduna State, Nigeria. It serves as a major terminal for buses traveling to various destinations across northern Nigeria.

**Mando Motor Park** (6.57637°E, 10.65192°N) is a prominent transportation hub in Kaduna, Nigeria, serving as a key terminal for intercity travel. It is strategically located near the Nigerian Air Force Base, facilitating easy access for travelers.

**Sabon Tasha Motor Park** (7.465183°E, 10.436754°N) is a prominent transportation hub located in the Sabon Tasha area of Kaduna, Nigeria. It serves as a key terminal for intercity travel, connecting passengers to various destinations across the region.

**Command Junction Motor Park (**7.4387°E, 10.4442°N) also known as Abuja Motor Park, is a prominent transportation terminal located in the Command Junction area of Kaduna South, Nigeria. It serves as a major hub for travelers heading to various destinations, particularly Abuja.

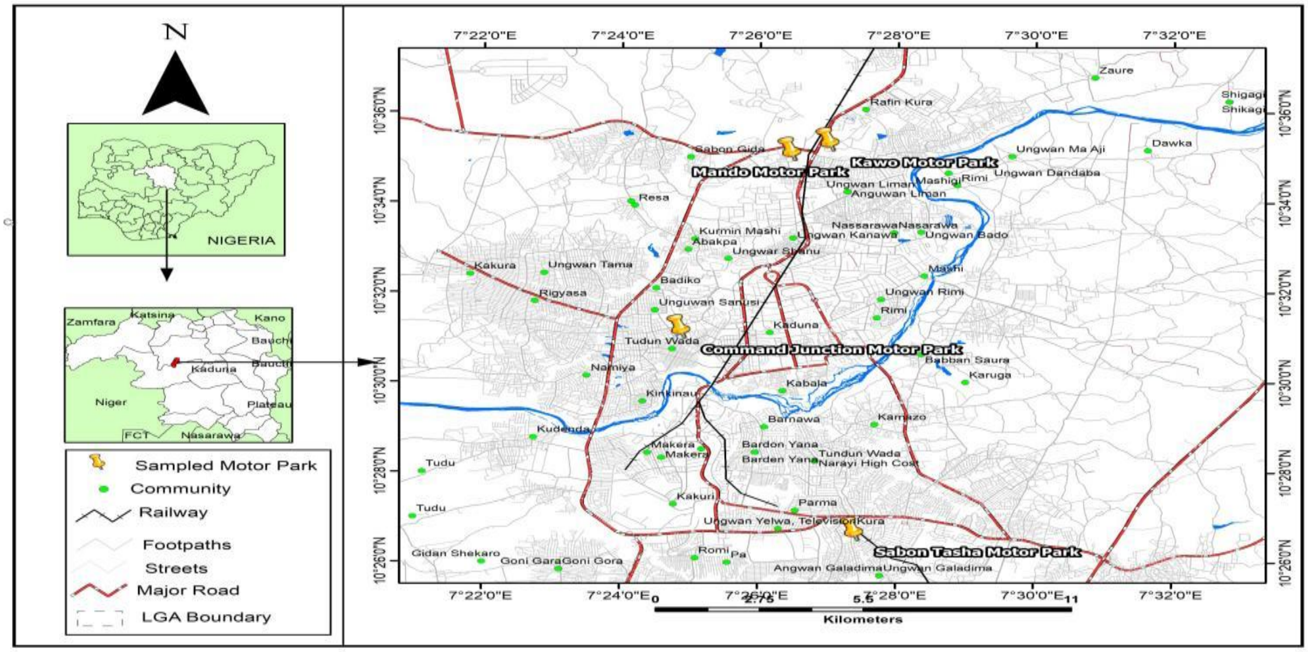


**Figure 1. Map of Kaduna State showing the sampling sites**

**Dust Sample Collection**

Composite surface dust samples were randomly collected from three points 10 m apart within the motor parks and control sites on a weekly basis over 8 weeks from notable motor park locations (Kawo, Mando, Sabon Tasha, and Command Junction motor parks) within the Kaduna metropolis, Northwestern Nigeria. Dust samples were collected within each park using a clean broom and a plastic packer (Taiwo et al., 2017). The samples were collected in a new paper envelope and properly labeled for later identification. During the sampling collection exercise, hand gloves and nose masks were worn for personal protection. Control dust samples were collected from the sites far away from the motor parks where there are fewer commercial activities (Taiwo et al., 2017). These samples were collected during the March 2025 to April 2025 dry season to avoid rain washing out the heavy metals and placed in well-labeled improvised polythenes. The collected samples were kept in the polythene bags and transported to the Kaduna Polytechnic laboratory for preparation and analysis.

**Sample Preparation, Treatment and Analysis**

The dust samples were oven-dried at 100–110 °C to remove moisture and subsequently sieved through a 2 mm nylon mesh, as recommended in standard analytical protocols (APHA, 2005; AOAC, 2000). Exactly 1.0 g of the dried, sieved sample was weighed into a 100 cm³ Pyrex beaker and digested with a mixture of 3 cm³ concentrated $HNO_3$ and 2 cm³ $HClO_4$ for 1 hour at 100 °C in a fume cupboard following established procedures (U.S. EPA, 1996). After cooling, the digest was filtered and diluted to 50 cm³ with deionized water. Heavy metal concentrations were then determined using an Atomic Absorption Spectrophotometer (Model: AAS-6800), and results were expressed in mg/kg.

**Pollution Load Indices (PLIs)**

Pollution load indices such as enrichment factor (EF), contamination factor (CF) and geo-accumulation index (Igeo), in metals, are essential tools in environmental monitoring used to assess the degree of heavy metal contamination in soils, sediments, and aquatic ecosystems. By measuring pollution levels and monitoring changes over time, these indices help in environmental management and remediation efforts initiatives (Barbieri, 2016).

**Enrichment factor (EF)**

Enrichment factor (EF) was used to evaluate the level of metal contamination and plausible natural or anthropogenic sources. EF is defined mathematically Barbieri (2016). The Enrichment Factor (EF) is a normalized ratio that helps distinguish whether heavy metals in soil or sediment stem from natural (crustal) sources or anthropogenic (human-related) activities (Table 1).

$$EF = \frac{(CX/Cref)sample}{(CX/Cref)background}$$

Where;

$C_{X=}$ Concentration of the target heavy metal (e.g., Pb, Zn, Cd)

$C_{ref=}$ Concentration of the reference element (Fe or Al)

Background= Measured in the background or baseline environment (e.g Earth's crust, deep soil)

Sample= Measured in the test sample

**Contamination factor (CF)**

The contamination factor is a metric used to assess the degree of pollution by comparing the concentration of a specific contaminant in an environment (usually soil, sediment, or water) to a baseline or background level of that contaminant (Ouchir *et al*., 2016; Chandrasekaran *et al*., 2016) (Table 2).

$$CF=\frac{Cn}{Cbn}$$

Where:

$C_{metal}$ = Measured concentration of the metal (or contaminant) in the sample.

$C_{background}$= Background concentration of the same metal (often taken from average shale value, crustal abundance, or local baseline).

**Geo-accumulation index (Igeo)**

The index of geo-accumulation (Igeo) is extensively used in the evaluation of pollution by comparing the levels of heavy metal found to background levels originally used with bottom sediments. It can also be used for the evaluation of road dust pollution (Barbieri, 2016). However, this equation developed by Muller (1969), is used to compute the Igeo values for each studied element (Table 3):

$$Igeo= \log2 \left(\frac{Cn}{1.5.\ BGn}\right)$$

**Table 1. Values, classes and qualitative description of enrichment factor (EF)**

| EF Value | EF Class | Qualitative Designation of Motor Park Dust |
|---|---|---|
| 0.5 ≤ EF ≤1.5 | 1 | Natural weathering processes |
| EF > 1.5 | 2 | Biota |
| EF < 2 | 3 | Deficiency to minimal enrichment |
| EF > 40 | 4 | Extremely high enrichment |

**Table 2. Values, classes and qualitative description of contamination factor (CF)**

| CF Value | CF Class | Qualitative Designation of Motor Park Dust |
|---|---|---|
| CF <1 | 1 | Low contaminated |
| 1 ≤ CF ≤ 3 | 2 | Moderately contaminated |
| 3 ≤ CF < 6 | 3 | Considerably contaminated |
| CF ≥ 6 | 4 | Heavily contaminated |

**Table 3. Values, classes and qualitative description of Geo-accumulation index (Igeo)**

| Igeo Value (log2 (x) | Igeo Class | Qualitative Designation of Motor Park Dust |
|---|---|---|
| Igeo⩽0 | 0 | Uncontaminated |
| 0<Igeo⩽1 | 1 | Uncontaminated to moderately contaminated |
| 1<Igeo⩽2 | 2 | Moderately contaminated |
| 2<Igeo⩽3 | 3 | Moderately to heavily contaminated |
| 3<Igeo⩽4 | 4 | Heavily contaminated |
| 4<Igeo⩽5 | 5 | Heavily to extremely contaminated |
| Igeo>5 | 6 | Extremely contaminated |

## RESULTS AND DISCUSSION

Table 4 to 10 present the results of the concentration of heavy metals, enrichment factor, geo-accumulation index and contamination factor in dust samples from (Kawo, Mando, Sabon Tasha and Command Junction Motor Parks) in Kaduna Metropolis.

In Table 2, Cd concentrations in dust samples from motor parks ranged from 0.001 to 0.05 mg/kg, while the control site showed a higher range of 0.01 to 0.12 mg/kg. The highest Cd concentration (0.05 mg/kg) was recorded at Mando Motor Park, although this value remains significantly below both the World Health Organization (WHO) maximum permissible concentration (MPC) of 3 mg/kg and the National Environmental Standards and Regulations Enforcement Agency (NESREA) limit of 1.05 mg/kg for dust samples. Interestingly, the control site exhibited a higher maximum concentration (0.12 mg/kg), which may indicate background or legacy contamination unrelated to motor park activities.

The presence of Cd in the samples could be linked to various anthropogenic sources, including pigments containing cadmium compounds (such as cadmium selenide, Cd/Se), the improper disposal of PVC plastics, nickel-cadmium batteries, used motor oils, and industrial sludge deposited on soils during vehicle dismantling operations (Jarup, 2003; Ebong *et al*., 2008). Morka *et al*. (2016) also highlighted that lubricating oils, vehicle wheels, and metal alloys used in engine parts could contribute to cadmium accumulation in the environment.

Overall, the relatively low levels of cadmium detected in this study suggest minimal Cd contamination in the dust samples collected from motor parks within the Kaduna metropolis. Similar findings regarding cadmium presence in Nigerian motor parts and urban dust have been reported by Nduka *et al*. (2025) and Laniyan and Popoola (2025).

In Kawo Motor Park, nickel (Ni) recorded the highest mean concentration of 0.63 mg/kg, while the control site showed a similar value of 0.60 mg/kg (Table 1). Despite this slight elevation, Ni concentrations in both cases remain below the maximum permissible concentration (MPC) limits set by both the World Health Organization (WHO) and NESREA**,** indicating minimal contamination. These findings are consistent with those reported by Soltani *et al*. (2015) and Saeedi *et al*. (2012), who attributed low but detectable Ni concentrations in urban dust primarily to anthropogenic sources such as the combustion of petroleum products**,** vehicular emissions, and vehicular **c**omponent wear**.**

The relatively low Ni concentrations observed in the study are comparable to background levels—suggest that motor parks within Kaduna Metropolis are not significantly contaminated by nickel**.** It is, however, essential to recognize that the composition and concentration of heavy metals in urban dust can vary significantly from city to city and country to country, depending on factors such as the volume of vehicular and commercial activity, the types of technologies used**,** industrial processes**,** as well as climatic and wind conditions **(**Soltani *et al*., 2015).

Comparatively, Ni concentrations reported in literature from other regions show variability. For instance, John *et al*. (2025) recorded Ni concentrations ranging from 0.065 to 0.073 mg/kg in dust samples collected from major and remote roads in Eastern Nigeria. In contrast, a study conducted in an urban motor park in Namibia reported higher concentrations, ranging from 1.45 to 2.08 mg/kg **(**James *et al*., 2023). Even higher levels were documented by Li *et al*. (2023**)**, who reported a mean Ni concentration of 27 mg/kg in outdoor dust from a highly industrialized urban area.

According to the results of this study, lead (Pb) concentrations in dust samples ranged from 0.02 to 3.13 mg/kg, while the control samples recorded concentrations between 0.02 and 1.13 mg/kg. The highest concentration of Pb (3.13 mg/kg) was observed at Kawo Motor Park, which is known to be the busiest commercial hub among the studied locations. Conversely, the highest Pb concentration in control samples (1.13 mg/kg) was recorded at Sabon Tasha Motor Park.

The elevated levels of Pb in these locations reflect increased human activity and vehicular emissions, particularly fuel combustion and engine exhaust, which are major sources of lead in urban environments (Nwachukwu *et al*., 2010). Additionally, Pb is a key component of lead-acid batteries and may also be introduced into the environment through tire wear**,** vehicle repairs**,** and erosion of contaminated surfaces. Activities such as panel beating**,** welding, and vehicle battery servicing common in and around motor parks can further contribute to heavy metal accumulation in surrounding dust (Danie *et al*., 2023).

Despite the relatively high Pb concentrations observed in some locations, the maximum value (3.13 mg/kg) remains below the WHO's maximum permissible concentration (MPC) of 10 mg/kg for lead in dust. This is consistent with findings reported by Danie *et al*. (2023). Furthermore, all observed Pb concentrations were well below the NESREA regulatory limit of 100 mg/kg, reinforcing the conclusion that, although lead is present and anthropogenically influenced, its levels in the study area do not yet pose significant environmental or public health risks. These findings are also in agreement with those of Jalalpoor *et al*. (2025), who reported similarly low Pb concentrations in dust samples from urban environments.

The highest concentration of chromium (Cr) in dust samples was recorded at Sabon Tasha Motor Park, with a value of 4.17 mg/kg, while the corresponding control concentration was highest at Kawo Motor Park (1.80 mg/kg). These concentrations are **(**MPC**)** set by both the World Health Organization (30 mg/kg) and NESREA (35 mg/kg), indicating a low risk of Cr contamination in well below the maximum permissible concentrations the study areas.

The Cr levels observed in this study are generally lower than those reported in other parts of Nigeria. For instance, Nimyel and Namadi (2020) and Shaibu *et al*. (2024) recorded higher concentrations in similar urban settings. Internationally, Li *et al*. (2023) reported Cr concentrations ranging from 22.61 mg/kg to 109.54 mg/kg in dust samples from urban parks in a megacity in central China, further emphasizing the relatively low Cr burden in the Kaduna motor parks.

Although chromium is a common component in automobile parts, including bodywork and alloy coatings, the concentrations observed in this study are not considered hazardous **(**El-Hassan *et al*., 2006). Nevertheless, Cr is non-biodegradable, which means it persists in the environment and can undergo transformation into more mobile and bioavailable forms, eventually accumulating in soil and other environmental compartments (Ghosh and Singh, 2005; Bartlett, 1988; Bartlett, 1993).

The computed Enrichment Factor (EF) values for heavy metals in dust samples collected from Kawo, Mando, Sabon Tasha, and Command Junction motor parks are presented in Table 5. EF is a widely used indicator that assesses the extent of enrichment or depletion of a particular metal in a sample relative to a reference material, often background soil or crustal abundance.

In general, EF values less than 0.5 are considered insignificant, as such low levels of enrichment are typically attributed to natural weathering and geogenic processes. In this study, the EF values for cadmium (Cd), nickel (Ni), lead (Pb), and chromium (Cr) across all four locations fell within this threshold, indicating that the presence of these metals is primarily due to natural sources rather than anthropogenic inputs.

Conversely, the EF values for other metals (not specified in the paragraph) exceeded 0.5, suggesting that their enrichment in the dust samples may be influenced by human activities, such as vehicular emissions, industrial inputs, or mechanical operations commonly associated with motor park environments.

The Contamination Factor (CF) values for cadmium (Cd), nickel (Ni), lead (Pb), and chromium (Cr) in dust samples from all the motor parks within Kaduna metropolis generally exceeded 1, indicating a pollution level. However, CF values for Cd (0.42) and Cr (ranging from 0.59 to 0.82) in the Mando, Command Junction, and Kawo motor parks were below 1, suggesting low contamination for these metals in those specific locations. The overall sequence of contamination, based on CF values, followed the order: Ni > Pb > Cr > Cd (Table 6).

These results suggest that dust samples from the Kawo, Mando, Sabon Tasha, and Command Junction motor parks are predominantly impacted by Ni, Pb, Cr, and Cd, albeit at varying contamination levels. While contamination with Cd, Cr, and Pb is generally low, the CF value for Ni at Command Junction motor park (3.60) notably exceeds 1, indicating moderate contamination by nickel in that area.

The Igeo values for heavy metals (Cd, Ni, Pb, Cr) in dust samples collected from Kawo, Mando, Sabon Tasha, and Command Junction motor parks are presented in Table 7. The majority of these samples exhibited Igeo values ≤ 1 for all four metals, indicating that the dusts range from uncontaminated to moderately contaminated.

Overall, the Igeo results suggest that the motor park dusts in Kaduna metropolis have been impacted by cadmium, nickel, lead, and chromium to varying degrees. Consequently, the contamination status of these dusts can be classified as uncontaminated to moderately polluted with respect to these heavy metals.

**Table 4. Heavy metal concentrations in dust samples from Kawo motor park**

| Heavy Metal | Concentration (mg/kg) | Control (mg/kg) | WHO/FOA (1996) (mg/kg) | NESREA (2009) (mg/kg) |
|---|---|---|---|---|
| Cd | 0.02±0.02 | 0.04±0.02 | 3.0 | 1.05 |
| Ni | 0.63±0.31 | 0.60±0.30 | 0.8 | 3.0 |
| Pb | 3.13±1.67 | 2.50±0.84 | 10 | 100 |
| Cr | 2.06±1.00 | 2.26±1.25 | 35 | 30 |

**Keys:** Cd, Cadmium; Ni, Nickel; Lead, Pb; Cr, Chromium; WHO, World Health Organization; FAO, Food and Agricultural Organization NESREA, National Environmental Standards and Regulations Enforcement Agency.

**Table 5. Heavy metal concentrations in dust samples from Mando motor park**

| Heavy Metal | Concentration (mg/kg) | Control (mg/kg) | WHO/FOA (1996) (mg/kg) | NESREA (2009) (mg/kg) |
|---|---|---|---|---|
| Cd | 0.05±0.04 | 0.12±0.12 | 3.0 | 1.05 |
| Ni | 0.45±0.44 | 0.23±0.23 | 0.8 | 3.0 |
| Pb | 1.67±1.67 | 0.84±0.84 | 10 | 100 |
| Cr | 1.73±1.73 | 0.92±0.85 | 35 | 30 |

**Keys:** WHO, World Health Organization; FAO, Food and Agricultural Organization
NESREA, National Environmental Standards and Regulations Enforcement Agency

**Table 6. Heavy metal concentrations in dust samples from Sabon Tasha motor park**

| Heavy Metal | Concentration (mg/kg) | Control (mg/kg) | WHO/FOA (1996) (mg/kg) | NESREA (2009) (mg/kg) |
|---|---|---|---|---|
| Cd | 0.02±0.02 | 0.02±0.02 | 3.0 | 1.05 |
| Ni | 0.42±0.42 | 0.32±0.31 | 0.8 | 3.0 |
| Pb | 2.78±1.67 | 1.13±1.13 | 10 | 100 |
| Cr | 4.17±1.17 | 1.80±0.79 | 35 | 30 |

**Table 7. Heavy metal concentrations in dust samples from Command Junction motor park**

| Heavy Metal | Concentration (mg/kg) | Control (mg/kg) | WHO/FOA (1996) (mg/kg) | NESREA (2009) (mg/kg) |
|---|---|---|---|---|
| Cd | 0.01±0.01 | 0.05±0.05 | 3.0 | 1.05 |
| Ni | 0.18±0.18 | 0.32±1.36 | 0.8 | 3.0 |
| Pb | 2.72±2.27 | 1.36±1.36 | 10 | 100 |
| Cr | 0.82±0.82 | 1.40±1.40 | 35 | 30 |

**Table 8. Enrichment factor (EF) of heavy metals in motor park dust samples**

| Motor Parks | Cd | Ni | Pb | Cr |
|---|---|---|---|---|
| Kawo Motor Park | 0.000 | 0.004 | 0.001 | 0.002 |
| Mando Motor Park | 0.001 | 0.000 | 0.001 | 0.001 |
| Sabon Tasha Motor Park | 0.000 | 0.000 | 0.004 | 0.003 |
| Command Junction Motor Park | 0.003 | 0.001 | 0.002 | 0.002 |
| Control | 0.001 | 0.007 | 0.002 | 0.002 |

**Table 9. Contamination factor (CF) of the heavy metals in motor park dust samples**

| Motor Parks | Cd | Ni | Pb | Cr |
|---|---|---|---|---|
| Kawo Motor Park | 1.00 | 1.03 | 1.25 | 0.82 |
| Mando Motor Park | 0.42 | 1.96 | 1.99 | 1.88 |
| Sabon Tasha Motor Park | 1.00 | 1.31 | 2.46 | 2.32 |
| Command Junction Motor Park | 1.00 | 3.60 | 2.00 | 0.59 |

**Table 10. Geo-accumulation index (Igeo) of the heavy metals in motor park dust samples**

| Motor Parks | Cd | Ni | Pb | Cr |
|---|---|---|---|---|
| Kawo Motor Park | 0.20 | 0.04 | 0.88 | 0.59 |
| Mando Motor Park | 0.08 | 0.00 | 0.40 | 0.38 |
| Sabon Tasha Motor Park | 0.20 | 0.26 | 0.49 | 0.47 |
| Command Junction Motor Park | 0.20 | 0.72 | 0.40 | 0.12 |

## CONCLUSION

This study investigated the concentrations and pollution levels of cadmium (Cd), nickel (Ni), lead (Pb), and chromium (Cr) in dust samples collected from Kawo, Mando, Sabon Tasha, and Command Junction motor parks within the Kaduna metropolis. The results revealed that the mean concentrations of all examined metals in the motor park samples exceeded their respective control values**,** suggesting a likely contribution from anthropogenic sources**.**

However, when compared with the maximum permissible concentrations (MPC) established by the World Health Organization (WHO) and NESREA for dust quality, the metal levels in all motor parks were below the regulatory limits, indicating that the study area is currently safe from significant metal contamination**.**

Furthermore, pollution indices including the Enrichment Factor (EF)**,** Contamination Factor (CF), and Geo-accumulation Index (Igeo)—indicated that the motor parks experience moderate contamination, largely attributable to human activities such as vehicular emissions and mechanical operations.

## REFERENCES

Adamiec, E., Jarosz-Krzemińska, E. and Wieszała R. (2016). “Heavy metals from non-exhaust vehicle emissions in urban and motorway road dusts,” *Environmental Monitoring and Assessment*, 88(6):369. https://doi.org/10.1007/s10661-016-5377-1

American Public Health Association (APHA). (2005). *Standard methods for the examination of water and wastewater* (21st ed.). Washington, DC: APHA–AWWA–WEF.

Association of Official Analytical Chemists (AOAC). (2000). *Official methods of analysis* (17th ed.). Gaithersburg, MD: AOAC International.

Barbieri M. (2016). The Importance of Enrichment Factor (EF) and Geo-accumulation Index (Igeo) to Evaluate the Soil Contamination. *Journal of Geology and Geophysics* 5:237. https://doi.org/10.4172/2381-8719.1000237

Bartlett R. J. (1988). Mobility and bio-availability of chromium in soils.*Adv. Envtal. Sci. Techn.,* 20: 267-304.

Bartlett R. J. and James B. (1983). Behavior of chromium VII in soils: Adsorption and reduction of hexavalent forms. *Journal of Environmental Quality,* 1(2):177-181. https://doi.org/10.2134/jeq1983.00472425001200020012x

Chandrasekaran, J., Brumin, M., Wolf, D., Leibman, D., Klap, C., Pearlsman, M., Sherman, A., Arazi, T., & Gal-On, A. (2016). *Development of broad virus resistance in non-transgenic cucumber using CRISPR/Cas9 technology.* Molecular Plant Pathology, **17**(7), 1140-1153.

Ebong G. A., Akpan M. M., and Mkpene V. N. (2008). Heavy metal content of municipal and rural dumpsite soils and rate of accumulation by Carica papaya and Talinum triangulare in Uyo Nigeria. *E-Journal of Chemistry,* 5(2):281-290. https://doi.org/10.1155/2008/683469.

El-Hassan, T., Mufeed B., Al-Omari, H., Ziadat, A., El-Alali, A., Al-Naser, F., Berdanier, B. W and Jiries, A. (2006). The Distribution of Heavy Metals in Urban Street Dusts of Karak City, Jordan. *Soil and Sediment Contamination,* 15:357-365. https://doi.org/10.1080/15320380600781698

Ghosh, M., & Singh S. P. (2005). Comparative uptake and phyto extraction study of soil inducedchromium by accumulator and high biomass weed species. *Appl. Ecol. Envtal. Res.*, 3(2):67-79. https://doi.org/10.15666/aeer/0302_067079.

Henry, M. U., Ime, U. H., Shakirdeen M. O., Ojochogu D. R., Ajibola O., Joseph K. B., Seyi A. and Joshua L. (2023). Evaluation of heavy metal concentration and pollution index in dust samples in Kaduna Metropolis. *FUDMA Journal of Sciences (FJS),* 7(6)276-281. https://doi.org/10.33003/fjs-2023-0706-2079.

Huang C. L., Bao L. J, Luo P, Wang Z. Y., Li S. M. and Zeng E. (2016). Potential health risk for residents around a typical e-waste recycling zone via inhalation of size-fractionated particle-bound heavy metals. *Journal of Hazard Mater*. 317:449–456. https://doi.org/10.1016/j.jhazmat.2016.05.093

Ihedioha, J. N., Ukoha, P. O., and Ekere, N. R. (2017). Comparative assessment of heavy metal levels in soil, vegetables and urban dust from different zones in a Nigerian city. *Journal of Environmental and Public Health*, 2952367. https://doi.org/10.1155/2017/2952367.

Jalalpoor, M., Chamani, A., Sobhanardakani, S. (2025). Surface Dust Contamination in Small Urban Parks: The Role of Spatial and Physicochemical Drivers in Toxic Elements Accumulation. *Water Air Soil Pollution.* 236**:**522. https://doi.org/10.1007/s11270-025-07136-9.

James A., Evans K. S. and Sylvanus A. O. (2023). Assessment of heavy metals pollution status of surface soil dusts at the Katima Mulilo urban motor park, Namibia, Geomatics, *Natural Hazards and Risk*, 14:1:2204181. https://doi.org/10.1080/19475705.2023.2204181.

Jarup L. (2003). Toxicity of heavy metals and sources in the environment.*British Medical Bulletin*, 68(1):167-182. https://doi.org/10.1093/bmb/ldg032.

Jin Y., O'Connor D., Ok Y. S., Tsang D. C. W., Liu. and Hou D. (2019). Assessment of sources of heavy metals in soil and dust at children's playgrounds in Beijing using GIS and multivariate statistical analysis. *Environmental International*. 124:320–328. https://doi.org/10.1016/j.envint.2019.01.024.

John K. N., Chideraa C. O., Vivian O. M. (2025). Health risk status of roadside dwellers by heavy metal(loid) contamination of dusts of major and remote roads from selected areas of Eastern Nigeria. *Discover environment*. 3:130. https://doi.org/10.1007/s43856-025-00082-z

Khanoranga K. S. (2019). Phytomonitoring of air pollution around brick kilns in Balochistan province Pakistan through air pollution index and metal accumulation index. *Journal of Clean Production.* 229:727–738. https://doi.org/10.1016/j.jclepro.2019.05.028

Laniyan, T. A., and Popoola, O. J. (2025). Integrated assessment of heavy metal contamination in urban road dust: implications for human health and ecosystem sustainability in Abeokuta, Nigeria. *Environmental Forensics*, 26(2):204-222. https://doi.org/10.1080/15275922.2024.2413634

Li, D., Lu, Q., Cai, L., Chen, L., and Wang, H. (2023). Characteristics of soil heavy metal pollution and health risk assessment in urban parks at a megacity of Central China. *Toxics*, 11(3):257. https://doi.org/10.3390/toxics11030257

Lian M., Wang J., Sun L., Xu Z., Tang J., Yan J., and Zen X. (2019). Profiles and potential health risks of heavy metals in soil and crops from the watershed of Xi River in Northeast China. *Journal of Ecotoxicology and Environmental Safety*. 169:442–448. https://doi.org/10.1016/j.ecoenv.2018.11.057

Luo X., Zeng J., Liu S., and Zhang L. (2015). An effective and recyclable adsorbent for the removal of heavy metal ions from aqueous system: magnetic chitosan/cellulose microspheres. *Bioresource Technology.* 194:403–406. https://doi.org/10.1016/j.biortech.2015.07.035

Magaji, B., Danbature, W. L., Shehu, Z., Sani, M. M., Sani, A. M., and Abubakar, A. (2020). *Evaluation of Some Heavy Metals in Soils around Major Parks in Gombe Town, Nigeria. Asian Journal of Applied Chemistry Research,* 4(4):1-5. https://doi.org/10.9734/ajacr/2020/v4i430122

Mohmand, J., Eqani, S. A. M. A. S., Fasola, M., Alamdar, A., Mustafa, I., Ali, N., & Shen, H. (2015). Human exposure to toxic metals via contaminated dust: Bio-accumulation trends and their potential risk estimation. *Chemosphere*., 132:142-151.

Moreno T, Karanasiou A, Amato F, Lucarelli F, Nava S, Calzolai G., (2013). Daily and hourly sourcing of metallic and mineral dust in urban air contaminated by traffic and coal-burning emissions. *Atmospheric Environmental*. 68:33-44.

Morka, J. C., Obiwulu, E., Ataine, T. & Anthony, D. C. (2016). Soil contamination due to heavy metals within auto-mobile workshop clusters along mariere by T-junction (α) and orubor by Prof. Ebie (B) Agbor, Delta State-Nigeria. *Int. J. Res. Sci. Eng. Technol.* 1(1):256.

Muller G., (1969). Index of geoaccumulation in sediments of the Rhine River, *Geojournal 2.* 108–118.

Nag, R., & Cummins, E. (2022). Human health risk assessment of lead (Pb) through the environmental-food pathway. *Science of the Total Environment, 810,* 151168. https://doi.org/10.1016/j.scitotenv.2021.151168

Nduka, J. K., Offor, C. C., & Mgboh, V. O. (2025). Health risk status of roadside dwellers by heavy metal(loid) contamination of dusts of major and remote roads from selected areas of Eastern Nigeria. *Discover Environment, 3*(1):1–15. https://doi.org/10.1007/s43862-025-00030-2

Nimyel, S. H., Namadi, M. M. (2020). Assessment of the Level of Heavy Metal Concentration in the Street Dust in Some Selected Locations In Zaria Metropolis, Kaduna State, Nigeria *FUDMA Journal of Sciences (FJS).*4:(3)93 - 98

Obanijesu, E. O., & Olajide, J. O. (2007). Trace metal pollution study on cassava flour's roadside drying technique in Nigeria. In E. B. Bongye, C. A. Brebbia, & E. K. Yanful (Eds.), *Appropriate technologies for environmental protection in the developing world: Selected papers from ERTEP* (pp. 399–406). Springer. https://doi.org/10.1007/978-1-4020-9139-1_50

Okunola, O. J., Uzairu, A., Uba, S., Ezeanyanaso, C. S., & Alhassan, Y. (2015). Distribution pattern of metals in atmospheric settling dust along roads in Kano Metropolis, Nigeria. *Journal of Applied Chemistry,*1-12. https://doi.org/10.1155/2015/739325

Ouchir, N., Ben Aissa, L., Boughdiri, M., & Aydi, A. (2016). *Assessment of heavy metal contamination status in sediments and identification of pollution source in Ichkeul Lake and rivers ecosystem, northern Tunisia.* Arabian Journal of Geosciences, 9, 539.

Pollution and ecological risk assessment in street dust of Tehran. *Journal of Hazardous Materials,* 227–228:9–17. https://doi.org/10.1016/j.jhazmat. 2012.04.002

Saeedi, M., Li, L. Y., & Salmanzadeh, M. (2012). Heavy metals and polycyclic aromatic hydrocarbons:

Sahakyan, L., Maghakyan, N., & Belyaeva, O. (2016). Heavy metals in urban dust: Contamination and health risk assessment: A case study from Gyumri, Armenia. *Arabian Journal of Geosciences,* 9*:*42. https://doi.org/10.1007/s12517-015-2120-2

Sahu, V., & Gurjar, B. R. (2021). Spatio-temporal variations of indoor air quality in a university library. *International Journal of Environmental Health Research, 31*(5):475–490. https://doi.org/10.1080/09603123.2020.1828281

Shah, S. I. H., Nawaz, R., Ahmad, S., & Arshad, M. (2020). Sustainability assessment of modern urban transport and its role in the reduction of greenhouse gas emissions: A case study of Metro Bus System (MBS), Lahore. *Kuwait Journal of Science,* 47(2):67–81.

Shaibu, M., Abbas, A. A., Clifford, O. C., & Abdullahi, S. A. (2024). Physicochemical analysis, heavy metals contaminants and health risks assessment in Harmattan dust within the Federal Polytechnic Kaura Namoda, Zamfara State, Nigeria. *International Journal of Chemistry, Mathematics and Physics,* 8(2):1-7. https://doi.org/10.22161/ijcmp.8.2.1

Soltani, N., Keshavarzi, B., Moore, F., Tavakol, T., Lahijanzadeh, A. R., Jaafarzadeh, N., & Kermani, M. (2015). Ecological and human health hazards of heavy metals and polycyclic aromatic hydrocarbons (PAHs) in road dust of Isfahan Metropolis, Iran. *Science of the Total Environment, 505,* 712–723. https://doi.org/10.1016/

Taiwo, A. M., Awomeso, J. A., Taiwo, O. T., Oremodu, B. D., Akintunde, O. O., Ojo, N. O., Elegbede, O. O., Olanrewaju, H. H., & Arowolo, T. A. (2017). Assessment of health risks associated with road dusts in major traffic hotspots in Abeokuta Metropolis, Ogun State, southwestern Nigeria. *Stochastic Environmental Research and Risk Assessment, 31*(2), 431–447. https://doi.org/10.1007/s00477-016-1187-9

United States Environmental Protection Agency (EPA). (1996). *Method 3050B: Acid digestion of sediments, sludges, and soils*. Washington, DC: U.S. EPA.

WHO. (2021). *Guidelines on air quality and heavy metal exposure*. Geneva: World Health Organization.

WHO/FAO (1996). *Food consumption and exposure assessment of chemicals.* Report of a FAO/WHO Consultation, Geneva. World Health Organization, Geneva.

Zhao, X., Lin, L., Zhang, Y. (2019). Contamination and human health risks of metals in indoor dust from university libraries: A case study from Qingdao, China. Human Ecological Risk.

Zheng, N., Liu, J., Wang, Q., & Liang, Z. (2010). Health risk assessment of heavy metal exposure to street dust in the zinc smelting district, Northeast of China. *Science* *of the Total Environment, 408*(4), 726–733. https://doi.org/10.1016/j.scitotenv.2009.10.075

Zhou, L., Liu, G., Shen, M., Liu, Y., Lam, P. K. S. (2021). Characteristics of indoor dust in an industrial city: Comparison with outdoor dust and atmospheric particulates. *Chemosphere*. 272. https://doi.org/10.1016/j.chemosphere.2021.129609.

Žibret, G., Van Tonder, D., & Žibret, L. (2013). Metal content in street dust as a reflection of atmospheric dust emissions from coal power plants, metal smelters, and traffic. *Environmental Science and Pollution Research, 20*(6), 4455–4468. https://doi.org/10.1007/s11356-012-1379-2.