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# CADMIUM AND COBALT IN KADUNA STREET DUST

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## ABSTRACT

The levels of cadmium and cobalt metals in Kaduna Street dusts collected from a variety of sampling sites are reported. Wide range concentrations of the metals were observed in street dust from different parts of the municipality. Their distributions were multimodal with a mean and standard deviation of 1.37 ± 0.478 and 2.624 ±0.324 $\mu gg^{-1}$ respectively. The results agreed with inputs from highly dispersed materials of local origin. Significant correlation between cadmium and cobalt indicated that these metals in the residential areas are affected by automobile exhaust emissions and other sources of the pollutants.

**Keywords**: *Cadmium, cobalt,* street *dust, Kaduna*

## INTRODUCTION

The component and quantity of street dusts are environmental pollution indicator in big cities (Sezgin *et al*., 2004) as a source of outdoor air pollutant (Yeung *et al*., 2003). The urban environment is composed of varying concentrations of trace elements from a vast array of anthropogenic sources (Hodel and Chang, 2004) as well as from natural geochemical processes (Shakourn and El-Talib, 1995). Street dust particles can be grouped into:

Elements geochemically associated in nature are related to resuspension of soil particles as their main source are building construction, renovation and weathering of building materials. Elements of anthropogenic origin that is, traffic petrol and diesel operated generating machines, coal combustion or domestic heating and elements related to industrial activity in an area. (Loredo *et al*., 2003).

Most trace elements especially the heavy metals remain in the soil nearly indefinitely. These metals remain bound to organic matter unless they are re-mobilized mechanically as wind –blown dust (Turer *et al*., 2001).

Human exposure to metals and their compounds in the environment is through food, air and water. Other forms of uptake are via skin contact. (Ewers and Schlipkőter, 1991a). However, over a period of time, adverse toxic effects may occur as a result of long-term low-level exposure (Ewers and Schlipkőter, 1991b).

Cadmium is not essential to plant and animal. Its high doses can lead to toxic effects (Stoeppler, 1991). It is a contaminant of many industrial products containing zinc (Hodel and Chang, 2004) and has been emitted in minor amounts into the environment in the form of dust/aerosols into the atmosphere, as effluents into rivers and lakes, and as solid from point sources (Stoeppler, 1991). Cadmium causes symptoms such as nausea; vomiting, abnormal cramp and headache in severe cases, diarrhea and shock-like state have been observed. Other effects of Cd include growth retardation, anemia and weight loss (Stoeppler, 1991).

Cobalt inhibits cellular respiration and enzymes of the citric acid cycle. Workers exposed to cobalt containing dusts develop progressive pulmonary fibrosis and lung damage (Taylor and Hawkins, 1987). The toxicity of cobalt is independent of its chemical form as its toxic effects are elicited by the oxide as well as by the metal and are not masked by alloying (Coates and Watson, 1971). In workers acutely exposed to cobalt carbonyl vapour, headaches, weakness irritability, change in reflexes and electrical activity of the brain has been reported (Herndon *et al.*, 1980).

This paper reports the cadmium and cobalt concentrations in Kaduna street dust in the residential, commercial and industrial areas with a view to determining their levels of pollution.

## MATERIALS AND METHODS

In the preparation of solutions, analytical reagent grade chemicals and distilled-deionized water were used. All glass wares were washed with detergent and rinsed with water before immersion in 10% nitric acid solution. They were further rinsed with distilled-deionised water before drying in the oven at $105^0$C. All weighing were done on Mettler Toledo AB54 analytical weighing balance.

### *Study Area*

Kaduna is an industrial city located on the southern end of the high plains of northern Nigeria, bounded by parallels $9^0 03^1$N to $11^0 32^1$N, and extends from the upper River Mariga on $6^0 05^1$E to $8^0 48^1$E on the foot slopes of the scarp of Jos Plateau (Udo, 1970).

### *Climate*

Kaduna experiences a typical tropical continental climate with distinct seasonal regimes, oscillating between cold to hot dry and humid to wet. These two seasons reflect the influences of tropical continental and equatorial maritime airmases which sweep over the entire country. However, in Kaduna, the seasonality is pronounced with the cold to hot dry season longer than the rainy season (Bello, 2000).

### *Sampling Zones and Bio indication network*

The entire Kaduna municipal was divided into eight mapping units of 10 $km^2$ to avoid spatial variability as shown in Fig.1. Each zone was further subdivided into large squares from where samples were collected.

### *Sampling*

Eight hundred street dust samples were collected between October 2004-April 2005 from different zones. Samples were collected from pavements, curbs, intersections such as round about, T-junctions and free ways using a plastic brush and tray (Loredo *et al.*, 2003; Yeung *et al.*, 2003) and were stored in plastic bags (Ayodele and Gaya, 1998).Kaduna municipal was subdivided into eight sampling zones. At each Sampling was carried out during the dry season being the period of highest pollution of air in the municipality resulting in the highest concentrations of the particulates (Dmuchowski and Bytnerowicz, 1994)

Zones b comprising Layin-Banki, Unguwar Shanu, Abakpa, Kurmin Mashi, zone c-Tudun wada comprising Unguwar Sunusi, Tudun wada, and Tudun nupawa and zone d-Kabala comprising Mando, National Eye Centre, Rigasa, Kabala West and Unguwar Muazu are predominantly commercial /residential areas. Zone e Kudenda is an industrial area. Zone f is also a commercial/residential area. Zone g comprising Unguwar Rimi and Kabala Costain is a predominantly residential area. Zone h Kawo comprising Kawo and Rafinguza is a commercial /residential area while zone I is the Central market, a predominantly commercial centre.

***Sample Treatment***

All dust samples were oven-dried at $105^0$C to a constant weight (Ayodele and Gaya, 1998) and were sieved through a 250µm mesh (Li and Shuman, 1996; Ayodele and Gaya, 1994). 1.0g of each sample was digested with $20cm^3$ of 6M nitric acid and was filtered through acid washed Whatman 540 filter paper into a $50cm^3$ volumetric flask and was diluted to the mark with water (Fergusson, 1987; Ayodele and Gaya, 1998). Concentrations of the metals were determined using an atomic absorption spectrophotometer (Buck Model 210 VGP) attached to IBM Personal Computer AT (Ayodele and Abubakar, 1998). The result of each sample was the average of ten sequential readings. Background light absorption and scattering were compensated for either by deuterium hollow cathode lamp or by tungsten/ halogen lamp. Distilled water used as blank was digested using the above procedure.

## RESULTS AND DISCUSSION

The frequency distribution pattern for cadmium in Kaduna metropolis street dust is as shown in Fig2a. The distribution is multimodal and is skewed towards high frequency of low concentrations with a mean of $1.37mgg^{-1}$ and coefficient of variation of 34.92%. This result is similar to that reported by Loredo *el al.* (2003) but in sharp contrast with those reported by Ordonez (1997). The frequency distribution pattern for cadmium in zone b is as shown in Fig. 2b; the distribution is multimodal with a mean of 1 $41mgg^{-1}$ and coefficient of variation of 22.98% (Table 1).

The frequency distribution pattern for cadmium in zone c as shown in Fig.2c. The distribution is skewed towards high frequency of low concentration with a mean of $1.194mgg^{-1}$and coefficient of variation of 29.56%. The frequency distribution pattern for cadmium in zone d is as shown in Fig.2d. The distribution is multimodal and skewed towards low frequency of high concentration with mean of $1.425mgg^{-1}$ and coefficient of variation of 25.19%.

The frequency distribution pattern for cadmium in zone e is as shown in Fig2e. The distribution is skewed towards high frequency of high concentration with a mean

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of 1.7957mg$g^{-1}$and coefficient of variation of 21.27%. The frequency distribution pattern for cadmium in zone f is as shown in Fig. 2f. The distribution is skewed towards low frequency of high concentration with a mean of 0.8949mg$g^{-1}$ and coefficient of variation of 25.59%. The frequency distribution pattern for cadmium in zone g is as shown in Fig. 2g. The distribution is skewed towards high frequency of low concentration with a mean of 0.8437mg$g^{-1}$ and coefficient of variation of 20.62%. The frequency distribution pattern for Cd in zone h is as shown in Fig 2h The distribution is multimodal and is skewed towards high frequency of high concentration with a mean of 1.4005 p.gg'[1]and coefficient of variation of 23.71%.The frequency distribution pattern for Cd in zone i is as shown in Fig. 2i. The distribution is skewed towards high frequency of high concentration with a mean of 1.9346mg$g^{-1}$ and coefficient of variation of 17.36%. Sources of Cd in all the areas are from local metal industries such as fabrication of galvanised materials, wear and tear of tyres and resuspension of soil particles such as building construction, renovation and weathering of building materials (Loredo *et al.*, 2003; Hodel and Chang, 2004).

The frequency distribution pattern for cobalt in Kaduna metropolis street dust is as shown in Fig 3a. The distribution is multimodal and is skewed towards high frequency of low concentration, with a mean of 2 624mg$g^{-1}$ and coefficient of variation of 41.16% (Table 2). The result obtained is in similar to that reported by De Miguel et al. (1990) for cobalt in Madrid-Spain street dust. The frequency distribution pattern for Co. in zone b, is as shown in Fig 3b. The distribution is multimodal with a mean of 3.081mg$g^{-1}$ and coefficient of variation of 39.37%.

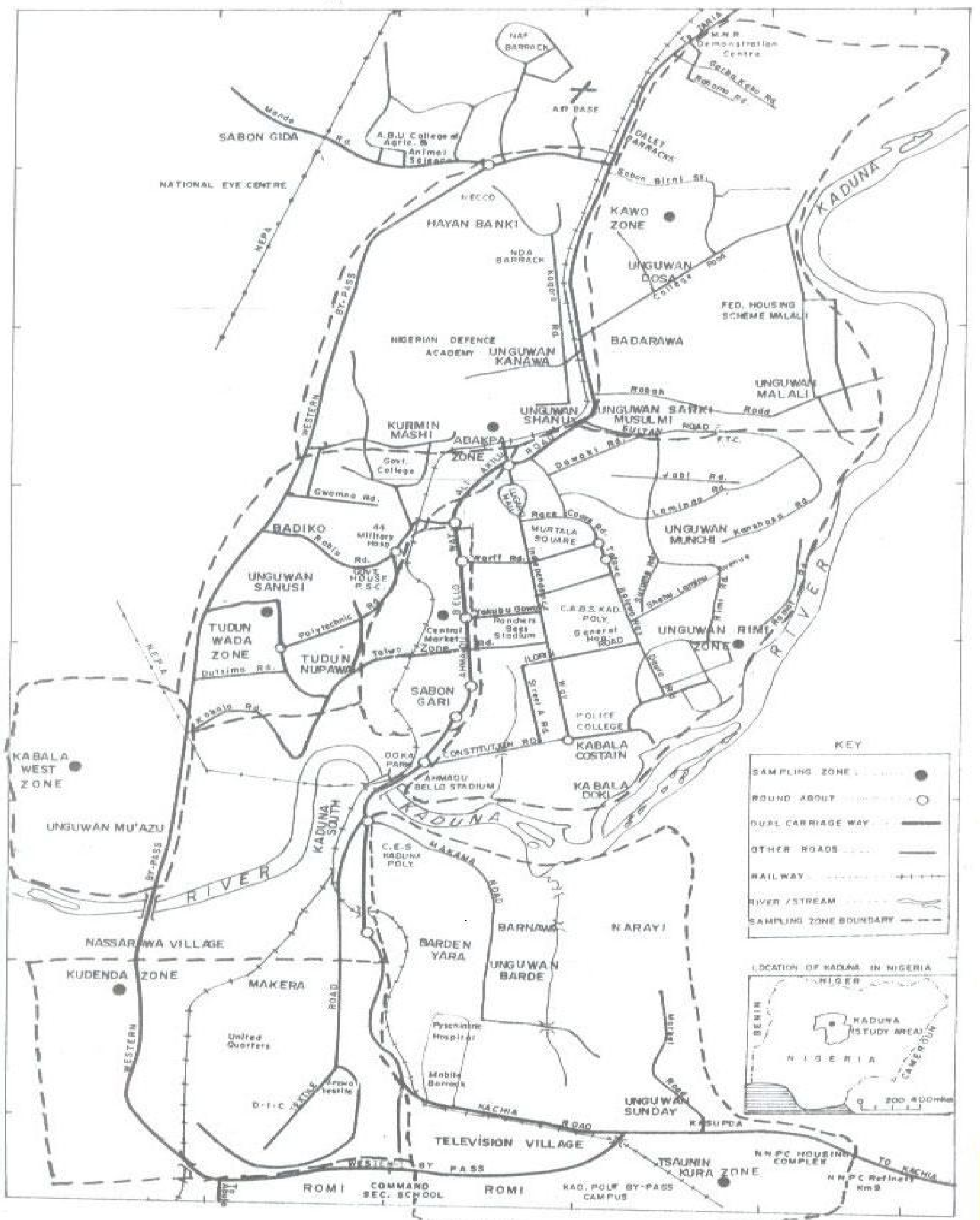


**Fig.1: showing map of Kaduna metropolis**

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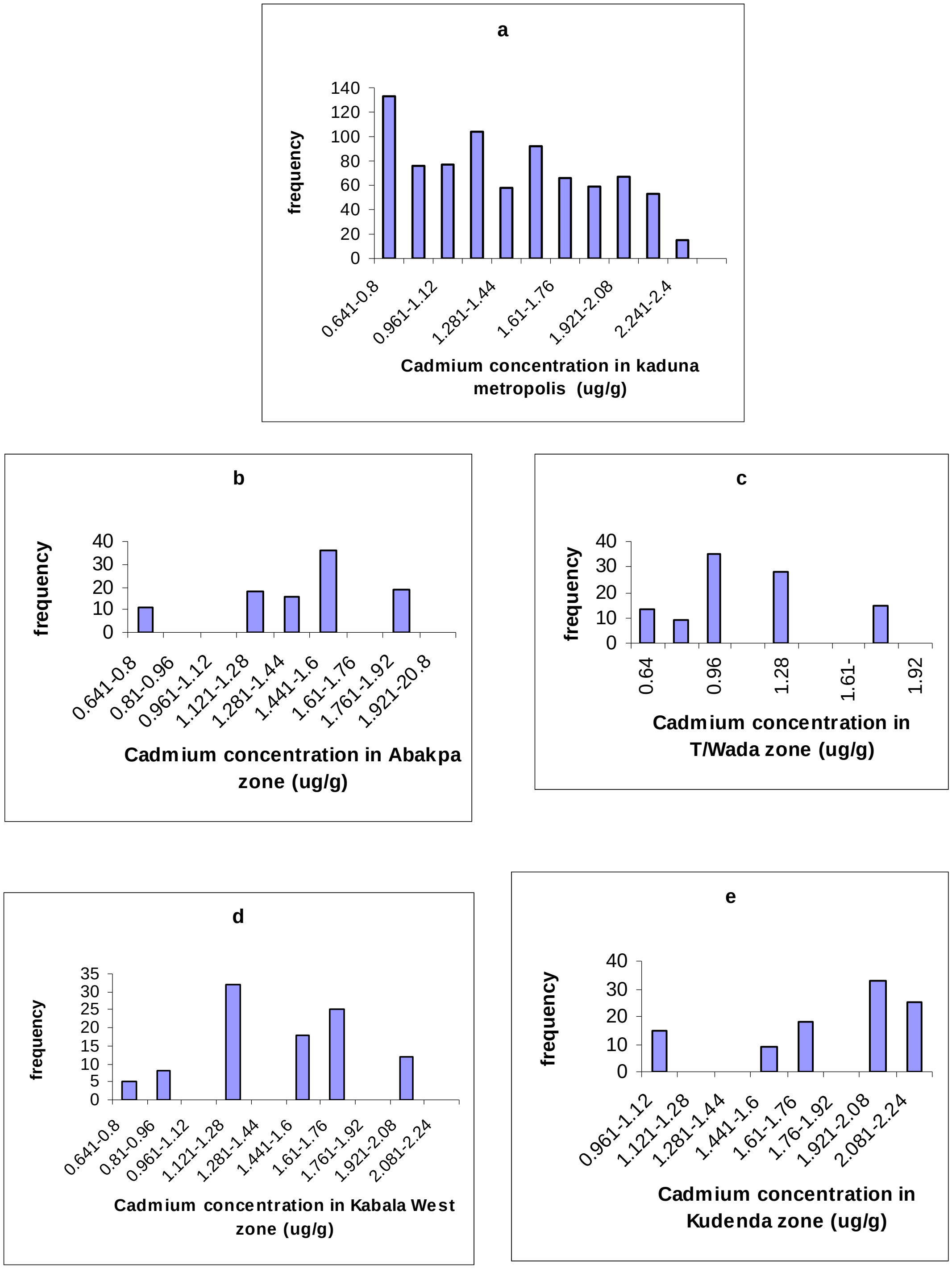


**Fig 2: Frequency distribution of cadmium in zones a-e**

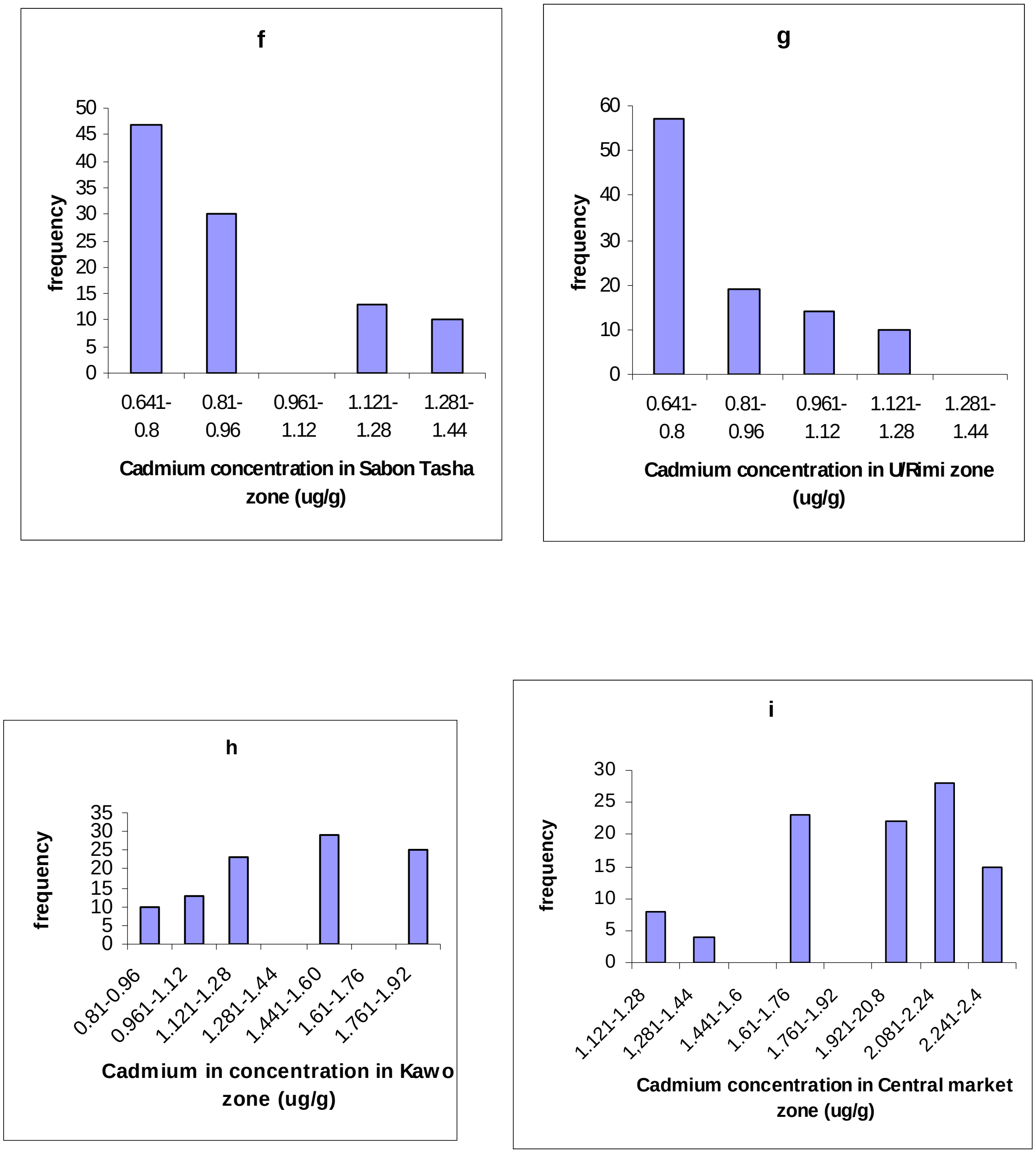


**Fig. 2: Frequency distribution of Cadmium in f-i**

**Table 1: Observed Distribution Pattern for Cadmium in all the zones**

| Zone | Observation on Cd frequency distribution | Mean | CoV(%) |
|---|---|---|---|
| A | Multimodal, skewed towards high frequency of low concentration | 1.37 | 34.92 |
| B | Distribution is multimodal | 3.08 | 39.37 |
| C | Skewed towards high frequency of low concentration | 1.194 | 29.56 |
| D | Skewed towards high frequency of high concentration | 1.425 | 25.19 |
| E | Skewed towards high frequency of high concentration | 1.7957 | 21.27 |
| F | Skewed towards low frequency of high concentration | 0.8949 | 25.59 |
| G | Skewed towards high frequency of low concentration | 0.8437 | 20.62 |
| H | Skewed towards high frequency of high concentration | 1.4005 | 23.71 |
| I | Skewed towards high frequency of high concentration | 1.9346 | 17.36 |

**Table 2: Observed Distribution Pattern for Cobalt in all the zones**

| Zone | Observation on Co frequency distribution | Mean | CoV (%) |
|---|---|---|---|
| A | Skewed towards high frequency of low concentration | 2.624 | 41.16 |
| b | Skewed towards high frequency of high concentration | 3.08 | 39.37 |
| c | Skewed towards high frequency of high concentration | 2.405 | 36.22 |
| d | Skewed towards high frequency of high concentration | 2.345 | 34.1 |
| e | Symmetrical | 2.521 | 33.94 |
| f | Symmetrical | 2.905 | 32.84 |
| g | Symmetrical | 2.253 | 29.45 |
| h | Skewed towards high frequency of low concentration | 2.205 | 42.97 |
| i | Skewed towards high frequency of low concentration | 2.711 | 35.09 |

The frequency distribution pattern for Co. in zone c is as shown in Fig. 3c. The distribution is multimodal and is skewed towards low frequencies of high concentrations with a mean of 2.405mgg$^{-1}$ and coefficient of variation of 36.22%.

The frequency distribution pattern for Co. in zone d is as shown in Fig 3d. The distribution is similar to the observed in zone c hence their sources are similar with a mean of 2.345mgg$^{-1}$ and coefficient of variation of 34.1%.

The frequency distribution pattern for Co. in zone e is as shown in Fig.3e.The distribution is symmetrical with a mean of 2.521mgg$^{-1}$ and coefficient of variation of 33.94%.

The frequency distribution pattern for Co. in zone c is as shown in Fig. 3c. The distribution is multimodal and is skewed towards low frequencies of high concentrations with a mean of 2.405mgg$^{-1}$ and coefficient of variation of 36.22%.

The frequency distribution pattern for Co. in zone d is as shown in Fig 3d. The distribution is similar to the observed in zone c hence their sources are similar with a mean of 2.345mgg$^{-1}$ and coefficient of variation of 34.1%.

The frequency distribution pattern for Co. in zone e is as shown in Fig.3e.The distribution is symmetrical with a mean of 2.521mgg$^{-1}$ and coefficient of variation of 33.94%.

The frequency distribution pattern for Co. is as shown in Fig. 3f. The distribution is symmetrical with a mean of 2.905mgg$^{-1}$ and coefficient of variation of 32.84%.

The frequency distribution for Co. in zone g is as shown in Fig. 3g. The distribution is symmetrical with a mean of 2.253mgg$^{-1}$ and coefficient of variation of 29.45%.

The frequency distribution pattern for Co. in zone h is as shown in Fig.3h. The distribution is multimodal and is skewed towards high frequency of low concentration with a mean of 2.205mgg$^{-1}$ and coefficient of variation of 42.966%.

The frequency distribution pattern for Co. in zone i is as shown in Fig 3i. The distribution is multimodal and is skewed towards high frequency of low concentration with a mean of 2.711mgg$^{-1\ 1}$ and coefficient of variation of 35.09%.

Monitoring trace metals in street dust has provided a tool for estimating the degree of contamination source and habit of the residential, commercial and industrial areas. The concentration of the various metals in street dust is a function of their proximity to major highway industrial areas and types of activities in the immediate surroundings. Our results exhibit a range of concentrations between the industrial, residential and commercial areas thus suggesting strong sporadic influence from anthropogenic sources (Hofstader et al., 1976; Fergusson, 1987; Ayodele and Gaya, 1998). Therefore, the primary sources of these metals in street dust are resuspension of soil derived dust, vehicle induced turbulence, geochemical processes, and wind blown dusts. In urban cities, people are exposed to a variety of potentially toxic chemicals. Of particular concern is the inhalation of fine-grained atmospheric particles with high concentrations of heavy metals (Loredo et al., 2003).

From geochemical data obtained by sampling dust samples in the urban areas of Kaduna, significant anomalies were detected and some conclusions could be drawn that in urban cities, people are exposed to a variety of potentially toxic chemicals. Of particular concern is the inhalation of fine-grained atmospheric particles with high concentrations of heavy metals.

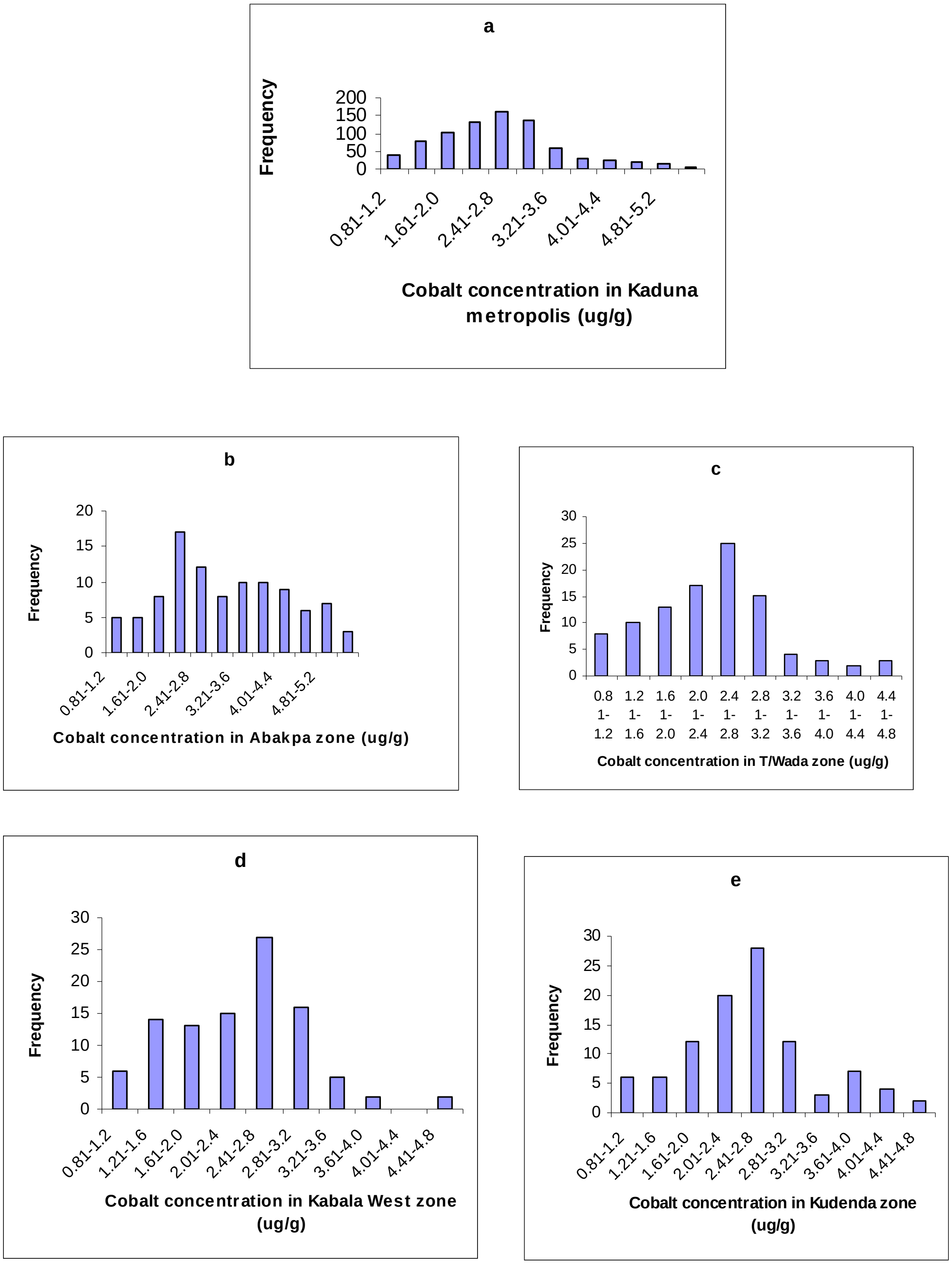


**Fig. 3: Frequency distribution of cobalt in zones a-e**

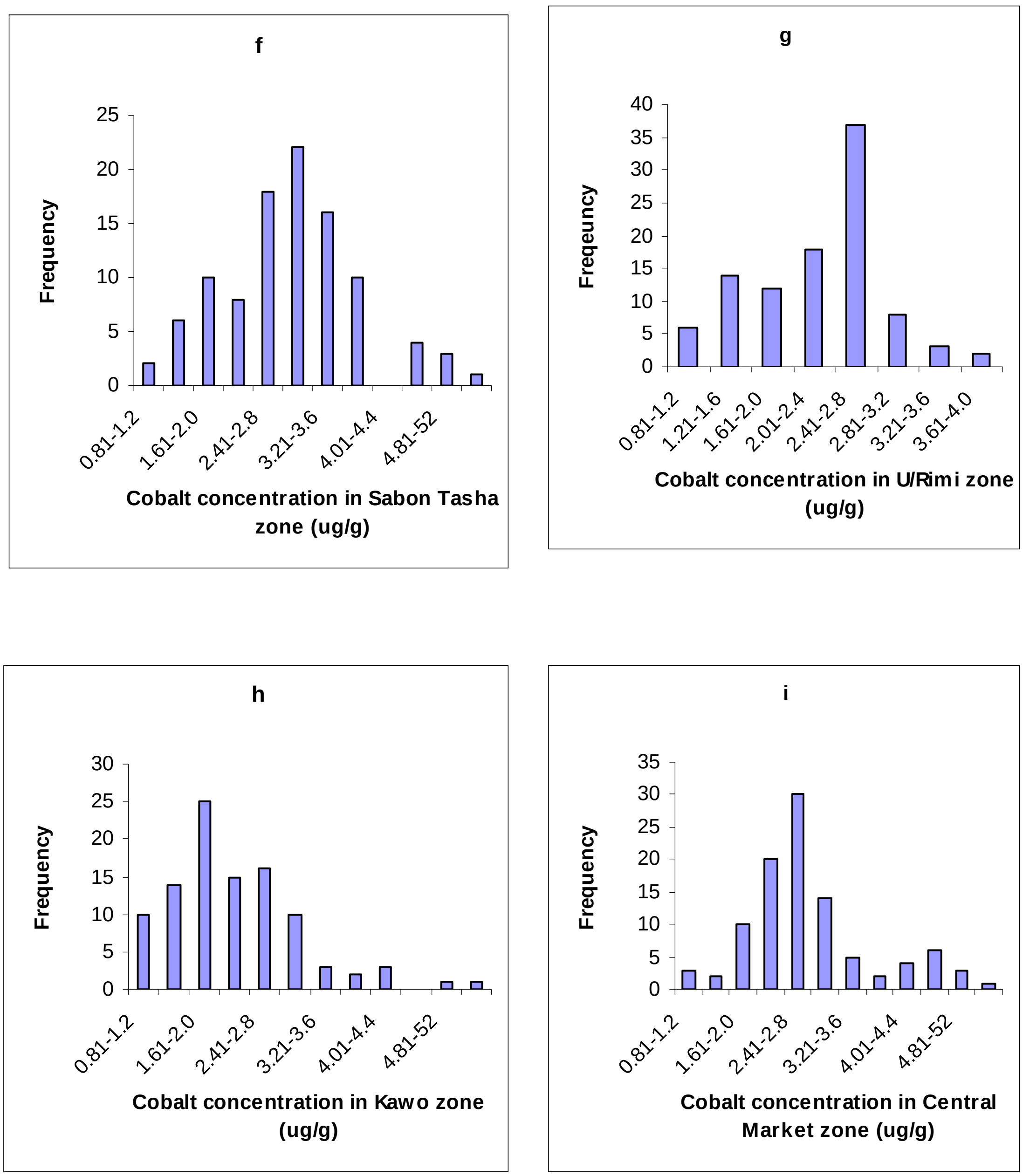


**Fig. 3: Frequency distribution of cobalt in zones f-i**

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