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A Survey of Levels of Some Heavy Metals in Scalp Hair of Urban Dwellers: A Case Study

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Abstract: Fifty eight samples of scalp hair were collected from donors of different trades in fourteen locations in Benin City and its environs and analyzed for Pb, Ni, V, Cr, Cd and Zn by atomic absorption spectroscopic method. The results obtained were subjected to data analysis such as factor analysis, correlation coefficient matrix and cluster analysis in order to determine the contributing sources and the behaviour of these metals. The highest mean levels of 8.60, 0.95 and 5.53 μg g^{-1} were obtained for Pb, Ni and Zn from donors: Traffic wardens, Battery chargers and Vulcanizers, respectively. For the control mean levels of 0.44, 0.05 and 0.20 μg g^{-1} were also determined for Pb, Ni and Zn for the non exposed persons in the same age group as the traffic wardens and small- scale entrepreneurs. Two factors were identified as source contribution from the result of factor analysis and this was in agreement with the cluster analysis and correlation coefficient matrix for both the locations and the metals. There was a significant effect of vehicular emission, industrial or commercial activities in the result obtained from donors in Benin metropolis than that of the controls, but no correlation between the levels of these metals and ages of the donors was established.

Key words: Toxic heavy metals, urban dwellers, scalp hair, small scale entrepreneurs, factor analysis

INTRODUCTION

In recent years, especially during the United Nations Development Decade industrialization in the developing countries and indeed in Nigeria has gradually led to the deterioration, degradation and contamination of the one time natural environment. Man's quest to modernize his environment has brought about great changes in the natural environment both intentionally and accidentally. Man has affected his environment by his agricultural activities, heavy industrial activities, construction works and other technological advancements. The consequences of all these are the introduction into the ecosystem of toxic chemical substances including heavy metals which may bring about the pollution of the environment.

Human beings, animals, vegetation and soils are the ultimate recipients of heavy metal constituents of particulate matter in the atmosphere. Since hair and nails accumulate trace elements for longer periods and are metabolically inert, the tissue may serve as important indicators for occupational exposure to heavy metal pollutants which can be toxic to humans. Also the use of hair and nails for such analysis, rather than urine or blood, as has been the convention in poisoning incidents and similar studies, has the advantage of facilitating specimen collection and storage. In contrast with blood and urine, which normally must be collected by specialists under very careful conditions to avoid contamination, samples of hair and nails can easily be collected by unskilled personnel.

Air pollution from motor vehicles in developing countries has not yet present a problem of the magnitude reached in highly industrialized countries. But as urbanization and industrialization develop in these countries, the contribution to air pollution from motor vehicle emissions has increased very rapidly as been reported (Ndiokwere, 1984). Some authors have explored the quantitative analysis of lead in scalp hair as an aid in clinical diagnosis of chronic and acute lead poisoning (Renshaw *et al*., 1972; Petering *et al*., 1973; Valkovic *et al*., 1975; Chattopadhyay *et al*., 1977; Fergusson *et al*., 1981). Some trace elements have been measured in hair and nails (Hammer *et al*., 1971; Gordon, 1973; Ndiokwere, 1985).

Air analysis has been used to determine the mineral status in animals and humans. Hair tissue analysis has been found to be an excellent tool for monitoring general health, nutritional status and toxic heavy metal exposure for both animals and humans (Manson and Zlotkin, 1985; Bhattacharya *et al*., 2004; Underwood, 1977; Chatterjee *et al*., 2004a, b; Muller, 1996; Gobel, 1998; Laker, 1981).

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In Benin City, traffic lights in junction areas along motorways hardly function. Traffic wardens are therefore deployed to these junction areas to allow free flow of traffic. Small-scale entrepreneurs are also concentrated along these motorways. These two categories of people are believed to be more exposed to some toxic heavy metals caused by environmental pollution resulting from automobile exhausts, road dust re-suspension, smoke and gases from industries and refuse incineration that are common in these part of the country.

In this study, the levels of some toxic heavy metals lead, nickel, zinc, chromium and cadmium in scalp hair of traffic wardens and small scale entrepreneurs along motor ways in Benin City, Nigeria have been determined. The background levels of these metals in scalp hair of people around rural areas where the level of these metals are considered minimal were also determined. The results obtained from this analysis will go a long way to ascertain the exposure level of these categories of people to these toxic metals and consequently reflect its abnormal level in the body after exposure.

MATERIALS AND METHODS

Sampling: Fourteen sampling locations were selected for this study. Twelve sampling locations were selected to cover the commercial centers of Benin City, where traffic wardens and small scale entrepreneurs were prevalent and well expose to motorized vehicle emissions and exhaust from industrial activities. Two locations were chosen to serve as control.

Samples of hair were taken with stainless steel clippers from fifty males made up of traffic wardens and small scale entrepreneurs (age 22 to 42 years) along motor ways in Benin City. The information supplied `by the donors showed that the scalp hair samples had not been dyed or bleached. The hair samples were stored in carefully labeled polyethylene bags and identified with the age of donors, sampling location and nature of business. Specimen of hair to serve as 'control' were similarly obtained from eight supposedly non-exposed male residents in the outskirt of Benin City, a rural village of about eighty kilometer from Benin City. This was to establish the normal level of these metals in the tissue. Difficulties were however, encountered in obtaining these samples because of the beliefs of people in this part of the World and are usually hesitant at given human tissue for non-clinical reason.

Pre-treatment of samples and analysis: Each hair sample was soaked in deionised water with stirring to remove any externally attached dust particles and other contaminants, which might also, contained trace metals. After each wash, the water was decanted and the sample was further boiled for few minutes, rinsed with deionised water and dried between filter papers. The samples were finally washed with carbon tetrachloride, CCl_4, by allowing a sufficient amount to cover the air. This was necessary to remove any oils or grease substances. The hair was thereafter rinsed with CCl_4 and air-dried.

The washing procedure was also necessary to ensure that salts of Na, K, Mg and Ca, which are normally accumulated by these tissues during growth, were quantitatively removed. This washing procedure is in agreement with the observations of Ndiokwere (1985) and Bate and Dyeer (1967), that the concentrations of some heavy metals in hair were essentially not affected by a similar washing procedure because of their tendency to complex with sulpurhydryl groups in the follicular proteins.

At the completion of the washing procedure, 1.0 g of the hair sample was accurately weighed and placed in a 250.0 mL polypropylene beaker and 10.0 mL of concentrated HNO_3 was added. The beaker was left over at room temperature and then heated to dryness. After cooling, 10.0 mL 30% hydrogen, H_2O_2, solution was added and heated again nearly to dryness. The residue was re-dissolved with 10.0 mL of 4.0 M HCl, warmed up and transferred to 500 mL volumetric flask. This was diluted with deionised water and made up to the mark. The solution was used for the elemental analysis.

For the analysis, the metal concentrations were determined in all standard solutions, samples and blank by atomic absorption spectroscopic method (AAS) using Buck Scientific Model 200A/210 atomic spectrophotometer with digital read out and appropriate Hollow cathode lamps as energy source for each element. Standard metal solutions were prepared from their pure metallic forms. All reagents were of BDH grade.

RESULTS AND DISCUSSION

The results of Pb, Ni, V, Cr, Cd and Zn levels measured in the hair of the 50 males of small scale business entrepreneurs (artisans and traders) along motor ways in Benin City are presented in Table 1. The Table also shows the ages of the donors and the location in Benin City. The Pb, Ni, V, Cr, Cd and Zn levels measured in the hair of 8 non-exposed donors resident in the outskirts of Benin City and a rural village (Usen and Idun) is also presented in Table 1. The mean levels of heavy metals in different donors and trades per sampling location are presented in Table 2 and 3, respectively.

Table 1: Concentrations of heavy metal (μg g^{-1}) in different donors

Location	Donor's occupation	Donors Approx. age	Pb	Ni	V	Cr	Cd	Zn
Urubi	Vendor	32	6.41	0.19	0.20	0.10	0.10	5.52
	Vulcanizer	38	5.87	0.19	0.10	-	-	4.77
	Vulcanizer	22	6.58	0.10	-	0.13	0.10	3.27
	GSM-Operator	24	5.52	0.10	0.15	0.20	0.12	2.76
Uselu	Trader	22	3.56	-	0.10	0.17	0.20	2.76
	Trader	28	4.45	-	-	-	0.10	2.09
	Taxi driver	30	4.63	0.10	-	0.13	-	2.09
	Trader	29	3.91	0.11	0.20	0.17	-	2.51
Ugbowo	Vulcanizer	22	8.36	0.36	0.40	0.20	0.10	5.52
	Vendor	24	7.83	0.36	0.20	0.13	0.12	5.52
	Traffic-W.	30	8.60	0.12	0.20	0.17	0.10	5.27
	Trader	28	8.54	0.12	0.10	-	-	3.26
Ring Rd.	Trader	32	7.20	0.36	0.40	0.30	0.18	3.26
	Trader	35	7.12	0.30	0.10	0.20	0.10	5.53
	Trader	28	6.58	0.10	0.40	0.40	0.30	5.03
	GSM-Operator	38	6.05	0.12	0.10	0.20	0.10	5.53
Third	Trader	40	6.23	0.10	0.15	-	0.10	4.77
	Trader	28	6.76	0.19	0.20	0.20	-	5.02
	Trader	31	3.20	0.30	0.10	0.13	-	5.02
	GSM-Operator	26	5.69	0.10	0.10	0.13	0.12	4.02
Sapele	Welder	41	4.98	0.37	0.12	0.20	0.10	3.26
	Welder	29	4.80	0.19	0.20	0.20	0.10	3.02
	Taxi Driver	37	4.98	0.19	0.20	0.13	0.20	4.02
	Motor Mechanic	25	3.91	0.10	0.12	-	-	4.27
Siluko	Battery Charger	29	7.12	0.15	0.10	0.20	0.12	5.05
	Vendor	33	6.23	-	0.12	0.17	0.20	2.26
	Commercial Motocycle	38	6.05	-	-	0.13	0.10	2.24
	Welder	39	5.34	0.20	0.18	0.13	0.12	4.52
Textile	Trader	28	6.23	0.36	0.40	0.27	0.30	3.26
	GSM Operator	27	5.34	0.31	0.10	0.20	0.18	2.26
	Commercial Motorcyclist	31	5.16	0.36	0.12	0.13	0.10	4.02
	Trader	26	6.05	0.20	0.20	0.13	0.12	5.03
Ekewan	Trader	30	3.20	0.10	0.30	0.20	-	3.26
	Trader	32	3.03	-	0.12	0.13	-	2.01
	Motor Mechanic	38	3.85	-	-	0.20	0.10	2.01
	Motor Mechanic	26	2.31	0.10	0.10	0.13	0.12	1.76
New Benin	Trader	31	6.41	0.07	0.30	0.20	0.10	4.77
	Commercial Motorcyclist	28	6.23	0.20	0.20	0.27	0.20	4.27
	Vendor	29	7.12	0.42	0.18	0.27	0.20	4.27
	GSM Operator	33	5.52	0.95	0.20	0.13	0.10	3.32
Ikpoba	Vulcanizer	32	7.12	0.36	0.32	0.20	0.20	4.52
	Trader	38	6.76	0.30	0.20	0.20	0.10	4.27
	Trader	29	7.12	0.19	0.10	0.13	0.12	4.02
	Trader	30	6.05	0.95	0.20	0.13	0.10	5.27
Agbor Rd.	Traffic Warden.	31	7.83	0.19	0.18	0.13	0.20	5.53
	Motor Mechanic	28	6.94	0.10	0.18	0.17	0.18	5.27
	Battery Charger	36	7.30	0.20	0.38	0.30	0.10	5.27
	Trader	37	7.12	0.36	-	0.20	0.12	4.77
Usen	Student	24	0.17	-	-	-	-	0.20
	Student	25	0.14	-	-	-	-	0.12
	Student	22	0.17	-	-	-	-	0.10
	Student	23	0.35	-	-	-	-	0.20
Idun	Student	28	0.31	-	0.10	-	-	0.20
	Student	30	0.35	0.95	0.08	-	-	0.20
	Student	24	0.44	0.83	-	-	-	0.10
	Student	26	0.62	0.83	-	0.13	0.10	0.20

The reported levels of these elements represent the mean values of three replicated analyses of each sample. The levels of these elements measured in the hair of the small scale entrepreneurs along motor ways in Benin City are well above the concentration range measured for the control group. The high level of these elements in the hair of the small scale entrepreneurs can be interpreted to be largely due to their exposure to motorized vehicle emission (automobile exhaust) and industrial activities.

In recent times, there has been a tremendous increase in traffic volume in Benin City due to the increase in the level of industrialization (especially small scale industries) and commercial activities; Benin City is also a transitory town. As a transitory town, Benin City experiences daily heavy traffic flow from the western to the eastern and northern parts of the country. The high level of Pb and Zn in the hair of these small scale entrepreneurs and traffic wardens is not unconnected with emissions from

Table 2: Mean levels and ranges of heavy metal (μg g^{-1}) in donors along motor ways in benin city

Variables	Minimum	Maximum	Mean
AGE	23.50	34.75	-
Pb	0.20	8.32	5.091±2.435
Ni	0.00	0.33	0.186±0.109
V	0.00	0.33	0.164±0.098
Cr	0.00	0.23	0.129±0.066
Cd	0.00	0.18	0.095±0.054
Zn	0.15	5.25	3.380±1.601

Table 3: Mean levels of heavy metal (μg g^{-1}) in different trades in the sampling locations

Sampling locations	Pb	Ni	V	Cr	Cd	Zn
Urubi (UR)	6.05	0.15	0.08	0.10	0.08	4.00
Uselu (US)	4.12	0.10	0.05	0.08	0.08	2.48
Ugbowo (UG)	8.32	0.30	0.22	0.15	0.08	5.25
Ring road (RR)	6.78	0.32	0.25	0.22	0.18	4.02
Third junction(TH)	5.50	0.18	0.12	0.10	0.05	4.72
Sapele Rd. (SA)	4.68	0.12	0.15	0.12	0.10	3.62
Siluko Rd (SI)	6.20	0.10	0.10	0.12	0.12	3.55
Textile mill Rd (TX)	5.72	0.12	0.28	0.18	0.18	3.65
Ekewan Rd (EK)	2.85	0.05	0.12	0.15	0.05	2.32
New-Benin (NB)	6.32	0.30	0.22	0.22	0.12	4.00
IkpToba (IK)	6.80	0.15	0.20	0.15	0.12	4.12
Agbor Rd (AG)	7.28	0.22	0.25	0.18	0.15	5.25
Usen (UN)	0.20	-	-	-	-	0.12
Idun (ID)	0.42	0.10	0.02	0.02	0.02	0.18

Table 4: Inter-correlation coefficient matrix for the elements

Correlation	Pb	Ni	V	Cr	Cd	Zn	Correlation
Pb	1.000	0.757	0.551	0.767	0.725	0.960	Pb
Ni		1.000	0.916	0.796	0.766	0.712	Ni
V			1.000	0.854	0.786	0.602	V
Cr				1.000	0.835	0.726	Cr
Cd					1.000	0.433	Cd
Zn						1.000	Zn

motor vehicle exhausts and from the wears and tears of brake pad and tyre to which they are exposed. Other factors responsible for the high levels of these elements in the hair of the small scale business entrepreneurs include road side dust, metal works and activities of other artisans.

The concentrations observed in the hair tissues have no correlation with the age of the donors but mainly dependent on anthropogenic sources.

Inter elemental relations: The correlation coefficient matrixes for the elements and the sampling locations are presented in Table 4 and 5. Correlation coefficient of 0.5 was taken as significant.

From Table 4, all the elements (parameters) determined are strongly correlated except V which is moderately correlated with Pb. In the same vein Cd is moderately correlated with Zn. This might be attributed to the same source as earlier refer to in the text. It might also be due to refuse incineration and other industrial processes. The sampling locations are also correlated as seen in Table 5 except Idun and Usen.

Source identification: One of the objectives of this study is to identify source contributing heavy metals in the areas under study. Therefore, the results were subjected to Factor Analysis (FA) and Cluster Analysis (CA). The results of factor analysis for the elements and sampling locations are presented in Table 6 and 7, respectively.

Two factors were identified for both the elements and sampling locations. Factors with variances ≥ 1 are significant. In this case there are two significant variances greater than unity and that explains the 80.52 and 10.67% for the elements (Table 6 and 7a-c). Those of the sampling locations are 98.47 and 1.40%. This signature represents a common source for all the elements and the sampling locations as seen from the positive correlation of all the elements and the sampling locations except Idun and Usen.

From Table 6, factor 1 has high loadings in Pb and Zn. This might probably represent vehicular emission/auto exhaust and industrial activities while factor 2 with high loadings in Ni, Cr, V and Cd might be due to road side dust, variety of metal processing industries and artisans. Table 7a which represents the factor analysis for the sampling locations have high loading for all the sampling locations except for the 'control' sites. All the sampling locations are moderately loaded in factor 2 and this is in agreement with the results of the correlation coefficient matrix (Table 5). The distinctive behaviour of Pb and Zn in Factor 1 also manifested itself in the result of varimax rotations for the elements (Table 7b and c). Pb and Zn were less significant in the first factor as compared to other metals and then significantly appear in Factor 2 in a less association with other metals. This indicates that roadside dust, varieties of metal processing industries and artisans are responsible for the levels of these elements found in the hair samples collected for analysis. The results of factor analysis for the sampling stations (Table 7b) showed that seven sampling stations participated to a lesser extent in Factor 1 while the remaining stations participated actively in Factor 2. This was in agreement with that of the varimax rotations.

The mean levels of these metals were highest for the traffic wardens, vulcanizers and battery chargers and lowest for the control sites when the various occupations/trades were compared (Table 8). This implies that these trades' men will be prone to the deleterious effect of these metals which will likely manifest itself health wise in the near possible future.

Table 5: Correlation coefficient matrix for the sampling locations

Correlation	UR	US	UG	RR	TH	SA	SI	TX	EK	NB	IK	AG	US	ID	UR
	1.00	0.99	0.99	0.98	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.09	0.03	UR
US		1.00	0.99	0.99	0.98	0.98	0.99	0.99	0.98	0.99	0.99	0.99	0.09	0.04	US
UG			1.00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.09	0.04	UG
RR				1.00	0.97	0.98	1.00	0.99	0.98	0.99	1.00	0.99	0.10	0.05	RR
TH					1.00	0.99	0.97	0.98	0.99	0.98	0.97	0.99	0.10	0.07	TH
SA						1.00	0.98	0.99	0.99	0.99	0.99	0.99	0.10	0.10	SA
SI							1.00	0.99	0.98	0.99	0.99	0.99	0.09	0.05	SI
TX								1.00	0.98	1.00	1.00	0.99	0.10	0.04	TX
EK									1.00	0.98	0.98	0.99	0.10	0.08	EK
NB										1.00	1.00	0.99	0.10	0.04	NB
IK											1.00	0.99	0.10	0.05	IK
AG												1.00	0.10	0.03	AG
UN													1.00	0.90	UN
ID														1.00	ID

Table 6: Principal factor (Component) analysis for the elements

	Factors		
Variables	1	2	Communalities
Pb	0.430	0.888	1.000
Ni	0.825	0.444	1.000
V	0.930	0.276	1.000
Cr	0.800	0.484	1.000
Cd	0.809	0.403	1.000
Zn	0.353	0.925	1.000
% of Variance	80.524	10.675	
Possible factors	Vehicular emission/ Automobile exhaust and Industrial activities	Road side dust/ variety of metal processing industries and artisan's	

Table 7a: Principal factor analysis for the sampling locations

	Factors		
Variables	1	2	Communalities
UR	0.784	0.620	1.000
US	0.754	0.655	1.000
UG	0.764	0.645	1.000
RR	0.742	0.669	1.000
TH	0.861	0.505	1.000
SA	0.830	0.557	1.000
SI	0.739	0.672	1.000
TX	0.760	0.650	1.000
EK	0.850	0.526	1.000
NB	0.762	0.648	1.000
IK	0.750	0.661	1.000
AG	0.810	0.587	1.000
UN	0.827	0.562	1.000
ID	0.496	0.866	1.000
% of Variance	98.474	1.404	
Possible factors	Vehicular emissions, Industrial activities	Road side dust, varieties of metal processing industries and artisans	

Table 7b: Varimax rotation for the elements

	Factors	
Variable	1	2
Pb	-0.261	0.615
Ni	0.322	-0.094
V	0.513	-0.335
Cr	0.277	-0.037
Cd	0.338	-0.125
Zn	-0.350	0.710

Table 7c: Varimax rotation for the sampling location

	Factors	
Variable	1	2
UR	0.113	-0.023
US	-0.036	0.158
UG	0.011	0.102
RR	-0.095	0.230
TH	0.557	-0.567
SA	0.364	-0.330
SI	-0.109	0.248
TX	-0.012	0.129
EK	0.483	-0.476
NB	-0.002	0.117
IK	-0.058	0.185
AG	0.249	-0.190
UN	0.344	-0.305
ID	-1.093	1.440

Cluster analysis: The results were also subjected to cluster analysis with the aid of cluster package using Euclidean Distance and complete linkage furthest neighbour as a measure of correlation. The results obtained for the elements and the sampling locations are shown in Fig. 1 and 2. These results are in agreement with the results of factor analysis. Two major clusters were identified for the elements and the locations, respectively. There was a significant clustering of Pb, Zn and Ni, V, Cr, Cd. That observed for the sampling stations are RR, IK, UR, NB, SI, TX, TH, SA and AG, UG, US, EK, UN, ID.

V/Ni ratio: Vanadium is found in petroleum in relatively high levels. It is associated with crude oil in two forms, as organo-metallic complexes of high molecular weight (Porphyrins) and as asphaltenic component of crude oil (Okuo and Ndiokwere, 2006). Hence vanadium is released into the atmosphere as a result of residual oil combustion. The ratio of vanadium to nickel in crude oil is about 2. This ratio has been used to identify residual oil as contributing to ambient fall out particles. The vanadium/nickel ratio obtained in this study is approximately 1.05. The reduction in the V/Ni ratio might result from the various stages which the crude oil had undergone before it is put into final use.

Table 8: Comparison of mean levels of heavy metal concentration in hair of donors of the various occupations/trades

Location	Denors occupation	Duration (Years)	Daily operation (h)	Level of heaving metal (μg g^{-1}) Pb	Ni	V	Cr	Cd	Zn
Ugbowo	Traffic warden	10	8	8.36	0.36	0.20	0.40	0.10	5.27
Agbor Rd.	Traffic warden	10	8	7.83	0.30	0.15	0.30	0.30	5.53
Agbor Rd.	Battery charger	12	11	7.30	0.30	0.40	0.40	0.20	4.77
Siluko Rd.	Battery charger	9	11	7.12	0.20	0.20	0.20	0.10	3.27
Ugbowo	Vulcanizer	9	11	8.36	0.36	0.20	0.30	0.20	5.52
Ikpoba Hill	Vulcanizer	8	11	7.12	0.36	0.15	0.20	0.20	5.52
Urubi	Vulcanizer	6	11	6.58	0.19	0.15	0.20	0.30	4.52
Urubi	Vulcanizer	2	11	5.87	0.19	0.18	0.17	0.18	3.27
Ugbowo	Vendor	6	8	7.83	0.36	0.20	0.13	0.12	5.52
New Benin	Vendor	5	8	7.12	0.36	0.12	0.17	0.20	2.26
Urubi	Vendor	7	8	6.41	0.19	0.20	0.10	0.10	5.52
Siluko Rd.	Vendor	4	8	6.23	0.19	0.20	0.17	0.10	4.52
New Benin	Commercial motocycle	6	12	6.23	0.20	0.20	0.27	0.20	4.27
Siluko Rd.	Commercial notocycle	5	12	6.05	-	-	0.13	0.10	2.24
Textile Rd.	Commercial notocycle	3	12	5.16	0.36	0.12	0.13	0.10	4.02
Ring Rd.	GSM-operator	2	10	6.05	0.12	0.10	0.20	0.10	5.53
Third	GSM-operator	2	10	5.69	0.10	0.10	0.13	0.12	4.02
Urubi	GSM-operator	1	10	5.52	0.10	0.15	0.20	0.12	2.51
New Benin	GSM-operator	2	10	5.52	0.95	0.20	0.13	0.10	3.32
Textile	GSM-operator	1	10	5.34	0.31	0.10	0.20	0.18	2.26
Sapele Rd.	Welder	18	10	4.98	0.37	0.12	0.20	0.10	3.26
Sapele Rd.	Welder	3	10	4.80	0.19	0.20	0.20	0.10	3.02
Sapele Rd.	Taxi driver	7	14	4.98	0.19	0.20	0.13	0.20	4.02
Uselu	Taxi driver	5	14	4.63	0.10	-	0.13	-	2.09
Agbor Rd.	Motor mechanic	5	12	6.94	0.10	0.18	0.17	0.18	5.27
Ekewan Rd.	Motor mechanic	3	12	2.31	0.10	0.10	0.13	0.12	1.76

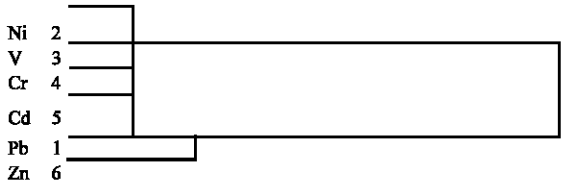

Fig. 1: Cluster analysis/dendrogram of the elements

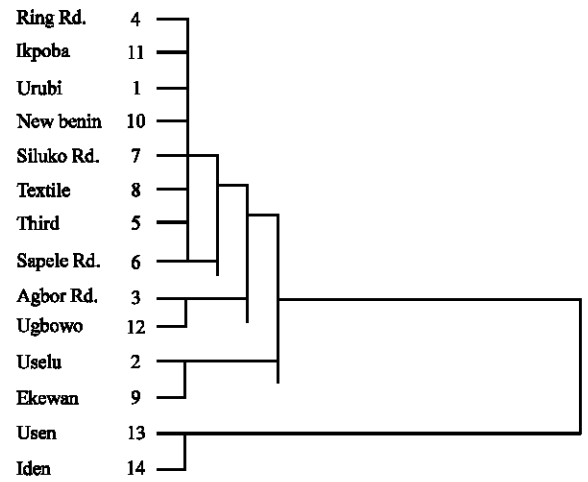

Fig. 2: Dendrogram of the locations

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