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Effect of Occupation on the Levels of Lead in Human Blood in Kenya

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Abstract
The occupation an individual is involved in exposes him or her to different levels of lead from the work environment. The main occupation of the study subjects included working in the petrol stations, teaching, nursing, street hawking, doing clerical work, working in public vehicles, farming and schooling. The aim of the study was to determine the effect of occupation on the lead levels in human blood in Nairobi City and Nyamira District, Kenya. The subjects involved in the different occupations were randomly selected and recruited for the study. The study used a questionnaire to assess lead exposure factors of the recruits, while atomic absorption spectroscopy and differential pulse anodic stripping voltammetry were used for determining the lead levels. The street hawkers in Nairobi City centre had the highest mean blood lead level of 36.85 16.98 µg/ dl while the teachers of Nyamira Town had the lowest mean blood lead level of 8.1 5.3 µg/ dl. The study provides an additional data pointing to elevated blood lead levels in occupationally exposed individuals.

Key words: Occupational exposure, BPb, AAS, DPASV.

1. Introduction

The occupation of an individual exposes them to different environmental lead levels. The main sources of human exposure to lead include leaded gasoline, industrial process such as lead smelting and coal combustion, lead-based paint, lead containing pipes or lead based soldier in the water supply systems and use of glazed ceramics (Mogwasi *et al*., 2012; Mbaria, 2007). Lead is taken into the human body by either inhalation or ingestion. Inhalation of lead occurs mainly from the polluted atmosphere that comes from industrial emissions or vehicular exhausts. The latter has been the most important source in many cities due to high densities of vehicles that use leaded gasoline (Ankrah *et al*., 1996). Lead is added to petrol in the form of organic lead compounds but the exhausts contain predominantly inorganic lead aerosols. Thus the atmospheric concentration of lead particles is usually high in areas where there is heavy vehicles traffic. The lead particles remain in the air from where some are inhaled by human beings and some are brought to the ground by rain. Lead in the soils and ground water may be taken up by plants and enters the food chain, leading to man (Onyari *et a.l*, 1991). Food becomes contaminated with lead at the source or during preparation. Canned food, water from distribution systems with lead pipes and food prepared, stored or served in lead glazed earthen ware have been found to contain high levels of the metal (Mogwasi *et al*., 2012). Studies carried out in Nigeria revealed that the occupational exposure of human subjects to lead significantly increased blood lead (59.6 ± 15.9 µg/ dl) compared with non exposed subjects blood lead (35 ± 7 µg/ dl; $p < 0.01$) (Dioka *et al*.,2004).

2. Materials and Methods

2.1 Sampling and Sampling Procedures

Four hundred subjects both male and female aged between 18 and 70 years were randomly recruited from four study sites in Nairobi City and Nyamira District. In Nairobi City the Central Business Center assumed to be highly polluted from high vehicular densities, close proximity to industries and other activities and a suburban region with medium level of pollution and subjects involved in different occupations. In Nyamira District participants from the Nyamira Town as an upcoming town with subjects involved in different occupations and therefore expected to have medium levels of pollution similar to Nairobi suburban, and a rural region with very few vehicles and no industries nearby were sampled. The subjects filled a questionnaire and provided blood samples. A questionnaire was used to collect information on occupation, known risk factors for increased lead exposure including traveling, smoking, use of glazed ceramics, and distance of residence from the road and working or living near factories/industries (Mogwasi *et al*., 2012).

The research protocol was approved by the Kenyatta National Hospital Ethics and Research Committee and the relevant Medical Officers in the study areas. All participants were explained of the study objectives and procedures and counseled on the lead exposure reduction procedures, and their willingness to participate sort. Blood samples, 5 ml, was collected from each subject into lead free vacutainer tubes containing 5 drops of EDTA anticoagulant by a qualified laboratory technician. The blood was stored in a cool box and transported to either Nyamira District Hospital or Kenyatta National Hospital for the preservation. Analysis for blood lead was carried out at Kenyatta University, Department of Chemistry Laboratory using an AAS procedure.

2.2 Laboratory Procedures

To 5 ml of whole blood sample 10 ml of concentrated nitric acid was added in a beaker and digested slowly below boiling point for 3 hours on a hot plate in a fume chamber. When the volumes had been reduced to about a third, 5 ml of 30 % hydrogen peroxide solution was added, evaporated at the same temperature and then the residues were dissolved in 10 ml of 1 % nitric acid and filtered. The digested blood samples were placed in 10 ml plastic vacutainer tubes which were free from lead and taken to Kenyatta University for analysis. The treatment [by wet digestion] of blood was done at Nyamira District Hospital for samples collected in Nyamira while those collected in Nairobi were treated at Kenyatta National Hospital. Strict precautions were taken when handling the blood samples to minimize HIV infection including disinfecting working area with a 5 % phenol.

The lead levels in digested samples were determined in triplicate by AAS (Buck Scientific Model 210 VGP) and DPASV (Buck Scientific Model 780 ZPV) procedures, which were validated using calibration, co-efficiency of variation and recovery methods. Freshly prepared standard solutions, together with a blank solution were used to construct the calibration curve and its regression equation used to determine concentration in samples. The relationships between the blood lead levels and the occupation of individuals were determined by correlation coefficient and linear regression. Further linear regression equations were used where applicable to enable prediction or estimation of the blood lead levels. The t-test was carried to determine the contribution of occupation of the subjects on the lead levels in the human blood.

3. Results

The subjects in Nairobi City Centre, Nyamira Town and Nairobi Suburban were more exposed than Nyamira Rural in terms of there working conditions. In Nairobi City Centre, Nyamira Town and Nairobi Suburban 28 %, 20 % and 16 % of the subjects worked in petrol stations, respectively, while14 %, 16 % and 20 % respectively were either involved in driving/conducting that possibly highly exposed them to lead. 26 % , 22 % and 14 % of Nairobi City Centre , Nyamira Town and Nairobi Suburban subjects respectively were involved in street hawking which mildly exposed them to lead and the rest of the subjects were involved in the occupations which lowly exposed them to lead (Teaching, nursing, farming and working in non lead factories). Nairobi Suburban subjects were exposed to lower environmental pollution than those at the City Centre while Nyamira Rural subjects were least exposed to environmental pollution.

The majority of the Nairobi City Centre subjects had monthly income of below 10,000 (54 %) while 46 % earned between Ksh 10,000-30,000. Most of the Nyamira Town subjects had an income of below Ksh 10,000 (78 %). The majority of the Nairobi Suburban subjects recruited had a monthly income of between Ksh 10,000-30,000 (38 %) while the majority of the subjects recruited from Nyamira Rural had a monthly income of below 10,000 (70 %). There were no subjects recruited who had a monthly income of above Ksh 30,000 for Nairobi city centre and Nyamira Rural, while 28 % of those from Nairobi Suburban earned above Ksh 30,000.

The street hawkers in Nairobi City Centre had the highest mean BPb level of 36.85±16.98 µg/dl, while clerks in Nyamira Town had the lowest mean BPb level (13.2±6.83 µg/dl) among the subjects recruited. Those who worked in occupation such as driving/conducting of public vehicles, petrol station attending and street hawking had high blood lead levels than those who worked in occupations like teaching, farming, nursing and clerical jobs. The differences in the mean BPb levels of those involved in other occupation and the clerks was statistically significant ($p < 0.05$) for Nairobi City Centre, Nyamira Town and Nairobi Suburban.

The results show that working in the petrol station, street hawking, driving/conducting of public vehicles exposed the subjects to high levels of lead. This is because there are lead emissions into their working environment by vehicles which are still using leaded gasoline (Mbaria, 2007).

The levels of BPb decreased with rise in monthly income. The subjects with no income had the highest BPb level in Nairobi City Centre, Nairobi Suburban and Nyamira Rural subjects with mean BPb levels of 34.47±19.89, 29.97±16.88 and 25.44±8.27 µg/dl, respectively. Those who earned above ksh30,000 had the lowest mean BPb levels in Nairobi City Centre, Nyamira Town and Nairobi Suburban with mean BPb levels of 19.70±5.42, 15.25±3.89 and 22.31±11.31 µg/dl, respectively. The mean BPb levels of subjects with incomes of above Ksh 30,000 and those with an income of below Kksh 10,000 were statistically significant ($p < 0.05$) in Nairobi City Centre, Nyamira Town and Nairobi Suburban. The subjects recruited in Nyamira Rural had income of less than Ksh 10,000 per month.

4. Discussion of results

The fact that the lowest income group in each area had the highest BPb level showed vulnerability of the low income. Mahaffey (1995) noted that BPb values of 10 µg/dl and above was common among children from low income population in the U.S. The association of the low income groups with high BPb levels could be due to risky marginal malnutrition, which besides increasing absorption of lead also increases susceptibility to the toxicity of the metal (USCDC, 2004). The subjects who worked in those occupations which required them to travel frequently using vehicles which are still using leaded gasoline or in the atmosphere which had high levels of lead had high blood lead levels. Those subjects who earned higher salaries were found to have low levels of lead. This was because they had enough resources which enabled them to feed on diets rich in calcium, phosphorus and zinc which mitigated the levels of lead in their blood. These our results agree with those found by other authors, for example studies by Dioka *et al* (2004) in Nigeria revealed that occupationally exposed human subjects had significantly increased blood lead levels compared to those that are not exposed.

The high BPb levels of those living close to or working in factory/industry or working near factory suggest that some factories emit lead to the environment. The mean BPb levels of subjects working in various Korean industries ranged from 55.4 µg/dl for those who worked in plastic product industries to 123 µg/dl for those who worked in radio and television broadcasting apparatus (KMOL, 2004; Kim *et al*., 2005). The work place is the primary source of lead exposure to adult workers in many industries including bridge building, house painting, battery manufacturing and radiator repair (USEPA, 2005). Paints and paint varnishes are known to contain a lot of lead (KMOL, 2004). Two subjects from Nyamira Town who had very high lead levels (117 µg/dl) worked with paints daily. The two subjects also resided within a range of 50 M from the moderate roads and were frequent users of glazed ceramics.

The results showed that blood lead levels were dependent on environmental as well as dietary factors. The main environmental risk factors identified were use of glazed ceramics, working or staying within 50 meters from a road busy with vehicular traffic, working/living near factory and cigarette smoke. The subjects who consumed diets rich in zinc, calcium and phosphorus had low levels of lead.

5. Conclusions

The subjects who were recruited for the study in the various study areas were exposed to different levels of environmental exposure to lead and they had diverse feeding habits. The main factors which were established to expose human beings to lead included; use of glazed ceramics, traveling, cigarette smoke, living/working near factories and residing within 50m of a busy road. Most individuals whose occupations exposed to these factors were found to have higher mean BPb levels than those whose occupations limitedly exposed.

The subjects from Nyamira rural (control) had the lowest mean BPb levels than those from Nairobi City Centre, Nairobi Suburban and Nyamira town. This was as a result of limited environmental exposure to lead in the rural setting as compared to towns. On the other hand, diets influenced the BPb level of the subjects. For instance, most of Nairobi suburban subjects earned better salaries enabling them to feed on balanced diets rich in Ca, Zn and P as compared with those from Nyamira town. The Nairobi Suburban subjects had lower mean BPb level (26.12±17.96 µg/dl) than that of Nyamira town (27.69±32.29 µg/dl) and Nairobi city centre (29.9±16.91 µg/dl). The differences between the mean BPb levels of Nyamira Rural and Nairobi City Centre were statistically significant ($P < 0.05$, df = 99). The results also revealed that those subjects who worked in well paying jobs feed on diets that had higher levels of Ca, Zn and P (Nairobi suburban residents) in their blood and had lower levels of lead. This is because the Ca, Zn and P tend to mitigate the levels of lead in the human body (mahaffey, 1985). These elements hinder the absorption and retention of lead in the human body. The study was able to reveal that the occupation of the individual determined his or her blood lead level.

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List of tables

Table 1: The percentage distribution of the subjects in different occupations in the four study areas

Occupation	Percentage distribution			
	Nairobi city Centre	Nyamira Town	Nairobi Suburban	Nyamira Rural
Petrol station attendants	28	20	16	0
Street hawking	26	22	14	0
Drivers/conductors	14	16	20	0
Teachers	10	16	10	0
Clerks	10	18	30	0
Farmers	0	0	0	70
Nurses	12	10	10	0
students	0	0	0	30

Table2: The percentage distribution of the monthly income of the subjects in the four study areas.

Monthly income(Ksh)	Percentage distribution				
	Nairobi city Centre	Nyamira Town	Nairobi Suburban	Nyamira Rural	
No income	0	0	10	12	
Below 10,000	54	78	24	70	
10,000-30,000	46	14	38	18	
Above 30,000	0	8	28	0	

Table3: The mean and the range of BPb levels (µg/dl) of the subjects grouped according to their occupation in the study areas.

Occupation	Mean Lead Concentration (range) (µg/dl)			
	Nairobi City Centre	**Nyamira Town**	**Nairobi Suburban**	**Nyamira Rural**
Petrol station attendant	27.75 8.18 (29-68)	36.5 22.64 (32-117)	26.3 5.83 (23-34)	None
Street hawking	36.85 16.98 (35-107)	33.4 36.98 (0-107)	27.84 14.51 (8-53)	None
Driving/conducting of public vehicles	35.50 19.54 (35-85)	36.71 25.17 (19-83)	29.1 18.3 (23-64)	None
Teaching	18.24 8.26 (10-40)	8.1 5.3 (0-45)	17.24 7.32 (0-25)	None
Clerical jobs	16.3 3.34 (15-20)	13.32 6.83 (1-37)	15.52 13.32 (5-38)	None
Nursing	25.86 9.8 (10-48)	13.37 8.32 (6-17)	24.99 17.89 (10-82)	None
Farming	None	None	None	21.2 8.7 (8-35)
Schooling	None	None	None	25.98 7.01(10-40)

Table 4: The mean and the range of BPb levels (µg/dl) of the subjects grouped according to their monthly income in the for study areas.

Monthly income	**Mean lead concentration (range) (µg/dl)**			
	Nairobi City Centre	**Nyamira Town**	**Nairobi Suburban**	**Nyamira Rural**
No income	34.47 19.89 (40-107)	None	29.97 16.88 (0-82)	25.44 8.27 (8-40)
Below 10,000	32.60 18.62 (10-85)	31.30 33.79 (0-117)	26.54 8.40 (14-48)	20.17 3.87 (12-26)
10,000-30,000	24.3 9.4 (30-54)	24.5. 22.39 (15-107)	24.89 4.82 (13-38)	None
Above 30,000	19.70 5.42 (15-30)	15.25 3.89 (10-21)	22.31 11.31 (0-62)	None