Levels of heavy metals (Cd, Pb) in blood donors at the Kinshasa University Hospital.

Le taux sérique des métaux lourds (Pb, Cd) *chez des donneurs de sang aux Cliniques Universitaires de Kinshasa.*

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Résumé

Objectif. Déterminer le taux sérique de cadmium et de plomb chez des donneurs de sang à Kinshasa, en RD Congo.
Méthodes. Cent vingt-quatre donneurs sains ayant fréquenté la banque du sang des Cliniques Universitaires de Kinshasa (CUK) entre le 1er janvier et le 31 décembre 2006 ont constitué l'échantillon d'étude. Leurs données cliniques ainsi que les taux sériques de Cadmium et de Plomb ((µg/l) ont été enregistrés. La sphectrométrie d'émission de masse a permis le dosage des métaux lourds et les moyennes obtenues ont été comparées entre hommes et femmes à l'aide du test t de Student. Les corrélations avec les paramètres anthropométriques étudiés ont été recherchées par le coefficient de corrélation de Pearson.
Résultats. Le taux moyen de cadmium était respectivement de 1.00 ±0.70 µg/l et de 5.07 ±1.00 µg/l chez les hommes vs les femmes ; tandis que celui du plomb de 93.59± 9.00 µg/l vs 100.76 ± 13.00µg/l. La différence entre les sexes était significative quant à l'imprégnation au cadmium (p=0.02). Une corrélation positive a été notée pour le cadmium avec l'âge (p< 0.00), et la parité (p=0.03). Le taux sérique de plomb était quant à lui, inversément corrélé au poids chez les hommes (p< 0.05). L'imprégnation toxique était plus marquée chez les femmes pour les 2 métaux, tout en l'étant d'avantage pour le plomb (81% vs 23% pour Pb et 25% vs 4% pour le Cd)
Conclusion. L'étude révèle une forte imprégnation de cadmium et de plomb chez les donneurs sains de Kinshasa et justifie des recherches plus approfondies sur les potentiels risques sanitaires dans cette population.

Mots clés : Donneur de sang; Cadmium et Plomb sériques

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Summary

Objective: To assess the serum levels of cadmium and lead in blood donors living in Kinshasa, Democratic Republic of Congo.
Methods.One hundred and twenty four healthy blood donors were recruited at the blood bank of the Kinshasa University hospital from January 1st to December 31th, 2006. Clinical data from the donors were recorded and serum levels of cadmium and lead (µg/l) were assayed by means of emission atomic spectrophotometry. Mean values in men versus women were compared using the Student t test, and correlations between serum levels of the two heavy metals and anthropometric parameters were assessed using the Pearson correlation coefficient.
Results: Mean blood levels were 1.00 ±0.70 µg/l vs 5.07 ±1.00 µg/l for cadmium, and 93.59± 9.00 µg/l vs100.76 ± 13.00µg/l for lead, respectively in men versus women. Cadmium impregnation was significantly different between women and men (p=0.02). Cadmium blood level appeared strongly correlated with age (p< 0.00) and parity (p=0.03), while a negative correlation was found between lead blood level and the weight only in men (p< 0.05). The toxic impregnation for both metals was higher in women; being more pronounced for lead (81% vs 23% for Lead; 25% vs 4% for Cadmium).
Conclusion: This study indicates a high impregnation of cadmium and lead in blood donors living in Kinshasa and highlights the accuracy of further investigation on related health risks.

Keys words : blood donor, cadmium, lead, blood levels

Introduction

Metals are present as trace elements in biological fluids at concentrations <1 µg/g of wet weight (1). Among these elements, some are non-essential and toxic, such as cadmium and lead. The later is an environmental contaminant generated by human activity (2, 3), and also associated with high toxicity, and has no evident enzymatic or metabolic benefit (4-6).

These heavy metals can affect vital functions directly via their toxicity or indirectly by inhibiting the absorption of essentials trace elements.

Cadmium environnemental or occupational exposure has many implications on renal function and skeletal development (4-7). The effects of high lead exposure on the kidney and the growth of the nervous system in children and infants were also reported (8). Other observed abnormalities were high blood pressure and microcytic anemia; the later could be induced by low iron absorption (4).

Previous studies have shown the availability of blood measures to assess the health risks of environmental and occupational exposure (6, 8-10). These studies aimed at helping the communities in the control of the quality of the environment, which is one of the millennium development goals of the United Nations for improvement of community health (2, 3).

Industrial pollution, food and tobacco consumption are the main contributing factors to bioaccumulation of cadmium and lead (4, 11-13). Food intake of cadmium in meals and water is estimated to be around 80% and the main source of lead is the intake of cereals and vegetables growing near mineral zones with intense activity (10, 11, 14).

Reports on environmental monitoring of indices of air, water and food pollution in Kinshasa have suggested a high risk exposure to cadmium and lead (10, 15-18). The present study aimed at determining the serum levels of cadmium and lead in Congolese blood donors living in Kinshasa, Democratic Republic of Congo.

Study site and subjects

A written informed consent was obtained from 124 healthy blood donors (88 women and 36 men, aged 16 to 49 years) attending the blood bank of the Kinshasa University Hospital. These donors were enrolled for a crossectional study covering the period of January 1st to December 31st 2006. Medical history of participants was recorded and parameters including the age, sex, smoking, alcohol consumption, cardiovascular diseases, current use of cholesterol-lowering medications, of vitamin-mineral supplements, and of hormone replacement therapy were probed by individual interview using a pre-established questionnaire. Clinical data on blood pressure, type of diabetes, heart or kidney failure, urinary tract infection were obtained. Information on serological status for syphilis or HIV infection, proteinuria by qualitative method, pregnancy and anaemia were recorded.

The serum levels of cadmium and lead were determined using the emission spectrophotometer.

Inclusion criteria for the study

Included subjects should be with no alcohol dependence, no current smoking status, no current use of steroids or other medications for chronic diseases. Those with high blood pressure (systolic > 139 mmHg or diastolic> 90 mmHg), type I diabetes , heart or kidney failure, urinary tract infection, hepatitis, syphilis or HIV infection, proteinuria by qualitative method, pregnancy (for women), anaemia (haemoglobin ≤ 1.62mmol/l) were excluded.

Assessement of serum levels of cadmium and lead

Blood was collected by arm vein puncture and centrifuged as previously reported (19-22). The serum samples were then stored at –20°C before lyophilisation. Prior to analyses, samples were submitted to microwave digestion in presence of 0.1% nitric acid (Merck Chemicals, South Africa) and 0.1% H2O2, and then diluted with distilled water to the 10ml-mark in a flask. All samples (n=124) were assayed for cadmium and lead with a coefficient of variation less than 10%. Quality control procedures were performed using a standard reference material to check each assay method.

Cadmium and lead were measured by atomic emission (Perkin-Elmer with inductively plasma) one year after sampling. The lyophilized samples were analysed under the following conditions: energy 1200 watts, nebulisation debit: 1.0 l/minute, plasma: 15 l/minute, Auxiliary Gaz: 0l/minute, pomp: 1.0 ml/minute. Intensity correction was performed by computer and integration time was 10 seconds. The detection limit was 0.03 µg /l and the ambient air was controlled to exclude atmospheric contamination. Serum cadmium and lead values (µg/l) are expressed as mean +/- SD of three separate assays. The values below the detection limit were considered null.

Ethical considerations

All subjects provided written informed consent and data were collected and managed anonymously, in conformity with ethical rules.

Statistical analysis

Data analyses were performed with the use of SPSS software (version 13.00). Comparison of means was made using the Student t test. Correlations between continous variables were obtained using the Pearson Correlation coefficient. The level of significance was set at 5%.

Results

The general characteristics as well as the distribution of serum levels of cadmium and lead (mean ± SD) of blood donors are summarised in Table 1.

Table 1. Characteristics, serum cadmium and lead levels in Congolese blood donors (*mean± SD*)

Variables	Men (n = 36)	Women (n = 88)	p
Age (*years*)	32.72± 9.00	29.39± 11.00	0.11
Height (*cm*)	163.64± 5.00	164.22±6.00	0.61
Weight (*kg*)	66.75± 14.00	63.53± 10.00	0.16
Cadmium (***µg/l***)	1.00±0.70	5.07±1.00	**0.02***
Lead (***µg/l***)	93.59± 9.00	100.76±13.00	0.74

The serum level of cadmium was significantly higher in women (5.07±1.00 µg/l) as compared to men (1.00 ±0.7µg/l) (p=0.02). Table 2 illustrates a negative correlation between cadmium serum level and age (p< 0.00) and between cadmium serum level and parity (p=0.03) in women. In men, a negative correlation was found between lead serum level and weight (p= 0.04).

Table 2: Correlations between serum levels of cadmium and lead and anthropometric variables in men and women.

Traces elements	Correlation	Men variables			Women variables			
		Age	Weight	Height	Age	Weight	Height	Parity
Cadmium	R	0.03	0.20	0.07	-0.32	-0.10	-0.02	-0.23
	P	0.86	0.24	0.69	0.00*	0.38	0.88	0.03*
Lead	R	0.06	0.35	0.16	0.10	0.10	0.00	0.57
	P	0.39	0.04*	0.19	0.33	0.35	0.53	0.60

**: p-value less than 0 .05*

The toxic impregnation to cadmium was found in 4% of men and 25% of women. The toxic levels of lead were found in 23% of men while 81% of women showed toxic levels of this heavy metal (Table 3).

Table 3. Distribution of serum levels cadmium and lead according to the gender

Level	Men						Women					
(µg/l)	normal	n	%	Toxic	N	%	normal	n	%	toxic	n	%
Cadmium	**< 0.5**	31	25	**>0.75**	5	4	**< 0.5**	57	46	**>5.07**	31	25
Lead	**< 1**	1	2.41	**93.59**	28	23	**< 1**	18	15	**100**	70	81

n = number of cases

Discussion

The objective of the present study was to evaluate the level of cadmium and lead impregnation in Congolese blood donors living in Kinshasa. The choice of this group of subjects was based on their potential healthy status as prerequisite. We used blood serum as matrix despite homeostatic regulation mechanisms (23), for ethical (acceptability and accessibility) and technical (obtaining cellular blood from a homogenous population) convenience; the other matrix was excluded.

In this study, a single blood sample was collected because the number of days is not important for individual assessement of results (7).

In men, the serum cadmium and lead levels were 1.00±0.70 µg/l and 93.59± 9.00 µg/l, respectively; whereas, in women, they were 5.07±1.00 and 100.76 ±13.0 µg/l, respectively. In the former group, 4% had toxic levels for cadmium and 23% had toxic levels for lead. The level of heavy metals was nevertheless higher in women, 25% for cadmium and 81% for lead (table 4).

Table 4 Reported data on serum cadmium and lead levels in Kinshasa population and in the literature (*µg/l*)

Authors	Year	Men		Women	
		Cadmium	Lead	Cadmium	Lead
WHO	1997	0.1-0.3	< 1	0.1-0.3	< 1
NHANES ɠ	2002	-	15.6	-	
Hutse et *al.*	2006	-	33	-	
Tuakuila et *al.*	2010	-	127	-	114
Kamba et *al.*	2011	1.00	93.59	5.07	100.76

ɠ NHANES: the National Health and Nutrition Examination Survey

Our results show a significantly higher serum cadmium level in women (p=0.02), suggesting a different degree of exposure of this group of female donors to heavy metals and perhaps a different pattern of health-related conditions.

Ortherwise this study has many limitations, which can affect the power of the results. First of all, the choice of a selected study population doesn't allow any extrapolation to the whole population of Kinshasa, therefore introducing a great selection biais. Secondly, the lack of informations on nutritional habits or occupational exposure of the participants is another major limitation on the accuracy of the obtained values, in addition to the difference in sample size between the 2 genders (more women than men). Aarhus previous report shows clearly the need of correlation of the bio-accumulation of cadmium and lead with occupations of the populations for a powerful interpretation of measures (23).

The levels of serum lead (> 100 µg/l) in the present study are relatively low as compared to those reported for some cities in the developing countries (24). These levels remain nevertheless very high in industrialised countries (25, 26). A slighty difference has been reported by Tuakila et al in a pilot survey in the same city of Kinshasa (16). This non significant difference in lead mean value (120 vs 100 µg/l) could be related to technical conditions or clinical presentation in the study population such as the timing for blood sampling, blood pressure level during sampling, stress, glucose and fructose concentrations, inflammatory status of patients, use of anticoagulant, storage conditions, and use of total blood as matrix…. Some authors have mentionned the likelihood of some confounders on the individual profile of blood lead and cadmium levels (20, 22, 27). Different methodological approach, as the use of total blood as matrix is known to raise the blood level of some trace elements (7, 22).

Highest values found in women compared to men for both heavy metals could be related to different occupational exposure as source of contamination as reported elsewhere (1, 3, 9).

An abundant medical literature devoted to the environmental risk of contamination by heavy metals has elucidated many risk factors (1, 6, 7). In our country, some identifiable factors could be the intensity of uncontrolled traffic, the lack of treatment of water used for domestic purposes or industrial matters. The poor management of used water by manufacturing companies located near water supply sources and distribution stations is also to be considered (10, 15, 16). Human activities are a great source of generation of environmental pollution by heavy metals, which can be discharged toward downstream area and inhaled (29). The consumption of insufficiently treated domestic water is an important vehicle of traces elements and toxic heavy metals. Using fishes from some rivers in Kinshasa as indicators, Musibono et al. reported an inefficient removal of heavy metals in the treatment process of water from the rivers before distribution for domestic use. They suggested there should still remain some cadmium and lead traces in water pipes in Kinshasa (15). This situation was highlighted by previous reports on the quality of drinking water in analyzed samples from different locations in Kinshasa. Cadmium and lead concentrations of respectively 21 µg/l and 49 µg/l were reported (10, 15, 16).

An additional environmental exposure risk is due to the soil texture in Kinshasa, which is essentially of sand type. Indeed, it is well established that filtered water from sandy soils, known to be rich in organics matters, increases the bio-disponibility of cadmium and lead (29). High degree of soil humidity consecutive to water irrigation or to inadequate drainage also increases cadmium and lead absorption by the leguminous plants as described elsewhere (25). This absorption is more important when the soil acidity is elevated, resulting in a higher concentration of metals in water (29, 30).

Considering the low lead phyto-toxicity, cooking ustensil or ceramic product content in lead may also contribute to the food contamination by lead (8, 11). The use of handmade or artisanal

manufactured ustensils in foundries is a common phenomenon in Kinshasa. To our knowledge, there is no evidence-based analytical study about the chemical composition of final products in these manufactures, thus limitining the real assessement of the extent of the related environmental health risk.

Conclusion

This study indicates a high impregnation of cadmium and lead in blood donors living in Kinshasa and highlights the need for detailed investigations on related health risks in the future. The higher toxic impregnation in women emphasizes the need for targeted interventions in this vulnerable group. Further research assessing the real health risk in our milieu should be encouraged to really state the related environmental health conditions

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