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Blood cadmium concentrations in general population of Tripoli region, Libya

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Abstract: *Cadmium is very well known as a toxic element and the epidemiological data linking cadmium and lung cancer are more apparent than for prostate cancer. Measurement of blood cadmium is important to monitor its levels for general population. In this study, blood cadmium of 116 male and 84 female of Libyan population aged 20 years or older from Tripoli region was determined using graphite furnace atomic absorption spectrometry (GFAAS). Lipid profile for the same samples including cholesterol, LDL, HDL and triglycerides were measured for comparison. Blood plasma cadmium levels were correlated positively with age (P for trend = 0.05). In the present study, the mean (SD) of cadmium concentrations of Libyan population was 0.86 µg/l (0.43), with the highest value 2.31 µg/l. These values showed that no risk cadmium levels were detected in blood for Libyan population in the current study.*

Keywords: *cadmium, blood plasma, Lipid profile, Tripoli region, Libya population*

I. Introduction

In the human body, cadmium is known to accumulate, particular in the lungs and kidneys, as recognised by [1]. This has the potential to result in kidney renal tubular damage. Importantly, humans may become exposed to cadmium from a number of sources, such as food and soil, with the occupational exposure of workers potentially arising within the mining industry. With this in mind, it is possible that cadmium may result in some degree of kidney dysfunction, consequently resulting in the re-absorption of various elements, namely amino acids, glucose and proteins [2]. During recent times, researches carried out on both animal and human samples have shown that skeletal damage (osteoporosis) may be a dangerous and very serious cadmium exposure-related outcome. Exposure to cadmium contributes to the development of numerous adverse health effects and causes a number of diseases, including cardiovascular conditions [1,3]. In the same vein, the lungs may also be affected as a direct result of exposure to cadmium [4]. A number of other cadmium exposure-centred outcomes may be recognised, including instabilities in terms of calcium metabolism and the occurrence of kidney stones.

Cadmium is one of reactive oxygen species which can be effect on glutathione and protein-bound sulfhydryl groups, which may induces increased lipid peroxidation [5]. In addition, biological structures containing sulfhydryl (–SH), carboxyl, and phosphate groups are highly attracted by cadmium, which inhibit various enzymes and disturb some metabolic processes, including lipid metabolism [6].

Few animal studies have focused on cadmium effect on lipid metabolism. These experimental animal studies reported that cadmium may cause alterations in the serum and tissue concentrations of some lipid compounds, including total cholesterol and other lipids parameters; otherwise, cadmium may cause dyslipidemia in various experimental modalities [6-9]. However, from these studies less reliable association between cadmium and lipid profile have been seen. It became very important to measure cadmium levels in human blood and connects with other human parameters such as lipids profile. In recent study, the correlation between cadmium and lipid profile in the blood for Korean population was investigated [10].

Measurement of cadmium levels in human blood and monitoring it from time to time among populations is become important. There are many studies from Mediterranean countries have determined cadmium concentrations in human blood for their populations such as Tunisia [11-15]. In the current study, aims were to determine cadmium concentrations in blood serum for Libyan population and to investigate the correlation between cadmium and lipid profile for the same population.

II. Materials and methods

2.1. Blood sample collection and study population

Ethical approval from biotechnology research centre (Tripoli, Libya); Ethics committee; was obtained for a study investigating the dietary and lifestyle habits of Libyan population from Tripoli region. Ethical approval was obtained for a questionnaire containing a series of questions regarding diet and exercises and the

volunteers were also asked to provide blood samples. The blood samples collected and serum was separated using centrifuge and then were kept at - 20°C until further analysis. Informed consent was obtained from the volunteers prior to sample collection and questionnaire completion. It was only possible to obtain blood samples from 200 volunteers. These samples were collected from Tripoli region during April 2013. The age of volunteers was ranged between 20 – 65 years. All these volunteers reported to be non-smokers (n=104) and smokers (n=96). The male percentage was 58% for all samples (see Table 1).

This study has been designed for determination of cadmium, and lipid profile in 200 blood plasma samples which were collected from people are living in Tripoli city, Libya. These samples were divided into three groups as an age factor for male and female (see Table 1).

2.2. Reagents

Deionized water was used for the preparation of reagents and standards. Analytical grade HNO_3 Nitric acid 63% v/v (BDH, UK).A commercial (Fisher) standard solution of cadmium (1000 mg/L) was used to prepare the standards. Hydrogen peroxide (W-WLAB, UK), ammonium dihydrogen phosphate (Merck, Germany) and Triton X -100 were used in the current study.

2.3. Sample preparation

Selected volume (about 5 ml) of blood was taken from each person and put it in unclothing tube (lithium heparin tube). All tubes were kept in refrigerator at $4C^{o}$ for analysis. 2 ml from the blood sample and 2 ml of diluted (1%) triton X-100 solution were putted in a centrifuge tube (Eppindorf tube) and the mixture in the tube was homogenised using a shaker for several seconds, after that the tube containing homogenised solutions were transferred to a centrifuge for four minutes with 10000 R / min. The upper layer (plasma) was transferred to a small cup using Pasteur pipettes. However, blood samples were analysed, total C, LDL-C, HDL-C and triglycerides were measured by enzymatic methods with commercially available kits. Cadmium concentrations in blood plasma samples were analysed using graphite furnace atomic absorption spectrometry.

2.4. Digestion procedure

Blood plasma samples were digested as a follow: 8 ml of concentrated nitric acid (63%) and 2 ml of hydrogen peroxide (30%) were mixed and then added to 1.5 ml of blood sample (plasma) in a Teflon container. The mixture was digested in microwave digester for complete digestion. A microwave digester with a power of 1000 Watts and a maximum temperature of 230˚C (Ethas plus, pty, Italy) was used in the current study. Cadmium concentrations in the digested samples were measured using graphite furnace atomic absorption spectrometry (GFAAS) model AA-8600FS Shimadzu Corporation with GTA-110 Graphite furnace.

2.5. Quality control and standard reference material

In the current study, standard solutions were prepared in a 10 ml measuring flask by addition of a certain volume of stock solution less than or equal 50 µl and completed with a 1% diluted triton X-100 solution to the mark. Standard solutions of cadmium were prepared in the range of 3 – 50 µg/l. Cadmium concentrations obtained by GFAAS technique were evaluated by the use of certified reference materials (QMEQAS 07B-06 and QMEQAS 07B-07, NIST, Canada) and were found to be in good agreement with the certified values of the reference materials.

2.5. Statistical analysis

Means and standard deviations (SDs) or standard errors (SEs) of blood plasma cadmium concentrations were calculated. Estimate statements in linear regression models were used to determine the adjusted mean and 95% confidence intervals (CIs) of each lipid measure with increasing cadmium level according to the quintile. The presence of a linear trend was evaluated by defining a linear contrast in each linear and logistic regression model. All statistical analyses were conducted using SPSS software (version 17).

Table 1: Demographic characteristics of participants in the Libyan population aged 20 years orolder.

Characteristics	No.	%
Sex		
Male	116	58
Female	84	42
Age (years)		
20–39	80	40
40–59	80	40
≥ 60	40	20
Education		
High school	20	10
> High school	180	90
Regular exercise		
Yes	47	23.5
No	153	76.5
Cigarette smoking		
Never	104	52
Current smoker	96	48

III. Results

The current study involved 200 libyan adults aged 20 years orolder; their demographic characteristics are presented in Table 1. Mean age and BMI of the current study population were 44.5 years, 21.4, respectively.

The Descriptive statistics and outcomes of the study participants of blood plasma cadmium concentration are presented in Table 2. Mean (SD) and median for blood plasma cadmium concentrations were 0.86 mg/l (0.43), and 0.81 mg/l respectively (see Table 2). However, minimum and maximum were 0.30 and 2.31 mg/l, respectively.

Table 2: Descriptive statistics of blood plasma cadmium levels for Libyan aged 20 years orolder.

Descriptive		Statistic	Std Error
Mean		0.8615	0.3051
95% CI for mean	Lower Bound	0.8013	
	Upper Bound	0.9216	
5% Trimmed mean		0.8184	
Median		0.8100	
Variance		0.1860	
Std. Deviation		0.4315	
Minimum		0.30	
Maximum		2.31	
Range		2.01	
Interquartile range		0.50	
Skewness		1.630	0.172
Kurtosis		2.647	0.342

Lipids profile were also measured for the same blood plasma samples, the mean (minimum-maximum) and median (in mg/dl) were 196.9 (159.1-230.2) and 199.5 for total cholesterol, 139.0 (124.3-200.1) and 139.0 for LDL, 41.8 (28.0-55.1) and 40.0, and 197.6 for HDL, (160.2-236.4) and 200.0 for triglyceride, respectively (see Figure 1). However, mean (minimum-maximum) and median was 4.82 (3.00-7.68) and 4.88 for triglyceride/HDL ratio, respectively.

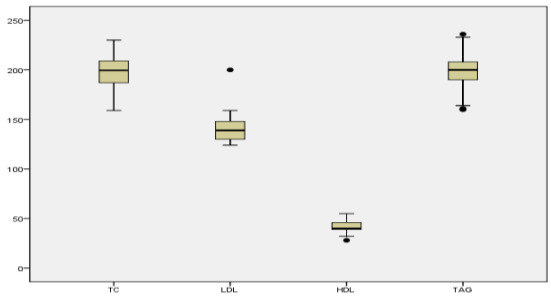

Figure 1 Box plot chart showing mean (mg/dl) and range of cholesterol (TC), low density lipoprotein (LDL), high density lipoprotein (HDL) and triglycerides (TAG).

The basic characteristics and outcomes of the results were analysed and cadmium concentrations in blood plasma samples are presented in Table 3. Blood plasma cadmium levels were correlated positively with age (P for trend = 0.05). However, no significantly correlations were found with other parameters such as sex, education, physical exercise and cigarette smoking (Table 3).

The trends in age and sex adjusted mean total C, HDL-C, LDL-C and triglyceride levels were not significantly related to increased blood cadmium concentration (Table 4). Also no significantly correction was detected for triglyceride-HDL ratio with by quintile blood plasma cadmium (Table 4).

Table 3: Demographic characteristics by quintile blood plasma cadmium categories among Libyan adults aged 20 years orolder.

Characteristics	Quintile blood plasma cadmium level (µg/L)					p for trend
	<0.51 (n=32)	0.51–0.70 (n=48)	0.71–0.91 (n=50)	0.92–1.02 (n=32)	>1.02 (n=38)	
Men, no. (%)	16 (50.0)	26 (54.2)	31 (62.0)	19 (59.4)	24 (63.2)	0.268
Age (yrs), mean (SD)	44.4 (14.3)	46.8 (12.3)	45.8 (13.5)	42 (14.1)	42 (12.8)	0.050
Education						
High school (%)	4 (12.5)	3 (6.2)	5 (10)	5 (15.6)	3 (7.9)	0.452
> High school (%)	28 (87.5)	45 (93.8)	45 (90)	27 (84.4)	35 (92.1)	0.671
Regular exercise, no. (%)						
Yes	8 (25)	9 (18.7)	10 (20)	10 (31.7)	10 (26.3)	0.623
No	24 (75)	39 (81.3)	40 (80)	22 (68.3)	28 (73.7)	0.345
Cigarette Smoking, no. (%)						
Never	13 (40.6)	19 (39.6)	26 (52)	16 (50)	21 (55.3)	0.661
Current smoker	19 (59.4)	29 (60.4)	24 (48)	16 (50)	17 (44.7)	0.312

Table 4: Age- and sex-adjusted blood lipid concentrations by quintile categories of Blood plasma cadmium among Libyan adults aged 20 years orolder.

Lipid measure mean (95% CI)	Quintile blood plasma cadmium level (µg/L)					P for trend
	<0.51 (n=32)	0.51–0.70 (n=48)	0.71–0.91 (n=50)	0.92–1.02 (n=32)	>1.02 (n=38)	
Total C (mg/dl),	196 (189.6-202.5)	192.6 (185-202.1)	200.1 (193.7-206.5)	195.1 (189.6-200.6)	198.5 (192-205)	0.340
HDL-C (mg/dl),	40 (38.5-41.5)	43 (40.8-45.2)	41.8 (40.3-43.3)	42.3 (40.1-44.4)	42.7 (40.4-45)	0.214
LDL-C (mg/dl),	140.2 (137-143.4)	138.8 (132.7-145)	137.9 (134.3-141.5)	137.1 (133.9-140.3)	137.7 (133.6-141.7)	0.808
Triglyceride (mg/dl),	198.2 (193.4-203)	194 (187.5-200.5)	200.8 (194.8-200.8)	196.9 (190.5-203.3)	197 (190.4-203.5)	0.618
Triglyceride-HDL ratio	4.97 (4.65-5.28)	4.61 (4.26-4.97)	4.85 (4.58-5.13)	4.75 (4.41-5.10)	4.73 (4.35-5.10)	0.544

IV. Discussion

It becomes very important to use some biomarkers in the epidemiological studies for detecting environmental contamination by pollutants. Cadmium body burden has been assessed using the cadmium levels in blood. Blood cadmium is most likely good estimates of cadmium body burden in environmentally exposed populations. Blood cadmium is valid biomarker of both recent exposure and long-term accumulation after long-term low-level exposure [2,16]. For this reason, in this study blood cadmium concentrations were determined for 200 persons of Libyan population and then used as a biomarker.

There is a lock of studies to measure cadmium levels in blood for Libyan population. In this study, mean ± SD (minimum – maximum) levels of cadmium in blood plasma samples (for 200 persons) were 0.86 µg/l ± 0.43 (0.30 – 2.31 µg/l).

Libya is one of Mediterranean countries which has similar climate compared with other Mediterranean countries. For Mediterranean countries, some studies of cadmium levels in blood have been reported such as Tunisia [11], Italy [12,13], Spain [14] and Egypt [15]. Feki-Tounsi et al. (2013) [11] has determined cadmium concentrations for Tunisia population, the minimum and maximum of cadmium concentrations of Tunisia study were 1.06 – 10.81µg/l. High level of cadmium in blood was detected in Tunisia study, the highest value (10.81µg/l) was very high compared with that measured in the current study (the highest value of cadmium was 2.31 µg/l) (see Table 5).

Table 5: Blood cadmium levels for Mediterranean countries.

Countries	Year	Mean ± SD	Minimum-Maximum
The current study (Tripoli region)	2015	0.86 ± 0.43	0.30 – 2.31
Egypt (Mansoura city) [15]	2002	2.07 ± 1.1	0.8 – 4.5
Tunisia [11]	2013	-	1.06 – 10.81
Spain [14]	1999	0.98 ± 0.94	-
Italy (Umbria) [12]	1999	-	– 3.4
Italy (Sardinia) [13]	2011	-	0.24 – 1.82

Egyptian study (Mansoura city) showed high mean of cadmium compared with any other Mediterranean countries except Tunisia study (2.07 µg/l) with median (1.7 µg/l) [15]. Results from the Egyptian study were twofold of that in the present study for both mean and median (see Table 5). However, the cadmium concentrations in the current were similar to that reported for both Italian and Spain populations [12-14] (Table 5).

In the current study among Libyan adults aged 20 years or older, those with high blood cadmium levels tended to be male, older and have a lower educational level, and to be heavy smokers. These results are consistent with the Korean study, which reported that high blood cadmium concentration was associated with increasing age, a less than high school education, and increased amount of smoking [10]. In the present study and the Korean studies, the cigarette smoking was one of the most important factors determining the cadmium body burden because cigarette smoke contains a considerable amount of cadmium taken up by the tobacco plant [17].

In the present study, it can be concluded that Libyan population has blood cadmium level with the uncontaminated range and no risk cadmium level was detected. On the other hand, blood plasma cadmium levels were correlated positively with age (P for trend = 0.05).

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