

# Determination of serum cadmium and lead in healthy adults from the west of Algeria

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## Abstract

Cadmium and lead are ubiquitous and non-biodegradable pollutants representing a great concern to human health. They share common environmental exposure routes through contaminated food, water, and soil. This study was conducted to determine the serum cadmium and lead levels in healthy adults. In the present work, differential pulse anodic stripping voltammetry (DPASV) using a hanging mercury drop electrode (HMDE) was used in order to determine the trace level of cadmium and lead ions in real samples. A population of one hundred and fifteen healthy adults with a mean concentration of  $0.67 \pm 0.31 \mu\text{g.L}^{-1}$  and  $53.11 \pm 3.25 \mu\text{g.L}^{-1}$  for cadmium and lead were determined, respectively. The accuracy and precision were in agreement with the certified values for both metals by using certified reference materials. Mean serum lead and cadmium in the current study indicates that in general the population studied here is not exposed to worrisome Pb and Cd levels.

**Keywords:** Serum; Cadmium; Lead; Healthy Adults; DPASV.

## 1. Introduction

Lead and cadmium are toxic elements for human; they perform no beneficial biological roles and can be very dangerous even at low concentrations. Lead is a bright silvery metal, slightly bluish in a dry atmosphere. It begins to tarnish on contact with air, thereby forming a complex mixture of compounds, depending on the given conditions (Monisha et al 2014). The main sources of lead and cadmium exposure are industrial and automobile emissions, water from lead pipes, paint, lead soldered cans, ceramics, plastic and battery manufacturing, and alloy production, smelting and refining, printing (Cho et al 2001). Absorbed from the soil, cadmium is found in certain foods, particularly potatoes, grains, sunflower seeds and leafy greens, as well as tobacco (Holdaway & Wuyi 2018). Hence human exposure of lead in the general population is either due to food or drinking water (Jenna 2018). Lead is absorbed into blood plasma from which it enters the blood cells. About 99% of lead in blood is present in erythrocytes and 90% of the total body burden of lead is found in the skeleton (Lennart 2004). The half-lives of lead and cadmium are 5–20 years in the bones and 10–30 years in the kidneys, respectively (Wu 2008). Absorbed cadmium and lead are excreted primarily in urine and reflect exposure from all sources (Yabe 2018). Lead, which affects many cellular processes and enzyme systems all over the body, has different possible mechanisms of action. The ionic mechanism of lead toxicity occurs mainly due to the ability of lead metal ions to replace other bivalent cations like  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{Fe}^{2+}$  and monovalent cations like  $\text{Na}^{+}$  which ultimately disturbs the biological metabolism of the cell (Fariborz & Abasalt 2016). The ionic mechanism of lead toxicity causes significant changes in various biological processes such as cell adhesion (Lidsky & Schneider 2003), intra- and inter-cellular signaling, protein folding, maturation, apoptosis, ionic transportation, enzyme regulation, and release of neurotransmitters (Garza & Vega 2006). Accumulated lead is toxic in most of its chemical forms, whether it is inhaled or ingested in water or food. Most research on cadmium and lead poisoning focuses more on its toxicity effects. Studies on these two heavy metals exposure and health impairment are continuing. There are studies on cardiovascular (Eshraghi et al 2017) systems effects due to lead exposure, hematopoietic (Chen et al 2015), and renal (Nasiruddin et al 2018), and there are studies on renal (Kim 2015), cardiovascular (Lee 2011), oxidative stress (Srivastava et al 2014), neurological (Mohammed et al 2016), and musculoskeletal (Jung et al 2012) systems effects due to cadmium exposure. Lead and cadmium are hepatotoxic (Andjelkovic et al 2019) and have been shown to increase viral activity (Checconi et al 2013). Studies have reported that exposure to lead increased the renal response to low levels of cadmium (Hambach et al 2013), and a dose-dependent interaction between prenatal co-exposure to lead and cadmium has been observed (Kim et al 2013).

The differential pulse anodic stripping voltammetry (DPASV) on a hanging mercury drop electrode is a good method for the determination of trace amount of metals in biological samples (Attar et al 2013). The aim of the present study is to introduce DPASV method for the determination of cadmium and lead in serum of healthy adults.

## 2. Materials and methods

### 2.1. Study area

Serum samples were collected from 115 inhabitants of Tlemcen city. All the subjects were disease-free and did not take any medication. The department of Tlemcen is situated in the northwest of Algeria. It is characterized by four big natural groups which are distinct and can be identified as follows: the littoral group, the sublittoral plain, the mountainous group, and the high steppe plains.

### 2.2. Equipment

Differential pulse anodic stripping voltammetry (DPASV) analysis was carried out on an MDE 150 polarographic stand. Measurements were carried out with a hanging mercury drop electrode, in a three-electrode arrangement. The auxiliary electrode was a wire of platinum with a considerably larger surface area than that of hanging mercury drop electrode (HMDE). An Ag|AgCl (KCl 3 M) was used as reference electrode. A magnetic stirrer and stirring bar provided the convective transport during accumulation. The whole procedure was automated and controlled through the programming capacity of the apparatus with Trace-Master 5 PC software.

### 2.3. Procedure

Ten milliliters of the supporting electrolyte solution were pipetted into the cell and deoxygenated with argon for 5 min. The accumulation potential - 950 mV was applied to a fresh mercury drop while the solution was stirred. Following the accumulation period, the stirring was stopped and after 5 s the voltammogram was recorded by applying a positive potential scan at 5 mV.s<sup>-1</sup>. All data were obtained at room temperature. The operatory conditions for determination of cadmium and lead have been optimized by (Attar et al 2012).

### 2.4. Reagents

All chemicals used were of analytical-reagent grade. Aqueous solutions were prepared by dissolving a certain amount of chemicals into high-purity deionized water. Acids used for the analysis were the nitric acid (69.5%, Fluka) and the perchloric acid (70-72%, Merck). Stock solution of cadmium and lead (1000 ppm, atomic adsorption standard, Aldrich) were prepared in deionized water. The concentration of cadmium and lead in the samples were determined using standard addition method.

### 2.5. Digestion

The procedure consisted in placing 0.5 mL of serum in a long-necked 50 mL flask together with 2 mL HNO<sub>3</sub>/HClO<sub>4</sub> mixture (3:1 v/v). The temperature of this mixture was slowly increased to 150°C for 4 hours in a hot plate, and then the temperature was maintained at 180°C until the evaporation of half of the acids. After cooling, the digested serum samples were made up to 5 mL using 0.25% HNO<sub>3</sub> and preserved in polyethylene tubes (Attar et al 2013). Special care was taken to avoid all contaminations.

## 3. Results and discussion

Since cadmium and lead are not an essential metals, the mere presence of those analyte in the individuals studied here means the existence of exposure. A linear response over the concentration range of 1.21 to 184 µg.L<sup>-1</sup> for Pb(II) and 0.19 to 1.13 µg.L<sup>-1</sup> for Cd(II) were observed under optimum conditions, with correlation coefficient (R<sup>2</sup>=1). Certified reference material for serum (Seronorm Trace Elements Serum, Billingstad, Norway) was used for the accuracy evaluation. It for lead was 97.21% and 97.47% for cadmium. The results of recovery calculated by using reference material for simultaneous determination of Pb(II) and Cd(II) by differential pulse anodic stripping voltammetry at the optimum conditions, its value obtained were 97.13%, and 97.85%, respectively. The mean values obtained in the different groups were compared by one-way ANOVA and t test. All samples and standards were analyzed by duplicates. This is strong evidence that this method is precise and reproducible.

The mean concentrations of one hundred and fifteen healthy human in the western Algerian population were 0.67 ± 0.31 µg.L<sup>-1</sup> for cadmium and 53.11 ± 3.25 µg.L<sup>-1</sup> for lead (Table 1). No significant differences were observed on blood copper concentrations after applying to them the Student's t-test.

**Table 1:** The Results of Means Cadmium and Lead Concentrations, S.D.S and Range

|                             | Cadmium     | Lead           |
|-----------------------------|-------------|----------------|
| Mean (µg.L <sup>-1</sup> )  | 0.67 ± 0.31 | 53.11 ± 3.25   |
| Range (µg.L <sup>-1</sup> ) | 0.17 - 1.87 | 23.73 - 131.65 |

No significant differences were observed, for either cadmium and lead in serum concentrations after applying to them the Student's t-test. The concentration levels of cadmium and lead in serum from Tlemcen City. It can be seen Fig. 1, using DPASV that had been obtained for the simultaneous of metals ion them. The standard addition method was used, in order to eliminate the matrix effect. The data obtained for samples spiked with known amounts of cadmium and lead showed good recoveries. The concentrations obtained for Cd(II) and Pb(II) in this sample were 0.71 µg.L<sup>-1</sup>; and 65.19 µg.L<sup>-1</sup>, respectively.

Studies on the effects of both metals on health have been conducted to date. In particular, humans are easily exposed to lead and cadmium that are present not only in the environment, but also in the food. Our study aimed to check if our city exposed in cadmium and or lead by analyzing the serum of healthy adults.

One hundred and fifteen healthy adults with a mean concentration of 0.67 ± 0.31 µg.L<sup>-1</sup> and 53.11 ± 3.25 µg.L<sup>-1</sup> for cadmium and lead were determined, respectively in west Algeria. Mean serum lead and cadmium in the current study indicates that in general the population studied here is not exposed to worrisome Pb and Cd levels.

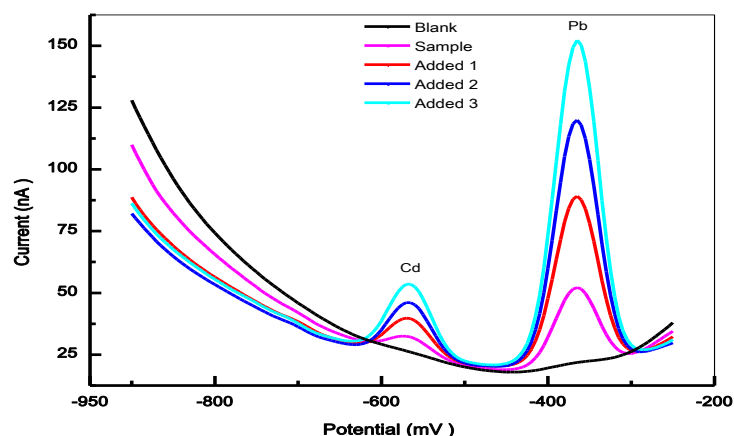


Fig. 1: Voltammograms of Cd and Pb in Serum Samples from Tlemcen City.

## 4. Conclusion

Mean serum Pb(II) and Cd(II) in the current study indicates that in general the population studied here is not exposed to worrisome lead and cadmium levels. The accuracy and precision (verified using certified reference materials) were in agreement with the certified values for both metals.

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