

Evaluation of Heavy metals (Cd, Pb and Hg) Concentrations in Serum Blood Samples of Male Smoker's and Male non-Smoker's at Sirte City – Libya: A Comparative Cross-Sectional Study

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قياس تركيز العناصر الثقيلة (الكاديوم، الرصاص و الزئبق) في عينات مصل الدم لدى المدخنين و غير المدخنين الذكور بمدينة سرت – ليبيا: دراسة مقطعية مقارنة

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Abstract:

This study investigated the levels of cadmium (Cd), lead (Pb), and mercury (Hg) in male smokers in Sirte City. Serum samples were collected from 58 male participants, including 30 smokers and 28 non-smokers (controls), aged 25 to 50 years. The blood samples were analyzed using Flame Atomic Absorption Spectroscopy (FAAS). The results indicated that lead concentration was significantly higher in the serum of smokers compared to non-smokers. Additionally, the cadmium concentration in smokers was more than 74 times that of non-smokers. However, there were no significant differences in mercury levels between the two groups.

Keywords: Heavy Metals, Blood, Smokers, Flame Atomic Absorption Spectrophotometer.

المخلص:

تناولت هذه الدراسة قياس مستويات العناصر الثقيلة (الكاديوم) و الرصاص و الزئبق لدى المدخنين الذكور في مدينة سرت ، جمعت عينات مصل الدم من 58 مشاركا ، منهم 30 مدخنا و 28 غير مدخن (مجموعة

ضابطة) ، و تتراوح أعمار المشاركين بين 25 الى 50 عاما ، و حللت عينات الدم باستخدام مطياف الامتصاص الذري باللهب و أشارت النتائج الى تركيز الرصاص كان أعلى بشكل ملحوظ في مصل المدخنين مقارنة بغير المدخنين ، بالإضافة الى ذلك كان تركيز الكاديوم لدى المدخنين اكثر من 74 ضعفا مقارنة بغير المدخنين ، كذلك لم تكن هناك فروق جوهرية في مستويات الزئبق بين المجموعتين.

الكلمات الدالة: العناصر الثقيلة ، الدم ، المدخنين ، مطياف الامتصاص الذري.

Introduction

Heavy elements are among the most important pollutants of industrial renaissance and the most dangerous to human health and all living organisms on planet Earth. Heavy elements represent an essential part of industrial waste, and the possibility of getting rid of them or disposing of them is very difficult. Their remaining in the soil and their accumulation in the cells of the human body represents a real danger that threatens human life by causing various types of cancers.

Recently, the consumption of tobacco products and the number of smokers have been steadily increasing worldwide. Smoking is a major source of intake of toxic elements. In tobacco plantations, herbicides, insecticides, and fungicides are used to control various parasites and plant diseases. Tobacco absorbs these toxic elements primarily from the soil or the environment. Once absorbed, the toxic elements enter the bloodstream and accumulate in the kidneys, impairing their ability to regulate the body's water balance. Consequently, many diseases, such as high blood pressure and cardiovascular disease, have emerged. [1]

Determining minerals and trace elements in foodstuffs is a crucial aspect of nutritional and toxicological analyses. The elements most commonly associated with health effects include cadmium (Cd), mercury (Hg), and nickel (Ni) compounds, all of which are classified as carcinogenic to humans by the International Agency for Research on Cancer. [2] Reported reference values for major U.S. cigarette brands indicate Cd levels ranging from 1.0 to 1.7 µg/g and lead (Pb) levels from 0.6 to 1.2 µg/g of dry tobacco. Additionally, cigarette smoke contains substantial amounts of Cd, with average levels in cigarettes ranging from 1000 to 3000 µg/kg. [3] One pack of cigarettes deposits 2-4 µg of Cd into the lungs of a smoker, while some smoke disperses into the air, affecting both smokers and nonsmokers alike. [4] The WHO estimates that the smoker inhales 2-6% of Pb in cigarettes. [5]

Cadmium is one of the most dangerous heavy metals affecting human health, as numerous studies have linked it to a variety of diseases and identified it as a major contributor to thyroid, pancreatic, and prostate cancers. Lead poses significant dangers due to its accumulation in the body, which can result in mental and physical developmental issues and, at high levels, can be fatal. Elevated lead levels are commonly found in industrial areas, car repair shops, oil refineries, and along asphalt roads. Mercury exposure can lead to severe poisoning and heart failure, while high levels of mercury can result in weak sperm and infertility. This toxic metal is often present in chemical laboratories, ore refining plants, and fertilizer production facilities. Despite extensive research demonstrating that cigarettes contain numerous hazardous substances and elements, many individuals continue to smoke excessively. Tobacco companies continue to profit from these products, and warning advertisements about the dangers of smoking have proven largely ineffective.

We chose these elements for measurement because their danger is confirmed and responsible for causing many diseases such as lung, prostate and skin cancer and educating people about these potential risks and the consequences of continuing to practice these harmful habits.

The main objective of this study is to determine the Concentrations of heavy metals in the blood of smokers male compared to non-smokers.in Sirte City.

Materials and Methods

The study was conducted during the period from November to December 2024. Blood samples were taken from random people at different places in Sirte City. The number of samples studied was 58 blood samples, including 30 blood samples from smoking men and 28 blood samples from non-smoking men, which were taken as a control group. Fresh blood samples were collected from men aged 25 to 50 years and kept under sterile conditions. The blood sample amount taken was (7 ml) from the forearm and stored in the median cubital vein. Coagulant was added for whole blood analysis and kept in the refrigerator. The samples were divided into 2 parts, firstly (4 ml) stored in an anticoagulant container, and the remaining (3 ml) collected in a serum container.

1- Preparation of Samples

Centrifugation is performed to separate blood from serum. After centrifugation, the serum is analyzed following the addition of deionized water and digestion by the device. For whole blood samples, wet digestion is applied prior to analysis. This process involves acid hydrolysis conducted on a hot plate. Alternatively, the procedure can be carried out in an aluminum-heating block and closed vessels at high temperatures using thermal heating. To begin, take 4 ml of the sample in a 100 ml volumetric flask and add 10 ml of nitric acid. Place the flask on a hot plate for about 2 hours, allowing the temperature to rise to 160 °C. Continue boiling regularly for an additional 2 hours to reduce the volume. Afterward, filter the samples using filter discs of grade 389 and allow the blood samples to cool. Once digestion is complete, add 10 ml of hydrogen peroxide (H₂O₂). Finally, dilute the solution to 50 ml and filter it again. The final sample solution is analyzed by FAAS. [11]

2- Instrumentation

The heavy metals in the blood samples were determined by using a Flameless Atomic Absorption Spectrophotometer (SHIMADZU, Japan). A centrifuge (Centurion Scientific, CR 2000, UK) was used for sample separation. A vortex mixer (KMC1300V, Korea), shaker incubator (GEMMYCO YCW-012S, USA), and deep freezer (LAB TECH, Korea) were used for sample preparations. All chemicals used were of analytical reagent grade and were obtained from Merck.

3- Statistical analysis

Data were expressed as means \pm standard deviation and were subjected to statistical analysis using the non-parametric Mann-Whitney U test and analysis of variance. Statistical significance was set at $p < 0.05$.

Results and Discussion

This comparative analysis reveals that smoking is strongly associated with elevated blood levels of toxic heavy metals, particularly cadmium and lead. The data support the hypothesis that tobacco use significantly increases the body burden of these harmful elements, which may contribute to the long-term health risks associated with smoking. These findings reinforce the necessity of public health strategies targeting smoking cessation, not only to prevent well-known respiratory and cardiovascular diseases, but also to reduce chronic toxic metal exposure. Table (1) shows the concentration of lead (ppm) in the blood serum of exposed groups compared to the control group. With regard to smokers, it was recently found that lead is present in high concentrations, exceeding even cadmium concentrations in the various types of cigarettes, in which the average concentration of lead and cadmium reached 2.46 mg/g and 1.8 mg/g of dry weight, respectively [6]. These ratios can also be inferred from these rates. It causes an increase in lead and cadmium in smokers' blood. This result is

consistent with the findings of Rhainds [7], indicating high levels of lead in smokers' blood. As can be seen from the results presented in Table (1), the concentration of mercury (ppm) in the serum of exposed groups is compared to the control group. There were no significant differences between the smokers' group and the control group, as its concentration in smokers' serum was ppm (0.0061 ± 0.0016), while the control group was at the ppm level (0.0052 ± 0.0053).

Table (1): Heavy metals level in serum blood of male smokers and non-smokers

Group	Amount of heavy metal ion (ppm)		
	Pb	Cd	Hg
Control	0.0045 (± 0.0016)	0.008 (± 0.004)	0.0052 (± 0.0053)
Smokers	0.0485 (± 0.0352)	0.6212 (± 0.383)	0.0061 (± 0.0016)

Figure (1) shows a comparison of cadmium concentrations in the serum of the exposed groups versus the control group. It was observed that smokers were more than 74 times more exposed to cadmium compared to the control group. The significant difference in their blood serum was measured at a level of 0.6212 ppm (± 0.383). The high concentrations of cadmium in the blood of smokers are attributed to the elevated levels of cadmium found in tobacco cigarettes, making tobacco one of its most significant sources. Smoking one pack a day results in cadmium exposure that is 5 to 10 times greater than that of infrequent smokers

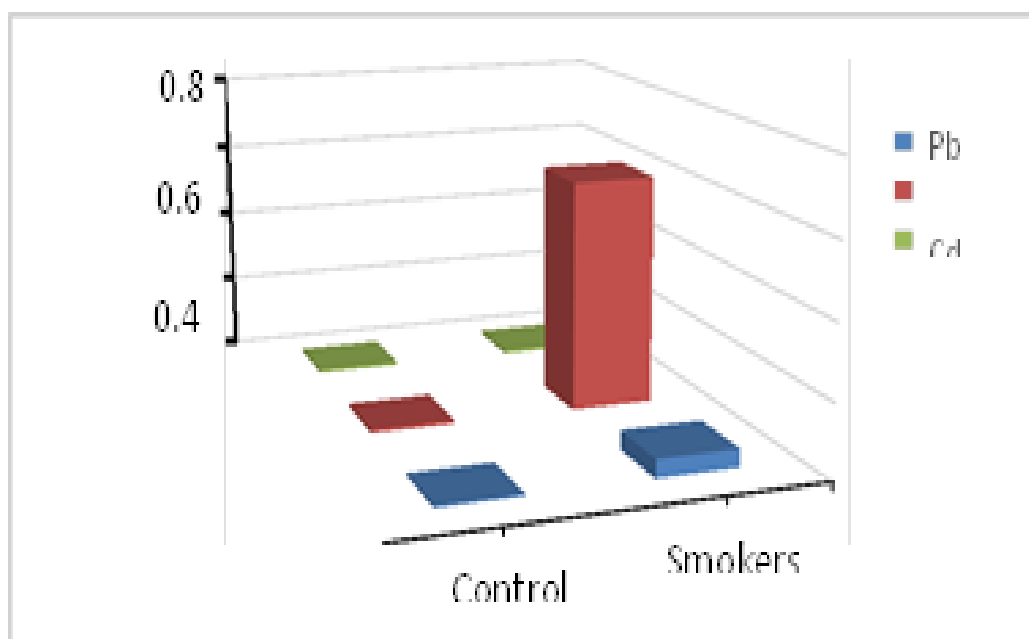


Figure (1): Heavy metals level in serum blood of male smokers

Because one tobacco cigarette contains about 1 ppm of cadmium, it is estimated that each smoker absorbs approximately 1-3 micrograms of cadmium when smoking one pack per day, which is roughly equivalent to the total estimated cadmium from all food sources. Therefore, smoking one pack (20 cigarettes) per day for a period of 20 years results in a cumulative estimate of around 20 mg of cadmium in a smoker's body [8,9]. Recently, Patricia [10] and her

coworkers revealed an increase in lead, cadmium, antimony, and barium in the urine of smokers compared to non-smokers. They explained that older smokers have toxic amounts of cadmium, as well as differences in creatinine levels between the two groups.

Conclusion

The results obtained in the present study show that mean blood cadmium, lead and nickel concentration were higher in smokers than in non-smokers. On the other hand, the study showed that the concentration of cadmium was high compared to the concentration of lead and mercury in blood serum, and this is attributed to the presence of cadmium in high concentrations in cigarettes tobacco.[12]

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