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The Effects of Air Pollution and Smoking on Cadmium Concentration in Human Blood and Correlation with Biochemical Parameters

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Abstract: Problem statement: The study described the research of the effects that the environment pollution and smoking have in cadmium concentration in human blood, as well as in the correlation between cadmium and the biochemical parameters. **Approach:** In a comparative study of cadmium concentration in blood of human population of two different environments in Kosovo, one nearby Kosovo Thermo Power Plants (Obiliq), a highly polluted environments (Investigated Group) and the other that was considered as relatively clean rural environment Dragash (control group). **Results:** The results showed that there exists a significant difference in the average concentration of cadmium in human blood between the Investigated Group (IG) and the Control Group (CG) ($t = -3.34$, $p = 0.0006$). The series of determination of cadmium concentration in blood of population that lives in this environment had shown direct effects in biochemical parameters (direct bilirubine, total bilirubine). **Conclusion:** Air pollution (from coal burning in power plant) and smoking were very important factors for the level of cadmium concentration in blood, which had an inhibitory effect in the syntheses of bilirubine.

Key words: Blood, cadmium, smoking, correlation, biochemical parameters

INTRODUCTION

Kosova possesses a considerable energy potential of coal (lignite). Currently in Kosova, coal is excavated only in the Prishtina Pool, in superficial Mines in Bardh and Mirash, which lie in an open surface, 10-15 km far from Prishtina[1]. Dust (flying ash) and bottom ash are the main components of the environment pollution, which results from the industrial area of Obiliq. These components contain elements with high toxic potential such as: Pb, Cd, As, Be and Hg[1,2].

The fact that coal contains many trace elements in it, potentially toxic, as well as the fact that a considerable amount of coal excavated in Kosova (85%) is burned to produce electricity, increased the attention of scientific institutions for the growth of knowledge regarding the presence of such elements in coal[1,2]. Measurements have shown that the emission of the crumbs of flying ash from Thermo Power Plant ”Kosova B” during 2005 exceeded the EU standards for 400-500%[4-6]. Tobacco is also a great contributor on the total level of cadmium concentration in blood. In general, smokers absorb a greater amount of cadmium compared to the other ways of absorption through human body. The human body absorbs about 1 up to 3 mg of cadmium per day through smoking[10-12]. Bilirubin is a substance produced by the breakdown of old red blood cells. Red blood cells contain hemoglobin, which is broken down to heme and globin. Heme is converted to bilirubin, which is then carried by albumin in the blood to the liver. In the liver, most of the bilirubin is chemically attached to another molecule before it is released in the bile. This "conjugated" (attached) bilirubin is called direct bilirubin; unconjugated bilirubin is called indirect bilirubin. Total serum bilirubin equals direct bilirubin plus indirect bilirubin[15]. The purpose of this study is to find the correlation between environmental pollution, smoking and the concentration of cadmium in blood[3], as well as the correlation between cadmium and Total Bilirubine (TB) and Direct Bilirubine (DB) in the blood of human population.

MATERIALS AND METHODS

We have investigated 75 human blood samples: 50 blood samples of the citizens from the industrial area of Obiliq, who in this project are treated as the Investigated Group (IG) and 25 blood samples of the citizens from the Municipality of Dragash (an environment without pollution), who in this project are treated as the Control Group (CG). The people of both of these groups were of different ages and genders.

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The preparation of samples for cadmium determination in blood was realized by putting 4.9 mL dilution solution (Triton X-100, 0.01 and nitric acid 0.1%) and 100 µL blood in monovets. Each sample was then centrifuged in 2500 rpm for 45 min after which they were put in auto-sampler cells and the measurement with GFAAS was performed[7-9] For the elimination of different obstacles during the phase of the absorbing signal measurement, there were used different modificatory matrixes in the graphite tube, like $NH_4H_2PO_4$ or $(NH_4)_2HPO_4$. Monovets with blood samples were centrifuged for 10 min 4500 rpm^{-1}, serum was divided and proceeded for analysis. Biochemical parameters were determined with BECKMAN COULTER Syncron CX7[13].

RESULTS AND DISCUSSION

In the industrial area of Obiliq, from the environmental point of view, the most important activities are those in coal (lignite) mines and the production of electric power. So, the other industrial areas of Obiliq, Power Stations Kosova and lignite mines are the biggest air contaminants in the country[1-2]. The results achieved from the analysis of blood samples on the human population of the investigated group (industrial zone of power station 'Kosova"), are compared with the results of blood samples at the human population of the control group (the population of Dragash, a mountainous municipality with a pure environment, uncontaminated). Study results, Table 1 and Fig. 1, show that there is a significant distinction between the average of cadmium concentration in blood in the investigated group and the control one. This distinction is as a result of the environmental pollution in the investigated group's locality.

Except the polluted environment, smoking is also an important factor of cadmium concentration in the blood of human population. Table 2 and Fig. 2 show the effect of tobacco in the concentration of cadmium in blood at the tested persons in the investigated group as well as in the control group. Cadmium concentration in blood in the group of smokers is evidently higher than in the group of non-smokers. This distinction is present in the control group as well as in the investigation group.

Table 1: The comparison of cadmium level in blood between Control Group (CG) and Investigated Group (IG)

	CG		IG
n	25.0000		50.0000
m, Cd (µgL^{-1})	0.7300		1.5600
SD	0.4331		1.2566
p		0.0060	
t		-3.3400	

Except the direct effect of the environmental pollution and smoking in cadmium concentration in blood, in this study the correlation between cadmium and biochemical parameters in blood is also analyzed. From the presented results in Table 3, we understand that in the investigated group there is no statistical correlation between cadmium and biochemical parameters TB and DB, whereas in the control group there exists a negative correlation with a high statistical significance between cadmium and TB and DB. Figure 3 graphically shows the difference in the correlation between cadmium and the total bilirubine in the control and investigated group. In the investigated group, flying ash that is emitted from the power station plants Kosova, except cadmium itself also contains other elements with a high toxic potential and with a higher quantity of participation in comparison with cadmium.

Table 2: The comparison of the level of Cd in blood between the smokers and non-smokers in the CG and IG

	CG		IG	
	25		50	
n	NS	S	NS	S
Percentage (%)	52.000	48.000	62.000	38.00
m,Cd (µg L^{-1})	0.420	0.980	1.080	2.28
t	-4.260		-4.620	
p	0.002		0.001	

Note: n: Number of samples, m: Average of concentration, NS: Non-Smokers, S: Smokers, t: t-test, p: Probability

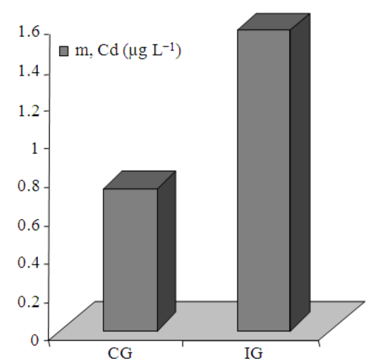

Fig. 1: Comparison of cadmium level in blood between Control Group (CG) and Investigated Group (IG)

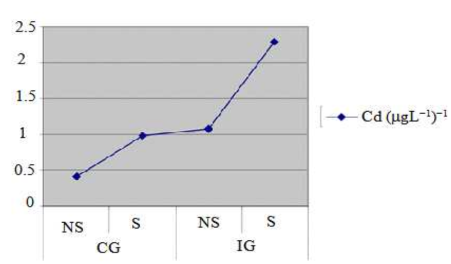

Fig. 2: The comparison of the level Cd in blood between the smokers and non-smokers in the CG and IG

Table 3: The correlation between Cd and biochemical parameters at the CG and IG

	Cd							
	CG				IG			
	n	m	r	p	n	m	r	p
DB	25	0.48	-0.393	0.0259	50	0.96	-0.105	0.2533
TB	25	11.00	-0.612	0.0005	50	10.00	-0.144	0.1815

Note: n: Number of samples, m: Average of concentration, r: Correlation index, p: Probability

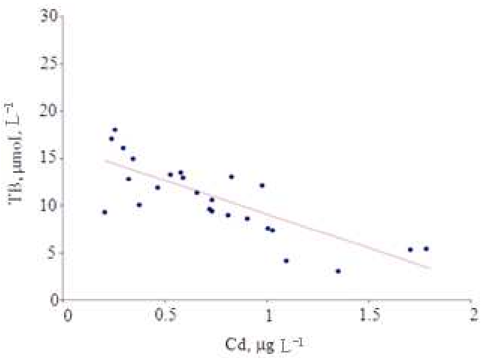

Fig. 3: Corelation between Cd and TB in the CG

The measurements have shown that lead is the main toxic component present in the flying ash (Pb = 18 mg kg^{-1}, Cd = 0.5 mg kg^{-1}, As = 0.3 mg kg^{-1}, Be = <0.5 mg kg^{-1}, Hg = 0.1 mg kg^{-1})[7]. When these toxic elements enter human organism, they are powerful competitors of cadmium in biochemical processes. As a consequence, in the investigated group there is a lack of correlation between cadmium and Total Bilirubine (TB) and Direct Bilirubines (DB). This competition is also presented in the published results[1] where it is shown that there exists a positive correlation in IG between Pb concentration in blood, the total bilurubine (r = 0.323, p = 0.018) and the direct bilurubine (r = 0.478, p = 0.0006). Relying on this, we can conclude that the positive correlation between Pb concentration, the total bilirubine and the direct bilirubine neutralizes the possible negative correlation between cadmium, TB and DB in the IG (Fig. 4). In control group (the population of the locality away from pollution effects) the only influential factor and potential source of cadmium concentration in blood is tobacco, which proves and which also results with the correlation between cadmium and total and direct bilirubines (Table 3).

Table 4 shows the correlation between Cadmium (Cd) and Total Bilirubine (TB), Direct Bilirubine (DB) and Indirect Bilirubine (IB) in the control group subject to smoking. There exists a regressive correlation, in the group of smokers, between cadmium and TB, whereas in the non-smokers' group there is no such correlation.

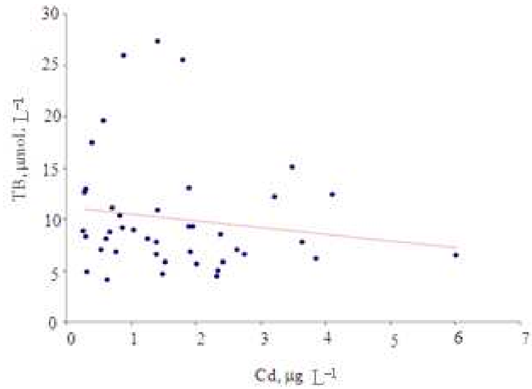

Fig. 4: Corelation between Cd and TB in the IG

Table 4: The correlation between Cd and TB, DB and IB in the control group subject to smoking

	Cd					
	S			NS		
	m	r	p	m	r	p
TB	8.05	-0.534	0.0366	13.90	-0.386	0.09600
t		-2.390		p	0.010	
DB	0.23	-0.384	0.1097	1.26	0.268	0.18860
t		-2.520		p	0.009	
IB	7.82	-0.565	0.0334	12.60	-0.434	0.08890
t		-2.220		p	0.010	

Note: TB: Total Bilirubine, DB: Direct Bilirubine, IB: Indirect Bilirubine, m: Average of concentration, r: Correlation index, p: Probability, t : T-test

Cadmium inhibits the activity of the enzymes[9] that participate in bilirubine's conjunction. Therefore, there is a reduction of total bilirubine (m = 8.05) in the group of smokers in comparison with the level of total bilirubine (m = 13.9) in the non-smokers' group (t = -2.39, p = 0.01). Biologic Implication of the change of bilirubina is related with anemia caused by the exposed group as well as with problems which would raise by conjugation of bilirubina in liver in different situations as hepatitis, therapy with medicaments that effects in liver[14]. This fact also arguments Table 4, in which it is clearly seen that the correlation between cadmium and the reduction of indirect bilirubine is with a high statistical significance in the group of smokers (p = 0.0334) while in the group of non-smokers there exists no such correlation. There is also a significant difference in the indirect bilurubine concentration between the group of non-smokers in comparison with the group of smokers (t = -2.22, p = 0.01). Although the Direct Bilirubine (DB) isn't in a significant correlation with cadmium, there exists a regressive correlation in the smokers' group (r = -0.384).

CONCLUSION

Based on our presented results we have come to these conclusions: There is a direct effect of the environment in cadmium concentration in the blood of the human population who live nearby Power Stations Kosova; smoking is an important contributor to cadmium concentration in blood; the influence of cadmium is inhibitory in enzymes that participate in bilirubine conjunction.

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