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Cadmium and cobalt pollution and their effect on behavior in children and adolescents and its social dimensions

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Abstract---Karbala provides theoretical assistance for Cadmium and Cobalt pollution prevention by determining blood levels and identifying relevant risk factors among adolescents. Blood Cd and Co levels determine by Graphite Furnace. Atomic Absorb piton Spectrometry (GFAAS)) result. Methods blood samples were taken from both males and females. A total of 100 subjects (average age of 13-17 years, 8 females, and 92 males) were included. The arithmetic means Cadmium concentration were patients their number 50 and control also 50 Mean ± SE (2538.± 0.92),(11.88± 0.89) resp. while Samples Patients and control (T=10.55)In addition to Cobalt concentration were patients their number patients and control Mean ±SE(64.00 ± 3.1),(30.71± 2.27) resp. and value(T=8.69) Conclusions . The levels of Cadmium and Cobalt in the blood of adolescents 13 to 17 years in Karbala governorate were higher than in other areas due to leaving schools and working in different professions at an early age and living in unhealthy families.

Keywords---cadmium, cobalt, adolescents, graphite furnace, atomic absorption spectrophotometry.

Introduction

Cadmium (Cd) It is a toxic and non-essential metal that poses a threat to human health, especially children and adolescents [1]. It occurs naturally in the environment as a derived pollutant. The sources may be industrial and agricultural, so pollution can reach humans through eating contaminated food and water Through inhalation of polluted dust and cigarette smoke, cadmium occupies the seventh rank among the list of dangerous substances [2]. It is a carcinogen and accumulates in the liver, kidneys, intestines and in the brain and leads to many damages, including impaired liver and kidney functions, adrenal gland damage and osteoporosis It affects the reproductive organs, nervous system, heart and blood vessels [3]. Moreover, cadmium has been linked to the development of cancer, which is classified as a human carcinogen. Cadmium toxicity leads to cell injury and cell death, as well as organ failure through various molecular pathways. Also, cadmium can penetrate the blood-brain barrier while it is present within the brain and thus affects the health of the brain [5]. Cobalt is one of the essential trace elements present in the human body [6]. It belongs to the iron group VIII. It is widely distributed in the natural environment and can be formed as a result of human activity. Cobalt deficiency is closely related to disorders of vitamin B12 formation, so it causes anemia and decreased thyroid functions and increases Risk of developmental abnormalities and failure in infants [7]. Water-soluble cobalt enters the body through the digestive system and is absorbed from the small intestine into the blood. Moreover, large amounts of the metallic cobalt and its oxide in dust and fumes can enter the body through the lungs and then reach the system Lymphatic and vascular cobalt accumulates mainly in the liver, kidneys, pancreas, heart, skeletal system and skeletal muscle [8].

Materials and Methods

- Ethics Statement: The Medical Ethics Committee of Karbala's Imam Hassan Hospital approved this research.
- Subject : From October 2021 to March 2022, this research was carried out at Karbala, Iraq.
- Questionnaire : Age, gender, connection with his parent, educational attainment, does he have tattoos, does he do drugs and consumes alcohol, does he reside in rural or urban regions, does he have past offenses, does he suffer from chronic conditions were all questions on the questionnaire.
- Methods: Blood samples were collected (3-5) ml of venous blood for children and adolescents, and the blood was placed in tubes that prevent clotting., and preserved were, kept at a temperature of 4 until the analysis was performed. The blood samples were digested with the digester solution, and a standard solution of cobalt and cadmium was prepared at concentrations of 10-30-60ppb, and then the standard curve was made and the concentration of heavy metals in the blood [9] was measured using the Graphite Furnace Atomic Absorb Piton Spectrometry (GFAAS).

Statistical analysis

Analysis of data was performed with IBM® SPSS® (SPSS Inc., IBM Corporation, NY, USA) Statistics Version 25 (2017) for Windows. In order to verify normal distribution of data the Shapiro-Wilk test was used (Shapiro-wilks, 1965 and Razali and Whai, 2011). Due to data had normal distribution, parametric statistical tests were applied. Demographic data, gender and age were described in terms of count and percentages. While Continuous variables such as age were expressed as mean ± standard error (SE). Descriptive analysis was performed in the form of numbers and percentages for qualitative data. Arithmetic means were calculated as central tendency measurement, while standard error as measure of dispersion for quantitative parametric data. For quantitative parametric data independent student t-test was used to compare measure of 2-independent groups (patients and control). Analysis of variance (ANOVA) followed by Duncan post was used to study effect of four groups of Occupation on Cadmium and Cobalt concentration of both control and patient groups. Furthermore, binary logistic regression was used to estimate odds ratios (OR), standard error, Wald test and *p*-values of factors affecting elevated blood Cadmium and Cobalt levels in the adolescents All statistical tests were 2-tailed and a p-value less than 0.05 was considered statistically significant.

Results

The main characteristics of the children and adolescents included in the study are shown in Table 1. The total number of subjects included was 100 (average age13-17years), the numbers of boys and girls were 92 (92%) and 8(8%) respectively. A total of 50% (50/100) of subjects was control and 50% (50/100) was patients. Moreover, for the majority of subjects, more than two-third (2/3) of the sample were students (66%), 34% of the sample was leave school. All students in the sample were single (100%). Most of the subjects in the sample were live with his parents (79%). More than half (1/2) (56%) of students classified as robberies following by scrimmage (20%) and finally drug abuse and other crime 12%. More than half (1/2) (58%) of students were live in urban status, non-smokers (53%) and not working (54%). From 50 patients more than half (62%) 31 subjects had tattoo and 62% of patients were not alcohol addiction.

Table1
Main characteristics of the adolescents children included in the study

Characteristics		Count	Percentage %
Category variables			
Gender	Male	92	92.0%
	Female	8	8.0%
Education	Leave	34	34.0%
	Student	66	66.0%
Social status	Single	100	100.0%
His relationship with his parents	with his mother	21	21.0%
	with his parents	79	79.0%
Type of crime	Robbery	28	56.0%

	Scrimmage	10	20.0%
	Drug abuse	6	12.0%
	Other Crime	6	12.0%
Living	Urban status	58	58.0%
	Rural status	42	42.0%
Occupation	Not working	54	54.0%
	A builder	22	22.0%
	street hawker	10	10.0%
	Other Occupations	14	14.0%
Tattoo	No	19	38.0%
	Yes	31	62.0%
Smoking	No	53	53.0%
	Yes	47	47.0%
alcohol addiction	No	31	62.0%
	Yes	19	38.0%
Drug abuse	No	46	92.0%
	Yes	4	8.0%
Grain type	Not applicable	46	92.0%
	one-zero	2	4.0%
	Crystal	2	4.0%
Tapa	No	44	88.0%
	Yes	6	12.0%
History crime	No	35	70.0%
	Yes	15	30.0%
History diseases	No	30	60.0%
	Yes	20	40.0%

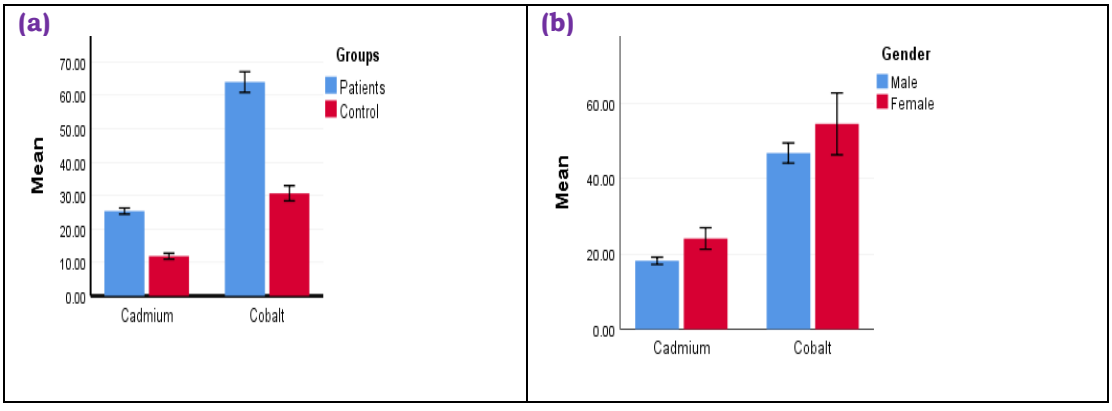
Numeric variable

Variable		Patient Group	Control group	P-value	Sig.
Age	Range	13 – 17	13 – 17	0.37	N.S.
	Mean ± SE	16.18 ± 0.15	16.36 ± 0.13		

Table 2 and figure (1) shows results of the comparisons between cadmium and cobalt of contents of samples, gender, education, his relationship with his parents, living and smoking using independent sample t-test. Results showed that, statistical highly significant differences existed in all traits levels of cadmium and cobalt of contents of samples (patients and control), education (leave and education), his relationship with his parents (with his mother and with his father), living (urban and rural stats) and smoking (no and yes smoking) (p-value <0.05) traits for cadmium and cobalt of contents except gender (male and female) (p-value >0.0.05) for cadmium and cobalt of contents. In general, high mean of cadmium and cobalt of contents were recorded in adolcent children who smoking, live in urban stats, leave education and live with mother.

Table 2
Independent sample t-test to comparison between cadmium and cobalt content of groups, gender, education, his relationship with his parents, living and smoking

Treats	Groups		t-value	p-value	Sig
	Control	Patients			
	Mean ± SE				
Cadmium	11.88± 0.89	25.38± 0.92	10.55	0.0001	H.s
Cobalt	30.71± 2.27	64.00 ± 3.1	8.69	0.0001	H.s
Gender					
Treats	Male	Female	t-value	p-value	Sig
	Mean ± SE				
Cadmium	18.16 ± 0.97	24.07 ± 2.86	-1.74	0.08	N.S
Cobalt	46.74± 2.66	54.46 ± 8.20	-0. 83	0.41	N.S
Education					
Treats	Leave	Student	t-value	p-value	Sig
	Mean ± SE				
Cadmium	25.27± 1.08	15.21± 1.08	5.95	0.0001	H.S
Cobalt	63.03± 3.65	39.29 ± 2.90	4.93	0.0001	H.S
The Family					
Treats	With his mother	With his parents	t-value	p-value	Sig
	Mean ± SE				
Cadmium	22.34± 1.85	17.64 ± 1.05	2.09	0.04	H.S
Cobalt	58.84± 5.68	44.30 ± 2.75	2.40	0.02	H.S
Living					
Treats	Urban status	Rural status	t-value	p-value	Sig
	Mean ± SE				
Cadmium	21. 75± 1.16	14.20± 1.27	4.28	0.0001	H.S
Cobalt	55.7 9± 3.29	35.71 ±3.23	4.23	0.0001	H.S
Smoking					
Treats	Yes	No	t-value	p-value	Sig
	Mean ± SE				
Cadmium	21.88± 1.11	15.75 ± 1.34	3.47	0.001	H.S
Cobalt	55.02 ± 3.73	40.57± 3.21	2.95	0.004	H.S



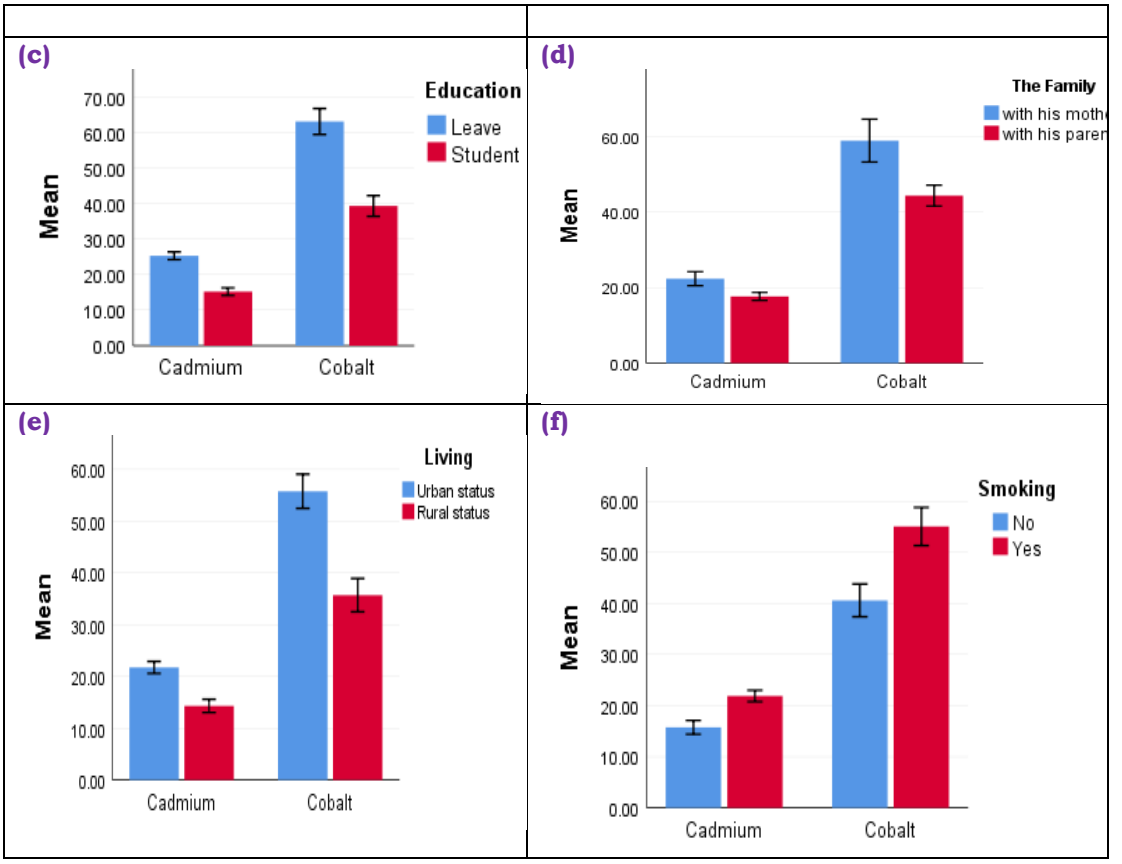


Figure 1. Cluster error bar chart with showing mean of cadmium and cobalt in (a) groups (patients and control), (b) gender (male and female), (c) education (leave and student), (d) His relationship with his parents (with his mother and with his parents), (e) living (urban status and rural status) and (f) smoking (no and yes) groups

The Table 3 and figure (2) shows the results of One-way ANOVA analysis between four groups of occupation on cadmium and cobalt contents. The results indicate highly significant differences between four groups of occupation (Not working, A builder, street hawker and Other Occupations) on cadmium ($p < 0.003$) and cobalt ($p < 0.007$) contents. In general, high mean of cadmium and cobalt of contents were recorded in Other Occupations group (23.39 and 58.67 respectively) following by street hawker and the lowest mean of cadmium and cobalt of contents were recorded by students who did not working (15.55 and 38.89 respectively). The Duncan post-hoc test revealed that, there was a significant effect between means of not working group a significant effect between means of not working and Other Occuptions groups in both of cadmium and cobalt contents. Also The Duncan post-hoc test revealed that, there was not significant effect between means of all combinations of three groups A builder, street hawker and Other Occupations in both of cadmium and cobalt contents.

Table 3
ANOVA, Duncan post hoc to study effect of four groups of Occupation on cadmium and cobalt contents of both control and patient groups.

Traits	Not working	A builder	street hawker	Other Occuptions	F – value	P-Value	Sig.
Cadmium concentration	15.55^{a} ±1.31	21.44^{ab} ±1.83	22.47^{b} ±6.76	23.39^{b}±1.68	4.95	0.003	H.S.
Cobalt concentration	38.89^{a} ±3.17	57.46^{ab} ±5.91	55^{b}±4.13	58.67^{b}±6.78	4.32	0.007	H.S.

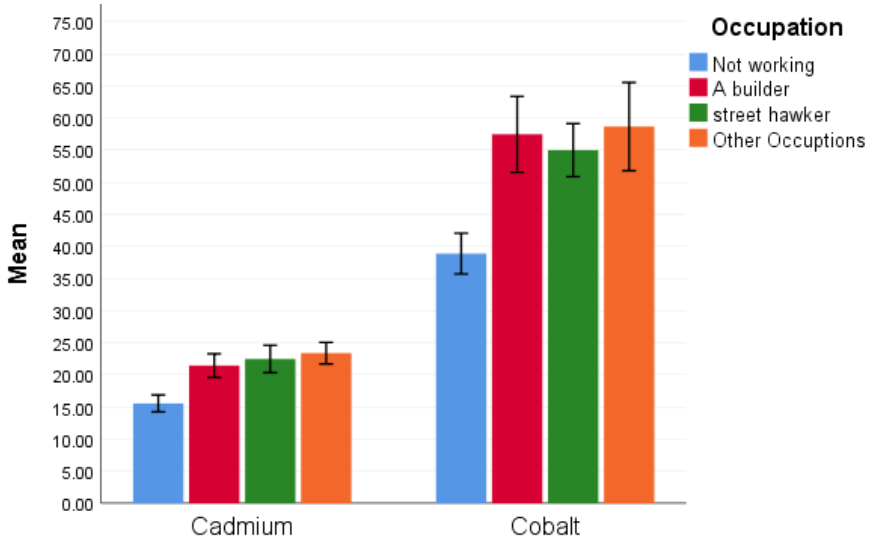


Figure 2. Cluster error bar chart with showing mean of cadmium and cobalt of four levels of occupation

Chi-Square Test

Chi-square test is a nonparametric test used for testing the hypothesis of no association between two or more groups, population or criteria (i.e. to check independence between two variables). It is used to analyze categorical data (e.g. male or female customers), it is not meant to analyze parametric or continuous data (e.g., height measured in centimeters or weight measured in kg, etc.). Frequencies, chi square value and significant are presented in Table (4) to test the relationship between two levels of cadmium concentration (high and low) and all demographic variables groups (patients and control), gender (male and female), education (leave and student), His relationship with his parents (with his mother and with his parents), living (urban status and rural status) and smoking (no and yes) groups. Results showed that, significant difference has been observed between two levels of cadmium concentration (high and low) and all demographic variables ($p<0.05$) except gender ($p<0.79$). To conclude, there is association

between two levels of cadmium concentration (high and low) and all demographic variables except gender.

Table 4
Chi-square test of independence of sample characteristics between two levels of cadmium concentration

		Cadmium-Catg		Chi-square	P-value	Sig.
		Low Cadmium	High Cadmium			
		Count	Count			
Samples	Patients	8	42	72.41	0.0001	H.S.
	Control	50	0			
Gender	Male	53	39	0.72	0.79	N.S.
	Female	5	3			
Education	Leave	4	30	45.21	0.001	H.S.
	Student	54	12			
His relationship with his parents	with his mother	5	16	12.76	0.0001	H.S.
	with his parents	53	26			
Living	Urban status	25	33	12.58	0.0001	H.S.
	Rural status	33	9			
Occupation	Not working	40	16	13.46	0.004	H.S.
	A builder	8	14			
	street hawker	0	10			
	Other Occuptions	4	10			
Smoking	No	40	13	14.13	0.0001*	H.S.
	Yes	18	29			

Frequencies, chi square value and significant are presented in Table (5) to test the relationship between two levels of cobalt concentration (high and low) and all demographic variables groups (patients and control), gender (male and female), education (leave and student), His relationship with his parents (with his mother and with his parents), living (urban status and rural status) and smoking (no and yes) groups. Results showed that, significant difference has been observed between two levels of cobalt concentration (high and low) and all demographic variables ($p<0.05$) except gender ($p<1.00$). To conclude, there is association between two levels of cobalt concentration (high and low) and all demographic variables except gender.

Table 5
Chi-square test of independence of sample characteristics between two levels of cobalt concentration

		Cobalt-Catg		Chi-square	P-value	Sig.
		Low Cobalt	High Cobalt			
		Count	Count			
Samples	Patients	0	50	100	0.0001	H.S.
	Control	50	0			
Gender	Male	46	46	0.0001	1	N.S.
	Female	4	4			
Education	Leave	0	34	51.51	0.001	H.S.
	Student	50	16			
His relationship with his parents	with his mother	2	19	17.42	0.0001	H.S.
	with his parents	48	31			
Living	Urban status	18	40	19.87	0.0001	H.S.
	Rural status	32	10			
Occupation	Not working	38	16	23.17	0.0001	H.S.
	A builder	8	14			
	street hawker	0	10			
	Other Occuptions	4	10			
Smoking	No	38	15	21.24	0.0001*	H.S.
	Yes	12	35			

A stepwise binary logistic regression was performed to ascertain the effects of all demographic variables as independents variables, gender (male and female), education (leave and student), His relationship with his parents (with his mother and with his parents), living (urban status and rural status) and smoking (no and yes) groups on elevated blood cadmium level in the teenagers as dependent variable with two categories. coefficient (B), standard error (SE), Wald test, P-value and odds ratio (OR) are presented in Table (6). Results of The logistic regression model was statistically significant, ($p < .01$). Holding all variables in the model constant subjects or students who live with his mother were 3.11 times more likely to had high level of cadmium than who live with his parents. Holding all variables in the model constant subjects or students who live urban status were 3.34 times more likely to had high level of cadmium than who live in rural status. Holding all variables in the model constant finally, subjects or students who not smoking were 0.27 less likely to had high level of cadmium than who smoking

Table 6
Logistic regression analysis showed Factors affecting elevated blood cadmium levels in the adolescents (6)

variables	B	S.E.	Wald test	P-value	Sig.	OR
Constant	0.64	0.46	1.94	0.16	N.S	0.53

His parent	1.34	0.63	3.29	0.03	Sig.	3.11
Livening	1.21	0.55	5.72	0.02	Sig.	3.34
Smoking	-1.31	0.48	7.68	0.006	H.S.	0.27

A stepwise binary logistic regression was performed to ascertain the effects of all demographic variables as independents variables, gender (male and female), education (leave and student), His relationship with his parents (with his mother and with his parents), living (urban status and rural status) and smoking (no and yes) groups on elevated blood cobalt level in the adolescents as dependent variable with two categories. coefficient (B), standard error (SE), Wald test, P-value and odds ratio (OR) are presented in Table (7). Results of The logistic regression model was statistically significant, ($p < .02$). Holding all variables in the model constant subjects or students who live with his mother were 6.73 times more likely to had high level of cobalt than who live with his parents. Holding all variables in the model constant subjects or students who live urban status were 5.49 times more likely to had high level of cobalt than who live in rural status. Holding all variables in the model constant finally, subjects or students who not smoking were 0.16 less likely to had high level of cobalt than who smoking

Table 7
Logistic regression analysis showed Factors affecting elevated blood cobalt levels in the adolescents (7)

variables	B	S.E.	Wald test	P-value	Sig.	OR
Constant	-0.29	0.46	0.38	0.54	N.S.	0.75
His parent	1.91	0.86	4.86	0.03	Sig.	6.73
Livening	1.70	0.54	10.89	0.001	H.S.	5.49
Smoking	-1.86	0.53	12.43	0.001	H.S.	0.16

Discussion

Cobalt and Cadmium Toxicity is indeed a major public, health issue in Iraq, and environmental activity is one of the main causes between many children and teens[10][11] In Karbala, Iraq, where there is much Cd and Co pollution, we discovered that students have higher BLLs than girls. This result is the different as what other studies in Pittsburgh have discovered about the BLLs of males and females. We found that the BLLs of male and female teenagers were 92% and 8%, respectively[12] Table 2 and figure (1) shows results of the comparisons between cadmium and cobalt of contents of samples, gender, education, his relationship with his parents, living and smoking using independent sample t-test. Results showed that, statistical highly significant differences existed in all traits levels of cadmium and cobalt of contents of samples (patients and control), education (leave and education), his relationship with his parents (with his mother and with his father), living (urban and rural stats) and smoking (no and yes smoking) (p-value <0.05) traits for cadmium and cobalt of contents except gender (male and female) (p-value >0.0.05) for cadmium and cobalt of contents. In general, high mean of cadmium and cobalt of contents were recorded in adolcent children who smoking, live in urban stats, leave education and live with mother This study is in agreement with other studies, including in Iran[13], others in Korea[14], and others in America[15] . We sought to explore what causes population studies to

be done all over the globe, and we already wanted to see if there was a link between those risk factors and what is being done now to protect people's health. Many major risk factors have been found in adolescents who were poisoned by cadmium and cobalt at a polluted site in Iraq You need to use these risk results to enhance public health in these areas so that bad health effects do not happen. For instance, policies should ensure families have a decent way to live and encourage teens to stop dealing with alcohol and live far from factories to cut down on Cadmium and Cobalt pollution.

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