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Relation between Concentrations of Lead, Cadmium and Mercury in Cord Blood and Prematurity in the Sidi Bel Abbes Region (West of Algeria)

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ABSTRACT

Background: Exposure to heavy metals such as lead, cadmium and mercury during pregnancy carries a great risk to the mother as well as the fetus. ***Methods:*** *Lead, cadmium and mercury were measured in umbilical cord blood samples of 3 groups women (30 women's for lead, 30 cadmium and 10 from mercury)* in maternity of Sidi Bel Abbes region in Algeria between 2016 and 2017.The objective of this study was to measure in the blood of the umbilical cord the concentration of lead (Pb), mercury (Hg) and cadmium (Cd), and to evaluate the relationship between these levels and prematurity. The lead, cadmium and mercury levels were measured by atomic absorption. ***Results:*** The study showed obvious variations in, maternal characteristics. The results revealed several factors predisposing to prematurity. The mean concentrations of cord blood lead, cadmium and mercury were; 18.97 µg/L, 0.26 µg/L, and6.20 nmol/L, respectively. There was a highly significant direct correlation between cord lead concentrations and gestational age(r=0.43; P = 0.017), and we found that gestational age and birth weight inversely correlated with cord mercury concentration (r=0.44 and r=0.57 respectively).No correlation was observed between cord cadmium concentrations and gestational age. ***Conclusion:*** This study has shown that pregnant women in this region were exposed to high levels for heavy metalswhich need an intervention.

Keywords: Lead. Cadmium, Mercury, Pregnancy, Prematurity, Fetal exposure, Algeria.

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INTRODUCTION:

Pregnant women and their fetuses are susceptible to the effects of exposure to environmental toxicants including lead, mercury and cadmium. Metals are ubiquitous in the environment, and exposure occurs through ingestion of food, water, soil, or dust; inhalation from air; and through direct contact with consumer products[1]. Exposure to heavy metals during pregnancy carries a great risk to the developing fetus[2]. Metals are potential risk factors for small for gestational age (SGA) births, and are hypothesized to induce growth restriction through oxidative stress mediated pathways[3]. Cigarette smoking is source of cadmium exposure[9]. Scientists suggest that cadmium may damage the placenta and reduce weight of newborn baby in pregnancy[4,5]. Toxicity from mercury may cause learning disabilities and it effects reproductive system and produces defects such as infertility, miscarriage and prematurity [6,7]. The aim of or study was to measure in umbilical cord blood, at delivery, the concentration of lead (Pb), mercury (Hg) and cadmium (Cd), and evaluate the relationship between this levels and prematurity.

PATIENTS AND METHODS:

A prospective study was conducted in public maternity in Sidi Bel Abbes region (west of Algeria), over a period of 01 years from December 2016 to October 2017. The ethical committee of our department approved the study. After signing a written informed consent, the patients were recruited to the study.

Gestational age patients over 36 weeks of amenorrhea were excluded from the study. Eventually, a total of number 70 pairs of mother-newborn were included in the study. All the patients completed questionnaires including information about age, ethnic origin, Socio-economic level, Level of education, BMI, history for prematurity and abortion and smoking habits.

Five mls of umbilical cord blood was collected immediately after delivery. The samples were chilled at (+4°C) until delivery to the laboratory CERBA France for detection of the trace elements. Inductively Coupled Plasma Mass Spectrometry (ICP/MS Agilent 7700 CE and 7500 CE) was used to measure the concentrations of lead and cadmium for 60 samples umbilical cord blood (30 samples for each metal).Thereafter ,Mercury concentrations have been measured from 10 samples umbilical cord blood, by Atomic absorption spectrophotometer (AAS, FIMS 400 Perkin Elmer) in the same laboratory. Recapitulating, lead was measured in 30 subjects, cadmium in 30 and mercury in 10 subjects. The detection limits for this study were as follows: Blood Pb (0.1µg/dL), Cd (0.2 µg/L), totalHg (5nmol/L).

The data collected during the research were analyzed using the statistical software (Spss version 22). To report the results we used a descriptive analysis method, calculating the means and standard deviations for the continuous data, the means were then compared using the Student's Test, for the nominal data we calculated the percentages of the different categories. Differences in patient's level of Mercury, lead and Cadmium according to different variables were assessed using the ANOVA test.

We evaluated the impact of the different heavy metals analyzed on birth weight and gestational age using the Pearson correlation. The result is reported in form tables and curves.

These statistical tests were considered significant if $p < 0.05$.

RESULTS:

A total of 70 deliveries were reported during the study period, lead and cadmium were measured in 30 subjects respectively and mercury in 10 subjects. The study showed obvious variations in maternal characteristics, socioeconomic status and obstetric/ gynecological history. We defined three groups; lead dosage group (30 subjects), cadmium dosage group (30 subjects), and mercury dosage group (10subjects).

Concentration of lead, cadmium and mercury in umbilical cord:

The dosage of these three metals revealed the following concentrations: lead concentrations ranging between 0 and 75µg/L (18.97 ± 14.22µg/L), cadmium between 0 and 0.4µg/L (0.26±0.07 µg/L), mercury concentrations ranged between 0 and 9 nmol/L (6.20±1.64nmol/L). (Table1)

Relationship between concentration of metals and maternal characteristics

The average concentration was measured for each metal, Pb, Cd and mercury in the cord blood and were all correlated with maternal characteristics (Table2).

Lead concentrations and maternal characteristics

The difference between the different Age groups of mothers and lead concentrationswas statistically significant ($P<0.001$), the highest rate of lead (20.57±11.01) is found in the category over 35 years old(Table2). In this group, a single subject less than 20 years old has a high level of lead (73.3µg/L), this result cannot have statistical significance. According to statistical analysis, patients with low socioeconomic status have the highest rates of lead (28.14±22.05) (Table2). No other statistically significant relationship could be detected between lead and the rest of the maternal characteristics studied (Table2)

Cadmium concentrations and maternal characteristics

Regarding the relationship between cadmium concentrations and maternal characteristics, our results did not reveal any statistically significant relation (Table2)

Mercury concentrations and maternal characteristics

Our result observed a significant relationship between birth weight, History of abortion and mercury concentrations ($P = 0.012$). No other statistically significant relationship could be detected between mercury and the rest of the maternal characteristics studied (Table2)

Correlation between gestational age, birth weight and cord concentrations of lead, cadmium and mercury:

As shown in **figure 1**, a highly significant direct correlation was found between cord lead concentrations and gestational age ($r=0.55$; $P = 0.002$). Furthermore, a clear correlation was found between the concentration of cadmium in the umbilical cord and the birth weight ($r= 0.25$), (**figure 2**), ***(Table 3)***. Finally we found that gestational age and birth weight inversely correlated with cord mercury concentration ($r=0.44$ and $r=0.57$ respectively), (**figure 3**).

Table1. Distribution of Lead, Cadmium and mercury concentrations in cord blood

Variable	Médiane	interquartile range
Cadmium µg/L	0,20	0,20-0,30
Lead µg/L	15,15	10,35-21,75
Mercury nmol/L	1,20	1,00-1,50

Table2. Relationship between concentration of metals and characteristics of the mother

	Lead (n=30)				*Cadmium (n=30)*				*Mercury (n=10)*			
Characteristics	**N**	**Mean Rank**	**Mann-Whitney U-test**	**P value**	**N**	**Mean Rank**	**Mann-Whitney U-test**	**P value**	**N**	**Mean Rank**	**Mann-Whitney U-test**	**P value**
History of prematurity												
YES	**3**	14,67	38,000	0,86	5	11,75	31,000	0,76	3	3,50	1,500	0,70
No	**27**	15,59			25	10,82			7	2,88		
History of abortion												
YES	**9**	13,44	76,000	0,40	6	14,00	22,000	0,23	3	5,00	1,491	0,13
No	**21**	16,38			24	10,29			7	2,50		
Level of education												
Illiterate	**9**	15,67	91,000	0,87	8	8,61	30,500	0,90	2	3,25	2,500	0,76
Secondary / university	**21**	15,11			11	8,36			7	2,83		
Passive smoking												
YES	**19**	15,18	98,500	0,79	15	11,00	55,000	0,91				
Non	**11**	16,05			15	11,00						
Residence												
Urban	**12**	18,25	75,000	0,16	16	10,09	45,000	0,29	4	4,25	0,500	0,128
Rural	**18**	13,67			14	12,00			6	2,17		
Socio-economiclevel												
Low	**7**	19,71	51,000	0,14	7	12,00	33,000	0,41	4	3,25	2,500	0,76
Normal	**23**	14,22			23	9,86			6	2,83		

Table3. Spearman correlation of mother's age, gestational age, birth weight and BMI with levels of lead, cadmium and mercury

	Lead		**Cadmium**		**Mercury**	
	R	P	R	P	R	P
Mother's age	0,274	0,143	-0.30	0,899	-0,304	0,619
Gestational age	0,550	0,002**	0,005	0,982	0,152	0,807
Birth weight	0,144	0,448	0,250	0,275	0,105	0,866
BMI	-0,141	0,458	-0,167	0,470	0,108	0,863

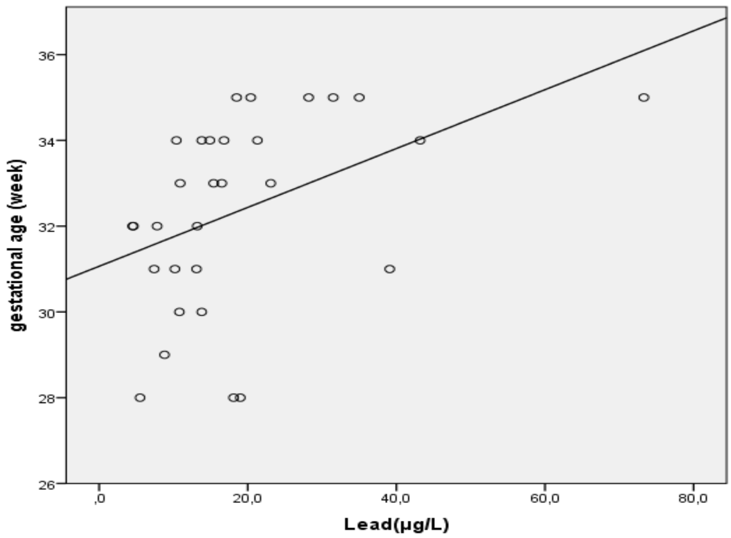

Figure 1: relation between Cord blood Lead and gestational age

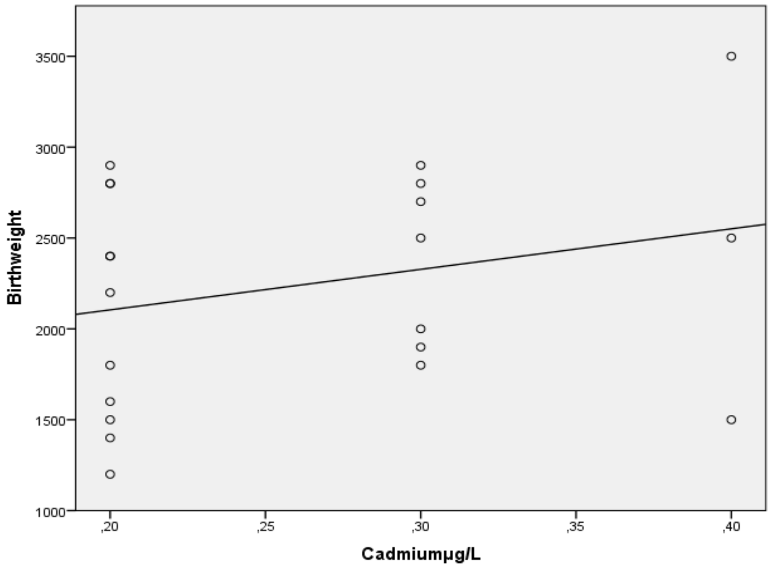

Figure 2: relation between Cord blood Cadmium and birth weight

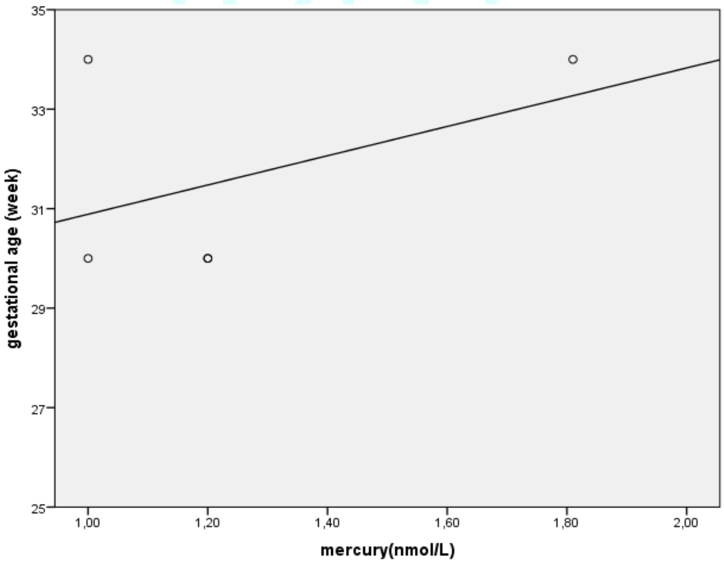

Figure 3: relation beween Cord blood Mercury and gestationnal age

DISCUSSION

The mean concentration of lead in cord blood found in this study was 1.89 µg/dL. Reports from South Africa a cord blood median lead concentration of 2.39µg/Dl[13]. A Canadian study found a cord blood arithmetic mean lead concentration of 2.8 µg/dL, and another study in Saudi Arabia found 2.5 µg/dl[14]. Also, Mean cord blood lead was higher than those reported in Brazil were (1.194µg/dL) [15].Belgium (1.47µg/dL) and Turkey (Eskisehir; 1.65µg/dL) [16, 17,18].

In our study highly significant direct correlation was found between cord lead concentrations and gestational age (P = 0.017). Multiple studies have found an association with SGA[7, 19, 20,27].

In our Study the meanconcentration of cadmium in cord blood was 0.26 µg/L, a value lower than that reported in Saudi Arabia (GM = 0.78 µg/L) [22,23],and consistent with the values reported in many studies conducted in other areas in China (GM = 0.20µg/L)[24],Nepal (GM = 0.29 µg/L)[25].

Our findings that not exceed the allowed level determined by OHSA (5µg/L) [26,27,28]. Pregnancy is a critical period in terms of cadmium toxicity, and several adverse outcomes such as preeclampsia, LBW, prematurity. Cadmium accumulates in the placenta interacting with the transport of micronutrients and may play a key role in the occurrence of intrauterine growth restriction[29, 30]. In this study, we found a clear correlation between the concentration of cadmium in the umbilical cord and the birth weight, in literature two studies found no effect of cadmium on fetal growth outcomes[30, 31], while others found relationships with birth weight or length[32, 33, 34, 35].

The average mercury content in the cord was 2.24µg/L. this value was lower than the Environmental Protection Agency (EPA) reference dose of 5.8 µg/L[36].

In our study mercury cord levels were higher than those found in Canada (Montreal; 0.69µg/L), Poland (0.88µg/L), Slovakia (0.8µg/L), South Africa (1.2µg/L), Sweden (organic; 1.4µg/Land inorganic; 0.34µg/L) and Turkey (0.5µg/L) [37].

Also, statistically significant relationship was observed between mercury exposure and abortion history in our study. Their teratogenic and foetotoxic roles were established. According to the WHO, it played a key role in the occurrence of spontaneous abortions[38,39, 40]. However, later analysis of a more complete dataset disproved[42].Concerning level of mercury and gestational age, four studies used mercury measurements in cord blood and maternal blood with higher exposure levels with larger samples than our study found an association between mercury and small gestational age[20,41].

CONCLUSION

The results of the present study provide relatively comprehensive information concerning the Pb, Cd and Hg levels in the cord of preterm newborns from west of Algeria. This study has shown that pregnant women in this region of the country were exposed to similar levels, compared to pregnant women in industrialized countries, or even higher levels for lead. Further research incorporating larger samples is needed to investigate the effects of pregnant women's exposure to heavy metals - particularly Pb, Cd, Hg and its impact on small gestational age. The health effects of prenatal exposure to heavy metals as well as to other pollutants to which human population is exposed should alert countries governments to endorse stricter standards and tighten legislation to protect future generations from diseases that may develop following prenatal exposures

Conflict of interest

Authors declared they have no competing of interest.

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