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Maternal blood lead levels and risk for low birth weight: a case-control study, Sidi Bel Abbes, Algeria

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Abstract

Several epidemiological studies have investigated high lead (Pb) exposure and pregnancy outcomes, but few studies have investigated the association of low lead exposure and low birth weight (LBW). The aims of this study were to estimate the maternal blood lead levels (BLL), to identify determinants for BLL among parturient woman and to evaluate the association of maternal BLL and LBW. From July 2017 to February 2018, we carried out a case-control study in the genecology and obstetrics hospital of Sidi Bel Abbes, Algeria. Lead concentrations in maternal blood samples collected at delivery were measured in 29mother who delivered term LBW cases group and 29mother who give birth to a term normal weight baby matched controls.Blood lead levels were analyzed by inductively coupled plasma mass spectrometry. Mean maternal BLLwere higher among normal groups than in mothers of LBW, but this difference was not significant (23,076 ±16,120, versus 18,086 ± 6,641 ug/l p=0.247).Our results indicate that the mean lead level was not higher in LBW neonates, and the whole blood lead was not related to the birth weight. In addition,there was interaction of daily kohl use and maternal BLL. This study suggests that maternal BLL was not significantly associated with LBW. Mothers with daily use of kohl during pregnancy were more likely to have elevated blood lead concentrations.

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Introduction

The birth weight of infant is presumably the most critical single factor that influences the future survival and personal satisfaction. It is additionally a significant predictor of post neonatal, baby and childhood morbidity and mortality. Consequently, birth weight has for quite some time been a subject of clinical and epidemiological studies and a territory for public health interest(Azhar *et al.*, 2004)Various preventable hazard factors have been connected to poor fetal development, including lead exposure during pregnancy(Jelliffe *et al.*, 2006; Rodosthenous *et al.,* 2017).

Lead (Pb) is a neurotoxic metal that is broad in nature. The expulsion of lead from water funnels, paint and sustenance jars, and a prohibition on lead added substances to petroleum in many nations has lessened introduction to lead as of late, albeit industrial exercises, for example, mining, purifying, lead shot produce and battery make and reusing are still of concern. Sustenance and drink, water, residue and soil stay as imperative wellsprings of introduction, as does cigarette smoking (Taylor *et al.*, 2014; Chełchowska *et al.*, 2015).

The placental barrier is porous to lead and levels in cord blood were accounted for to achieve 5 to 10% of the maternal BLL (Klein *et al.* 1994; Mirghani *et al.* 2010).Also lead might be discharged from maternal bone stores among pregnancy and hence may turn into a wellspring of intoxication for the fetus from 12 weeks of gestation until birth(Mirghani *et al.,* 2010).Lead can be transmitted from the future mother to herfetus through the placenta(Ahamed *et al.,* 2009;Torabi *et al.*, 2018).

In spite of the way that the hostile consequences for pregnancy outcomes at elevated lead exposure have been documented for a considerable length of time, there is vulnerability in regards to the effect of presentation to bring low levels ordinarily experienced daily, for example, that because of lead containing cosmetics (Mirghani *et al.,* 2010). Variety studies have recommended that maternal exposure to low lead levels during pregnancy is a negative indicator of birth weight(Zhu *et al.,* 2010; Xie *et al.,* 2013) length of newborn and head circumference (HC)(Xie *et al.* 2013).In contrast, other studies found no associations between maternal blood lead levels and any birth outcome measures for the same levels. The aims of this study were to find the probable association of low lead exposure during pregnancy and low birth weight (LBW) in west of Algeria.

Materials and Methods

This study was a case-control study conducted in genecology and obstetrics hospital of Sidi Bel Abbes, West of Algeria. Form July 2017 to February 2018,a total of 29 cases and 29 matched controls were incorporated into our examination. Cases were mothers who delivered a live singleton term low birth weight infant (gestational age ≥ 37 weeks and birth weight <2500g). Controls were mothers who delivered a live singleton term infant with normal birth weight between ≥2500g and <4000g.

Women with multiple pregnancies, and those who gave birth to a preterm, a dead at birth infant or an infant with a birth weakness were excluded. For each case, one control was randomly selected based on the matching variables infant sex. The appropriateness criteria for participants are: a) residence in the study areas at the time of the recruitment period for a period of one year at least. b) Absence of illnesses such as chronic hypertension, renal failure and preeclampsia.

Participants were invited to provide blood sample and participate in a face-to-face interview. The questionnaire elicited on maternal information included socio-demographic factors (maternal age, education, occupation, weight and height), obstetric history and sources of lead exposure; and on newborn characteristics (weight, sex, gestational age, head circumference, Apgar score).

On the day of delivery 4 milliliters of venous blood from 58 pregnant women was placed in a heparinized tube and stored at -20°C prior to analysis. The total lead concentrations in blood were determined by inductively coupled plasma mass spectrometry.

The data were analyzed on the Statistical Package for Social Sciences version 23 (SPSS). The general characteristics of cases and controls were presented as a number (%), and the Pearson chi-square test was used to evaluate the differences in the variables between cases and controls.

We examined the relationship between birth weight, lead levels and known determinants of size at birth using by Mann – Whitney and Kruskal-Wallis tests since the distributions of lead levels were found to be skewed following the Kolmogorov–Smirnov normality test.

We used bivariate correlation to evaluate the relationship first time between lead levels and newborn parameters then between BLL and the use of kohl in the other hand. The Partial correlation was assessed to eliminate the impact of confounders variables.

Results

The mean maternal age at delivery was 29,05±5,945 years with a scope of 19– 44 years and the average Body Mass Index (BMI) was 23.3 kg/m . There were 22 male newborns and 36 female newborns with mean weight 2846,81 ±611,901 g. General characteristics of the cases and controls are presented in Table 1.

Compared to the controls, the case mothers had lower educational attainment (less than high school 69,0%vs. 41,4%) with significant statistical difference. There were higher percentages of case mothers who were underweight (40,7%vs. 17,9%) and more likely to be primiparous (41,4%vs. 27,6%) than controls.

Table 1. Association between maternal characteristics and low birth weight cases and controls groups.

Characteristics		Case (N=29)	Control (N=29)	*P* value (x^2)
Infant sex	Male	11 (37,9%)	11 (37,9%)	
	Female	18 (62,1%)	18 (62,1%)	1
Maternal age(years)	<25	06 (20,7%)	10 (34,5%)	
	25-29	10 (34,5%)	05 (17,2%)	0,259
	>=30	13 (44,8%)	14 (48,3%)	
Education	Less than high school	20 (69,0%)	12 (41,4%)	0,035
	high school or more	09 (31,0%)	17 (58,6%)	
Pre-pregnancy BMI	Underweight	11 (40,7%)	05 (17,9%)	
	Normal	08 (29,6%)	06 (21,4%)	0,056
	Overweight	08 (29,6%)	17 (60,7%)	
Parity	Primiparous	12 (41,4%)	08 (27,6%)	
	Multiparous	17 (58,6%)	21 (72,4%)	0,269
Residence	Urban	09 (31,0%)	14 (48,3%)	
	Rural	20 (69,0%)	15 (51,7%)	0,180
Use of kohl	Yes	03 (10.3%)	10 (34.5%)	0.028
	Non	26 (89.7%)	19 (65.5%)	
Occupational status	Employed	05 (17,2%)	03 (10,3%)	
	Un-employed	24 (82,8%)	26 (89,7%)	0,446

The mean maternal BLL was 20,581±12,476 ug/l with a range of 7,90 to 80,60 ug/l . The controls mothers had higher BLL 23,076 ±16,120 ug/l compared to the case mothers 18,086±6,641 ug/l, but this difference was not significant (p<0.247).

The correlation between maternal lead concentrations and weight of neonates was analyzed, which showed no significant relationship between these variables. The correlation between lead levels in maternal blood and head circumference of newborns, gestational age and Apgar score were also assessed, and no significant correlation was found between lead concentrations and the newborns' characteristics. Similar results when the correlation was assessed in terms of newborns birth weight categories. Therefore, the correlation between these variables was not significant neither in cases (low birth weight infants) nor in controls (normal birth weight infants) Table 2.

Positive significant relationship was found between birth weight and maternal BLL using the partial correlation witch was assessed by eliminating the effects of maternal age, gestational age, parity, maternal occupation and education statue (Correlation coefficient, 0,292 and significance level, 0,034).

Table 2. Association between maternal BLL and newborn parameters.

variable	Total population (n=58)		Cases LBW (n=29)		Controls NBW (n=29)	
	Correlation Coefficient	Sig	Correlation Coefficient	Sig	Correlation Coefficient	Sig
Birth weight	0,164	0,218	0,085	0,663	0,026	0,893
Head circumference	0,044	0,777	0,070	0,750	0,075	0,739
Gestational age	-0,026	0,847	-0,054	0,782	-0,266	0,164
5 min Apgar score	0,176	0,187	0,327	,083	-0,027	0,889

As mentioned in Table 3, Kruskal Willy test analyses revealed that maternal age and prepregnancy BMI categories were not associated neither with blood lead levels nor with newborn's birth weight. Mannwhiteny test showed that education level (less than high school/high school or more), passive smoking (yes/no), parity (primiparous/multiparous), occupation statue (employed/unemployed), as well as gender of newborn and area of residence (urban/rural) were not associated with the tow variables (lead concentrations and birth weight).However, analyses revealed that maternal blood lead levels and newborn birth weight were higher in the daily user kohl group than in not users of this cosmetic product group, with p < 0.001 and p < 0.020 respectively.

As shows Table 4, a significant correlation between maternal blood lead levels and use of kohl (cosmetic product) (p <0,001). Related to infants groups only controls group had a significant association between the two variables. This significant relationship between maternal BLL persisted also after using the partial correlation by eliminating the effects of maternal age, parity, maternal occupation, education statue and BMI (Correlation coefficient, -0,429 and significance level, 0,002).

Discussion

This study gives proof to adverse effects of maternal BLL on pregnancy outcomes. The principal purpose of our study is to establish the stated research hypothesis, that the low birth weight is adversely influenced by exposure to low lead concentrations. In this case-control study, 58 delivered women and their newborns were examined. The blood lead levels reported in other studies (Gundacker *et al.* 2010; Dwivedi *et al.* 2013; Xie X*et al.* 2013 ; Rodosthenous *et al.*, 2017; Torabi *et al.* 2018)had tendency to be higher than that in our investigation (mean 20,581±12,476 ug/l).

Although lead is one of the most poisonous studied metals for the fetus during pregnancy, no significant association was found with low birth weight and maternal blood lead levels in this study.

Mean of lead concentration in controls group was higher than in cases group but the difference was not statistically significant. Furthermore, no significant association was found between level of Pb in maternal blood and the studied pregnancy outcomes (head circumference, gestational age, sex and Apgar score).

In this regard, Iranpour *et al.*, 2007 found similar result. The comparison of maternal BLL between 32 newborn with intrauterine growth retardation (IUGR) and 34 normal newborns reported that maternal BLL of healthy neonates was higher than that of IUGR neonates; though, this difference was not significant. Nevertheless, maternal BLL was not related with LBW (Iranpour *et al.*,2007).

Table 3. Association between maternal BLL, birth weight and maternal characteristics.

Variables		Lead level ug/L	P value	Birth weight g	P value
Infant sex	male	21,30 ±17,89	0.320	2819,32 ± 680,19	0.987
	Female	20,54±08,92		2863,61 ± 575,69	
Maternal age(years)	<25	17,84±06,62	0.545	3043,44 ± 515,21	0.108
	25-29	22,99±15,8		2657,33 ± 491,29	
	>=30	21,44±13,86		2835,56 ± 702,21	
Education	Less than high school	19,58±10,25	0.606	2709,22 ± 611,89	0.104
	high school or more	22,20±15,19		3016,15 ± 579,09	
Pre-pregnancy BMI	Underweight	20,84±16,27	0.763	2704,69 ± 552,71	0.296
	Normal	21,16±13,84		2802,14 ± 506,33	
	Overweight	20,61±09,87		2981,20 ± 679,89	
Parity	Primiparous	21,29±18,06	0.086	2773,75 ± 569,85	0.432
	Multiparous	20,20±08,46		2885,26 ± 636,91	
Residence	Urban	22,50±15,19	0.395	2998,48 ± 589,52	0.150
	Rural	19,69±10,97		2747,14 ± 614,04	
Use of kohl	Yes	30,45±21,34	0,001	3180,00 ± 459,36	0.020
	No	17,73±06,35		2750,56 ± 620,66	
Occupational status	Employed	22,50±12,77	0.603	2491,25 ± 813,64	0.103
	Un-employed	20,53±12,88		2903,70 ± 563,06	

Other currents studies ((Al-Saleh *et al.*, 2014; Taylor *et al .,* 2016; Wang *et al .,* 2017) also reporting no effects of lead exposure on pregnancy outcomes.Additionally, Mirghani tested the association between lead exposure and pregnancy outcomes, as well as gestational age, premature rupture of membranes, and even weight at birth, and found no significant relationship between exposure to lead and these pregnancy outcomes (Mirghani *et al.*, 2010).

Table 4. Association between maternal BLL and the daily kohl use.

variable	Total population (n=58)		Cases LBW (n=29)		Controls NBW (n=29)	
	Correlation Coefficient	Sig	Correlation Coefficient	Sig	Correlation Coefficient	Sig
Daily kohl use	-0,429	0,001	-0,207	0,281	-0,453	0,014
Daily kohl use [a]	-0,429	0,002	-,069	,761	-,469	,024

[a]partial correlation by eliminating effect of: maternal age, parity, BMI, mothers occupation and education statue.

In another study performed at Al-Kharj hospital of Saudi Arabia during 2005 - 2006, the levels of three toxic metals (lead, cadmium, and mercury) were measured in maternal blood, and their effects on birth weight and small for gestational age (SGA), were assessed. As showed the result, lead, unlike other heavy metals has no impacts on the weight and SGA of newborns (Al-Saleh *et al.*, 2014).

In a study carried out in Kuwait, Abdur Rahman *et al.*,2012 investigated the incidence of high BLL in pregnant women and its effect on birth weight, head circumference, Apgar score, gestational age, and other newborn characteristics. Results show no significant relationship between maternal BLL and any of the outcome variables tested (Rahman *et al.* 2012).From the study in 1986relating maternal and cord blood Pb levels with measures of size and Apgar scores, the analysis did not approach statistical significance (Ernhart *et al.*,1986).

In a cross sectional study, a total of 70 pregnant women and their newborns were selected at Mousavi Hospital of Zanjan, Iran, suggest that lead levels was not related with gestational age, height, or head circumference(Torabi *et al.*, 2018).

In contrast, several studies have suggested that prenatal low lead levels exposure is a negative predictor of pregnancy outcomes. Xie *et al.* detected decreasing birth weight across quartiles of maternal lead, with an adjusted difference of -47 grams (95% CI: -128, 35) in the highest vs. lowest quartile (Xie *et al.,* 2013).Other Study sought to evaluate the relationship between toxic metals, nutrient combinations and birth weight among 275 mother-child pairs found that prenatal blood Pb was associated with lower Birth weight. Essentials elements Fe, Se, Ca and folate did not modify these relations (Luo *et al* ., 2017).

Taylor *et al.*, examined Blood samples of pregnant women derived from the Avon Longitudinal Study of Parents and Children (ALSPAC) and suggest that an increase of 1 μg/dl was associated with changes in birth weight of −9.93 g, head circumference −0.03 cm and crown–heel length −0.05 cm(Taylor *et al .,* 2016). Few data are available on the sex differences in the association between lead prenatal exposure and pregnancy outcomes. Findings of study done in Shanghai between September 2008 and October 2009 suggest that prenatal lead exposure may have sex-specific effects on birth outcomes. Furthermore, a significant inverse association was found between cord BLL and head circumference only in the male group, and the decrease of ponderal index was significantly with increasing cord BLL only in females (Wang *et al.,* 2017).

Concerning sources of lead, previous research focused on high dose lead exposure of women in the workplace such as smelters, lead battery plants and printing factories. Much less work concentrated on studying the effect of low dose sources of lead such as from food, air, soil, house dust and cosmetics.

In this item, contamination generally is greater in urban than rural areas where there is no specific or identified point sources, though, our finding showed that no differences in blood lead levels are observed between urban and rural maternal residence. A detailed research (Carrel *et al .,* 2017). Confirm our result and suggest that rural populations are at as great of risk of elevated blood lead levels as are urban populations.

Many studies have reported the chemical content of kohl and surma, particular Pb contents and as known the entry of this metal into the body is typically by ingestion or inhalation of particulates, though exposure through the skin or eye is possible(Al-Ashban *et al .,* 2004; Tiffany-Castiglioni *et al* ., 2012). Our findings suggest that frequency use of kohl during pregnancy was correlated with maternal BLL, but this relationship persist only in controls group that may be explain elevate lead concentration in mothers in controls and not in cases. Naveed Zafar Janjua found that mothers who used surma (an eye cosmetic) daily had higher cord BLL (11.5 ug/dl) as compared to those who used it less frequently (9.4μg/dl), (Janjua *et al.*, 2008).

Conclusion

From the small group of women participated in the present study it can be decided that prenatal lead does not have significant effect on newborn characteristics (sex, weight, age at birth and Apgar) and is unlikely to increase the risk of low birth weight. We found association between maternal frequency uses of kohl and lead levels, this finding add to proof from past investigations proposing that maternal low lead exposures might be related with cosmetics product and encourage the use of lead-free kohl in order to reduce sources of lead exposure with the end goal to protect fetal health.

What is already known on this topic?

Lead in maternal blood can be transmitted to the fetus through the placenta from 12 weeks of gestation until birth.

Lead is a toxic heavy metal associated with adverse pregnancy outcomes.

Maternal blood lead concentrations that do not produce clinical toxicity on pregnant women have been linked to adverse off spring.

What this study adds

The present study suggests that prenatal low lead exposure was not associated with low birth weight infant.

Competing of interest

Authors declared they have no competing of interest.

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