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Study of the Relationship between Blood Lead Level and Complete Blood Counts in Pregnant Women

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Abstract

Background: Lead exposure is one of the global health problems, especially among pregnant women.
Objectives: In this regard, the present study aimed to investigate the correlation between blood lead and blood indicators in healthy pregnant women.
Methods: This correlational study was conducted on 80 pregnant women hospitalized in Ayatollah Mousavi Hospital in Zanjan during 2015. After receiving informed consent, 3.5 mL of their blood samples were taken for measuring the blood lead and indicators. Then, Symex was used to analyze hematologic indicators, followed by utilizing the potentiometric method and Ion3 to measure the blood lead level. Finally, data were analyzed by SPSS software, (version 22) applying a Pearson correlation coefficient and linear regression. A P-value of less than 0.05 was considered statistically significant.
***Results*:** The mean blood lead of the subjects was 6.24±1.74 µg/dL. Based on the results, a significant correlation was found between blood lead and hemoglobin (Hb: r=-0.39, P<0.001), mean corpuscular volume (MCV: r=-0.26, P=0.02), mean corpuscular hemoglobin (MCH: r=0.27, P=0.013), mean corpuscular hemoglobin concentration (MCHC: r=-0.327, P=0.003), and platelet number (Plt: r=0.359, P= 0.001). However, no significant correlation was observed between blood lead and other platelet and blood indicators.
Conclusion: Overall, blood lead affects blood indicators. Therefore, it is suggested to plan and implement strategies to reduce exposure to lead in the environment, especially for pregnant women.

Keywords: pregnancy, blood lead level, complete count of blood cells

Introduction

Lead is regarded as one of the first heavy metals discovered by the humans who have used lead since 5000 years ago owing to its unique characteristics such as low melting point, softness, flexibility, and corrosion resistance [1]. The World Health Organization considers lead as one of the "Top Ten Chemical Concerns of General Health" [2]. This problem is more evident in developing countries due to the use of leaded gasoline, and during a highly sensitive period of pregnancy, it is associated with potential lifelong effects on the growth and development of the fetus [3,4]. In addition, no level of blood lead is safe while, fortunately, preventing exposure to lead is completely possible. The blood lead level (BLL) during pregnancy should be less than 10 µg/dL, but according to the report of the Centers for Disease Control and Prevention, follow-up and intervention activities start at 5 µg/dL and more. Lead with a simple diffusion mechanism reaches the fetus from the placenta and is measurable before the 12 th week in the fetal brain, and therefore, it is associated with adverse pregnancy and fetal consequences [5].

Further, fetus exposure to lead increases during pregnancy due to increased re-absorption from mother's bones, especially in women who smoke

and consume less calcium. The importance of this topic in developing countries is greater because of food poverty [3-6]. Although medium and high concentrations of blood lead are associated with midwifery adverse consequences and lead exposure in a perinatal period even at a very low level increases adverse consequences to mother and fetus [7] and is a risk factor for the fetus growth [8].

Several studies showed that there is a significant relationship between BLLs and blood disorders [9] so that the role of lead oxidative stress is confirmed in pregnant women with anemia [10]. Furthermore, lead causes a chain of disorders so that it releases reactive oxygen species and reduces basic metals to perform antioxidant reactions by oxidative stress mechanism. Moreover, it disturbs the membrane integrity and releases lipid peroxidases by affecting the composition of cellular fatty acids [11]. Several studies also confirmed the association of lead with hypochromic microcytic anemia [12] and the reduced level of red blood cell (RBC) parameters (i.e., RBC, hemoglobin, and hematocrit) [13]. However, most studies focused on men and non-pregnant women, and on the other hand, there is also a physiological anemia during pregnancy due to increased blood volume [14].

Occupational exposure to lead is a major health problem in Iran and in some areas, food is infected with lead as well [15]. Previous research addressed lead and lead derivative plants using lead pottery and the eating soil and then investigated the risk factors for lead contamination in pregnant women, which was found to lead to an increase in BLLs, [16]. On the one hand, the largest lead mine in the Middle East is located in Zanjan Province. According to the announcement of Zanjan Provincial Government Research Committee, lead studies are among the research priorities. Therefore, the current study sought to evaluate the correlation between blood indicators and blood lead in healthy pregnant women in Ayatollah Mousavi Hospital in Zanjan.

Methods

This study was conducted on 80 pregnant women admitted to Ayatollah Mousavi Hospital in Zanjan for delivery during June-March 2015. After obtaining permission from the Ethics Committee of Shahid Beheshti University of Tehran (IR.SBMU.PHNM.1394.244), the data were collected using a purpose-based method. Based on the correlation between blood lead and blood indicators and considering the data of previous studies, alpha, beta, and the sample size were 0.05, 0.01, and n=80, respectively.

$$n \geq \left\lceil \frac{\left(z_{1-\alpha/2} + z_{1-\beta}\right)}{0.5 \times \ln\left[(1+r)/(1-r)\right]} \right\rceil^2 + 3$$

$$r = 0.35$$

$$\alpha = 0.05 \Rightarrow z_{1-\alpha/2} = 1.96$$

$$\beta = 0.10 \Rightarrow z_{1-\beta} = 1.28$$

This is the third article extracted from the master's thesis entitled "The Relationship Between Blood Lead Levels and Preeclampsia" [17,18].

Sampling was performed using a purpose-based method and the subjects included healthy pregnant women who passed a natural perinatal period and were admitted to the mentioned hospital for the termination of pregnancy. The inclusion criteria were being within the age range of 15-40 years, having Iranian nationality, being an inhabitant of Zanjan and having single pregnancy, not suffering from drug and alcohol abuse, being within the pregnancy age of 37-41 weeks, as well as not being pregnant with IVF. The exclusion criteria included diagnosis of hypertension, preeclampsia, or diabetes during labor, delivery, and postpartum. Therefore, the subjects were followed up after the hospital discharge upon obtaining informed consent from the subjects. After obtaining demographic, midwifery, and medical questionnaires from the subjects and explaining the research purpose, 3.5 mL of blood was taken and kept in k3 EDTA tubes at room temperature and then sent to the laboratory in less than an hour. As regards the blood lead test, 1.5 mL blood was analyzed by PSAIon3 (STEROGLASS, Italy) and potentiometer. This highly accurate and sensitive device is used to precisely isolate heavy metals

from media such as blood, water, foods, chemicals, and pharmaceuticals, as well as petroleum products and derivatives [19]. In addition, 2 mL of blood was tested by Symex in order to analyze the blood parameters, followed by testing a sample for 10 times (with the same result) to estimate the reliability of the device.

The tests were performed by a single person to ensure that the same procedure was performed by the same person and device. Eventually, SPSS software (version 22), Pearson correlation coefficient, and linear regression were used to analyze the data. A P-value less than 0.05 was considered statistically significant.

Results

A total of 80 pregnant women participated in this study. Their mean age and the mean pregnancy age (the ultrasound of the first trimester) were 27.37±6.01 and 39.01±2.3, respectively. Other demographic characteristics are shown in Table 1.

Table 1: Demographic Characteristics

Variable		Figure (%)
Mother's Level of Education	Illiterate	0(0)
	Below high school education	51(63.75)
	University degree	29(36.25)
Household income (Rials*)	10000000>	10(12.5)
	20000000-10000000	45(56.25)
	>20000000	25(31.25)
Parity	Nulliparous	38(47.5)
	Multiparous	42(52.5)
Abortion	0	63(78.75)
	1	13(16.25)
	2	2(2.5)
	3≤	2(2.5)
Mother's job	Housewife	68(85)
Delivery	Employed	12(15)
Delivery	Normal delivery	47(58.75)
	Cesarean section	33(41.25)

Note. *The Iranian currency.

The mean blood lead in these subjects was estimated at 6.24±1.74 μg/dL. Among 80 subjects, 20 cases (25%) had low blood lead levels (BLLs) of 5 μg/dL, three cases (3.8%) had BLLs above 10 μg/dL, and finally, 57 subjects (71.3%) had BLLs of 5-10 μg/dL. Further, the Pearson correlation coefficient was utilized to determine the correlation between blood lead and blood indicators (Table 2).

Table2: The Correlation Between Blood Lead Levels and Blood Indicators of the Subjects

Blood Indicators	SD ±mean	Person Correlation	P value
WBC (µmoL)	15040.51±17434.46	0.93	0.41
RBC (µmoL)	4.46±0.412	-0.08	0.47
Hb (g/dL)	13.04±1.21	-0.39	0.001>
HCT (%)	39.37±6.64	-0.125	0.2
MCV (fl)	86.91±5.60	-0.26	0.02
MCH (pgr)	29.41±2.70	0.27	0.013
MCHC (g/dL)	33.51±1.31	-0.327	0.003
Plt (µL)	$199.88 \times 10^3 \pm 46.17 \times 10^3$	0.359	0.001
Lyn (%)	18.39±5.56	0.037	0.8
Mix (%)	5.85±2.08	0.112	0.45
Net (%)	171.02±0.841	-0.043	0.7
RDW (%)	13.48±1.31	0.184	0.113
PDW (%)	33.41±2.11	0.18	0.23
MPV (fl)	10.51±0.85	0.071	0.64
PLCR (mg/dL)	30.01±6.53	0.095	0.53

Note. WBC: ; RBC: Red blood cell; Hb: Hemoglobin; HCT: Hematocrit; MCV: Mean corpuscular volume; MCH: Mean corpuscular hemoglobin; MCHC: Mean corpuscular hemoglobin concentration; Plt: Platelet number; Lyn:; Mix; ; Net: ; RDW: Red distribution width; PDW: Platelet distribution width; MPV: Mean platelet volume; PLCR: Platelet large cell ratio.

As shown, a significant correlation is found between blood lead and hemoglobin, mean corpuscular hemoglobin concentration (MCHC), mean corpuscular hemoglobin (MCH), mean corpuscular volume (MCV), and platelets. In other words, hemoglobin, MCV, and MCHC demonstrate a reduction by increasing the blood levels of lead while MCH and platelets represent an increase in this regard.

Discussion

The current study attempted to investigate the relationship between blood lead and blood indicators in healthy pregnant women who had passed the natural perinatal period. Totally, 71.3% of the subjects had blood lead levels (BLLs) of 5-10 µg/dL. Based on the findings, a significant association was observed between blood lead and blood indicators (i.e., hemoglobin, MCHC, MCH, and MCV) and the platelet number. Similarly, Berman et al., studying individuals working at a battery plant, found a significant relationship between blood lead and platelet indicators in such a way that the number of platelets reduced while an increase was detected in the platelet volume diffusion and platelet large cell ratio [20]. Furthermore, Dobrakowski et al. studied short-term exposure to lead and its effect on the blood system of the workers and demonstrated that this exposure increased the number of platelets and white blood cells while it reduced MCH, MCHC, and platelet indicators. Lead may cause bleeding, which is due to a reduction in the relevant cytokines, therefore, leading to an increase in the number of platelets while a decline in platelet indicators [21]. In the current study, a significant positive correlation was found between blood lead and the number of platelets, which blood lead accounts for 12.9% of the platelet changes.

Based on the findings of most studies, BLLs affect hemoglobin, hematocrit, and the other blood indicators of the red blood cell. Anemia can be observed at high concentrations of blood lead (50 µg/dL) as well [22,23], whereas at lower concentrations, these changes only relate to some hematological indicators. In the study by Lauon Lyon et al., a significant relationship was found between BLLs above 5µg/dL and reduced hemoglobin, hematocrit, and the number of red blood cells [10]. In another study conducted on battery plant workers, blood lead caused a reduction in blood hemoglobin, hematocrit, and red blood cells. BLLs were also higher in those with iron deficiency anemia [24]. Moreover,

studies conducted on children with anemia showed similar results so that blood lead in these subjects was significantly related to the severity of anemia [25]. Likewise, the findings of another study demonstrated that chronic exposure to lead caused MCV anemia [26].

In a study on pregnant women with anemia, oxidative stress markers in this group were significantly higher compared to the control group. Oxidative markers such as the products of lipid peroxidase, superoxide dismutase, and catalase had a significant correlation with BLLs, which may be the cause of anemia in this group of women [11]. In another study investigating pregnant women exposed to lead in the environment, a reduction was detected in serum erythropoietin concentration, which may be due to the nephrotoxic effect of the lead. Thus, another theory of anemia caused by lead poisoning may be the nephrotoxic impact of the lead [27]. In the present study, the statistical population encompassed healthy pregnant women (with no anemia) and a significant correlation was found between blood lead, reduced hemoglobin, and other blood indicators in the physiological range, indicating that lead in healthy people reduces blood indicators in the physiological range as well. Therefore, pregnant women are recommended to prevent exposure to professional or occupational lead in order to keep lead concentrations below 5 μg/dL [5].

Overall, a significant correlation was observed between blood lead and hemoglobin, platelet, mean corpuscular hemoglobin concentration, mean corpuscular hemoglobin, and mean corpuscular volume. It is suggested to conduct further studies such as a clinical trial or case-control study taking into account a larger number of samples. Eventually, such studies are suggested to plan and implement strategies to reduce exposure to lead in the environment, especially for pregnant women.

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Conflict of interest

The authors declare that there is no conflict of interest.

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