Original Article

Effect of low lead exposure on gestational age, birth weight and premature rupture of the membrane

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Abstract

Objective: To find out the effect of prenatal exposure to low lead from cosmetics on gestational age, premature rupture of the membrane and birth weight.

Methods: The study was carried out in the mountainous Aseer region, Southwest of Saudi Arabia where the air is thought to be clean and free of lead pollution due to the absence of petroleum smelting and other heavy industries. The region is famous as a holiday resort for tourists from Arabia and the gulf countries.

All 176 pregnant women included in the study were of singleton pregnancies of gestational age 27 weeks or more who attended the antenatal outpatient clinic of the main maternity hospital. On the day of delivery 4 milliliters of venous blood from each singleton parturient was placed in a heparinized non-silica containing tube and stored at -20°C prior to analysis.

Results: Ninety-four (70.1%) women out of 134 had maternal blood lead concentration < 200 μg/L and only 40 women had > 200 μg/L. The mean difference in gestational age was 10.5 days, showing a non significant difference (P=0.152). Ninety-three women (72.7%) out of a total of 128 who had blood lead concentration <200 μg/L gave birth to infants weighing an average of 2.87 kg while 35 women who had blood lead level > 200 μg/L gave birth to infants weighing an average of 2.99 kg. The mean difference was 0.12 kg which is non-significant (P=0.261). Regarding premature rupture of the membrane a total of 127 women with maternal blood lead levels above 200 μg/L showed no significant differences (P=0.64). The Chi-square test of the relationship between the birth weight (kg) and the levels of blood lead below 150 μg/L was not significant while the relationship between the birth weight (kg) and the levels of blood lead above 200 μg/L resulted in very slight differences in the values of infants' birth weight.

Conclusion: The detected low lead exposures from cosmetics does not produce statistically significant effects on the three pregnancy outcomes; gestational age, premature rupture of the membrane or birth weight. However, the importance of low lead exposure from the 100% lead sulfide eye cosmetic "kohl" is emphasized" (JPMA 60:1027; 2010).

Introduction

The placental barrier is permeable to free serum lead and levels in cord blood were reported to reach 5 to 10% of the maternal blood level.[1] In addition lead may be released from maternal bone reserves during pregnancy and thus may become a major source of intoxication for the foetus.[2] Lead content in foetal organs increase with gestational age and may affect the nervous system and calcium dependent organs. Besides the classical signs of lead poisoning, pregnant women risk spontaneous abortion and increased blood pressure. Manifestations in

the foetus and newborn include low birth weight, foetal hypotrophy and malformation. Other manifestations are not seen until several years after birth and they include retarded mental development and muscular and behavioural disorders.[3]

From the perspective of human reproduction, lead is known to cause number of adverse outcomes in women. Effects in women include infertility, miscarriage, premature membrane rupture and premature delivery.[4] Recent findings indicate that lead may be toxic at levels previously thought to have no effect.[5] Despite the fact that the adverse effects on pregnancy outcomes at high levels of lead exposure have been recognized for years, there is uncertainty regarding the impact of exposure to lower levels commonly encountered daily, such as that due to lead containing cosmetics. Evidence from experimental models and human epidemiological studies suggest that the previously accepted "safe" level of 250 g/L is still too high.[5] Adverse reproductive outcomes may occur at blood lead Level commonly found in the population of many industrialized nations. The U.S. Public Health Services stated that there is no safe level for lead, and as a practical measure recommended reduction of blood lead levels to less than 100 µg/L in women of childbearing age.[6]

Recently, the toxic effects due to exposure to low-level lead have been the subject of media attention. In most countries, the acceptable occupational limit for lead exposure is being progressively decreased as the adverse health effects of lead are being recognized. Further the sensitive nature of the foetus to hazardous substances via maternal sources is of critical concern. Preterm delivery, congenital abnormalities and decrease in growth stature have all been associated with prenatal lead exposure at previously acceptable levels.

New sources of lead poisoning have been identified raising important public problems, particularly for pregnant women.[7] Theoretically, pregnant women can no longer be exposed to occupational sources according to public health regulations. Local customs in this region does not accept women to work in industry. However, other sources such as lead containing cosmetics are now in the public "eye". Lead remains a significant public health problem not only to men at work, but to women using lead containing cosmetics. The black eye make-up "Kohl" which is 100% Lead sulfide is applied by women in many countries and is widely used in Arabian Peninsula, Africa and India.[8] It contribute significantly to lead poisoning.[9] Lead pollution from cosmetics was shown to increase maternal and foetal blood lead concentration. A study of the effect of prenatal exposure to low lead from cosmetics on gestational age, premature rupture of the membrane and birth weight would help to cast light on this problem, and suggests avenues for more research.

Subjects and Methods

The study was carried out in the mountainous Aseer region, Southwest of Saudi Arabia where the air is thought to be clean and free of lead pollution due to the absence of petroleum smelting and other heavy industries. The region is famous as a holiday resort for tourists from Arabia and the gulf countries.

All 176 pregnant women included in the study were of singleton pregnancies of gestational age 27 weeks or more who attended the antenatal outpatient clinic of the main maternity hospital. All women included in the study were using the black eye make up 'Kohl' available in the local markets. Kohl is imported illegally in many countries from the Far East and has been found to be strongly correlated with elevated blood lead levels.[10]

On the day of delivery 4 milliliters of venous blood from each singleton parturient was placed in a heparinized non-silica containing tube and stored at -20°C prior to analysis. Collection of umbilical cord blood was carried out by drawing blood from vessels on the cord and stored in the same way. Whole blood was mixed in equal volumes with 0.2% triton x 100/antifoam B solution. Total lead concentrations were measured by electrothermal atomization atomic absorption spectrometry (Varian, Zeeman AA300 spectrometer) coupled to a mass spectrometer which was precalibrated using lead reference standards. An IBM computer was used to record and process the data. All measurements were recorded as the mean of two determinations. All women with blood lead concentrations > 200 µg/L were called for an interview regarding personal and occupational characteristics which may have relevance, such as the use of the black eye make-up "Kohl", type of residence and other personal history. Premature membrane rupture is defined as foetal membrane rupture prior to labour onset, irrespective of gestational age; low birth weight is defined as a delivery of less than 2.500 kg; and reduction in gestational weeks is defined as less than 36 completed weeks calculated from date of conception.

The data was analyzed on the Statistical Package for Social Sciences (SPSS). Student's t-test and chi-square test were used as tests the significance and the 5% level of significance was used.

Results

Presented in Table-1 is the analysis of premature rupture of the membrane for a total of 127 women with maternal blood lead levels above and below 200 µg/L. No significant differences (P=0.64) in the number of cases with

Table-1: The relationship between blood lead levels above and below 200 µg/L and premature rupture of the membrane.

[Pb] g/L	Premature rupture of the membrane		Total
	Yes	No	
< 200	5.3 (n = 5)	94.7 (n = 81)	86
> 200	4.9 (n = 2)	95.1 (n = 39)	41
Total	5.2 (n = 7)	94.8 (n = 120)	127

Fishers exact test for one tail P = 0.64024.

Table-2: The relationship between blood lead levels (µg/L) and the mean gestational age (weeks).

[Pb] µg/L	No. of Cases	Mean Gestational Age (weeks)	SD
< 200	94	39.4	1.938
> 200	40	37.9	6.578

P = 0.152, t-value = 1.46.

Table-3: The relationship between blood lead levels (µg/L) and the birth weight (kg).

[Pb] µg/L	No. of Cases	Birth Weight (Kg)	SD
< 200	93	2.87	0.54
> 200	35	2.99	0.53

P = 0.261, t-value.

premature rupture of the membrane above or below these blood lead levels was found.

Table-2 shows that 94 (74.0%) women out of 127 have maternal blood lead concentration < 200 µg/L and only 33 women had > 200 µg/L. In the latter group of women the mean difference in gestational age was 10.5 days, showing a non significant difference (P=0.152). Similar calculations have shown no difference in the above result if the cut off point of blood lead concentration is reduced to 150 µg/L.

Table-3 shows that 93 women (73.2%) out of a total of 127 who had blood lead concentration < 200 µg/L gave birth to infants weighing an average of 2.99 kg while 34 women who had blood lead level > 200 µg/L gave birth to infants weighing an average of 2.87 kg. The mean difference was 0.12 kg which is non-significant (P=0.261).

Taking the average value of birth weight as 2.500 kg for this region,[10] it was calculated that in the group with lead content < 200 µg/L, 49 (52.7%) infants had an average birth weight; 18 (19.4%) had below average birth weight, and 26 (28%) had low birth weight. While in the group with lead content > 200 µg/L, 24 (70.6%) infants had average weight, 3 (8.8%) had below average birth weight and 7 (20.6%) had low birth weight. Chi square test (3.5) was not-significant.

Discussion

Heterogeneity of the pregnancy outcomes addressed in different studies required more research to clarify the effect of low lead exposure on the unborn foetus. In this study maternal and umbilical cord blood lead levels were measured in pregnant women, and its effects on gestational age, premature rupture of the membrane and infant birth weight were observed.

Previous research concentrated 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. The WHO sets standards of blood lead level not to exceed 100 µg/L.[11] Previous findings have shown that the mean maternal blood lead concentrations in cosmetics-using-women is 112.76 µg/L, and the mean umbilical cord blood level is 82.38 µg/L.[12] It is also demonstrated that lead freely crosses the placenta, and others have shown that it may cause irreversible damage to the unborn foetus. Many studies examined the association of maternal blood lead and premature rupture of the membrane.[13-16] Some of these studies reported either a decline or a slight non-significant increase in premature rupture of the membrane with increasing maternal blood lead.[15,16] Other studies found no correlation or apparent association between maternal blood lead level and premature rupture of the membrane.[13,14] The findings of this study do not support this hypothesis. These results would suggest that at this low level of exposure from cosmetics there is no effect on premature rupture of the membrane.

The Cincinnati study noted a half-week's reduction in gestation for every 10 µg/L increment in blood lead.[17] A cross sectional study involving 236 mothers carried out in Glasgow, concluded that gestational age was significantly reduced according to the cord and maternal blood lead levels.[18] Findings from the present study show that the levels of lead exposure from cosmetics appear to cause non significant effect on gestational age.

It is known that birth weight standards vary with ethnic or cultural characteristics as well as with maternal height, weight, sex of the baby and maternal blood lead concentrations. Another confounding effect in this region is the high altitude (7000 feet above sea level). A study conducted in the area has shown that the average birth weight is 2,500 kg which is similar to this study.[10]

Maternal blood lead level is influenced by several physiological processes during pregnancy, including enhanced mobilization of maternal lead storage from bone, which tends to increase circulating levels. It is apparent that

there is a dynamic relationship between bone and blood, and that physiologic processes are continuous. This would mean that there isn't a half life for blood lead, rather, maternal and foetal blood lead concentrations measured here represent dynamic triangular relationship between maternal blood, bone and the unborn foetus. Therefore, the outcome of pregnancy depends on complex dynamic processes. Cultural customs in this region shelters women from industrial pollutants; we therefore suggest the widely used eye cosmetic "Kohl", which contains 100% lead sulfide play a central role in this dynamic process. And personal interviews with the pregnant ladies support that.

From the small group of women subjected to low lead exposure from cosmetics it can be concluded that prenatal lead does not have significant effect on gestational age, and is unlikely to increase the risk of premature rupture of the membranes and is less associated with reduced birth weight. Some studies conducted at low lead exposure levels show similar findings.[4,19-21] Other studies which report severe effects of lead on pregnancy outcomes can be summarized as either being conducted at higher lead levels, or different confounding effects other than those mentioned above played a role, or multivariant different statistical methods were used. However, it can be emphasized that a small shift in gestational age or premature rupture of the membrane may have profound importance in infant health and survival, therefore lead exposure from cosmetics or otherwise should be avoided.

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