Maternal and umbilical cord blood lead level in Abha Maternity Hospital, Southern Saudi Arabia

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ABSTRACT

Objective: To determine maternal and umbilical cord blood lead levels in the main maternity hospital in Southern Saudi Arabia, and to identify the possible source of lead. Study design: Whole blood (4 ml) was collected from a total of 172 pregnant ladies and similarly from the cords on the day of delivery. Blood lead concentration of both maternal and umbilical cord was measured using atomic absorption spectrophotometry. Personal interviews of the mothers was conducted to identify the possible sources of lead. Results and conclusion: The mean concentration of lead in maternal and cord blood were 112.8 ± 7.84 and 82.38 ± 5.52 μg/L, respectively. There was a direct relationship between maternal and umbilical cord blood lead level (p<0.001). Our results of personal interviews indicate that lead-containing cosmetic “khol” is the most likely source of lead in the blood of pregnant females.

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Keywords: Blood lead, cosmetics, pregnancy.

Lead is the fifth most abundant metal in the world, after iron, copper, zinc and aluminum. High blood lead levels can affect survival and development of the fetus and the infant. Sterility, abortion, stillbirth, premature delivery and adverse pregnancy outcomes such as low birth weight, failure to thrive and impaired mental development of infants were recognized at low lead exposure levels. Lead can readily cross the placenta during the entire pregnancy and fetal levels ultimately equilibrate with maternal levels. Wong et al published an extensive review of the effect of low-level lead exposure in utero, indicating that prospective studies consistently identified a link between maternal blood level of 100-150 μg/L and disturbance in early infant and neurological behavior performance. The authors concluded that the previously accepted “safe maternal blood level” of 250 μg/L is too high, and that adverse reproductive and neurobehavior effects may occur at blood lead levels commonly found in the population of many nations today. To date four prospective studies examined pregnancy outcomes related to maternal blood lead levels. The Port Pirie study showed that preterm deliveries were significantly related to maternal blood lead levels at delivery. The risk was 8-9 times greater at exposure levels of 140 μg/L. The Cincinnati study noted a half week reduction in gestation for about every 100 μg/L of increment in blood lead. A prospective study conducted in a total of 500 deliveries in a hospital in Thailand showed maternal and cord blood lead concentrations of 62 and 16 μg/L respectively. At such levels there was no association between adverse pregnancy outcomes and maternal blood lead levels. Animals studies have shown that pregnant rats given 250 ppm lead acetate in their drinking water from conception until termination showed tubular injury with frequent mitosis. In spite of government legislation and modernization an important source of lead in Saudi Arabia, as well as other countries, continues to be cosmetics. Lead sulfide is a component of black eye make-up, particularly in Nigeria (Trio), India (Surma), and the Arab world (Kohl) that is capable of producing lead toxicity. Long term exposure to low level of lead such as from cosmetics may present an additional hazard when physiological stress that results in abnormally high calcium metabolism (e.g. in pregnancy) cause the mobilization of bone lead and

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Table 1 - Descriptive statistics for maternal and umbilical cord blood lead concentrations (µg/L).

<table>
<thead>
<tr>
<th></th>
<th>Maternal</th>
<th>Cord</th>
</tr>
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<tbody>
<tr>
<td>Mean</td>
<td>112.76</td>
<td>82.38</td>
</tr>
<tr>
<td>Std. dev</td>
<td>102.80</td>
<td>72.41</td>
</tr>
<tr>
<td>Std. error</td>
<td>7.84</td>
<td>5.52</td>
</tr>
<tr>
<td>Count</td>
<td>172</td>
<td>172</td>
</tr>
<tr>
<td>Minimum</td>
<td>20.00</td>
<td>10.00</td>
</tr>
<tr>
<td>Maximum</td>
<td>600.00</td>
<td>500.00</td>
</tr>
<tr>
<td>Variance</td>
<td>10567.33</td>
<td>5243.70</td>
</tr>
<tr>
<td>Coef. var.</td>
<td>0.91</td>
<td>0.88</td>
</tr>
</tbody>
</table>

Fisher’s r to z  Correlation  p-Value  
MOTHER, M & F  .46  .0001

172 observations were used in this computation.

consequent increase in circulating lead levels. Blood, kidney and the nervous system are all sensitive to elevated levels of soluble lead.9 The aim of this study is to provide information on the health risks posed by use of lead-containing traditional cosmetics commonly used by women, some men and children in this area. Such a problem cannot be solved unless it has been clearly expressed and people are aware that it exists.

Subjects and methods. All 172 pregnant women included in this study were of singleton pregnancies of gestational age 26 weeks and more who attended the antenatal outpatient clinic at Abha Maternity Hospital (Southern Region of Saudi Arabia) and consecutively delivered at the same hospital. On the day of delivery 4 ml of venous blood from the 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 as above. 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 spectrophotometry (Varian, Zeeman AA300 spectrometer) coupled to a mass spectrometer which was precalibrated using lead reference standards. The wavelength used was 283.3nm. An IBM 30 computer was used to record and process the data. All results were reported as the mean of two determinations. All patients with lead concentrations above 200 µg/L were called for an interview regarding personal and occupational characteristics which may have been relevant, namely type of residence, use of black eye make-up (khol) and other personal history.

Statistical analysis was conducted using a Macintosh statistical package program, Excel 4, Statview 4 and CA-Cricket Graph 3; for the calculation of standard deviations, coefficient of variance, and Pearson’s correlation coefficients. Values of p<0.05 were considered significant and blood lead level ≥ 200 µg/L were categorized as high values.

Results. During the course of this study, a total of 172 pregnant mothers and 172 newborns were studied. Shown in Figures 1 and 2 respectively are histograms of maternal and umbilical cord blood lead concentrations in µg/L. The minimum and maximum maternal blood lead level were 20 and 600 µg/L, respectively while those measured in cord blood were 10 and 500 µg/L, see Table 1. Mothers with blood lead level ≥ 200 µg/L who are considered at risk represent 8.2% of the total 172 pregnancies, while of newborns 6.9% have blood lead level above 200 µg/L. Significant statistical correlation (p<0.0001) was found between maternal and cord blood lead levels (Table 1) which implies that lead crosses the placenta and transfers to the fetus (Fig. 1). The mean of maternal and umbilical cord blood lead concentrations were 112.76 ± 7.84 and 82.38 ± 5.52 µg/L, respectively (Table 1).

An interview with all women with blood lead concentrations above 200 µg/L failed to reveal an association between their elevated blood lead and the common sources of lead such as petrol, house paints, or nearby refinery or industry. Job occupation and leaded pipes were excluded since all women were housewives and no regional water pipe network

![Figure 1 - A correlation graph of umbilical cord blood lead concentration versus maternal blood lead concentration of the total of 172 mothers and 172 infants.](image)
exists. However, 14 of the 50 (28%) respondents with blood lead levels above 200 μg/L admitted to using black eye make-up (khol) periodically before and during pregnancy. Finally, many inhabitants of this area are still closely adhered to their traditional remedies and cosmetics, and in large this part of Saudi Arabia is free of air, water and industrial pollution; serving as the most important holiday resort.

**Discussion.** In humans only a small number of chemicals, administered as drugs, present in the diet or in the occupational environment are recognized as human teratogens. In parallel, about 60% of congenital anomalies have no identified cause and probably some compounds such as cosmetics may contribute to certain anomalies. Lead toxicity causes hematological, gastrointestinal and neurological dysfunction in adults and children, symptoms are usually noted with blood lead greater than 193 μg/L. Prolonged exposure as in cases of cosmetics may also cause chronic nephropathy, hypertension and reproductive impairment. Lead inhibits enzymes; alters cellular calcium metabolism; stimulates synthesis of binding proteins in kidney, brain and bone and slows nerve conduction. Less severe exposure to lead, designated by blood lead level encountered in this study (Figs. 2, 3), has been implicated in poor pregnancy outcome, impaired neurobehavioral development, reduced stature in young children and higher blood pressure in adults. Dust, water and paint chips are still major sources of lead, but lead from cosmetics, folk remedies, food supplements, food preparation utensils and improperly prepared infant formula have caused epidemic and sporadic severe lead toxicity. Recent research findings indicate that lead may be toxic at levels previously thought to have no effect. While there are some indications of an association between lead and the production of anomalies, any dose-response relationship or casual mechanism has yet to be established.

A study conducted in the northern part of Saudi Arabia measured the ratio of two lead isotopes in the blood of school children with a view to identifying the most important source of lead. The authors concluded that lead from cosmetics and traditional remedies were the most likely source of exposure. Sources such as petrol, drinking water and household dust were excluded. The toxic effects of low level lead exposure have been the subject of a good deal of research and media attention in recent times. In most countries, the acceptable occupational exposure limit for lead is being progressively decreased as the adverse health effects of lead are being identified at levels approaching those found in non-occupational environments. Due to the increased sensitivity of the fetus to hazardous substances, the exposure to lead of the unborn child via maternal sources such as cosmetics is of critical concern. Preterm delivery, congenital abnormalities and decreases in growth status have all been associated with prenatal lead exposure at "acceptable" levels. There is an accumulation of evidence which indicates that maternal exposures prior to conception can play an important role in determining blood lead levels during pregnancy. In light of these observations the practice of removing the pregnant woman from lead sources may be of questionable value with regard to providing sufficient protection for the fetus. Significant positive correlation was observed between the concentrations in maternal and cord blood lead levels (correlation coefficient, r=0.46 and p-value <0.001). These results suggest that, like essential metals, most heavy metals can move rather freely across the human placenta; therefore the potential health effects of heavy metal transfer from mothers to young infants cannot be discounted. We found that the percentage of women who have blood lead levels which may place them at risk for poor reproductive outcomes is 23.8% (i.e. 41 of 172, see Fig. 2). Such effects, if confirmed, may have implications for public health
intervention strategies.16

Finally, lead in bone is not a physiological sink, but can be mobilized back into the circulation in response to normal or “pathological” changes in mineral metabolism. Bone lead may be a significant source of target organ exposure under certain conditions, such as pregnancy. The accumulation of lead in bone cells may have toxic consequences for bone status of the fetus and some of the mechanisms by which lead could affect bone mineral metabolism may also play a role in other target organs.17 However, we think that further investigations are warranted to delineate the importance of elevated concentration of lead from cosmetics in the blood of pregnant women.

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References