ORIGINAL REPORT

Lead Concentration in Breast Milk of Lactating Women who Were Living in Tehran, Iran

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Abstract- It is obvious that lead intake is of concern not for its beneficial/essential effects on metabolism, but rather for its toxic actions, which can be especially damaging to children. The objective of this study was to analyze the concentration of lead in milk of mothers during prolonged lactation. Milk samples from 43 mothers were collected at 2 months postpartum. Lead was analyzed using atomic absorption spectrophotometer. The value of lead in human milk was 23.66±22.43 µg/l. Lead concentration in human milk of mothers was higher than other countries and no significant relationship was found between levels of human milk lead and mother's education, age, parity, height and weight. The concentrations of lead in the milk samples were high, which makes a major public health hazard for the inhabitants, especially neonatal and children, of the industrial locations.

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Introduction

Human milk represents the pattern of nutrients most suitable to meet the physiological requirements of the young infant. Hence, an accurate and complete knowledge of the composition of human milk is essential to understand more adequately the nutrient requirements of the infant as well as for developing more adequately defined formulas to be used as a substitute for human milk (1).

Trace elements have an essential role in growth and development. Although they are required only in small amounts, intakes may not always be adequate. Populations where food intake may be restricted by cultural, economic, and/or climatically factors need to be studied to determine how a limited dietary intake affects health.

The availability of essential elements to infants depends solely on the trace-element content of the breast milk, length of breast feeding, physiologic factors such as nutrient absorption and nutrient supplementation of the mother (1).

Breast milk contains both essential and nonessential trace elements. Lead (Pb) is non-essential, potentially toxic heavy metal with hepatotoxic, neurotoxic and nephrotoxic properties even at very low concentrations. The objectives of this study were to determine the concentration of lead in the breast milk of healthy lactating women who were living in Isfahan, Iran. Concentration of lead was determined by graphite furnace atomic absorption spectrometry in 37 milk samples from healthy lactating women collected on first to sixth postpartum week. The mean±SD of the concentration of lead in human milk was 7.11±3.96 µg/l (range 3.06-19.47 µg/l), respectively. The results of this study showed the lead in the milk samples from lactating women in Isfahan was high, which makes a major public health hazard for the inhabitants, especially neonatal and children, of the industrial locations. The results of the present study indicate a need for establishing safe intake values of heavy metals in human milk (2).

Lead was measured in placental tissue, umbilical

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cord and maternal blood samples of 1578 women who delivered at the Al-Kharj King Khalid Hospital between 2005 and 2006. The aim of this study was to evaluate the status of heavy metal exposure in mothers and their newborns and to identify predictors of maternal exposure. Lead was detected in all cord and maternal blood and in 96% of placental tissues. Only in 0.89% and 0.83% of cord and maternal blood samples were the levels of lead above the CDC threshold limit of 10 µg/dl. Maternal blood lead was also higher (2.3%) than the German Reference value in women of 7 µg/dl. Approximately 9.3% of women had a placental lead above the 95th percentile in the range of 0.83-78 µg/g dry weight, a level of possible developmental toxicity. This study provides informative baseline bio-monitoring data and reveals a substantial exposure to heavy metals in non-occupationally exposed Saudi mothers and their newborns that might jeopardize the health of both. Additional research is also urgently needed to explore factors such as environment, diet, lifestyle and/or cultural habits contributing to maternal and fetal exposures (3). The literature is rather cloudy on this issue partly due to the extremely large range in reported lead concentrations in breast milk.

Most of the data for the past 15 years are shown in table 1. The very high levels reported in some papers are probably due to contamination of the milk during sampling and analysis (*e.g.* the Austrian and Italian studies). All units for breast milk are standardized to parts per billion (ppb). Note that in the United Arab Emirates, over 94% of the sample used Kohl (lead-bearing) cosmetics (4). Centers for Disease Control "Level of Concern" of 10 µg/dl) and for breast milk was 3.5 µg/dl or 35 parts per billion (mean 2.47 µg/dl) compared to the allowable level of lead in drinking water of 1 µg/dl in Australia (4).

The main objective of our study was to measure the concentration of lead in milk of lactating women who were living in Tehran, Iran. Level of this metal was examined in relation to selected parameters Such as mother's education, age, parity, height and weight.

Materials and Methods

Thirty lactating women who were living in Tehran, Iran intended to breast-feed, for at least 2 months postpartum, were recruited during pregnancy. They were non-smokers with normal pre pregnancy weight and weight gain during pregnancy.

All women instituted lactation without problems and breast-fed success fully, as defined by infant growth and maternal satisfaction, for various lengths of time.

Demographic data of the mothers including maternal age, height as well as weigh at the beginning and at the end of pregnancy, pregnancy complications, smoking, place of residence, education, occupation, number of children, supplement intake during pregnancy were also recorded. The study was approved by the biochemistry department of Tehran University of Medical Sciences.

Table 1. Lead Concentrations in breast milk.

Pb Milk (ppb)	No	Country	Date	Reference
0.7±0.7	9	Australia	1998	Gulson *et al*. (submitted)
0.7±0.4	75	Sweden	1995	Palminger Hallen *et al*.
1.04 mean / 0.55 median	210	Canada	1986	Dabeka *et al.*
1.7	72	Czech	1989	Zahradnicek *et al.*
2.6±1.6	27	Germany	1988	Schramel *et al.*
2.8±1.6	39	U.S.A.	1984	Rockway *et al.*
<10	2	U.S.A.	1996	Baum *et al*.
13.3 (urban), 9.1 (rural)	20 20	Germany	1985	Sternowsky & Wesselowski
17±2	100	U.S.A.	1985	Rabinowitz *et al*.
21	97	Scotland	1982	Moore *et al.*
25	35	Mexico	1993	Namihara *et al.*
25 (urban), 21 (rural)	89 91	Malaysia	1983	Huat *et al.*
30	39	U.K.	1993	Richmond *et al*.
36±15	51	Austria	1993	Plockinger *et al.*
48±12	114	Malaysia	1985	Ong *et al.*
70±17	25	UA Emirates	1994	Sokas *et al.*
127 (urban), 46 (rural)	20 34	Italy	1992	Guidi *et al*.

Table 2. Somatometric characteristics of the mothers and human milk lead.

Mothers (n=30)	Mean	SD
Age (year)	27.14	4.897
Height (cm)	160.65	6.20
Weight (kg)	71.15	22.6
Lead (µg/l)	23.66	22.43

Table 3. Demographic characteristics of the mothers (n=30)

Demographic characteristics	Mothers	No (%)
Education	Elementary	4 (13.3)
	Secondary	5 (16.6)
	University	21 (70)
Occupation	Housewife	26 (89.7)
	Other	3 (10.3)
Smoking	Yes	0
	No	30 (100)

Sample collection

Breast milk samples (10-20 ml) were collected on 2 months postpartum. Samples were collected in the morning ≥ 1h after the previous breast feeding. Breast milk was expressed by hand from one breast into containers provided by investigators.

Samples were transferred to tubes and frozen at -20º until analysis.

Metal analysis

Milk samples were analyzed as follows: A known volume of milk (10 ml) was digested under pressure with nitric acid (Merck). The digested sample was quantitatively transferred to clean poly ethylene tubes and the volume was restored in the original value (10 ml) with high purity water the content of lead was determined by flame atomic absorption Spectrophotometry (Perkin Elmer 311).

Statistical analysis

Descriptive data were presented as a mean values±standard deviation. One-way ANOVA test was used for further statistical analyses. The value $P<0.05$ was considered statistically significant. All statistics were done using the SPSS computer package version13 (SPSS, Chicago, IL, USA).

Results

The somatometric characteristics of the mothers and human milk lead are presented in tables 2 and the demographic characteristics of the mothers are shown in table 3.

The concentration of lead in the milk of the mothers (n=30) was significantly higher than other countries (23.66±22.43 µg/dl versus 15-20 µg/dl).

Discussion

The data for trace-element content of human milk differ widely from region to region. These variations may be due in part to differences in sampling and analytical techniques rather than to geographic variation. However, these technical factors did not contribute to the variation in the present data because we have achieved satisfactory accuracy and precision in our analytical methods. The literature is rather cloudy on this issue partly due to the extremely large range in reported lead concentrations in breast milk (5).

The very high levels reported in some papers are probably due to contamination of the milk during sampling and analysis. All units for breast milk are standardized to ppb (6). If a pregnant woman is concerned that she may have suffered a high exposure from lead, either as an acute dose (short-term such as from renovating a lead-contaminated house), or from chronic exposure (long-term), it would be worthwhile to have her blood lead tested in the 3 trimesters when she is having other normal pregnancy tests performed and then speak to a specialist (7).

If the blood lead levels are <10 µg/dl then there should be no cause for concern as the amount of lead in breast milk should be only about 5% or probably less of that in her blood (7,8). As an example, Baum and Shannon (9) describe two subjects in the USA whose blood leads were 34 and 29 µg/dl. The breast milk contained <10 ppb. If a mother's blood lead level is above 20 µg/dl, it is recommended that a test of the breast milk should be undertaken, even if wholly breast feeding at these low levels the impact on blood lead of the infant will be small (9).

If a mother's breast milk lead levels are in the hundreds of ppb ranges, it may be worth considering not breast feeding, in consultation with expert medical opinion. It is well established that there is an inverse relationship between calcium intake and uptake of lead. Furthermore, the preliminary data obtained by us indicate that intake of calcium supplements can reduce the amount of lead mobilized from the mother's skeleton during pregnancy (7).

The U.S. National Institute of Health Consensus Conference on Optimal Calcium Intake recommended

that for pregnant and lactating women the optimal daily intake of calcium should be 1200 mg/day (8).

There is a linear relationship between lead in breast milk and in the mother's blood so that, for example, in the 1993 Mexico study, the maximum blood lead was 99 µg/dl (compared with the U.S. Centers for Disease Control "Level of Concern" of 10 µg/dl) and for breast milk was 3.5 µg/dl or 35 ppb (mean 2.47 µg/dl) compared to the allowable level of lead in drinking water of 1 µg/dl in Australia (8).

Milk is a significant source of Pb for infants and toddlers. Levels of this element in domestic food animal tissues and milk are presently within acceptable ranges for human consumption (10).

The dietary intake of metals was studied in seven male and seven female children at the age of 1.5 to 5.3 years living in a remote area of Germany, the North Sea island Amrum. The dietary intake of lead was measured by a seven-day-duplicate study using atomic absorption spectrometry. The median lead was 2.1 µg /(kgbw x week) [range: 0.63-5.1 micrograms/ (kgbw x week)] (11,12).

Their results revealed: higher Pb concentration in the samples from urban areas; effect of dietary habits seem to play a role in metal levels in human milk as the logistic regression models revealed (13). Literature concerning various factors affecting metal concentrations in breast milk is in general controversial (14,15).

In our study lead concentration in human milk of lactating women who were living in Tehran, Iran was higher than other countries (23.66±22.43 µg/dl versus 15-20 µg/dl) and no significant relationship was found between levels of lead in human milk and age, weight, parity, education, height and occupation of mothers. The results of the present study indicate a need for establishing safe intake values of heavy metals in human milk. In conclusion, human milk lead was higher than other countries (23.66±22.43 µg/dl versus 15-20 µg/dl) which make a major public health hazard for the inhabitants, especially neonatal and children, of the industrial locations.

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