RELATIONSHIP BETWEEN LEAD LEVELS IN DRINKING WATER AND MOTHERS' BREAST MILK

BY

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ABSTRACT

Lead has been proven to be one of the most difficult environmental health problems. This study was performed on fifty two drinking tap water samples (surface and groundwater) collected in Sept. 2007 from different districts of Dakahlyia governorate and fifty two breast milk samples from lactating mothers hosted in Dakahlyia governorate hospitals. All these samples were subjected for lead analysis. Lead level in drinking groundwater showed higher levels (mean 0.019 mg/l= 1.90µg/dl)) than in drinking surface water (mean 0.014 mg/l=1.40µg/dl)). Also, an elevation of lead levels in breast milk of mothers drinking groundwater (mean 3.59µg/dl=0.035mg/l) was noticed when compared with that of mothers drinking surface water (mean 2.55µg/dl=0.025mg /l). The comparison between mean lead levels in drinking water and mothers' breast milk samples showed positive relationship. The mean lead levels of breast milk of mothers drinking groundwater and groundwater samples were 0.035 mg/l and 0.019 mg/l respectively, while the mean lead levels were 0.025 mg/ l and 0.014 mg/ l in breast milk of mothers drinking surface water and surface water samples, respectively. Lead concentrations in breast milk of the studied samples were elevated by exposure to smoking. Calculated daily intake of lead in breast milk according to its lead values was presented, based on 840 ml breast milk for a 5.5 kg infant per day. Infant of mothers drinking surface water would ingest (3.81 µg/kg/day), however infant of mothers drinking ground water would ingest (5.34 µg/kg/day) which was higher than the permissible value established by WHO which is 5 µg/kg/ day.

INTRODUCTION

Lead was selected to determine its level in drinking water, breast milk and blood due to its multifactorial danger. It acts as anti-essential trace element in the human body, highly toxic cumulative element in man and animals; and widely distributed in the atmosphere, earth, ocean and groundwater (Deveci, 2006; Lalor et al., 2006). Transfer of Lead to human fetus occurs readily throughout gestation (Harville et al., 2005). For neurological, metabolic and behavioral reasons, children are

vulnerable to the effects of lead than adults; lead has been shown to be associated with impaired neuro-behavioral functioning in children (Graff et al., 2006).

The most common sources of lead in the home are: drinking water, water pipe connection, different types of paint, and pottery (PHS, 1990; N. J. D. H, 1992; Jeyanthi and Shanthi, 2007). Lead in drinking water is probably absorbed completely compared to lead in food. Adults absorb 35% of the lead they drink and the absorption rate of lead in children is greater than 50%. (ASTDR, 1988; CDC, 1991; Goldberg et al., 1991; Tripathi et al., 1991; Newton et al., 1992). The permissible limit of lead in drinking water is 0.01 mg/l (WHO, 1997) and 0.05 mg/l (EMH, 1995).

Breast milk is the ideal nutrient for the newborn, but unfortunately also a route of excretion for some toxic substances including lead. Lead reach into breast milk through passive transfer, this depending on three major characteristics; polarization of the chemical at body pH, lipid solubility and molecular weight (Robert, 1994; Chen et al., 2006). The daily permissible intake estimated by WHO, 1972 for infant is 5μg/kg/day of breast milk (Namihira et al., 1993). Lead levels in human breast milk and drinking water samples from different exposure situations can give information on the correlation between water and milk levels.

The aim of the present work is to correlate between the lead levels in drinking water (surface and groundwater) of Dakahlyia governorate and breast milk of lactating mothers.

SUBJECTS AND METHODS

Drinking water samples :

Fifty-two drinking tap water samples (surface and groundwater) were collected in Sept.2007 from different districts of Dakahlyia governorate, (Table 1).

Breast milk :

Fifty-two breast milk samples were collected from lactating mothers joining their babies in governorate hospital of previously mentioned districts, (Table 2). A history was taken from the mothers through answering a questionnaire, which included; age, source of drinking water (manual pump or tap water), nature of occupation, and smoking (active or passive exposure).

Table (1) : Localities of drinking tap water samples in Dakahlyia governorate.

Location/ Main surface water stations	Samples (n)	Location/ Groundwater	Samples (n)
Mansoura	15	Mit-Ghamr	13
Talkha	10	Aga	9
Sherbin	5	Total	22
Total	30		

Table (2) : Localities of lactating mothers .

Location	Samples (n)
Mansoura	15
Talkha	10
Sherbin	5
Mit-Ghamr	13
Aga	9
Total	52

Procedure of breast milk sampling:

- 5 ml of each breast milk sample was collected manually in labelled sterile polyethylene lead free tube.

- The nipple areas were cleaned with water before expressing the milk; the first few drops were discarded and only the midstream flow was collected.

- Tubes were sealed immediately and kept at 4°C.

All samples; drinking water and breast milk were analyzed for lead levels using Zeeman (USA) 4100 ZL atomic absorption spectrophotometer with graphite furnace unit. The standard solutions were performed at agricultural research center laboratories, Cairo. All samples and standards were read to the same accuracy and at the same time.

Statistical analysis:

Both statistical analysis and tabulation were carried out. Data were summarized as means (X), and standard deviation (SD). Differences were analyzed using t-student test for comparison between the two groups.

RESULTS

Table (3) showed that Lead levels of drinking groundwater samples were ranged from 0.016 to 0.023 mg/l with mean of 0.019±0.003 mg/l. Also, lead levels of drinking surface water samples were ranged from 0.011-0.017 mg/l with mean of 0.014±0.002 mg/l).

Table (4) showed that there was statistically significant increase in lead levels in drinking ground water compared to surface water ($p < 0.001$).

The mean age of mothers drinking surface water was 29.4 ± 5.7 years, while the mean age of mothers drinking groundwater was 26.1 ± 6.2 years, with statistically non significant difference ($p = 0.052$) as shown in (Table 5).

Table (6) showed that there was statistically significant increase in lead levels in breast milk of mothers drinking ground water compared to mothers drinking surface water ($p < 0.001$).

Table (7) showed a positive correlation between lead levels in drinking water and mothers' breast milk , however there was statistically significant increase in the lead levels in breast milk compared to its levels in drinking water in both group ($p < 0.001$).

Table (8) showed a significant increase of lead levels in breast milk of women passively exposed to smoking compared to non exposed one ($p < 0.001$).

DISCUSSION

Bioaccumulation of lead and its mobilization in mother's milk constitute a serious health hazard to the newly born children. Many studies showed that intoxication of newborn may be caused by breast feeding with milk containing heavy metals; (Iarushkin, 1992; LaKind et al., 2005). In the present work, All investigated water samples were considered suitable for drinking according to EMH (1995), where these samples showed lower levels of lead than the permissible limit (0.05mg/l). According to WHO (1997), they showed higher levels of lead than the permissible limit (0.01 mg / l) (Table 3).

Overall mean lead level in drinking groundwater showed higher levels than in drinking surface water (Table 4). Levels of lead in drinking water sampled at the source are usually below 0.05 mg/l. However, water taken from taps in homes where lead is present in the plumbing can contain levels up to 1 mg/l (Sherlock et al., 1986).

An elevation of lead concentrations in breast milk of mothers drinking ground water was noticed when compared with that of mothers drinking surface water (Table 6). The higher levels of lead in drinking water and mothers' breast milk of groundwater origin observed in the present work could be attributed to more industrialization, living near high-traffic roads and the potential exposure to automobile exhaust, in addition to the use of lead water pipes lines. Pipe system may still be joined by lead solder and lead lined storage tanks are common in houses (Mosaad and Ghanem, 1999). The comparison between mean lead levels (mg/l) in drinking water and mothers' breast milk samples showed positive relationship (Table 7).

In this study, all women were non-occupationally exposed to lead. They had no special habits but, twenty five women (48.1%) were exposed passively to smoking i.e. passive smokers. These women showed higher lead contents in their breast milk compared to non exposed women (Table 8). Similar finding was encountered in a study by Kwapuliski et al., (2004).

The permissible lead limit established by WHO is 5 µg/kg/day based on 840 ml breast milk for a 5.5 kg infant per day (Sternowsky and Wessolowski, 1985). In the present study, calculated daily lead intake in breast milk according to its values was presented. Infant of mothers drinking surface water would ingest (3.81µg/kg/day), however infant of mothers drinking ground water would ingest (5.34 µg/kg/day) which was high-

er than the permissible value established by WHO. In the study done by Abdel-Latif and El-Kolaly (1997), they found that an infant 5.5 kg for woman from Cairo would ingest 6.6 µg/kg/ day, while an infant for a woman from other governorates would ingest 4.3 µg/kg/ day which are lower than the daily permissible limit.

CONCLUSION

Lead is excreted in breast milk and may reach high levels in women living in polluted areas, and those exposed to passive smoking compared to non exposed women. This may exceed the daily hazard to suckling infants. Prolonged contact with lead plumbing can increase the lead content in tap water with subsequent increase of lead burden in infant fed formula and infant blood.

Recommendations :

1- Specialized multiple stages filters must be used mainly in water stations and also in houses.

2- Chemical analyses must be carried-out periodically for the surface and groundwater to ensure the water suitability for drinking purposes (water must be free from lead or within the permissible limit of WHO).

3- Avoid passive exposure to smoking during lactation.

Table (3) : Lead levels (mg/l) in drinking tap water samples.

No	Districts	Lead mg/l	No	Districts	Lead mg/l
Surface water			28		0.015
1	Mansoura	0.011	29		0.017
2		0.012	30		0.016
3		0.015	Groundwater		
4		0.014	Mit-Ghamr		
5		0.013	31		0.022
6		0.012	32		0.017
7		0.015	33		0.017
8		0.014	34		0. 016
9		0.015	35		0. 019
10		0.013	36		0. 016
11		0.013	37		0.023
12		0.016	38		0.016
13		0.015	39		0.018
14		0.014	40		0.020
15		0.015	41		0.018
16	Talkha	0.016	42		0.017
17		0.016	43		0.016
18		0.015	Aga		
19		0.014	44		0. 017
20		0.015	45		0. 021
21		0.017	46		0. 018
22		0.016	47		0. 019
23		0.014	48		0.016
24		0.015	49		0.017
25		0.016	50		0.017
26	Sherbin	0.016	51		0. 020
27		0.014	52		0. 019

Table (4) : Mean lead levels in drinking tap water samples.

Lead levels	Drinking surface water		Drinking groundwater		t =7.21
	(n)	Mean ± S.D mg/l	(n)	Mean ± S.D mg/l	
	30	0.014 ± 0.002	22	0.019 ±0.003	P<0.001***
Range	0.011 -0.017		0.016 – 0.023		

P***: highly significant

Table (5) : Age of the studied groups.

Age (ys)	Mothers drinking surface water (n =30)	Mothers drinking groundwater (n = 22)	t = 1.49
Range	25-40	18-35	P=0.052
Mean ±S.D	29.4±5.7	26.1±6.2	

P: non significant

Table (6) : Mean lead levels of mothers' breast milk (mg/l) as regard the type of drinking water.

Lead levels	Surface water (n =30) Mean ±S.D	Groundwater (n=22) Mean ±S.D	t =5.46
Range	0.015 – 0.037	0.025 – 0.049	P<0.001***
Mothers' breast milk	0.025±0.006	0.035±0.007	

P***: highly significant

Table (7) : Comparison between mean lead levels (mg /l) in drinking water and Mothers' breast milk as regard the type of drinking water.

Lead levels	Surface water		Groundwater	
	(n) of samples	Mean ± S.D	(n) of samples	Mean ± S.D
Water samples	30	0.014±0.002	22	0.019±0.003
Mothers' breast milk	30	0.025±0.006	22	0.035±0.007
	t= 9.53		t= 9.85	
	P<0.001***		P< 0.001***	

P***: highly significant

Table (8) : Mean lead levels of mothers' breast milk (mg/ l) as regard passive exposure to smoking .

Lead levels	Women exposed passively to smoking(n=25) Mean ±S.D	Non exposed women (n=27) Mean ±S.D	t = 5.16
Range	0.026 – 0.039	0.020 – 0.031	p < 0.001***
Mothers' breast milk	0.038±0.004	0.028±0.002	

P***: highly significant

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العلاقة بين مستويات الرصاص فى مياه الشرب ولبن ثدى الأمهات

المشتركون فى البحث

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أجرى هذا البحث على ٥٢ عينة من مياه الشرب سطحية وأرضية (مياه الصنبور) من منازل بمراكز مختلفة فى محافظة الدقهلية فى سبتمبر ٢٠٠٧ وكذلك ٥٢ عينة من لبن ثدى أمهات مرضعات (من بعض مستشفيات مراكز المحافظة) وذلك لتقييم العلاقة بين نسبة الرصاص فى لبن الأمهات اللاتى يشربن مياه أرضية وأن هذه الزيادة أكبر من تلك الموجودة فى لبن الأمهات اللاتى يشربن مياه سطحية، وقد يعزى ذلك للتوافق بالنسبة لتحليل عنصر الرصاص لعينات مياه الشرب ولبن الثدى بمنطقة الدراسة، كما وجد أن مستوى الرصاص فى عينات لبن الثدى تأثر بتعرض الأمهات للتدخين السلبى، ومن هذه النتائج يتضح أن الأطفال الرضع معرضين لمستويات عالية من الرصاص نتيجة إفراز الرصاص فى لبن الأمهات والذى يمثل خطراً حقيقياً على صحة الأمهات الحوامل وأجنتهم.

نوصى بالآتى :

١- إستخدام فلاتر المياه المتعددة المراحل بالمنازل ومحطات مياه الشرب.

٢- عمل تحاليل دورية لقياس مستوى الرصاص فى مياه الشرب للتأكد من خلوها من الرصاص ومقارنتها للمواصفات العالمية.

٣- تجنب التدخين السلبى أثناء الرضاعة.