Relationship between Lead levels in Drinking Water and Mothers' Breast Milk- Dakahlyia-Egypt

A Ghanem, S El-Azab, R Mandour, M El-Hamady

Citation

A Ghanem, S El-Azab, R Mandour, M El-Hamady. *Relationship between Lead levels in Drinking Water and Mothers' Breast Milk- Dakahlyia-Egypt*. The Internet Journal of Toxicology. 2007 Volume 5 Number 1.

Abstract

A study was conducted 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 to confirm a relationship between their lead content. Smoking habit was also taken in to consideration. All these samples were subjected for lead analysis. Drinking groundwater showed higher lead levels (mean 0.019 mg/l= 1.90µg/dl)) than 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 in drinking water is probably absorbed more than lead in food. Adults absorb 35% of the lead they drink and the absorption rate for children is greater than 50%.(2 , 3 , 6 , 16 , 12). The permissible limit of lead in drinking water is 0.01 mg/l according to WHO (17) and 0.05 mg/l according to EMH (5).

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 (13 , 4). The daily permissible intake estimated by WHO, 1972 for infant is 5 µg/kg/day of breast milk (11).

The aim of present study was to confirm a correlation between the lead levels in drinking water (surface and groundwater) of Dakahlyia governorate and that of breast milk of lactating mothers living in that area.

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), Fig. (1).

Figure 1

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		

Figure 2

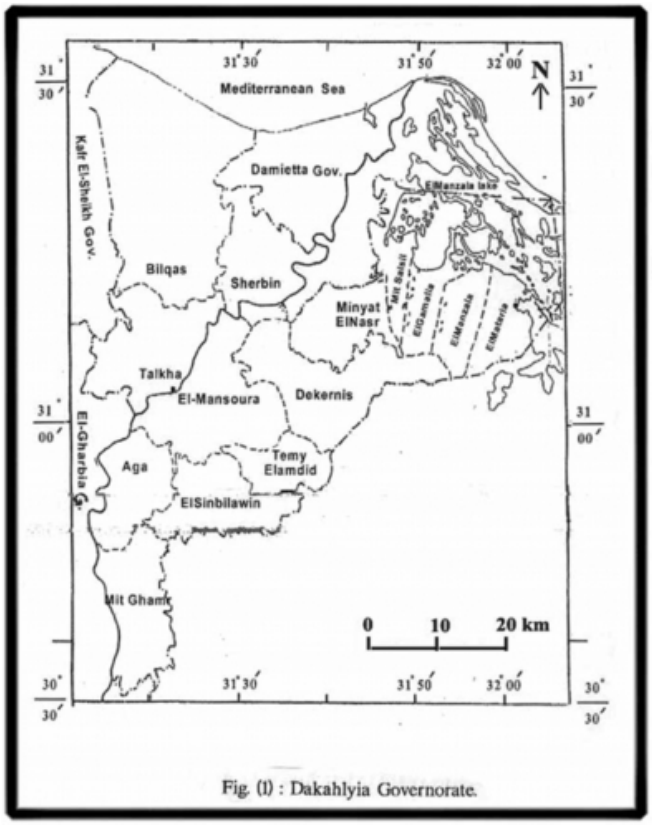

Fig. (1) : Dakahlyia Governorate.

BREAST MILK SAMPLES

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, nature of occupation, and smoking (active or passive exposure).

Figure 3

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 ºC.

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.

Figure 4

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

Figure 5

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

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).

Figure 6

Table 5: Age of the studied groups

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

P: non significant

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).

Figure 7

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**
Mothers' Breast milk	0.025±0.006	0.035±0.007	**P<0.001*** **
Range	0.015- 0.037	0.025 – 0.049	

P: highly significant

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).

Figure 8

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 mg/l	(n) of samples	Mean ± S.D mg/l
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) showed a significant increase of lead levels in breast milk of women passively exposed to smoking compared to non exposed one (p< 0.001).

Figure 9

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
Mothers' Breast milk	0.038±0.004	0.028±0.002	p < 0.001***
Range	0.026 – 0.039	0.020 – 0.031	

P: highly significant

DISCUSSION

It is a known fact that intoxication of newborn may be caused by breast feeding with milk containing heavy metals (7 , 9). In the present work, all investigated water samples were considered suitable for drinking according to EMH (5) where these samples showed lower levels of lead than the permissible limit (0.05) mg/ l but, according to WHO (17) 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 (14).

An elevation of lead concentrations in breast milk of mothers drinking groundwater 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 (10). 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 Kwapulinski et al., (8).

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 (15). 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 (3.81 µ g/kg/day), however infant of mothers drinking groundwater would ingest (5.34 µg/kg/day) which was higher than the permissible value established by WHO. In the study done by Abdel-Latif and El-Kolaly (1), 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 excretion via breast milk reached high levels among women living in polluted areas and those exposed to passive smoking compared to non exposed women hence suckling infants were getting more lead. Prolonged contact with lead plumbing also increased 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. Drawing water for drinking after flushed from the tap water by 1-2 minutes.
4. Programmes should be developed to facilitate identification the pollution of lead on the basis of monitoring data.
5. The use of PVC (poly vinyl chloride) pipes and engineering practices to minimize plumb solvency in water treatment and water distribution systems.
6. The abstinence from smoking, improved diet and vitamins supplementation shall play an important role in lowering lead levels and thus preventing lead toxicity in pregnant women and their fetuses.

ACKNOWLEDGEMENT

We are grateful to the authorities of the Dakahlyia governorate hospitals, for their valuable support which help us to complete this work.

References

1. Abdel-Latif, S.A. and El-Kolaly, H.R. (1997): Lead concentration in breast milk of nursing mothers. Sc. J. Az. Med. Fac., 18: 733.
2. Agency for Toxic Substances and Disease Registry, ATSDR. (1988): The nature and extent of Lead poisoning in children in the United States. Areport to congress, Atlanta:ATSDR.
3. Centers for Disease Control and Prevention, CDC. (1991): Preventing lead poisoning in young children: A statement by the Centers for Disease and Control. Atlanta, GA: US Department o Health Services, Public Health Service.
4. Chen, G.X.; Zeng, G.Z. and Li, J. (2006): Correlations of blood lead levels in infant, in maternal blood and in breast milk. Zhonghua Yu Fang Yi Xue Za Zhi. ;40(3):189-91.
5. Egyptian Ministry of Health (EMH). (1995): Standards for drinking water.Internal Report.
6. Goldberg, R.C.; Hicks, A.M.; O, leary, L.M. and London, S. (1991): Lead exposure at uncovered outdoor firing ranges. J. Occup.Med. , 33:718-719.
7. Iarushkin, V.I. (1992): Heavy metals in the mother-newborn infant biological system in the technology- related biogeochemical environment.Gig. Sanit., (5-6):13.
8. Kwapulinski, J.; Wiechula, D. and Fischer, A. (2004): The influence of smoking and passive smoking to occurrence of metals in breast milk. Przegl Lek.,61(10):1113-1115.
9. LaKind, J.S.; Brent, R.L.; Dourson, M.L.; Kacew, S.; Koren, G.; Sonawane, B.; Tarzian, A.J. and Uhl, K. (2005): Human milk biomonitoring data: interpretation and risk assessment issues." J. Toxicol. Environ. Health, A. 22;68(20):1713-1769.
10. Mosaad, S.M. and Ghanem, A.A. (1999): Relationship between lead in breast milk and lead in blood of urban and rural mothers. Mans. J. Forensic. Med. Clin. Toxicol., 11:227-236.
11. Namihira, D.; Sadivar, L.;Pustilnik, N.; Carreon, G. J. and Salinas, M.E. (1993): Lead in human blood and milk from nursing women living near a smelter in Mexico city. J. Toxicology. Environ. Health, 38(3): 225.
12. Newton, D.; Pickford, C.J.; Chamberian, A.C.;Sherlock, J.C. and Hislop ,J.S.(1992): "Elevation of Lead in urine, blood from its controlled ingestion in Beer." Hum Exp.Toxicol., 11:3-9.
13. Robert,J. (1994): Evaluation of health hazards or work environment. Arch. Environ. Health, 43:212.
14. Sherlock, J.C.; Pickford, C.J. and White, G.F. (1986): Lead in alcoholic beverages. Food Additives Contamination, 3: 347-354.
15. Sternowsky, H.J. and Wessolowski, R. (1985): Lead and cadmium in breast milk. Higher levels in urban vs rural mothers during the first 3 months of lactation. Arch. Toxicol., 57(1):41-45.
16. Tripathi, R.K.; Sheretz, P.C.; Lewellyn, G.C. and Armstrong, C.W. (1991): Lead exposure in outdoor firearm instructors. Am.J.Public Health, 81:752-755b.
17. World Health Organization (WHO) (1997): Guideline for drinking waterquality health criteria and other supporting information. Geneva, Vol. 2, 254-266. Smelter in Mexico City. J. Toxicology Environ. Health, 38(3):225.

Author Information

Abdel-Aziz Ghanem
Forensic Medicine and Clinical Toxicology Department, Faculty of Medicine, Mansoura University

Somaia M. El-Azab
Forensic Medicine and Clinical Toxicology Department, Faculty of Medicine, Mansoura University

Raafat A. Mandour
Toxicology Lab., Emergency Hospital, Faculty of Science, Mansoura University

Mona S. El-Hamady
Forensic Medicine and Clinical Toxicology Department, Faculty of Medicine, Mansoura University