



LEAD TOXICITY IN SOME RURAL COMMUNITIES IN ASSIUT GOVERNORATE

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ABSTRACT :

Lead is a natural element that is persistent in water and soil. Human exposure occurs primarily through diet, air, drinking water, and ingestion of paint chips. Absorption is increased in persons suffering from iron and calcium deficiency. Lead is a multitargeted toxicant, causing effects in the gastrointestinal tract, hematopoietic system, cardiovascular system, central and peripheral nervous systems, kidneys, immune system, and reproductive system. The present study is medical and environmental assessment of some cases of residential lead poisoning appeared, on November 2003, in some rural communities in Assiut Governorate. The study included thirty eight persons of both sexes belonging to three rural families. One of these families was living in the North of Assiut City, while the other two families were living in two separate areas in the Western of Assiut City. Twenty one persons of these families were admitted to the Department of Tropical Medicine and Gastroenterology of Assiut University Hospital. They were complaining of severe intermittent abdominal pain and constipation. They were subjected to clinical and hematological examination in addition to blood and urine lead level estimation. The same was done to the other members of these families in addition to analysis of some environmental samples (drinking water, wheat and interior soil) by Graphite Furnace Atomic Absorption Spectrometry. Blood and urine analysis revealed high lead levels. There were significant relationship between these levels and the presence of anorexia, vomiting, colic and constipation, and highly significant relationship between these levels and the presence of Burton's lines and basophilic stippling. The results of drinking water, soil and wheat analysis revealed very high lead levels exceeding the recommended levels. The results indicated that people in these communities are exposed to lead by ingesting contaminated water, food, dust and other materials or by inhaling airborne particulate matter that contains lead. Additional studies and interventions will be needed to address these situations. Many different organizations (both public and private) have to be involved in its abatement.

INTRODUCTION:

Lead is a naturally occurring element that has been used almost since the beginning of civilization. Today, the major environmental sources of metallic lead and its salts are paint, auto exhaust, food, water and folk remedies as

use of kohl^[1,2,3]. People who have some association with a factory site in a lead-consuming industry are at risk of lead poisoning^[4].

Lead contaminating drinking water is most often a problem in houses that are either very

old or very new. The source of lead in such water is most likely pipe or solders plumbing^[5]. All kinds of water however may have different levels of lead. Groundwater is extensively used for drinking water supplies in developing countries. The most contaminants of groundwater are heavy metals^[6,7].

Most of the lead absorbed into the body is excreted either by the kidney or through biliary clearance. Adults may ultimately retain only 1% of absorbed lead, but children tend to retain more than adults. The three major compartments for the distribution of lead are blood, soft tissue, and bone. Almost all (99%) blood lead is associated with erythrocytes, and 50% of erythrocyte lead is bound to hemoglobin^[8]. However the most sensitive and specific test in the evaluation of lead toxicity is the whole blood lead level^[5]. Measurement of urinary lead might be useful as a proxy for plasma lead levels in studies of lead toxicity^[9].

Because of differences in individual susceptibility, symptoms of lead exposure and the onset vary. Frequently, lead exposure appears asymptomatic, but still impairing the health of children and adults. With increasing exposure symptoms of mild toxicity appear at BLLs (Blood Lead Levels) from 35 to 50 ug/dL in children and 40 to 60 ug/dL in adults, in the form of myalgia, paresthesia, mild fatigue, irritability, lethargy and occasional abdominal discomfort. Symptoms of moderate toxicity are arthralgia, headache, general fatigue, tremor, vomiting, constipation, and weight loss. Severe toxicity is frequently found in association with BLLs of 70 ug/dL or more in children and 100 ug/dL or more in adults. The symptoms of severe toxicity are blue to black lead lines (Burton's lines) on gingival tissue, paresis or paralysis, colic (intermittent, severe abdominal cramps). In adults lead encephalopathy may occur at extremely high BLL s e.g., 460 ug/dL.

Renal impairment is a late effect of chronic exposure and may not be detected without specific testing. In lead exposed patients the peripheral blood smear may be either normochromic and microcytic or hypochromic and microcytic. There may be basophilic stippling in patients who have been significantly poisoned for long period, however these results are not specific to lead exposure (they should be differentiated from other causes, especially iron deficiency anemia)^[10].

In the last few years it was noticed that there is increasing frequency of cases of lead poisoning in Upper Egypt. Many of them were admitted to the Tropical Medicine & Gastroenterology Department of Assiut University Hospital. Some of them were from Aswan 1998, Sohag 2001, and New Valley (Al-wady Al- Gadid) 2002. All of the cases were confirmed to have lead poisoning.

Aim: The present study is a medical and environmental assessment of some cases of residential lead poisoning that appeared in some rural communities in Assiut Governorate that may reveal the essential need of effective regulations to reduce residential lead exposure.

SUBJECTS AND METHODS:

On November 2003, twenty one cases of suspected lead poisoning were admitted to the Department of Tropical Medicine and Gastroenterology of Assiut University Hospital. They were belonging to three rural families (at Mankbad and Al-Baliza villages), 13 of them were males and the other 8 were females. They were complaining of severe intermittent abdominal pain, constipation with dark stool, loss of appetite, metallic taste in the mouth, vomiting, weakness, insomnia, headache, tinnitus and arthralgia. One case had foot drop and another one had convulsions. These

symptoms appeared after 5-10 days of fasting during the month of Ramadan, as all of them were Muslims.

An environmental survey was done by a teamwork from the Forensic Medicine & Toxicology and Tropical Medicine & Gastroenterology Departments. All members of the three families (thirty eight persons) were subjected to clinical and hematological examination. Blood and urine lead levels were estimated. Samples from the drinking water, canal water, interior soil and wheat were analyzed for their lead content.

Blood, urine, water, wheat and interior soil samples were analyzed for lead determination at the Biochemistry Department-the Faculty of Medicine, Assiut University-by Graphite Furnace Atomic Absorption Spectrometry according to Hernandez-Avila^[11]. While hematological analysis was done in the Clinical Pathology Department.

Statistical analysis:

Different statistical methods were used to analyze results including Chi-square, ANOVA and independent samples tests. Also descriptive statistics were calculated (mean and standard deviation).

RESULTS:

The environmental survey revealed that, one of these families (Family 1) was living in a rural area on the high way in the North of Assiut City (at Mankbad village). The house was located beside a canal of stagnant water draining ceramic factory. Where this family and other families in the locality were using it for domestic purposes. The house like other houses in the locality was poor with old painted walls and the ground was dusty. They were drinking underground water from a common hand-

pump. The other two families were from two rural localities in Western of Assiut City (at Al-Baliza village) far away from traffic roads but near a road for agricultural vehicles. The first of them (Family 2) was living in a poor old painted house; they were drinking tap water from a common underground well. The other (Family 3) was sharing other families in the locality in drinking underground water from a hand-pump; they were living in poor old painted house with dusty ground. They were using water of a canal in front of the house for domestic purposes. The fathers of these three families were farmers and the mothers were house wives, while the sons and daughters were either working with their fathers or were pupils. All cases were improved with chelating therapy and symptomatic treatment.

The frequency of symptoms and signs in symptomatic patients of lead poisoning were shown in Fig. (1). This reveals that the common findings were pallor, colic, costipation, Burton' lines, anorexia, weight loss, and vomiting.

There was highly significant elevation of blood lead levels and urine lead levels in symptomatic persons in comparison to asymptomatic members in the three families as shown in table (1).

Table (2) shows the relation between the clinical presentation and lead levels in blood and urine in symptomatic patients. It shows that about (90.5%) of the cases were suffering from colic and constipation while pallor was present in (95.25%) and basophilic stippling was present in about (81%) of the cases. There were significant relationships between these levels and the presence of anorexia, vomiting, colic and constipation, and highly significant relationships between these levels and the presence of Burton's lines and basophilic stippling.

Table (3) shows the mean values of the laboratory findings in the investigated cases. It revealed low red blood cell (RBCs) count and mild reduction in hemoglobin level. Blood and urine lead levels were high in comparison with the normal values. However there was a negative correlation with significant difference

between RBCs count and urine lead values, “ $r = - 457, p = 0.037$ ”.

Table (4) shows the lead levels and its percentage changes in water, wheat and soil samples of the three families. These values were high in comparison with the maximum recommended levels.

Figure (1) : Frequency of symptoms and signs in symptomatic patients of lead poisoning

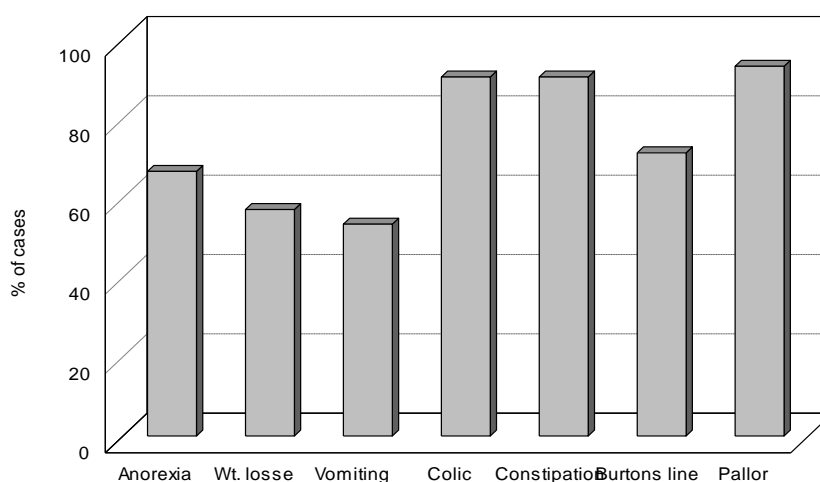


Table (1): Comparison between the lead levels (in blood and urine) in symptomatic and asymptomatic persons of the three families

Families	Presentation	No.	Blood lead		Urine lead	
			Mean± SD	P value	Mean± SD	P value
Family I	Symptomatic	5	138.3± 34.8	**	112.7± 12.4	**
	Asymptomatic	6	63.8 ± 21.3		57.9 ± 13.2	
Family II	Symptomatic	8	124.6± 21.5	**	119.6± 15.7	**
	Asymptomatic	4	60.7± 30.4		67.3± 12.3	
Family III	Symptomatic	8	120.6± 27.3	**	110.5± 11.3	**
	Asymptomatic	7	58.6± 30.8		54.9± 12.1	

Total number of persons: 38

Normal lead value in adult blood (40 ug/ dL) and in urine (80 ug/ dL)

** = Significant at 0.01

Table (2): Relation between the clinical presentation and lead levels (in blood and urine) in patients with lead poisoning

Symptoms & Sign	No.	%	Blood lead		Urine lead	
			Mean± SD	P value	Mean± SD	P value
Anorexia	14	66.67	108.3± 36.8	*	114.0± 11.4	*
Wt. Loss	12	57.14	104.7 ± 38.8	NS	113.4 ± 12.2	NS
Vomiting	11	52.38	114.6± 21.5	*	119.6± 15.7	*
Colic	19	90.48	90.7± 30.4	*	107.1 ± 12.3	*
Constipation	19	90.48	100.6± 27.3	*	110.5± 11.3	*
Burton's lines	15	71.43	158.6± 30.8	**	114.9± 12.1	**
Pallor	20	95.25	144.3 ± 97.6	NS	109.8 ± 13.7	NS
Basophilic stippling	17	80.95	119.3± 26.8	**	115.3± 11.7	**

Total number of cases: 21

Normal lead value in adult blood (40 ug/ dL) and in urine (80 ug/ dL)

* =Significant at 0.05 level

** = Significant at 0.01

NS = Not significant.

Table (3): Mean values of the laboratory findings in the investigated cases

Items	Mean	± SD
HGB	10.19 g/dL	1.21
WBC	8.36 X10 ⁶ /L	2.68
RBC	3.66 X10 ¹² /L	0.49
HCT	29.68	3.47
Blood lead	96.64ug/dL	37.86
Urine lead	108.29ug/dL	14.87

Normal lead value in adult blood (40 ug/ dL) and in urine (80 ug/ dL). There was a negative correlation with significant difference between RBCs and urine lead values, "r = - 457, p = 0.037".

Table (4): Lead levels and its percentage changes in water, wheat and soil samples of the three families

Item	M.R.L.	Family (1)		Family (2)		Family (3)	
		Estimated Value	% change	Estimated value	% change	Estimated value	% change
1- Drinking water		66 ug/L	340	83 ug/L	453.33	75ug-L	400
2- Canal water:							
Near the factory	15 ug/L	100 ug/L	556.67	-	-	-	-
Near the house		85 ug/L	44	-	-	50ug/L	333.33
3- Wheat sample	0.5ug/G	40ug/G	7900	14ug/G	2700	18ug/G	3300
4- Soil lead level	4.0ug/kg	7 ug/kg	75	6.3ug/ kg	57.5	5.8ug/kg	45

M.R.L. = Maximum recommended level.

DISCUSSION:

Lead is a toxic substance, which accumulates in the body and can cause serious health problems; especially for children^[8]. The present study revealed the environmental pollution and the associated health risks on exposure to lead. The study revealed that people in these communities were exposed to lead from a variety of sources the most important sources are:

- 1-Drinking water from corrosion of plumbing systems through the use of lead solder and other lead containing materials in connecting household plumbing to public water supplies. Ground and surface water are also contaminated by lead consuming industry and agricultural activities.
- 2-Soil and dust, which have been contaminated by air emissions from auto exhaust or from deteriorated, based paint in old houses.

3-Food, which can be contaminated by lead in air, water or food containers.

4-The skeleton is an important endogenous source of labile lead as the bones and teeth contain more than 95% of the total lead in the body^[9].

Environmental limits are set to protect the most susceptible persons in general. In U.S.A. the Environmental Protection Agency (EPA) has set a national ambient air quality standard for lead 1.5 ug/m^3 , it has established (4.0 ug/kg) for lead in residential soils and the maximum recommended level for lead in drinking water as 15 ug/L above which the water source requires treatment^[12]. Also Food and Drug Administration (FDA) has set various action levels regarding lead in food items. These levels are based on FDA calculations of the amount of lead a person consume without ill effect. For example FAD has set an action level of 0.5 ug/ml for products intended for use by infants and children and has banned the use of lead-soldering food cans^[13,14].

The results of drinking water, wheat and interior soil analysis in the present study revealed high lead levels exceeding the previous recommended levels and were explaining the high blood and urine lead levels in persons who consumed them. The results agreed with the results of a field study on the magnitude of some heavy metals in shallow wells (hand – pumps) in rural areas at Assiut Governorate that revealed high lead levels in Northern and Western locations of Assiut that exceed W.H.O. guidelines^[15]. The use of lead solder in connecting household plumbing to public water supplies is not banned in Egypt so when water stands motionless for extended periods of time such as overnight, lead concentrations in water can sometimes increase greatly^[16].

Interior house dust can become contaminated with lead as a result of the deterioration or disturbance of lead paint, the tracking or blowing of contaminated soil, and the fall-out of airborne lead particulate from industrial or vehicular sources. Older homes in poor condition have much higher dust lead levels than older homes in good condition^[17]. In Egypt there are currently no policy controls for the use of lead in paints, nor there are import or export restrictions regarding paints, however sampling conducted for the Lead Exposure Abatement Plan, in the period from September 1996 to September, 1997 in Cairo, indicated that most paint available in stores and markets is either lead free or has low levels of lead^[16]. In the present study lead in paint is considered an additional potential hazard producing lead dust in old painted houses due to chipping, peeling or flaking of the old paint. This can be mouthed by a child increasing the risk of lead poisoning. It was documented that lead in soil results in human exposure through contamination of homegrown vegetables. Vegetables easily develop surface contamination; and less commonly, lead incorporated into the flesh of the vegetables^[4].

Lead exposure is influenced by both community characteristics and individual-level factors^[8]. Nutritional status is being increasingly shown to influence the extent of lead absorption. High intake of fat and inadequate intake of calories have also been associated with enhanced lead absorption. Lead absorption is increased when the stomach is empty; small frequent meals reduce absorption^[4]. The experimental evidence obtained with laboratory animals shows that the toxicity of lead can be increased by deficiency of certain essential nutrients such as calcium, iron, zinc and selenium. It was suggested that multiple marginal nutritional deficiency may be of

importance in determining the response of humans to the toxic effects of various heavy metal pollutants^[18]. Irregular food intake, high dietary fat intake, low dietary calcium and iron deficiency can increase the risk of lead toxicity in a contaminated community^[19]. Ascorbic acid intake is but one of several nutritional factors that may influence lead toxicity through an influence on absorption, elimination, transport, tissue binding, or secondary mechanism of toxicity^[20]. An inverse relationship of serum ascorbic acid levels to blood lead levels in both children and adults was reported^[21]. The association of both high blood lead levels and low dietary ascorbic acid intake (in adults) with poverty raises the possibility of occurrence of lead poisoning manifestations^[19,22].

There are many researches which have studied the effects of Ramadan fasting on body physiology as well as on the different biochemical, hematological, and metabolic parameters. Fasting was associated with an increase in urine osmolarity and a decrease in urine volume^[23]. It was noted an increased serum thyroxin level at Ramadan which was considered the result of adaptation of the body to reduced food intake^[24]. A very mild but significant increase in the serum levels of phosphate and non-significant decrease in calcium levels was noted^[25,26]. The presence of the previous factors may explain the appearance of symptoms of lead toxicity in the present study during the fasting days of the month of Ramadan.

One area of incomplete understanding concerns individual variation in response to lead exposure. As the persons of the three families were sharing the contaminated water supply with other residences in their localities, but the symptoms appeared on certain families and some persons in these families were asymptomatic although their blood lead levels

were high. The differential response of individuals to lead has been associated with a genetic polymorphism in the second enzyme of the synthesis pathway of delta-aminolevulinic acid dehydratase (ALAD)^[27]. Generally speaking, genetic polymorphism is the occurrence of two or more forms (alleles) of the same gene in a population and it is a major cause of variation in human response to environmental contaminants. The results of the studies showed that the enzyme's polymorphism may modify not only the uptake and distribution of lead in the body, but also the toxic effects of lead that are mediated by aminolevulinic acid^[27,28].

On conclusion: Results of this study indicated that people in these communities are exposed to lead by ingesting contaminated water, food, dust and other materials or by inhaling airborne particulate matter that contains lead. The elevated levels of lead in their bodies may result in various health and developmental problems. So additional studies and interventions will be needed to address these situations. The nature of lead exposure requires that many different organizations (both public and private) to be involved in its abatement. Their collaboration is crucial to put plans for preventing exposure through controlling or eliminating lead sources and providing such communities with clean drinking water.

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التسمم بالرصاص في بعض المناطق الريفية بمحافظة أسيوط رجاء محمد عبد المعبود*، مديحة محمد العطار، نادية عبد السلام، سهير محمد أحمد**، أحمد مدحت نصر

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يعتبر الرصاص معدن طبيعي يتواجد في المياه والتربة. يتعرض له الإنسان من خلال الأكل والهواء ومياه الشرب وتناول الأطعمة في أواني يدخل الرصاص في صنعها أو طلاءها. ويتزايد معدل امتصاصه في الأفراد الذين يعانون من نقص الكالسيوم والحديد، ويتوزع الرصاص في جسم الإنسان في الدم والأنسجة الرخوة والعظام.

وقد أثبتت الدراسات أن حوالي ٩٩% من الرصاص الموجود في الدم يوجد في كرات الدم الحمراء ويتحد ٥٠% منهم بالهيموجلوبين. ويؤثر التسمم بالرصاص على أجهزة الجسم المختلفة وخاصة الجهاز الهضمي والدم والجهاز الدوري والجهاز العصبي والكلية والجهاز المناعي والجهاز التناسلي .

وقد هدفت هذه الدراسة إلى التقييم الطبي والبيئي لحالات من التسمم بالرصاص في بعض قرى محافظة أسيوط في شهر نوفمبر ٢٠٠٣، وقد شملت الدراسة ٣٨ شخصا من المرضى وعائلاتهم، إحدى هذه العائلات تقطن شمال مدينة أسيوط بينما العائلتين الأخرين تقطنان غرب مدينة أسيوط. وقد تم احتجاز واحد وعشرون مريضا من هذه العائلات بقسم الجهاز الهضمي بالمستشفى الجامعي بأسيوط. وقد كان هؤلاء المرضى يشكون من آلام شديدة بالبطن وإمساك وقد خضع هؤلاء المرضى وكذلك باقي أفراد أسرهم الذين لم يشكوا من أعراض المرض للفحص الإكلينيكي والفحوصات المعملية اللازمة شاملة قياس مستوى الرصاص بالدم والبول. وقد شملت هذه الدراسة أيضا تحليل عينات بيئية مختلفة من مياه الشرب والقمح والتربة في المناطق التي تسكنها هذه العائلات .

وقد أظهرت النتائج المعملية ارتفاع مستويات الرصاص بالدم والبول مع وجود علاقة ذات دلالة إحصائية بين هذه المستويات وبين بعض الأعراض مثل فقدان الشهية والقيء والمغص والإمساك كما وجدت علاقة ذات دلالة إحصائية عالية بين هذه المستويات وبين ظهور الخطوط الزرقاء في لثة هؤلاء المرضى والتنقيطات بخلايا الدم الحمراء . كذلك أثبتت نتائج تحليل العينات البيئية ارتفاع شديد في نسبة الرصاص بمياه الشرب والتربة والقمح مقارنة بالمعدلات المصرح بها .

وبذلك أشارت هذه الدراسة إلى تعرض السكان في هذه المناطق إلى التسمم بالرصاص عن طريق تلوث الطعام والماء والهواء . لذلك نحن بحاجة إلى دراسات إضافية أخرى في هذا المجال يشارك فيها هيئات عامة وخاصة مختلفة حتى نتمكن من التخلص من هذا التلوث والحد من مصادر التلوث البيئي بالرصاص وتأثيرها السلبي على صحة الإنسان.