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Lead Levels in Human Blood as Biological Test in Different Egyptian Environments

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Abstract: Lead being a toxic heavy metal that has no known biological use or function in the body. It is a common environmental contaminant; exposure to it must be a preventable risk in all areas of Egypt. Today mankind is exposed to the highest levels of this metal comparing to the primitive man due to its industrial use. There are different sources of environmental pollution with lead as lead alkyl additives in petrol, manufacturing processes, incineration of refuse and combustion of coal. The contaminated atmosphere by lead in urban and non-urban areas in Egypt may lead also to the contamination of foods. The present study aimed to assess the concentrations of blood lead levels (BLLs) in residents of urban sites (residential–traffic and residential-industrial) and non-urban site (rural areas near cultivated lands), and to compare these values with other reference levels in other localities, this study was accomplished during the period of 1/5/2010 to 1/11/2012. Data showed that BLLs in residents of urban sites (residential–traffic and residential -industrial) and non-urban site are quite variable among the three areas. The highest mean of BLLs was detected in the residential-industrial areas (15.4972µg/dl) followed by the residential traffic areas (8.6298µg/dl). However, rural areas recorded the lowest lead levels in blood (5.4062µg/dl). BLLs was observed to be related to the seasonal variations, which could be explained by the meteorological conditions which affect Greater Cairo and resulted in high concentrations of particulate matter (PM) and their Pb content in different environments. This suggests that residents of Cairo city are exposed to high leaded dust especially in winter time. From the data presented here, it can be concluded that environmental exposure to lead is still a particularly severe problem in Greater Cairo, for urban populations and for rural populations. BLLs of Greater Cairo residents showed a decreasing trend after leaded gasoline was banned in Cairo. But our study also showed that the BLLs were still higher than that in developed countries, which suggested that prevention and controlling of lead pollution would be a long-term mission in Egypt. Longitudinal studies in a larger population sample are needed to validate the results.

Key words: Blood lead levels · Industrial areas · Lead concentrations · Lead exposure · Residential · Residential-traffic areas · Rural areas · Seasonality

INTRODUCTION

Lead being a toxic heavy metal that has no known biological use or function in the body [1]. Today mankind is exposed to the highest levels of this metal comparing to the primitive man due to its industrial use. There are different sources of environmental pollution with lead. Lead alkyl additives in petrol are combusted and emitted into the atmosphere and can be responsible for high concentration of lead in some vegetation, roadside, soil, air, water and plants [2]. Manufacturing processes, incineration of refuse and combustion of coal, are also other sources of lead in the atmosphere; hence it is not surprising that lead levels are highest in area of intense industrialization [3, 4]. The levels of lead in the atmosphere of Egyptian industrial and urban areas were higher than the levels in other countries [3]. The authors reported that the annual mean concentration of lead exceeded both the Egyptian Standard [5] and WHO air quality standard [6]. The contaminated atmosphere in urban and industrial areas by lead in Egypt may lead to the contamination of foods beside the other different sources such as water and soil. So, various concentrations of lead were detected in different types of

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foods in Egypt [7-9]. The tissue specimens of the body that can be utilized for the determination of lead (Pb) concentration are blood, urine, scalp hair, teeth, nails and internal organs. Of the six specimens, urine gives information of what the body has lost, not what is retained, generally not considered as a sensitive indicator for exposure [10]. Teeth are not readily available, very little are known about nails, while internal organs are available only from autopsies. Hence blood and hair are the only two viable options the researcher is left with. As hair bind Pb at high concentrations and its growth is continuous, it gives a record of long term exposure [11]. Thus, blood Pb is a good marker of recent Pb exposure, while the determination of Pb in hair provides a lasting record of intake of metal over weeks or even months [1]. The current reference range for acceptable blood lead concentrations in healthy persons without excessive exposure to environmental sources of lead is less than 5µg/dl for children [13] and less than 25µg/dl for adults [14]. Previous to 2012 the value for children was 10 (µg/dl)[15]. The current biological exposure index (a level that should not be exceeded) for lead-exposed workers in the U.S. is 30µg/dl in a random blood specimen.

The present study was conducted for monitoring the concentrations of blood lead levels (BLLs) in residents of urban sites: a) residential–traffic (Faysal) and b) residential-industrial (Shoubra El-Kheima and Helwan) and non-urban site (rural areas near cultivated lands) and to compare these values with other reference levels in other localities, and to explore the relationship between weather, soil, and dust and blood lead levels (BLLs), in Egypt during the period of 1/5/2010 to 1/11/2012.

MATERIALS AND METHODS

Materials:

Chemicals and Reagents: Stock standard solution of lead (Pb) (1000 mg/l), absolute alcohol, hydrochloric acid, concentrated nitric acid of high grade, Triton x-100, ammonium phosphate dibasic and K_3EDTA were purchased from Merck (Merck, Darmstadt, Germany). De-ionized water from Milli Q water purification was used.

Blood Samples: A total of 180 blood samples were collected from peoples of the different three models represent different environments in Great Cairo (Egypt), i.e. industrial (Shoubra El-Kheima and Helwan), heavy traffic (Faysal) and rural (near cultivated lands) areas, during the period of 1/5/2010 to 1/11/2012, which 60 blood samples were collected from each area. The collected samples of blood were stored in clean polyethylene tubes at 4°C during transportation. Once received, they were frozen at -20°C until time for analysis. The number of blood samples was collected during five stages. The first one included 60 samples collected from the three localities (20 samples from each) during the period of 1/5/2010 to 26/10/2010 (St-1). The second, third, fourth and fifth stages of samples collection were collected during the periods of 1/11/2010 to 30/4/2011 (St-2), 1/5/2011 to 20/10/2011 (St-3), 1/11/2011 to 30/4/2012 (St-4) and 1/5/2012 to 1/11/2012 (St-5), respectively, where10 samples from each locality and from each stage were collected.

Methods and Procedures

Test Principle: Lead is measured in blood based on the method described by Miller *et al*. [16]. Blood samples and aqueous standards are diluted with a matrix modifier (nitric acid, Triton x-100 and ammonium phosphate). Quantification is based on the measurement of light absorbed at 283.3 nm by ground state atoms of lead from a hollow-cathode lamp source by atomic absorption spectrophotometer.

Determination(Instrumentation): Perkin-Elmer(Norwalk, ct) model 4110ZL atomic absorption spectrometer, which is equipped with auto-sampler, a longitudinal Zeeman back ground correction system, and a transversely heated graphite atomizer (THGA). The instrument was interfaced to a personal computer (330-p75, IBM) running the Perkin-Elmer proprietary software package (version 3.1) that controlled the spectrometer. Wavelength, slit width and lamp current were 283.3 nm, 0.7 nm and 10 mA, respectively. Integrated absorbance signals: read delay 0.0 sec, read time 5 sec., BOC 5 sec. A dilution of 1:10 blood (20µl) deposited in a THGA tube.

Method's Validity

Quality Assurance: Quality assurance procedures and precautions were carried out to ensure reliability of the results. All processing work is performed under clean conditions, including laminar flow hoods. The materials used for collecting and processing were screened for possible lead contamination. Acid cleaned volumetric flasks and other glassware were soaked in a soapy solution (2% solution detergent) for 24 h., then rinsed and soaked in 10-15 % nitric acid solution for 48 h., then rinsed with ultrapure water and dried under clean conditions. De-ionized water was used throughout the study. The samples were generally and carefully handled to avoid any contamination.

Determination of Detection Limit: The detection limit is defined as the concentration which will produce an absorbance signal three times the standard deviation of the blank or the magnitude of the baseline noise [17]. The baseline noise may be statistically quantitated by making 10 or more replicate measurements of the baseline absorbance signal observed for an analytical blank, and determining the standard deviation of the measurements.

Questionnaire: A questionnaire was completed for all subjects in the present study for identifying the non-occupational confounding factors, which contained the following points: age, cigarette-smoking habit (smoker, nonsmoker), hair color, history of special habits, the use of certain drugs and occupational history about the nature of past and present history, to exclude exposure to lead. Regions of residents were determined according to the official distribution of Egyptian Governorates.

Statistical Analysis: The data obtained from this study was statistically subjected to analysis of variance (ANOVA) and means separation was by Snedecor and Cochran [18]. The least significant difference (L.S.D) value was used to determine significant differences between means and to separate means at $p \leq 0.05$ using SPSS package version 15.0.

RESULTS AND DISCUSSION

The multidisciplinary actions, which have been taken by decisions makers to minimize environmental lead exposure, have only succeeded to reduce lead concentration to 1-2 times the EGL/94 annual limit of 1 $\mu g/m^3$. Since the study of Nasralla [19], who revealed that the measured lead concentrations at Cairo city center were more than 6 times that of EPA standard, till, the study of El-Taieb *et al.* [4] and that of Zaki *et al*. [20], in which the average concentrations of Pb has decreased to be between 1-2 $\mu g/m^3$ at the most their studied sites, with higher average values at the industrial sites. So, the lead concentrations in air still exceed the EGL/94 annual limit of 1 $\mu g/m^3$, at urban and residential sites. Moreover, at the industrial sites it may exceed 6 to 16 times the EGL/94 annual limit. Also inside homes, the surface Pb per area in all homes studied at urban and residential sites by Khoder *et al*. [21] and Hassan *et al*. [2] still exceed the US EPA guidelines of the interior floor Pb dust wipe. In our study, Pb levels in blood were determined as exposure indicators of lead pollution. The results of our study vary

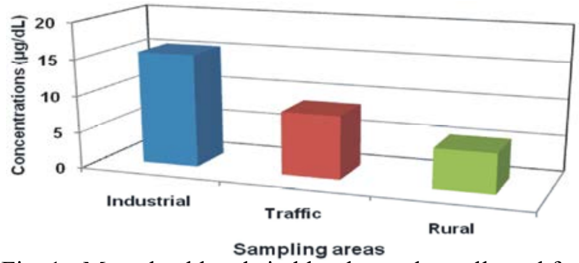


Fig. 1: Mean lead levels in blood samples collected from industrial, traffic and rural areas during the period of 1/5/2010 to 1/11/ 2012.

Table 1: Mean lead levels in blood samples collected from industrial, traffic and rural areas during the period of 1/5/2010 to 1/11/ 2012.

	Concentrations (µg/dl)±SD	
Area of the samples collection	Mean±SD	Range
Industrial	15.4972[a]±3.55	9.60 - 22.20
Traffic	8.6298[b]±1.71	4.50 -12.40
Rural	5.4062[c]±0.44	3.10 - 9.28
LSD 0.05	0.92	--
Cairo areas (urban sites) (120) samples	11.9618±4.444	2.5-22.6

-All values are means of samples number determinations in each area±standard deviation (SD).

-Means within rows with different letters are significantly different ($p \leq 0.05$).

- (60) samples in each area.

considerably according to the activity of each site. Therefore, it was essential to identify the normal ranges in each location or area. The investigated groups were that of Greater Cairo residents, residents of urban sites and rural site. The urban site was divided into two sites, the residential-traffic site and the residential- industrial site. Table1 and Fig. 1 show the mean of BLLS of the residents of urban sites mean of BLLs of residential-traffic site and the residential- industrial (11.96±4.444µg/dl) was twice more than that detected value in rural residents (5.4062±0.44µg/dl). However, this is in accordance with the same observation noticed by Nasralla *et al*. [22] for Cairo residents since 30 years. It also showed that the BLLs of Cairo residents recorded an obvious reduction in the levels than that recorded by Nasralla *et al*. [22] for urban and rural residents (30.5±9.4µg/dl and 12.14±6.2µg/dl, respectively). In the present study, mean BLLs in the studied population indicated significant differences ($p<0.05$) among the three studied areas. The highest mean value was recorded in the population living in industrial areas followed by those of the heavy traffic areas (15.4972µg/dl±3.55 and 8.6298µg/dl±1.71, respectively). However, the lowest BLLs were recorded in the population living in rural area (5.4062±0.44 µg/dl). These results are in accordance with the observation noticed by Nasralla *et al*. [22] for Cairo urban residents and rural residents. Nassralla *et al.* [22] reported higher blood lead levels in urban people (30.51±9.4µg/dl) than that of rural individuals (12.14±6.2µg/dl). Also, Mortada *et al*. [23] mentioned in their study that the BLLs of the residents of Cairo city (mega city) were more than those of Mansoura city. They attributed that difference to the dense traffic of Cairo city, which may lead to more Pb emissions from automobile exhaust, in addition to the industrial activities of the Cairo city itself and that of the surrounding cities and districts. Also, Abdel-Rassoul *et al*. [24] and Omar *et al*. [25] stated that, the mean BLLs of those who lived in Alexandria city (an urban area) was significantly higher than that of those who lived in Kafr Al-Sheikh (a rural area) and 56.7%, and 6.7% of children from Alexandria and Kafr El-Sheikh, respectively, had a BLL more than 20µg/dl. On the contrary, in China, residents of rural areas had BLLs higher than those living in urban and suburban sites and this was proved by Ye *et al.* [26] and Liu *et al.* [27]. The former found that BLLs in suburban children (60.33µg/l) were higher than that in downtown (58.09µg/l) or in the countryside (56.72µg/l) [26]. Liu *et al*. [27] proved that preschool boys and girls living in rural areas (Xuebu and Huashan) had higher mean BLLs above 10 µg/dl than children living in urban and suburban areas.

Comprising our results for blood Pb with those previously published in Egypt included 30.51±9.4 µg/dl [22]. Youssef [28] studied blood lead levels in 360 people of Greater Cairo, who concluded that the mean blood lead levels increased steadily with age, from 16.76 µg/dl for those under age 15 to 33.81µg/dl for those over 55 years old. Shakour and El-Taieb [29] reported that mean blood lead levels of 21 children in El-Waily residential area of Cairo was 55.18 µg/dl, their ages ranged between 3.5 to 15 years with a mean age of 8 years old. According to the authors, about 85% of the children's blood lead levels exceeded 30µg/dl. In a study of Attia *et al.* [30], they found that the mean blood lead level of children in Sharkia was 31.6µg/dl. They reported also that child or at least one of his families was treated before from lead poisoning. Chappell *et al.* [31] in their study about Greater Cairo of Egypt estimated mean blood lead levels for young children range from 14.4 µg/dl for children less than 1 year to 18.8 µg/dl for children between 5 and 6 years old. According to this study, results indicated that approximately 64% of children less than 6 years have blood lead levels over 10µg/dl and approximately 14% have blood lead levels over 20µg/dl. On the other hand, Monir *et al*. [32] found a value of 8.8µg/dl as a mean for the BLLs of children in a non-industrial area. Sharaf *et al*. [33] evaluated lead pollution abatement on children's blood lead levels from Greater Cairo, Egypt during the period of 1999 and 2002. They showed that mean lead level in children living in the residential areas has mean age of (7 years) was 3.95µg/dl. In the traffic area, of age (5 years) mean lead level in their blood was 7.406µg/dl.

In the last few years it was noticed that there is increasing number 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, Sohage 2001, and New Valley (Al-Wady Al-Gadid) 2002. All of cases were confirmed to have lead poisoning [34]. Medical and environmental assessment of some cases residential lead poisoning appeared on November 2003, in some rural communities in Assiut Governorate was studied [34]. Blood analysis revealed high lead levels (mean value, 96.64µg/dl). The authors reported 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. All the previous studies showed that the exposure of the general population in Cairo to Pb was reduced but not substantially. As this exposure level appear to be higher than those in other parts of Asia, where it was 2.02µg/dl for the general population of Japan [35], 3.3µg/dl for those of China [36] and in Sweden it was 1.1µg/dl [37].

Table 2 and Fig. 2 show the seasonal variations of blood lead levels in residents of Cairo city (urban and rural sites) for years 2010-2011, 2011-2012 and 2012. It was observed that, during summer of the year 2010-2011 (St-1) the mean BLLs of resident's urban and rural sites was lower than that of the winter season of the same year 2010-2011 (St-2). This pattern had been repeated for the next year 2011-2012 (St-3 and St-4). The year 2012 till its end (St-5) showed the highest mean of the BLLs for the residents of the residential-traffic site and that of the rural site. Then, there was a marked drop in the mean BLLs of residential -industrial areas for the last studied summer 2012 (14.7675µg/dl). Regarding to BLLs of residential-industrial areas from 2010-2012, data proved that the lowest level of blood lead could be seen in summer 2010 (14.5650µg/dl), then increased significantly in the winter 2010-2011 (15.9500µg/dl). The pattern of decreased level in summer and its increase in winter has been repeated in next year of the study (2011-2012). Then, there was a marked drop in BLLs of residents-industrial areas for the last studied summer 2012 (14.7675µg/dl). The significant

Table 2: Mean lead Levels (µg/dl) in blood samples collected from industrial, traffic and rural areas during the period (stages/intervals) of 1/5/2010 to 1/11/2012

	Mean concentrations (µg/dl)±SD					
Areas	St-1	St-2	St-3	St-4	St-5	LSD0.05
Industrial	14.5650^{b}±3.28(20)*	15.9500^{a}±0.63(10)	15.8400^{a}±0.56(10)	16.2190^{a}±0.83(10)	14.7675^{b}±0.83(10)	4.99
Traffic	7.4681^{c}±1.73(20)	8.6000^{b}±0.54(10)	8.4178^{b}±0.42(10)	9.6722^{a}±0.48(10)	10.5729^{a}±0.48(10)	3.90
Rural	5.0550^{b}±1.06(20)	5.9350^{a}±0.07(10)	4.4100^{b}±0.09(10)	5.9085^{a}±0.02(10)	6.3610^{a}±0.03(10)	1.77

-All values are means of samples number determinations in each period from each area±standard deviation (SD).

-Means within columns with different letters are significantly different ($p \leq 0.05$).

-( )* Samples number in each period from each area.

St-1: 1/5/2010 to 26/10/2010St-2: 1/11/2010 to 30/4/2011. St-3: 1/5/2011 to 20/10/2011

St-4: 1/11/2011 to 30/4/2012St-5: 1/5/2012 to 1/11/2012.

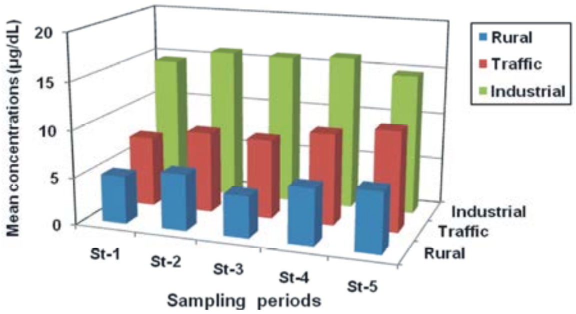
Table 3: Mean lead levels (µg/dl) in blood samples collected from industrial, traffic and rural areas during summer and winter collection through the period of 1/5/2010 to 1/11/2012.

	Mean concentrations (µg/dl)±SD		
Areas	Summer	Winter	LSD0.05
Industrial	14.8863^{b}±3.62(40)*	16.0293^{a}±1.56(20)	3.00
Traffic	8.4498^{b}±1.99(40)	9.0150^{a}±0.72(20)	1.66
Rural	5.2130^{b}±1.29(40)	5.9210^{a}±0.11(20)	1.08

-All values are means of samples number determinations in each season from each area±standard deviation (SD).

-Means within columns with different letters are significantly different ($p \leq 0.05$).

- ( )* Samples number in each season from each area.



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St-5: 1/5/2012 to 1/11/2012

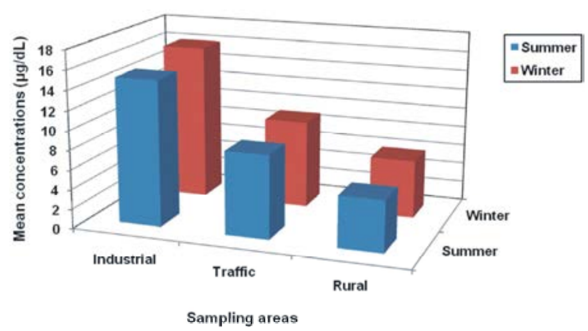

Fig. 3: Mean lead levels (µg/dl) in blood samples collected from industrial, traffic and rural areas during summer and winter collection through the period of 1/5/2010 to 1/11/2012.

decrease of BLLs seen in Summer 2012 (St-5) for industrial residents than that of Summer 2011 (St-3) in the present investigation could be explained by the disturbed conditions which forced great numbers of industries to stop their activities and to decrease its use from Mazout, due to the shortage in fuel that Egypt faced since the revolution and the instability in the economic situations.

With respect to residential-traffic areas, significant marked increase of BLLs from 7.4681µg/dl in summer 2010 (St-1) to 10.5729µg/dl in summer 2012(St-5) could be explained by the disturbed conditions that the environments of Greater Cairo facing since the revolution of January 2011 and lack of regularity in street cleanup. The accumulation of great amount of street dust will be re-suspended in the atmosphere, causing more pollution.

In Table 3 and Fig. 3 we reorganized all the data according to two seasonal groupings. The mean of BLLs was 14.8863µg/dl, 8.4498µg/dl and 5.2130µg/dl in summer (hot dry periods) for residents of residential-industrial sites, residential-traffic sites and rural sites, respectively. The corresponding values in winter were 16.0293µg/dl, 9.0150µg/dl and 5.9210µg/dl, respectively. Data proved that the winter months are associated with higher BLLs in residents of urban and non-urban sites. The seasonality of BLLs in residents is related to the seasonal distributions of dust lead outdoor. The study of El-Taieb *et al*. [4] showed the highest concentrations of lead in dust was recorded during winter season, while the lowest concentrations was observed at the four urban sites of their study in both indoor and outdoor atmospheres. But the out-door concentrations of lead were relatively higher than indoor concentrations. The mean concentrations of lead in four studied sites exceed the Egyptian standard for lead of 1µg/m^3. The author explained this variation by the effect of seasonal meteorological variations.

Meteorological conditions could be the factors affecting the level of Pb. So the low wind speed and low temperature mostly present in winter-spring favor accumulation of pollutants, while the high temperature in summer favors the air convection and the dispersion of pollutants. Though the high wind speed, sometimes present in winter, favors the dispersion of pollutants, it could also re-suspend more dust pollution, which enhances the concentration of particles in the atmosphere. These factors could increase the level of Pb in blood of GC residents, especially during winter seasons. In addition, Pb was more enriched in fine particles [20]. Fine particles can enter the human body more easily than coarse particles and deposit in the tracheobronchial and alveolar regions of the lung, and Pb would be accumulated continuously and have more harmful effect on the human health. The low values of lead during the summer seasons and the high values during the winter seasons could be explained by the meteorological conditions which affect Greater Cairo and resulted in high concentrations of particulate matter (PM) and their Pb content most of the years in different environments. In addition to these two seasonal effects, low winter time temperatures often result in stable weather conditions that aggravate the effects of particle emission from traffic and industrial activities. Moreover, in the Egyptian study of Hassan, [2], the mean concentration of Pb in the entryway, stairs and household dust of urban areas (residential-traffic areas) exceeded the maximum permissible limit 100 µgm^{-1} for Pb in soil. The author proved also, the presence of indoor sources of Pb beside outdoor sources. He found also, that the small particle size of dust had high Pb. Also, Khodeir *et al*. [21] found high concentrations of Pb in the settled dust in an urban area of Giza, Egypt despite decades of using unleaded gasoline. The seasonality of lead levels has been studied by Laidlaw *et al.* [38] and Yiin *et al.* [39], their results showed that children appear to receive the highest dust lead exposure indoors and outdoors during the summer. And the seasonality of blood lead levels in children is related to the seasonal distributions of dust lead in the home. In addition, children were likely to contact high leaded street dust or soil during longer outdoor play periods in summer. Our study confirm this seasonality but in winter time.

Generally, the Pb pollution for residential-Industrial areas follows the same pattern of that of residential-traffic residents and rural, in having lower pollution in summer seasons than in winter seasons. But Pb pollution of residential-industrial areas residents was the heaviest among the other environmental activities, which suggested that these sites were mostly exposed to local industrial activities. The lead sources and consecutive exposure to the inhabitants in GC has further been evaluated and presented in a report by the Egyptian Environmental Affair Agency [40], the major industrial sources of lead were from diesel combustion and lead smelters.

CONCLUSION

From the available data, the results supply valuable information about lead levels in blood samples collected from different Egyptian environments (industrial, heavy traffic and rural areas). It could be concluded that blood lead levels in residents of various sites (urban or rural) are relatively high. Residents of urban sites are at high-risk for lead pollution. The elevated levels of lead from which they suffer, create an appreciable threat to their health, especially the health of young children, who are the population of most concern. BLLs were related to seasonal variations, which could be explained by the meteorological conditions which affect Greater Cairo and resulted in high concentrations of particulate matter (PM) and their Pb content most of the years in different environments. This suggests that residents of Cairo city are exposed to high leaded dust especially in winter time or the cold periods. The present results can be used to test the chemical quality of foodstuffs in order to evaluate the possible risk associated with their consumption by humans. It could be recommended that monitoring of lead levels in biological samples at regular intervals and maintaining data base should be done in order to evaluate whether any health risks from lead exposure do exist, to assure food safety and to protect the end user from contaminated foods. Also, monitoring of blood lead levels among populations at high risk environments is very important. Besides, put plans by specified organizations for preventing exposure through controlling or eliminating lead sources. The nature of lead exposure required that many different organizations to be involved in its abatement. Reducing or preventing the use of leaded gasoline especially in industrial and traffic areas by national authorities. The use of unleaded gasoline and natural gas should be extended to cover all the Egyptian country, i.e. all the Egyptian governorates.

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REFERENCES

1. White, L.D., D.A. Cory-Slechta, M.E. Gilbert, E. Tiffany-Castiglioni, N.H. Zawia, M. Virgolini, A. Rossi-George S.M. Lasley *et al*. 2007. New and evolving concepts in the neurotoxicology of lead. Toxicology and Applied Pharmacology, 225(1): 1-27.
2. Hassan, S.K.M., 2012. Metal concentrations and distribution in the household, stairs and entryway dust of some Egyptian homes. Atmospheric Environment, 54: 207-215.
3. Shakour, A.A, N.M. El-Taieb and S.K. Hassan, 2006. Seasonal variation of some heavy metals in total suspended particulate matter in Great Cairo atmosphere. The 2nd International Conference of Environmental Science and Technology, Egypt.
4. El-Taieb, N.M., A.A. Shakour and S.K. Hassan, 2002. Indoor/outdoor concentration of potentially toxic elements in urban areas in Greater Cairo, Egypt. Egyptian J. of Occupational Medicine, 26(1): 139-150.
5. Egyptian Environmental Affair Agency (EEAA), 1994. Environmental Protection Low No. 4.
6. WHO, 1992. Lead Environmental Aspects. Environmental Health Criteria 85, Geneva.
7. Hosney, I.M., W.I. El Kholy, R.K. El Dairouty, H.S. Sahar, M.A. El Shenawy, H. Amra, M. Abou Donia, A.A.K. Abou-Arab and M.M. El-Sayed, 2010. Microbiological, mycotoxin and some chemical contaminants of retailed Great Cairo area liquid milks. 4th International Conference, Innovation in Food Science and Nutrition: Future Challenges, NRC, Cairo, pp: 27-29.
8. Enb, A., M.A. Abou-Donia, N.S. Abd-Rabou, A.K. Abou-Arab and M.H. El- Senaity, 2009. Chemical composition of raw milk and heavy metals behavior during processing of milk products. Global Veterinaria, 3(3): 268- 275.
9. Abou-Arab, A.A.K., M.A. Abou Donia and A. Enb, 2008. Chemical composition, metals content and pesticide residues in raw, pasteurized and UHT milk and their dietary intake. J. Egypt. Soc. Toxicol., 39: 111-121.
10. Graziano, J.H., 1994. Validity of lead exposure markers in diagnosis and surveillance. Clin. Chem., 40: 1387-1390.
11. Radomska, K., A. Graczyk, J. Konarski and B. Adamwicz, 1991. Evaluation of macro and micro element content in the human body determined by hair analysis. Pol. Iny. Lek., 46: 461-463.
12. Suzuki, T., 1988. Hair and nails. Advantages and Pitfalls When Used in Biological Monitoring: in Clarkson T.W., Fiberg I., Nordberg G.F. and Sager P.R. eds: Biological Monitoring of Toxic Metals: New York, Plenum Press, pp: 623-640.
13. Advisory Committee On Childhood Lead Poisoning Prevention (ACCLPP) . CDC. May 2012. http:// www.cdc.gov/ nceh/lead/ ACCLPP/acclpp_main.htm. Retrieved 18 May 2012.
14. Low Level Lead Exposure Harms Children: A Renewed Call for Primary Prevention. *Centers* for Disease Control and Prevention. http:// www.cdc.gov/ nceh/ lead/ ACCLPP/ Final_Document_010412.pdf. Retrieved 5 January 2012.
15. http://www.cdc.gov/nceh/lead/ACCLPP/Final_Document_010412.pdf. Retrieved 5 January 2012. NIOSH, 2012
16. Miller, D.T., D.C. Paschal, E.W. Gunter, P.E. Stroud and J. D'Angelo, 1987. Determination of blood leads with electro-thermal atomic absorption using a L'vov platform and matrix modifier. Analyst, 112: 1701-1704.
17. Beaty, R.D. and J.D. Kerber, 1993. Concepts, Instrumentation and Techniques in Atomic Absorption Spectrophotometery. Copyrighted by The Perkin-Elmer, Norwalk, CT, USA.
18. Snedecor, G.W. and W.G. Cochran, 1980. Statistical Methods. 7th Ed. Oxford and IBIT public. Co. New York.
19. Nasralla, M.M., 1984. Lead in urban environment. Egyptian J. of industrial Medicine, 8: 53-63.

20. Zakey, A.S., M.M. Abdel-Wahab, J.B.C. Pettersson, M.J. Gatari and M. Hallquist, 2008. Seasonal and spatial variation of atmospheric particulate matter in a developing mega city, the Greater Cairo, Egypt. Atmosphera, 21(2): 171-189.
21. Khodeir, M.I., S.K. Hassan and A.A. El-Abssawy, 2010. An Evaluation of Loading Rate of dust, Pb, CD, and NI and metals Mass Concentration in the settled Surface Dust in Domestic Houses and Factors Affecting Them. Indoor and Built Environ., 19(3): 391-399.
22. Nasralla, M.M., A.A. Shakour and E.A. Said, 1984. Effect of lead exposure on traffic policemen, Egyptian J. industrial Medicine, 8: 87-104.
23. Mortada, W.I., M.A. Sobh, M.M. El-Defrawy and S.E. Farahat, 2002. Reference intervals of cadmium, lead, and mercury in blood, urine, hair and nails among residents in Mansoura City, Nile Delta, Egypt. Environmental Research Section, A, 90: 104-110.
24. Abdel Rasoul, G.M., M.A. Al-Batanony, O.A. Mahrous, M.E. Abo-Salem and H.M. Gabr, 2012. Environmental Lead Exposure among Primary School Children in Shebin El-Kom District, Menoufiya Governorate, Egypt. The International Journal of Occupational and Environmental Medicine, 3(4): 186-194.
25. Omar, M., M. Ibrahim, A Hala, *et al*., 2001. Teeth and blood lead levels in Egyptian schoolchildren: relationship to health effects. Journal of Applied Toxicology, 21: 349-52.
26. Ye, X., H. Fu and G. Guidotti, 2009. Environmental Exposure and Children's Health in China. Archives of Environmental and Occupational Health, 62: 61-73.
27. Liu, J., Y. Ai, L. McCauley, J. Pinto-Martin, C. Yan, X. Shn and H. Needleman, 2011. Blood Lead Levels and Associated Socio-demographic Factors among Preschool Children in the South Eastern region of China. Paediatr. Perinat. Epidemiol., 26(1): 61-69.
28. Youssef, Z.A., 1991. Biological monitoring of lead and carbon monoxide: A thesis, Cairo, Faculty of Medicine, Cairo University.
29. Shakour, A. and N. El-Taieb. 1994. Effect of atmospheric lead exposure on urban children. Egyptian J. of Occupational Med., 18(1): 37-47.
30. Attia, W.M.K., F.M Abdel-Kareem, A.A. Mohamed, and A.H. Hussein, 1996. Screening tools detection Pediatrics of children at risk for lead exposure. Zagazig. Univ. Med. J., 11(2): 144-153.
31. Chappell, R., P. Billig, E. Brantly, S. Ault and H.S. Ezzeldin, 1997. Lead exposure abatement plan for Egypt. Environmental Health Project. Activity report No. 32. Prepared for the USAID Mission to Egypt under EHP Activity No. 256-CC. US Agency for International Development, Washington DC 20523.
32. Monir, Z.A., A. Koura, S. Mawogood, A. Abdel Aziz and S. El-Housseiny, 2003. Growth and development in school age children relation to blood level. Egypt. Med. J. NRC., 2(2): 93-112.
33. Sharaf, N.E., A.A. Shakour, N.M. Amer, M.A. Abou-Donia and N. Khatab, 2008. Evaluation of children's blood lead level in Cairo, Egypt. American-Eurasian J. Agric& Environ. Sci., 3(3): 414-419.
34. Abdel-Maaboud, R.M., M.M. El-Attar, M.A. Mohamad, S.M. Ahmed, A. Abdulkhaliq, K.M. Swaileh, R.M. Hussein and M. Matani, 2005. Levels of metals (Cd, Pb, Cu and Fe) in cow's milk, dairy products and hen's eggs from the West Bank, Palestine. International Food Research Journal, 19(3): 1089-1094.
35. Zhang, Z.W., C.S. Moon, S. Shimbo, T. Watanabe, H. Nakatsuka, N. Matsuda-Inoguchi, K. Higashikawa and M. Ikeda, 2000. Further reduction in lead exposure in women in general populations in Japan in the 1990s, and comparison with levels in east and south-east Asia. Int. Arch. Occup. Environ. Health, 73(2): 91-7.
36. Watanabe, T., Z.W. Zhang, J.B. Qu, W.P. Gao, Z.K. Jian, S. Shimbo, H. Nakatsuka, N. Matsuda-Inoguchi, K. Higashikawa and M. Ikeda, 2000. Background lead and cadmium exposure of adult women in Xian City and two farming villages in Shaanxi Province, China. Sci. Total Environ., 247(1): 1-13.
37. Lars, G. and T. Lundh, 2010. Metal concentrations in blood and hair in pregnant females in southern Sweden. Journal of Environmental Health, 72(6): 37-41.
38. Laidlaw, M.A.S., H.W. Mielke, G.M. Filippelli, D.L. Johnson and C.R. Gonzales, 2005. Seasonality and children's blood lead levels: developing a predictive model using climatic variables and blood lead data from Indianapolis, Indiana, Syracuse, New York, and New Orleans, Louisiana (USA). Environ Health Prespect, 113: 793-800.
39. Yiin, L.M., G.G. Rhoads, P.J. Lioy, 2000. Seasonal influences on childhood lead exposure. Environ Health Perspect, 108: 177-182.
40. Egyptian Environment Affair Agency (EEAA), 2002. Report - 1999 Baseline Lead Emissions Inventory for the Greater Cairo Area, Cairo Air Improvement Project (CAIP), Chemonics International, Inc. USAID/Egypt, Office of Environment USAID Contract No. 263-C-00-97-00090-00.