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Evaluation of Children's Blood Lead Level in Cairo, Egypt

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Abstract: Lead is a highly toxic pollutant, exposure to which can produce wide range of adverse health effects for both adults and children, but childhood lead poisoning is more frequent. There's no safe exposure to lead, CDC has defined an elevated BLL's as $ 10 ug/dl but evidence exists for subtle effects at lower levels. In Egypt, children are exposed to lead from airborne lead and lead bearing dust The aim of this study was to evaluate lead pollution abatement on children's blood lead level. Data of year 1999 and 2002 has been taken from the lead monitoring stations, which are distributed by EEAA all over the Cairo city, they are used to identify sources of atmospheric lead then to assess a relation between the concentration of lead in 4 areas representing the different activities present in Cairo city and BLLs of children living in these areas. The mean value of blood lead level in the studied population was (4.817±2.97 ug/dl) with a range (1.1-14.3), the mean of children's BLLs living in the traffic areas showed the highest mean, followed by that of the mixed areas then that of the residential areas and finally that of the industrial areas, while the same pattern could be seen also in the atmospheric lead concentration for year 2002 in the studied areas, where the maximum concentration of atmospheric lead was recorded in the traffic areas followed by the mixed areas and finally that of the residential areas. The total mean of atmospheric lead concentration for year 2002 was significantly decreased in comparison to that for year 1999 especially for the industrial areas followed by the residential areas, then the traffic areas, which means by the year 2002, there was a control on emissions of lead from the industrial sources. There were no correlation between concentrations of atmospheric lead during year 2002 and BLLs of children living in the 4 studied areas, because the decreasing percentage of atmospheric lead concentration was not great. Lead is still emitted in Cairo atmosphere and living in traffic dense areas can contribute greatly to childhood lead poisoning, due to vehicles that still using leaded gasoline and enter Cairo every day from other governorates and the resuspension of street dust (lead bearing dust), by the wind, vehicles motion and by anthropogenic activities, in addition to its past contamination with lead, which had been accumulated over years. EEAA & MEAA should continue their efforts to eliminate or control sources of lead pollution, with tighter control on vehicle emissions specially those which are still using leaded gasoline and enter Cairo governorate. To promote legislation supporting lead prevention activities. Researches should continue to screen children for exposure and to provide medical and environmental interventions for those identified with elevated BLLs.

Key words: Children % blood lead level % atmospheric lead concentration % unleaded gasoline

INTRODUCTION

Lead is a hazardous, heavy metal that has a damaging impact on human health. Evidence from many countries suggests that human exposure to lead is one of the most serious health problems facing populations, especially children and exposure to lead is a preventable risk [1].

Lead poisoning often occurs with no obvious symptoms, it frequently goes unrecognized. Elevated lead levels can adversely affect mental development and performance [2], kidney function and blood chemistry [3, 4]. Lead-related pollution also causes cardiovascular problems in adults even with low levels of exposure, as well as adverse reproductive effects for women [5]. This is particularly a risk for young children, due to the

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increased sensitivity of young tissues and organs to lead as well as to their greater chance of ingesting lead with soil and dust, for them, even very low levels can result in reduced IQ, learning disabilities, behavioral problems [6, 7], stunted growth [8], impaired hearing and kidney damage. Lead poisoning has also been associated with juvenile delinquency and criminal behavior [9].

Lead and lead compounds can adversely affect human health through either direct inhalation or ingestion of lead-contaminated soil, dust, or paint. The exposure is primarily caused by airborne lead and lead in dust and soil. In congested urban areas, where only limited or no initiatives to reduce lead emissions have been taken, exhaust fumes from vehicles using leaded gasoline typically accounted for 90 percent of airborne lead pollution [10] and contributed greatly to the number of cases of childhood lead poisoning, as much of that, lead remains in soil, where it was deposited over years, especially near well traveled roads and highways.

In Egypt, auto exhaust is a major source of atmospheric lead in greater Cairo, beside lead smelting industry, unleaded gasoline was used in greater Cairo since 1999, but until now unleaded gasoline was not used by all the Egyptian governorates, which make vehicle emissions continues even to day to present a hazard [11], in addition to their marked increase in number.

Exposure to lead is estimated by measuring levels of lead in children's blood (ug/dl). The center for disease control and prevention (CDC) has set a level of concern at 10 ug/dl, but recent researches telling us now that there is no level of lead exposure that can be considered safe.

According to CDC [12], there were 13.5 million children with elevated blood lead level in year 1978 (BLL=10 ug/dl), by the year 2002, that number had dropped to 310,000 and the mean of BLL in children aged 1-5 years decreased from 2.7 to 2.0 ug/dl.

In Egypt, there is no national examination survey to provide data and estimate the prevalence of elevated blood lead levels among children, through which we can evaluate the efforts of EEAA to reduce lead concentration in the environment of greater Cairo, to implement targeted strategies to prevent lead exposure and so to eliminate childhood lead poisoning.

Aim of the study: The aim of this work is to evaluate the effectiveness of various efforts to reduce the environmental lead levels, through determination of BLLs in children recruited from Cairo city, from different geographic areas.

MATERIALS AND METHODS

This study was conducted on 79 children, who aren't exposed to unusual exposure for lead, it included 40 boys and 39 girls aged from 3-15 years with no major health disorders or neuropsychological changes. Children were recruited from different geographic areas in Cairo. Blood was collected by venipuncture for all children. The flameless atomic absorption (Perkin Elmer) using the graphite tube model 2380 has been used for the determination of lead in whole blood, using the precipitating method done by Yee *et al.* [13].

The air quality in Greater Cairo represents a great interest to the Egyptian government, especially regarding the negative impact on public health. In this context, the Ministry of State for Environmental Affairs and Environmental Affairs Agency measure concentrations of lead and fine particles in ambient air. A total of 14 sites are located in the greater Cairo area. Most of the sites are located in residential areas or industrial areas surrounded by residential or urban areas. In the present study, data from these sites were used to identify sources of atmospheric lead in Cairo city for year 1999 and 2002, after being classified into four areas representing the main sources of lead in Cairo, then we correlate the concentration of atmospheric lead in these different areas with children's blood lead levels, living in these areas.

RESULTS

In Table 1, the studied population has been classified into 4 groups, representing the 4 activity areas of Cairo, where its descriptive statistics showed that, children living in the residential areas has a mean±SD of age (7.51±2.92) and a mean±SD of BLL (3.95±2.854).

Table 1: Descriptive statistics of the studied population in the 4 studied areas

	Variable		
Studied areas	Gender	Age (years)	BLLs (ug/dl)
Residential areas	Male: 15	Mean: 7.51	Mean: 3.95
n=38	Female:23	SD: 2.92	SD: 2.854
Traffic areas	Male: 12	Mean: 5.65	Mean: 7.406
n=17	Female:5	SD: 3.03	SD: 3.023
Industrial areas	Male: 4	Mean: 8.06	Mean: 2.725
n=8	Female: 4	SD: 2.809	SD: 1.051
Mixed areas	Male: 9	Mean: 7.03	Mean: 5.163
n=16	Female: 7	SD: 3.519	SD: 1.935
P- value	NS*	NS**	P <0.00*

* P values were evaluated by F-ratio

** P values was evaluated by Chi-square test

Table 2: Atmospheric lead concentration during year 1999 and year 2002 in the 4 studied areas

Studied areas	Residential area	Traffic area	Industrial area	Mixed area	F-ratio	p-value
Atmospheric lead conc. for year 1999 Mean±SD ug/m^3	1.19±0.816	1.80±0.27	14.05±4.76	1.26±0.11	195.5	P<0.0
Atmospheric lead conc. for year 2002 Mean±SD ug/m^3	1.08±0.09	1.76±0.19	4.38±1.32	1.21±0.02	143.5	P<0.0

Table 3: Mean and SD between the different studied areas related to atmospheric lead concentration during year 1999 and year 2002

Studied area	Atmospheric lead conc. in year 1999 Mean±SD ug/m^3	Atmospheric lead conc. in year 2002 Mean±SD ug/m^3	Paired-t test	P-value
Residential area	1.19±0.816	1.08±0.09	10.01	P<0.00
Traffic area	1.80±0.27	1.76±0.19	4.747	P<0.00
Industrial area	14.50±4.76	4.38±1.32	8.212	P<0.00
Mixed area	1.26±0.11	1.21±0.02	1.861	N.S
Mean±SD of total Atmospheric lead conc	2.70±0.47	1.6±0.112	3.132	P<0.005

Table 4: Correlation coefficient between concentrations of atmospheric lead during year 2002 and blood lead levels of children in the 4 studied areas

Blood lead levels of children in the 4 studied areas	Concentrations of atmospheric lead during year 2002	
	r	p-value
Residential areas	0.1	N.S
Traffic areas	0.1	N.S
Industrial areas	0.1	N.S
Mixed areas	0.4	N.S

The mean±SD of the age of children living in the traffic areas was (5.65±3.03) and the mean±SD of their BLL was (7.406±3.023), while children living in the industrial areas has mean±SD for their age (8.06±2.809) and that of their BLL was (2.725±1.051) and finally the mean±SD of the age of children living in the mixed areas was (7.03±3.519) and that of their BLL was (5.163±1.935).

The age and sex had no statistical significance among the 4 groups, while the mean of BLLs in the studied population showed significant difference among the 4 studied areas, the mean of children's BLLs living in the traffic areas showed the highest mean, followed by that of the mixed areas then that of the residential areas and finally that of the industrial areas.

The results obtained from Table 2 revealed that, there was significant difference between the means of atmospheric lead concentration in the studied area for year 1999 and for year 2002, where the maximum concentration of atmospheric lead was recorded in the industrial areas followed by the traffic areas then the mixed areas and finally the residential areas foryear 1999, while the mean of atmospheric lead concentrations in the studied area showed the same pattern for year 2002

Table 3 showed that, the total mean of atmospheric lead concentration for year 2002, was significantly decreased, in comparison to that for year 1999. The mean of atmospheric lead concentration for the industrial areas and the residential areas followed by the traffic areas were significantly decreased.

Table 4 showed that, the results of the correlation tests between concentrations of atmospheric lead during year 2002 and blood lead levels of children in the 4 studied areas were not markedly correlated.

DISCUSSION

The past use of leaded gasoline was responsible for 90 % of the atmospheric lead, which comes from automobile exhaust [10]. Recently, only at 1996 the sold gasoline is completely unleaded in the Cairo's stations, yet the leaded gasoline is still used in other Cairo governorates, which surrounds Cairo city [11].

Lead is confirmed neurotoxin, research suggests, there is no safe exposure to lead and children's intellectual functioning is impaired by blood lead concentration, below 10 ug/dl [6,7], so blood lead levels in children should be reduced below the levels so far considerable acceptable [14]. In this study the mean value of blood lead level in the studied population was (4.817±2.97 ug/dl) with a range (1.1-14.3), this level was lower than that reported in Egypt by Monir *et al.* [4], as she found a value of (8.8±1.5 ug/dl) as a mean blood lead level of children in a non industrial area, as well as Attia *et al.* [15] found a value of (31.6 ug/dl) as a mean blood lead level of children in Sharkia, i.e. child or at least one of his family was treated before from lead poisoning.

But this level was higher than that reported in the United States, where data from (NHANES) survey 1991-1994 showed that average BLLs in children had decreased from 2.7 ug/dl to 2.1 since the late 1970s [16,17] and the children 's BLLs continue to decline throughout the United States [18].

While Hits *et al.* [19], found that the reduction of the smelter emission through management programs in Trail city had led to dropping of average air lead level to 0.03 ug/m^3 and the average blood lead level in preschool children at the end of shut down was decreased to 4.7 ug/dl, which is consistent with the total mean of the BLLs of the studied population.

The mean of BLLs in the studied population showed significant difference among the 4 studied areas, as the mean of children's BLLs living in the traffic areas showed the highest mean, followed by that of the mixed areas then that of the residential areas and finally that of the industrial areas, while the atmospheric lead concentration year 2002 should not the maximum concentration of atmospheric lead to the industrial areas, followed by the traffic areas, then that of the mixed areas and finally that of the residential areas. The last three sites exceeded the maximum Egyptian limit defined in the executive regulation of law (4)/1994 (1 ug/m^3), this finding is in agreement with the results of Risk and Khodheir [11]. These could be explained by the presence of more than one million vehicles circulating on Cairo streets (Cairo was the governorate with the largest number of vehicles, 29.5% of the total registerated vehicles in Egypt were in Cairo), so mobile emissions are one of the major sources of air pollution in greater Cairo. Although, the use of unleaded gasoline had started since year 1996, but the leaded gasoline is still used in other Egyptian governorates which surrounds Cairo city so this high emission may be due to its emission from vehicles that still using leaded gasoline and enter Cairo every day from other governorate.

Another source of lead in Cairo may be due to the resuspension of street dust (lead bearing dust) by the wind, vehicles motion and anthropogenic activities, in addition to its previous contamination with lead due to the past use of leaded gasoline, which has been accumulated over years, this was confirmed by the presence of highest concentration of lead in the street dust of the traffic areas followed by that of the industrial areas in the study done by Shakour *et al.* [20]. So living in traffic dense areas can contribute greatly to childhood lead poisoning.

The mean of BLL of children living in the mixed areas showed the third highest mean, followed by that of children living in the residential areas, which showed the least mean. To our mind, it is not because of housing compliance status but mostly due to the least traffic activity to which these areas were exposed, as Rappezo *et al.* [21]concluded that current housing compliance status (house's lead hazard control) may be helpful in primary prevention but didn't impact change in blood lead level for exposed children to high environmental lead, also our explanations were supported by that of Hits *et al.* [22], who found that the blood lead level of Canadian children not living near point sources appeared to be leveling off following the phase out of leaded gasoline.

The present study showed that the total mean of atmospheric lead concentration for year 2002 was significantly decreased in comparison to that for year 1999, the mean of atmospheric lead concentration for the industrial areas and the residential areas followed by the traffic areas were significantly decreased. This means, by the year 2002, there was a control on emission of lead from the industrial sources. This could be explained by the activities done by MSEA and EEAA to improve Cairo air quality specially lead emissions from greater Cairo, as after the useful introduction of lead free gasoline, the smelting industry has become the main source of lead emission in Cairo, so the cleaning up of lead contaminating sources from the industrial areas by their relocation outside the residential blocks, as well as switching to the natural gaz instead of Mazout in the industrial areas and power generation sectors. These steps reduce atmospheric lead concentration compared to their concentration before relocation (concentration of atmospheric lead in the industrial areas was 14.5±4.76 ug/m^3 during year 1999 and 4.38±1.32 ug/m^3 during year 2002), this explanation is similar to that of Hits *et al.*, [19] who suggests to pay increased attention to the active sources, as reduction of the smelter emission through management programs in Trail city had led to dropping of average air lead level to 0.03 ug/m^3 and the average blood lead level in preschool children at the end of shut down was decreased to 4.7 ug/dl.

The results of the correlation tests between concentrations of atmospheric lead during year 2002 and blood lead levels of children living in the 4 studied areas were not markedly correlated, because the decreasing percentage of lead concentration was not great [11]. Because, lead is still emitted in Cairo atmosphere, due to vehicles that still using leaded gasoline and enter Cairo every day from other governorate, the resuspension of street dust (lead bearing dust), in addition to the increase in industrial activities and the higher level in fuel consumption, beside the expansion of land transport, led to increase in number of cars. This limited decrease was also described by Morrison [23], when he found that lead accessibility reduction programs had failed to eliminate child blood lead levels, many factors have contribute to this failure, notably the continued presence of airborne high lead pollutants in air, dusts and soil in residential areas, inappropriate maintain of obsessive levels of household cleanliness in order to minimize lead uptake from dusts deposited within the home and community and lack of coordination between various arms of government. As well as Albalak *et al.* [24] in Jakarta, Indonesia, found that BLLs of children in his study were moderately high after phasing out of gazoline and consistent with BLLs of children in other countries where leaded gasoline is still used.

To attain the goal of eliminating childhood lead poisoning, we require to intensify the governmental efforts, to reduce the environmental lead to less than the maximum permissible limit, especially in dense traffic areas and the residential areas, by promoting the use of leaded free gasoline by all the Egyptian governorates by controlling of all types of mobile sources in greater Cairo by relocating lead polluting industries especially the small scale ones outside the residential blocks by application of lead contaminating soil abatement and house decontamination programs and promoting legislation supporting lead poisoning preventing activities. To evaluate these preventive measures, we have to use follow up studies to environmental lead levels and its correlation to children's blood lead and childhood lead poisoning through a national blood lead surveillance.

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