Blood lead levels in Kuwaiti schoolchildren suspected of lead exposure

Ayesha M. Molla, PhD, Akram S. Al-Khalily, BSc, Nizar Y. Hussain, PhD

ABSTRACT

Objectives: To study the effect of using drinking water taken from water coolers fitted with immersed lead-containing cooling coils on the blood lead levels of Kuwaiti schoolchildren. Design: During January 1995, under the supervision of physicians from the Preventive Medical Department of the Ministry of Public Health and the Laboratory Administration of the Ministry of Health, blood was collected from a random sample of 274 schoolchildren aged up to 12 years. This was analyzed for lead content using atomic absorption spectrometry. Setting: Outpatient clinics of the five district hospitals covering the whole area of Kuwait. Results: Overall geometric mean (with 95% confidence interval) blood lead levels of the Kuwaiti children was found to be 0.48 (95% confidence limit, 0.43-0.53) μmol/l, a value which was considered to be within safety levels by the American Center for Disease Control (CDC), in Atlanta in 1991. However one way analysis of variance (ANOVA) test on log transformed data revealed significant differences (p<0.002) between the different groups of children. Duncan-multiple range test showed that blood lead levels for the children living in the areas of Al-Jahra, Al Adan and Al-Farwania hospitals were significantly higher (p<0.05) compared to the blood lead levels for the children living in areas of Al-Amiri and Al-Mubarak hospitals. Of our total study children 1.5% (4/274) had more than 1.21 μmol/l, (25 μg/dl), the upper acceptable limit for blood lead level. Apparently no clinical symptoms were noticed in our study children. Conclusions: One way analysis of variance (ANOVA) test on log transformed data revealed a significant difference (p<0.002) in the blood lead levels between the groups of children from five different areas of Kuwait. Overall geometric mean lead levels for Kuwaiti children was similar to 0.48 μmol/l (10μg/dl), advised to be the safe level by the CDC in Atlanta in 1991. We conclude that the log blood lead levels are normally distributed in a Gaussian shape.

Keywords: Blood lead level, geometric mean (GM).

Lead is known to be a major environmental toxin and its adverse effects on health are well documented.1 Several studies have addressed the mechanism of cellular toxicity of lead, leading to hematological, renal and neuroendocrine dysfunction.2-5 Anemia and increased level of erythrocyte protoporphyrin have been observed in patients with blood lead levels of 1.92 μmol/l and abnormalities in peripheral nerve conduction were detected at a level of 0.96 μmol/l.6,7 Recent studies suggest that low to moderate levels of lead exposure are risk factors for growth in stature during early childhood.8-10 Association between low level lead exposure and reduced cognitive function in children has also been reported.11 For children, the American Center for Disease Control (CDC) in 19916 revised the safe level for blood lead from <1.21 μmol/l (25 μg/dl) to <0.48 μmol/l (10 μg/dl). Previously in Kuwait a cohort of Arab Bedouin children was screened for lead poisoning12 and a significant number of children were found to have elevated (1.207 μmol/l) blood lead levels. This was attributed to several traditional folklore remedies widely practiced in Kuwaiti Bedouin communities. Lead poisoning has also been reported among cable solderers in Kuwait.13 In a recent study in Saudi Arabia, it was found that out of a total of 1047 healthy children, 77.4% had blood lead levels equal to or less than 0.608 μmol/l. The authors used this value as a reference for the Saudi population.14

During January 1995, an accidental occurrence at the Faculty of Science in Kuwait University led to the finding that the drinking water from the widely used water coolers was contaminated with lead, reaching levels exceeding the internationally acceptable limit of 0.48 μmol/l for children. It was suspected that the source of this contamination were the cooling coils which were immersed in the tanks.

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Table 1 - Geometric mean (95% confidence interval) blood lead levels in children from different areas of Kuwait.

<table>
<thead>
<tr>
<th>District hospitals</th>
<th>No. of children</th>
<th>Blood lead level (μmol/l) geometric mean (95% Confidence interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al-Jahra</td>
<td>50</td>
<td>0.50 (0.42 to 0.59)</td>
</tr>
<tr>
<td>Al-Adan</td>
<td>49</td>
<td>0.54 (0.43 to 0.65)</td>
</tr>
<tr>
<td>Al-Amiri</td>
<td>53</td>
<td>0.42 (0.29 to 0.55)</td>
</tr>
<tr>
<td>Al-Mubarak</td>
<td>60</td>
<td>0.43 (0.30 to 0.53)</td>
</tr>
<tr>
<td>Al-Farwania</td>
<td>62</td>
<td>0.50 (0.42 to 0.59)</td>
</tr>
<tr>
<td>All</td>
<td>274</td>
<td>0.48 (0.43 to 0.53)</td>
</tr>
</tbody>
</table>

This study was undertaken to determine the effect of drinking from this supply on the accumulation of lead in the blood of schoolchildren aged up to 12 years; these children being the most susceptible to lead poisoning.

Subjects and methods In January 1995, a random sample of 274 school children aged up to 12 years were selected at different outpatient clinics located in five districts of Kuwait. These children were undergoing treatment for minor ailments, but were otherwise healthy without signs of any systemic diseases. Blood samples were collected under the supervision of physicians from Preventive Medicine, Department of the Ministry of Public Health, Kuwait and Laboratory Administration of the Ministry of Health.

About 5 ml of blood was collected in EDTA containing vacutainers. Whole blood lead levels were estimated using a graphite furnace attached to a Model 703 Perkin Elmer atomic absorption spectrophotometer. Accuracy and precision of the method was regularly monitored using quality control samples.

Statistical analysis. The SPSS statistical package was used for data analysis. Frequency distribution curve was plotted using natural log of blood lead levels. Geometric mean blood lead levels (with the 95% confidence intervals) were estimated and tested by using one-tailed t-test to determine whether the mean levels from the five different groups of Kuwaiti children were significantly higher than the advised 0.48 μmol/l set by the CDC. Using log transformed data one way analysis of variance (ANOVA) test was used to observe whether significant differences existed between and within them. Duncan-multiple range test was carried out to identify which of the groups were significantly different between them.

Results Table 1 shows the geometric mean with 95% confidence intervals of blood lead levels for all groups. The overall, as well as the individual group means, were similar to the safe lead levels 0.48 μmol/l as recommended by CDC (one-tailed t-test).

Log blood lead levels (mean ± SD) in children from different areas of Kuwait are given in Table 2. One way analysis of variance (ANOVA) test revealed significant differences in the mean log blood lead values between the five study groups (p<0.002). Duncan-multiple range test showed that blood lead levels for children living in the areas of Al-Jahra, Al-Adan and Al-Farwania hospitals were significantly higher (p<0.05) compared to the lead levels for the children living in the areas of Al-Mubarak and Al-Amiri hospitals. Figure 1 shows that the log-blood lead levels are normally distributed.

Discussion Kuwaiti school children were suspected of exposure to excessive concentrations of lead, following the discovery that the school water coolers were lead contaminated; the source being the cooling lead coils inside the containers. As compared to the reference value of 0.608 μmol/l for Saudi Arabian children the geometric mean (± SD) lead levels for the Kuwaiti children were less, being 0.48 μmol/l. Also the overall as well as the group mean lead levels were similar to the "safe" level of 0.48 μmol/l set by the CDC. Elevated (>1.21 μmol/l) lead levels were found in 1.5% of Kuwaiti children as compared to 3.5% of Saudi children. In the UK 0.1-0.18% of children<sup>16,17</sup> and 2% of Caucasian children in USA have been reported to have higher than the upper acceptable blood lead level.<sup>4</sup> It was also noted that 12% of black children in USA have been reported to have blood lead levels higher than the upper acceptable limit, suggesting environmental pollution was worse in the areas inhabited by black children as compared to those of the

Table 2 - Mean (± SD) Log blood lead levels in children from different areas of Kuwait.

<table>
<thead>
<tr>
<th>District hospitals</th>
<th>No. of children</th>
<th>Log blood lead level (μmol/l) (Mean ± SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al-Jahra</td>
<td>50</td>
<td>-0.67 ± 0.30*</td>
</tr>
<tr>
<td>Al-Adan</td>
<td>49</td>
<td>-0.62 ± 0.37*</td>
</tr>
<tr>
<td>Al-Amiri</td>
<td>53</td>
<td>-0.86 ± 0.47</td>
</tr>
<tr>
<td>Al-Mubarak</td>
<td>60</td>
<td>-0.85 ± 0.49*</td>
</tr>
<tr>
<td>Al-Farwania</td>
<td>62</td>
<td>-0.69 ± 0.33*</td>
</tr>
<tr>
<td>All</td>
<td>274</td>
<td>-0.74 ± 0.41</td>
</tr>
</tbody>
</table>

ANOVA TEST:
F. Ratio: 41608 p<0.002
* Duncan-multiple range test:
p<0.05
Mean squares
0.6778: Between groups
0.1629: Within groups
caucasian children. ANOVA test analysis (Table 2) revealed significant differences (p<0.002) in the log mean values obtained between the 5 study groups of children suggesting that the study population was exposed to varying degrees of lead contamination. Children living in Al-Jahra, Al-Adan and Al-Farwania areas had significantly higher blood lead levels (p<0.05, Duncan-multiple range test) compared to the children living in Al-Amiri and Al-Mubarak areas. A previous report from Kuwait showed that a significant number of schoolchildren attending the emergency department of Al-Jahra hospital had high levels of blood lead and erythrocyte protoporphyrin. Folklore remedies containing oral preparations of lead and use of a lead contaminated eye cosmetic “kohl” were attributed to be the causative factors. Similar customs might also have been practiced in these three areas, Al-Jahra, Al-Adan and Al-Farwania respectively. Figure 1 illustrates that the log blood lead levels of the Kuwaiti children are normally distributed in a Gaussian shape. These results suggest that the geometric mean of 0.48 μmol/1 may be used as a reference value for the Kuwaiti children.

Since low-level exposure to lead during early childhood is associated with impairment of neuropsychological development, the Kuwaiti community should have a high degree of awareness with regard to possible environmental lead pollution. This is specially important because although our means were not significantly different from the safe level of 0.48 μmol/1 set by the CDC, the previous report did show presence of high blood lead levels in Bedouin Kuwaiti children. Finally, our study showed that the contamination of the drinking water from the coolers has not led to development of any apparent abnormality among the healthy Kuwaiti children at this time.

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References


