

# Blood lead levels and $\gamma$ -glutamyl transferase activity in battery factory workers in Jordan

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## ABSTRACT

**Objectives:** The aim of this study is to investigate blood lead levels in workers of lead acid battery factories and the relationship between those levels and the activity of  $\gamma$ -glutamyl transferase ( $\gamma$ -GT).

**Methods:** Samples of blood were collected during the period from July 2001 to August 2001 from 95 workers of the 2 lead-acid battery factories in Amman, Jordan. They were categorized into 2 groups based on the nature of their work: direct (high exposure) and indirect contact (low exposure) groups. Lead concentration in whole venous blood and  $\gamma$ -GT activity was measured.

**Results:** Mean blood lead levels were  $51.4 \pm 1.8$  and  $23.9 \pm 3.8$   $\mu\text{g/dl}$  for both direct and indirect groups.  $\gamma$ -Glutamyl transferase mean activity was found to be  $29.2 \pm 2.6$  U/L for direct and  $23 \pm 5.7$  U/L for indirect contact groups. Fifty healthy individuals were selected as controls. Their mean blood lead levels and  $\gamma$ -GT mean activity were  $12.3 \pm 0.5$

$\mu\text{g/dl}$  and  $25.6 \pm 1.2$  U/L. As results indicated, no significant relation was found between lead blood levels and  $\gamma$ -GT activity ( $p=0.303$ ) or between lead blood levels and duration of exposure in both direct and indirect groups ( $p=0.61$ ). However, significant relation was found between lead blood levels and type of work ( $p$  value approached zero) and between lead blood levels and duration of exposure in those workers with lead blood levels exceeding 20  $\mu\text{g/dl}$  and employed for more than one year ( $p$  value approached zero).

**Conclusion:** Lead blood levels among workers in lead acid battery factories in Jordan are high. In most cases, they are higher than the limit permitted by the World Health Organization. Therefore, good protection measures should be taken in such factories to avoid the negative impact of high lead blood levels on the health of workers.

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Lead has been and continues to be a persistent source of toxicological concern. Exposure to lead has been shown to affect a number of different biochemical and physiological processes, tissues and organ systems in both laboratory animals and humans.<sup>1</sup> Lead poisoning are preventable environmental disease, affecting certain occupational categories such as welders, leaded paint factory workers, painters and lead-acid battery factory

workers.<sup>2</sup> Lead showed to be a potent inhibitor of several enzymes. Some of these enzymes are involved in the heme biosynthesis.<sup>3</sup> In addition, it might affect membrane enzymes. Columbano et al<sup>4</sup> demonstrated that single administration of lead nitrate to Wistar rats induced the activity of  $\gamma$ -glutamyl transferase ( $\gamma$ -GT).  $\gamma$ -Glutamyl transferase is a membrane bound enzyme that

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directly involved in the salvage of extracellular glutathione (GSH).<sup>5</sup> -Glutamyl transferase that released from the cell membrane can be detected in the serum and can be used as a clinical test. Heavy metals are usually introduced into the body by direct exposure to fumes and dust, or by the consumption of contaminated water and food. Industry is one of the main sources of lead pollution, particularly in lead-acid battery factories.<sup>6,7</sup> Lead pollution due to the use of leaded gasoline, lead-acid battery manufacturing and the use of printing presses has been reported in some neighboring countries such as Iraq<sup>8,9</sup> and Israel.<sup>10,11</sup> Lead-acid battery factory workers in Sudan had blood lead levels higher than 40 µg/dL.<sup>12</sup> Elevated blood lead levels have also been reported among lead-acid battery factory workers in Tobago and Trinidad<sup>13</sup> and at the storage battery workers in Korea, where the mean blood lead level among workers was 54 µg/dL.<sup>14</sup> The upper limit for lead levels in human body should not exceed 40 µg/dL.<sup>15-16</sup> Lead toxicity has been studied through the depletion of delta aminolevulinic acid dehydratase or hemoglobin.<sup>7,18</sup> Iron deficiency anemia in children has been reported to be lead-induced.<sup>19</sup> Levels of lead in bone could serve as a dosimeter for cumulative exposure to lead as well as an internal source of circulating lead for several years after environmental exposure has stopped.<sup>20</sup> Heavy metals such as lead can be detected directly by testing blood, urine or other tissues or organs, or indirectly by the inhibition of certain enzymes.<sup>18</sup> Lead-acid battery factories are the main industrial sources of lead emission in Jordan. Therefore, workers in lead-acid battery factories were chosen for the evaluation of blood lead levels.

**Methods.** Subjects recruited in this study were 95 Jordanian workers from the only 2 lead-acid battery factories in Amman, Jordan. Samples of blood were collected during the period from July 2001 to August 2001. They were categorized into 2 groups based on the nature of their work: 1. Direct contact group (high exposure) was comprised of 83 workers who were directly exposed to lead and all workers on the production line such as casting, mixing and charging batteries were included. 2. Indirect contact group (low exposure) was consisted of 12 workers who were indirectly exposed to lead such as directors, managers, secretaries, drivers and cleaning personnel. Sex and age were matched and 50 healthy individuals were selected as controls.

A questionnaire was filled-up by a trained graduate student for each participant in the study. The information obtained was regarding the socio-demographic factors, occupational history and medical history. The protocol of the study was approved by the medical ethics committee at Jordan University of Science and Technology School of Medicine, Irbid, Jordan and all participants submitted their informed consent prior to their inclusion in the study. Five ml anticubital venous

blood was collected in heparinized; lead free vacutainers. Precautions were taken to avoid possible contamination of the samples. Samples were placed on ice immediately after collection and then were stored at -20 until analysis. Samples were analyzed within few days after collection. Lead concentration in whole venous blood was measured by graphite furnace atomic absorption spectrometry (Shimatzu model AA680) at the laboratory of Environmental Health Directorate, Ministry of Health, Amman, Jordan. Measurements were taken at wavelength of 283.3 nm. Duplicate determinations were taken for each sample and averaged. -Glutamyl transferase activity was measured on Hitachi-911 analyzer using commercial kits obtained from Roche diagnostics according to the manufacturer's recommendations.

**Statistical analysis.** T-test was used to examine the differences between blood lead levels and the activity of -GT.

**Results.** The lead acid battery factory workers who participated in this study were of low socio-economic status and low level of education. **Table 1** shows the distribution of the participating workers in groups according to their jobs, age, blood lead levels and -GT activity. The mean blood lead levels for both direct and indirect groups were  $51.4 \pm 1.8$  µg/dl and  $23.9 \pm 3.8$  µg/dl. The mean duration of employment for direct and indirect contact groups was  $10.3 \pm 5.4$  years and  $12.5 \pm 8.2$  years. Exposure to lead in jobs or activities outside the factories was rare. The difference in mean blood lead levels between directly exposed, and those indirectly exposed was statistically significant (*p* value approached zero). No significant relation was found between lead blood levels and age (*p* value=0.091) and between lead blood levels and -GT activity (*p* value=0.303). Furthermore, no relation was found between blood lead levels and length of exposure (*p* value=0.61). However, there was a significant relation between blood lead levels and length of exposure in those workers who have been exposed to lead more than one year and had blood lead levels more than 20 µg/dl (*p* value approached zero).

Table 1 - Blood lead levels and -glutamyl transferase activity in workers of lead acid battery factories in Jordan.

Groups	n	Lead µg/dl	γ-glutamyl transferase U/L
Control	50	12.3 ± 0.5	25.6 ± 1.2
Direct contact	83	51.4 ± 1.8	29.2 ± 2.6
Indirect contact	12	23.9 ± 3.8	23 ± 5.7

Discussion. Blood lead concentration is the most reliable index of lead exposure. The factor most influencing blood lead levels is environmental exposure.<sup>20</sup> The 2 lead-acid battery factories that manufacture car batteries in Jordan were included in this study. In these factories, there are very little or no precautionary measures to ensure safety, good ventilation, and suitability of workplace and cafeterias. Furthermore, the average work hours per week is 48 hours and most of the workers have been working approximately 10 years. Even though there is a medical supervision of health and safety, there are many cases of high lead blood levels. **Table 1** indicates that lead blood levels are dependent on the type of work. The high blood lead levels of direct contact group was due to a higher lead exposure in their working environment. Battery workers neglect to use facemasks during work and this significantly increases blood lead levels due to inhalation. Mean blood lead levels are generally found to be higher among smokers, those who drink alcohol and those who do not always wash their hands.<sup>22</sup> They are also greatly affected by air lead levels, especially among battery repair and casting workers where inhaled lead is the most important source of lead exposure.<sup>23</sup> Although air lead levels were not tested in our study, it is more likely that the battery-casting workers were exposed to lead fumes arising from lead melting at a high temperatures. Blood lead levels showed no relation with age ( $p$  value=0.091). The parameters which showed significant relation with blood lead levels were type of work ( $p$  value approached zero) and duration of exposure in workers who have been exposed to lead for more than one year and have blood lead levels of more than 20  $\mu\text{g}/\text{dl}$  ( $p$  value approached zero). -Glutamyl transferase activity and its relation to lead toxicity are controversial. Columbano et al<sup>4</sup> demonstrated that single administration of lead nitrate to Wistar rats induced the activity of -GT. Morisi et al<sup>24</sup> showed the direct relationship between lead levels and -GT activity. On the other hand Mortada et al<sup>25</sup> demonstrated that no change in -GT activity in traffic policemen (lead-exposed group). In our study -GT activity did not show relation with blood lead levels ( $p$  value = 0.303), except in some cases where we noticed high blood levels of -GT among those workers with high lead blood levels and duration of employment more than 5 years. The presence of these cases of high -GT activity resulted in a higher number of the standard error among factory workers compared with controls.

In conclusion, the results of our study reveal a high prevalence of elevated blood lead levels among lead acid battery factory workers in Jordan. Exposure to lead fumes increased the absorption of lead. The mean value reported for blood lead levels among battery factory workers of  $51.4 \pm 16.7 \mu\text{g}/\text{dl}$  was similar to those working in large battery factories, and it is higher than the limit of 40  $\mu\text{g}/\text{dl}$  that permitted by the World Health Organization.<sup>24</sup> Therefore, good protection measure

should be taken in such factories to avoid the negative impact of high lead blood levels on the health of workers.

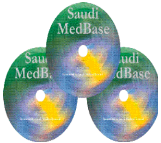
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**Search Word: blood lead levels**

**Authors:** Molia AM, Al-Khaliliy AS, Hussain NY  
**Institute:** University of Kuwait and the Clinical Chemistry Laboratory, Al-Adan Hospital, Kuwait.  
**Title:** Blood lead levels in Kuwaiti schoolchildren suspected of lead exposure  
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**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 5 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 umol/l (95% confidence limit, 0.43-0.53), 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 difference ( $p < 0.002$ ) 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 umol/l, (25 g/dl), the upper acceptable limit for blood lead level. Apparently no clinical symptoms were noticed in our study children. **Conclusions:** One way ANOVA test on log transformed data revealed a significant difference ( $p < 0.002$ ) in the blood lead levels between the groups of children from 5 different areas of Kuwait. Overall geometric mean lead level for the Kuwaiti children was similar to 0.48 umol/l (10 ug/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.