

# LEAD EXPOSURE AND POSSIBLE ASSOCIATION WITH VIOLENT CRIMES: A FIELD STUDY IN TWO JORDANIAN PRISONS

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## Abstract

Environment has its impacts on behaviors. One of the major environmental contributors is the environmental exposure to lead. Lead is accumulated in the body and its impacts last for a long time. Several studies have associated crime rates with lead exposure. The objectives of the present study were to investigate lead levels among prisoners in two selected prisons in the Northern of Jordan and to investigate any possible correlation between lead levels and crime related variables. Methodology included visiting two prisons in the northern of Jordan, meeting 46 prisoners, filling a prepared questionnaire, and withdrawing a blood sample from each participant. The study also included 27 participants as a reference group. Blood lead level was measured using Atomic absorption Spectroscopy. Study findings showed that prisoners had a higher blood lead level ( $0.924 \pm 1.79$   $\mu\text{g/dl}$ ) compared with control group ( $0.570 \pm 0.560$   $\mu\text{g/dl}$ ). No significant variation was observed between two study groups ( $P$  0.480). The results revealed positive association between crowded traffic and lead exposure among prisoners ( $P$  0.038). A positive association was also found between blood lead level and monthly income ( $P$  0.000), and number of family members ( $P$  0.000). Taken together, although the study findings showed no significant association between blood lead concentration between prisoners and reference participants, it is observed that prisoners have about double concentration of blood lead and it is highly possible that our findings supported the environmental hypothesis which explained the effects of removal of lead from gasoline in lowering crime rates in US.

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**Keywords:** lead exposure, crime, prisoners, environment

## **Introduction**

It has been reported that the rates of violent crimes steadily increased in the United States (US) till the mid the mid-1990s when a declining rate of 3-4% yearly was observed. In 2010, a declining rate of 13% was reported (Federal Bureau of Investigation, 2010; U.S. Department of Justice, 2010; Mielke and Zahran, 2012).

Scientists of criminology failed to explain the sudden decreased trends in violent crime based on various theories that have been proposed to explain crime such as demographic, cultural, economic, and law enforcement (Fox, 1996; Nevin, 2007). The alternative hypothesis explaining the unexpected decline in violent crime rates was the environmental hypothesis which has been developed and is consistent with the neurotoxicity hypothesis, in which exposure to lead (Pb) impacts neurotransmitter and hormonal systems and accordingly lead to aggressive and violent behavior (Stretesky and Lynch, 2001, 2004). The findings of Dietrich et al (2001) showed the presence of association between early exposure to lead and antisocial acts by adolescents.

Lead is considered as a neurotoxin which its influences last for long time and impact behaviors of exposed children (Olympio et al., 2009). Other studies by Cecil et al (2008, 2011) using Magnetic Resonance Imaging (MRI) pointed to decreased volume of grey matter among adults who were exposed to lead when they were children compared to their counterparts of adults who were not exposed to lead in childhood stage.

It has been estimated that between 1992 and 2002, when lead was removed from gasoline, there was accompanied decline of approximately a 56% in violent crime (Reyes, 2007).

There are multi-sources for lead exposure (Goodlad, Marcus, and Fulton, 2013). Previous studies including the study of Byers and Lord (1943) showed that ingestion of lead by chewing cribs and furniture parts which were coated by lead-based paint. During the 20th century, lead sources included lead-based paints, lead plumbing, and leaded gasoline which participated into preschool children in the United States (Hubbs-Tait et al., 2005).

It is worth to mention that lead exposure at low levels is still considered important because lead resulting from automobiles and industrial processes remain in water and soil for years. Furthermore, it has been indicated that homes may still have lead paints, particularly those homes in low income regions (Stretesky and Lynch, 2001).

Several studies have reported higher amounts of blood lead in various parts of the world. Examples include Romania, Mexico, and China in which the mean blood lead level was more than 5 µg/dL (Kordas et al., 2007; Wang et al., 2008; Nicolescu et al., 2010).

## Study objectives

The main objective of the present study is to investigate lead levels among prisoners in two selected prisons in the Northern of Jordan and to investigate any possible correlation between lead levels and crime related variables.

## Methods and subjects

### Study population

Study population included prisoners in prisons in the Northern of Jordan who had criminal behaviors that led to their arrest and placing them in the prison. The managers of these prisons (Qafqafa and Um Allolo) had received formal letters to permit for the prisoners to voluntarily participate in the study and to fill a questionnaire and give blood samples.

### Study sample

Study sample included 73 participants among which are 46 prisoners and 27 persons as controls outside the prisons from the general populations.

### Study procedure

Blood samples were collected by a trained person, from each participant, a blood samples was taken for testing lead (Pb) by Atomic absorption.

## Results

### Study participants

The present study included 75 participants of whom 46 were prisoners and 27 participants as a reference group (table 1).

Table 1: Study participants

Participants	Frequency (N)	Percentage (%)
Prisoners	46	63
Control group	27	37

### General characteristics of participants and their statistical significance

In the present study, we investigated the general characteristics of control group and group of prisoners searching for any possible variation between them. Social status did not show any significant variation among study groups (P 0.564). Age was also not a predictor of committing crime among study participants (P 0.831). Educational level was not shown to be a predictor of committing crime (P 0.075). The trend observed is that participants in control group were more educated. Occupation was not also a predictor of crime committing (P 0.567). Resident place did show significant variation between study groups (P 0.570). Various sources of pollution were investigated including: crowded traffic, factories, sanitation stations and fuel

stations. Crowded traffic was shown to be a significant predictor for crime committing (P 0.038). Although other factors were not significantly varied (P > 0.05) among study groups, the observed trends pointed to have prisoners more close to sources of pollution. Both study groups were smokers in similar patterns and accordingly smoking was not significant predictors for committing crime (P 0.269). Previous intake of drugs, alcohol and medicines was not also a significant predictor for committing crime (P 0.598). Type of housing either independent home or flat did not show significant variation to commit crime (P 0.215). Home possession was also not a significant predictor of committing crime (P 0.643). Painting chips due to tearing of ceilings and walls showed similar patterns in homes of both study groups and accordingly were not a significant predictor of crime committing (P 0.50). Among prisoners, the main crimes that lead to prison were in the following patterns: violent crimes were 50%, possession crimes 43.48%, and murder crimes 6.25%.

Finally, the mean lead concentration was  $0.924 \pm 1.79$  microgram/dl among prisoners and  $0.570 \pm 0.56$  microgram/dl among control group participants. The relationship between two study groups and lead concentration was not statistically significant (P 0.480) (table 2).

Table 2: General characteristics of participants and their statistical significance

Variable	Prisoner's group		Control group		P value
	Frequency (N)	Frequency (N)	Frequency (N)	Percentage (%)	
<b>Social status</b>					0.546
- Single	17	36.95	19	70.37	
- Married	28	60.88	7	25.93	
- Divorced	1	2.17	1	3.70	
<b>Age</b>					0.831
- <19	0	0	2	7.4	
- 20-29	21	45.65	16	59.3	
- 30-39	18	39.14	7	25.9	
->40	7	15.21	2	7.4	
<b>Educational level</b>					0.075
- illiterate					
- reading and writing	10	21.73	2	7.40	
- primary	7	15.22	0	0	
- secondary	12	26.09	5	18.52	
- university and more	16	34.78	13	48.15	
<b>Occupation</b>					0.567
-student	0	0	6	22.22	
- technician	19	41.39	7	25.92	
- farmer	1	2.17	0	0	
- retired	4	8.70	1	3.70	
- unemployed	8	17.39	3	11.11	
- others	14	30.34	10	37.04	
<b>Resident place</b>					0.570
- city	24	52.17	3	11.11	

- village	18	39.14	23	85.18	
-Camp	4	8.96	1	3.71	
<b>Sources of pollution</b>					
- crowded traffic	26	56.52	7	25.92	0.038
- factories	8	17.39	1	3.71	0.708
- sanitation stations	6	13.04	1	3.71	0.840
- fuel stations	19	41.30	4	14.81	0.640
<b>Smoking</b>					
- yes	34	72.34	21	77.78	0.269
-no	13	27.66	6	22.22	
<b>Previous intake of:</b>					
- Drugs	5	10.87	2	7.41	
-Alcohol	12	26.09	7	25.92	0.598
- Medicines	4	8.70	2	7.41	
-all of the above	8	17.39	2	7.41	
- none of the above	17	36.96	14	51.95	
<b>Type of housing :</b>					
-independent home	30	65.22	22	81.48	0.215
- flat	12	26.09	4	14.82	
- others	4	8.70	1	3.70	
<b>Home possession:</b>					
- possessed	24	52.17	23	85.19	0.643
- rent	22	47.83	4	14.81	
<b>Painting chips:</b>					
- yes	22	47.83	14	51.85	0.50
- no	24	52.17	13	49.15	
<b>Reasons for prison:</b>					
- violent crimes	23	50			
- possession crimes	20	43.48			
- murder crimes	3	6.52			
<b>Lead concentration (microgram/dl)</b>	0.924 $\pm$ 1.79		0.570 $\pm$ 0.560		0.480

### The relationship between lead concentration with monthly income and number of family members

We investigated the relationship between lead concentration with monthly income, and number of family members; both variables were statistically significant (P 0.000 for both respectively) (table 3).

Table 3: The relationship between lead concentration with monthly income and number of family members

	First variable		Second variable		P value
	Mean	Standard deviation	Mean	Standard deviation	
Lead concentration (microgram/dl)-	1.82	4.01	325	225	0.000

monthly income (JD)					
Lead concentration (microgram/dl)-no. of family members	1.72	3.87	6.21	4.62	0.000

## Discussion

The present study was conducted to investigate the environmental effects on violent behaviors that may be considered as crimes and place actors in prisons. Anyhow, prisoners are easily accessible compared with other participants in other studies.

The results of our data showed that exposure to lead among study participants either prisoners or in control group is relatively lower than reported in other studies. The blood lead level among prisoners was  $0.924 \pm 1.79$   $\mu\text{g/dl}$ , and this was lower than that of control group  $0.570 \pm 0.560$   $\mu\text{g/dl}$ . No significant variation was observed among prisoners and reference participants ( $P$  0.480). However, it is internationally recognized that low exposure level to lead is still an important topic because lead resulting from automobiles and industrial processes remain in water and soil for years (Stretesky and Lynch, 2001). Other studies have reported higher levels of blood lead levels including Romania, Mexico, and China in which the mean blood lead levels were more than 5  $\mu\text{g/dL}$  (Kordas et al., 2007; Wang et al., 2008; Nicolescu et al., 2010). It is worth to mention that low exposure to lead has to be taken seriously because lead has no biological functions as reported in several studies (Nemsadze et al., 2009; Rosin, 2009; Warniment et al., 2010; Gharaibeh et al., 2014).

Variables within general characteristics of participants did not show any significant variations among participants ( $P > 0.05$ ) except for crowded traffic in which prisoners were more likely to be exposed to lead compared with participants in control group ( $P$  0.038). In light of this context, our findings agree with other studies such as the study of Stretesky and Lynch (2001). Actually, our findings support the environmental hypothesis which has been developed and consistent with the neurotoxicity hypothesis, in which exposure to lead (Pb) impacts neurotransmitter and hormonal systems and accordingly lead to aggressive and violent behavior (Dietrich et al, 2001; Stretesky and Lynch, 2001, 2004).

The present study indicated to significant association between blood lead level of prisoners and each of monthly income and number of family members. Actually, both variables can be understood within the context of economy and by thus it is plausible to think of the consideration that homes may still have lead paints, particularly those homes in low income regions (Stretesky and Lynch, 2001).

## **Conclusion**

Although the study findings showed no significant association between blood lead concentration between prisoners and reference participants, it is observed that prisoners have about double concentration of blood lead and it is highly possible that our findings supported the environmental hypothesis which explained the effects of removal of lead from gasoline in lowering crime rates in US.

## **References:**

- Byers, R. K., & Lord, E. E (1943). Late effects of lead poisoning on mental development. *American Journal of Diseases of Children*, 66, 471–494.
- Cecil KM, Brubaker CJ, Adler CM, Dietrich KN, Altaye M, Egelhoff JC, et al (2008). Decreased brain volume in adults with childhood lead exposure. *PLoS Med*,5:e112. doi:10.1371/journal.pmed.0050112.
- Cecil KM, Dietrich KN, Altaye M, Egelhoff JC, Lindquist DM, Brubaker CJ, et al (2011). Proton magnetic resonance spectroscopy in adults with childhood Lead exposure. *Environ Health Perspect*, 119:403–8. doi:10.1289/ehp. 1002176.
- Dietrich KN, Ris MD, Succop PA, Berger OG, Bornschein RL (2001). Early exposure to lead and juvenile delinquency. *Neurotoxicol Teratol*, 23:511–8.
- Federal Bureau of Investigation. Uniform crime reports: crime in the United States. Washington, DC: Department of Justice; 2010<http://www.fbi.gov/about-us/cjis/ucr/crime-in-the-u.s/2011/preliminary-annual-ucr-jan-jun-2011>.
- Howard W. Mielke, Sammy Zahran (2012). The urban rise and fall of air lead (Pb) and the latent surge and retreat of societal violence. *Environment International* 43, 48–55.
- Hubbs-Tait, L., Nation, J. F., Krebs, N. K., & Bellinger, D. C (2005). Neurotoxicants, micronutrients, and social environments: Individual and combined effects on children's development. *Psychological Science in the Public Interest*, 6, 57–121.
- James K. Goodlad, David K. Marcus, Jessica J. Fulton (2013). Lead and Attention-Deficit/Hyperactivity Disorder (ADHD) symptoms: A meta-analysis. *Clinical Psychology Review* 33, 417–425.
- Jessica Wolpaw Reyes (2007). Environmental policy as social policy? The impact of childhood lead exposure on crime. National bureau of economic research 1050 Massachusetts avenue Cambridge, MA 02138.
- Kordas, K., Casavantes, K. M., Mendoza, C., Lopez, P., Ronquillo, D., Rosado, J. L., et al (2007). The association between lead and micronutrient status, and children's sleep, classroom behavior, and activity. *Archives of Environmental and Occupational Health*, 62, 105–112.

- Nemsadze K, Sanikidze T, Ratiani L, Gabunia L and Sharashenidze T (2009). Mechanisms of lead-induced poisoning. *Georgian Med. News*, 172-173: 92-96.
- Nicolescu, R., Petcu, C., Cordeanu, A., Fabritius, K., Schlumpf, M., Krebs, R., et al (2010). Environmental exposure to lead, but not other neurotoxic metals, relates to core elements of ADHD in Romanian children: Performance and questionnaire data. *Environmental Research*, 110, 476–483. <http://dx.doi.org/10.1016/j.envres.2010.04.002>.
- Olympio KPK, Gonçalves C, Günther WMR, Bechara EJH (2009). Neurotoxicity and aggressiveness triggered by low-level lead in children: a review. *Pan Am J Public Health*, 26:266–75.
- Rick Nevin (2007). Understanding international crime trends: The legacy of preschool lead exposure. *Environmental Research* 104, 315–336.
- Rosin A (2009). The long-term consequences of exposure to lead. *Isr. Med . Assoc. J.*, 11: 689-694.
- Stretesky PB, Lynch MJ (2001). The relationship between lead exposure and homicide. *Arch Pediatr Adolesc Med*,155:379–82.
- Stretesky PB, Lynch MJ (2004). The relationship between lead and crime. *J Health Soc Behav*, 45:214–29.
- U.S. Department of Justice, Office of Justice Programs. National crime victimization survey, criminal victimization. September, Highlights Bureau of Justice Statistics; 2010 <http://www.bjs.gov/content/pub/pdf/cv10.pdf>.
- Wang, H., Chen, X., Yang, B., Ma, F., Wang, S., Tang, M., et al. (2008). Case control study of blood lead levels and attention deficit hyperactivity disorder in Chinese children. *Environmental Health Perspectives*, 116, 1401–1406. <http://dx.doi.org/10.1289/ehp.11400>.
- Warniment C, Tsang K and Galazka SS (2010). Lead poisoning in children. *Am. Fam Physician.*, 81: 751-757.
- Yousef Saleh Khader, Mamoun Abd allah Gharaibeh, Sulaiman Khalid Matarneh (2014). Lead exposure among five distinct occupational groups: comparative study. *Pak. J. Pharm. Sci.*, 27 (1): 39-43.