*International Journal of Basic and Applied Sciences*, 14 (5) (2025) 83-86

International Journal of Basic and Applied Sciences

*Website: www.sciencepubco.com/index.php/IJBAS*
*https://doi.org/10.14419/tk276347*
***Research paper***

# Assessment of The Relationship between Heavy Metals and Oxidative Stress in Municipal Workers in The City of Al-Shatraa

**Ibtihaj Ahmed Kadhim [1 *], Zainab J. Kadhim [2], Azhar Saeed Mohammed [3]**

*[1] Department of Biology Science, College of Education for Girls, Shatrah University, Iraq*
*[2] College of Applied Science, Al-Shatrah University, Iraq*
*[3] Dhi-Qar Health Office, Al-Shatrah General Hospital, Iraq*
**Corresponding author E-mail:Ibthhaj-ahmad80@shu.edu.iq*

*Received: July 15, 2025, Accepted: August 21, 2025, Published: September 4, 2025*

**Abstract**

Background: Exposure to non-essential heavy metals is a major and growing global threat to environmental pollution. Because of its redox, when antioxidant defenses are insufficient to stop the creation and overproduction of reactive oxygen species (ROS), it can result from redox characteristics. Thus, the present study aimed to observe heavy metal levels and oxidant and antioxidant status. And also to evaluate the relationship between them. Methodology: This study was conducted on a group of workers and municipal controls. During the period between 2023 - 2024. This study includes 40 municipal workers and 40 controls. Patients and controls aged 20- 50 years. Serum PB, Hg, NO, and catalase, SOD, Tf, and CP levels were determined. Results: It was noted that the workers' group's serum components (pb, Hg, NO, and CP) significantly increased (P≤0.05) when compared to the control group. It was discovered that the workers' group's serum concentrations of Tf, SOD, and catalase were significantly lower than those of the control group (P≤0.05). The
present study has reported a positive correlation between ( Hg, NO, and CP). While it was found a negative correlation was found between PB ( catalase, SOD, and Tf).

***Keywords***: *municipal workers, heavy metals, oxidants, antioxidants*

## 1. Introduction

Heavy elements are divided into essential and non-essential minerals. Essential nutrients, such as manganese, cobalt, iron, and zinc, are present in trace amounts in the body and play critical roles as cofactors, coenzymes, and/or mediators. However, when humans or organisms are exposed to high levels of these essential minerals, they can become. toxic (Amadi et al., 2019; Iyer et al., 2015). On the other hand, one of the main worldwide issues is environmental pollution and exposure to non-essential heavy metals as lead (Pb), arsenic, cadmium, and mercury. threat and increasing. Some of them are non-essential and have no known benefit to the physiological processes of living organisms, regardless of their environments. (Kim et al., 2017; Lee et al., 2019; Neal, 2015; Shaban et al., 2021). Lead is one of the oldest toxic heavy metals, available in professional and environmental sources. (Kim et al 2015; Bradberry et al 2016; Wani et al 2015) . It enters the body through inhalation, ingestion, or skin contact, and is then distributed to RBCs, as well as mineral and soft tissues. Because biological systems are unable to remove inorganic lead, it builds up to dangerous levels. (Chandrasekaran et al., 2014). People with a high concentration of heavy metals in their bodies are more susceptible to various diseases. Toxicity is divided into types, including neurological diseases, diabetes, cardiovascular diseases, infertility, kidney damage, and cancer. This is due to the interaction of lead and its compounds with the normal functions of organs and body systems. (Wani et al, 2015; Rehman et al, 2018). Most of these minerals have redox properties that contribute to reactive oxygen species (ROS) overproduction and activation. where defensive antioxidants are not sufficient to prevent this from occurring. It has become clear in previous years that excessive production of ROS leads to oxidative damage. A group of studies has shown that exposure to heavy metals is associated with increased oxidative stress. (Killian et al, 2020) Reactive oxygen species (ROS) generation that is excessive, along with an imbalance between oxidants and antioxidants, is known as oxidative stress (OS) (Sies et al., 2017; Hadeel et al., 2018). Endogenous antioxidants are depleted, and oxidation products are produced under stress. They are involved in cellular malfunction, somatic cell death, and damage to cellular macromolecules and structures. (Holbrook and Finkel, 2000); Zaid, and Sayer, 2022). Occupational exposure to lead and mercury has increased oxidative stress in the body, causing the generation of free radicals and the disruption of antioxidant defense mechanisms. This poses a particular concern for municipal workers engaged in activities involving hazardous waste or working in recycling facilities, as they are at an elevated risk of experiencing oxidative stress. Excess exposure to these metals has long-term negative effects on the health of organisms, such as increased risk of cardiovascular diseases, neurological issues, and cancer. this study aimed to estimate the correlation between lead(Pb), mercury (Hg), and oxidative stress among municipal workers,

given the potential health hazards linked to exposure to these heavy metals. Both lead and mercury are toxic substances capable of building up in the body and causing a range of health problems, notably oxidative stress.

## 2. Research gap

Earlier studies have identified the toxicity of heavy metals and their connection to oxidative stress, most of them being carried out on industrial employees, miners, or those based at fuel Stations, and practically nothing on municipal employees. There is limited evidence on how occupational exposures/factors, specific to waste handling and long-term contact with the environment, affect the depletion of antioxidants. In addition, few empirical studies correlate levels of Pb, Hg, and oxidative biomarkers in this group, thus forming a gap in the knowledge of occupation-specific health risks.
Aim: The present study aimed to observe heavy metal levels and oxidant and antioxidant status. And also to evaluate the relationship between them

## 3. Methodology:

This study has been conducted on a group of municipal workers and controls, during the period between 2023 - 2024. This study includes 40 municipal workers and 40 controls. Patients and controls aged 20- 50 years. A quantity of 5 ml is collected from everyone in the two groups (supervisors and employees). The samples were left in the chamber to coagulate. temperature in discarded, empty tubes, then centrifuge the samples for ten minutes at 3,000 x g. After that, separate the serum from the samples and keep them at -20 °C. to measure biochemical parameters, unless used immediately. It was evaluated levels of (Pb, Hg, NO, catalase, SOD, Cp, Tf). The concentration of elements in the blood was determined using an atomic spectrometer, and the blood levels of catalase, SOD, and NO were determined using enzyme-linked immunosorbent assays (ELISA).

### 3.1 Statistical procedures

All measured values of concentrations are analyzed using the statistical program SPSS version 23.0. by using means ± SD to represent the results. All parameters in all groups under study were compared using the independent sample t-test, and the P system values were considered ($P<0.05$).

## 4. Results and Discussion

(Table 1 explains the distribution of age, body mass index, substance use, and duration of exposure among the workers.

**Table 1:** Characteristics of the study participants

| Variable | | Workers n=40 | Controls n=40 | p-value |
|---|---|---|---|---|
| **Age (Years) n (Mean ±SD)** | 20- 30 | 13 (26.25±5.34) | 15(24.57± 6.23) | 0.123 |
| | 31-40 | 15(38.67±7.78 | 12(34.33±6.32) | 0.456 |
| | 41-50 | 12(47.33±9.23) | 13(45.51±8.97) | 0.098 |
| **BMI (Kg/m²) n (Mean ±SD)** | Normal weight | 25(24.34±4.23) | 28(23.98±5.23) | 0.131 |
| | Over weight | 14(28.37±6.78) | 12(26.23±3.34) | 0.008 |
| | Obese | ……. | …….. | ……. |
| **Substance use** | Smoking | 10 | 0 | ….. |
| | Alcohol | 3 | 0 | ……. |
| **Duration of work (years)** | 3 years | 5 | …… | …… |
| | 4-6 | 11 | ……. | |
| | 7-10 | 9 | …….. | |
| | Above 10 years | 15 | …… | |

*n= Number , BMI= Body Mass Index,SD= Standard Deviation*

Table 2 shows the levels of Pb, Hg, and Oxidant-Antioxidant Status in workers and controls. We noticed a substantial rise in the levels of (Pb, Hg, NO, CP) in the workers' blood (study samples) compared to the standard group. While we observed the opposite in serum concentration (catalase, SOD, and Tf) in the workers group in comparison with the controls group. In Table 1, there was a higher proportion of workers aged between 31-40 years (15, 37.5) than their controls (12, 30%). The proportion of workers with normal BMI (25, 62.5%) compared to that of controls (28, 70%) was not significantly different, whereas, overweight workers (14, 35%) category was significantly greater than that of the controls (12, 30%) ($p=0.008$). Only the workers reported smoking (10, 25%) and alcohol (3, 7.5) use. Working for more than 10 years was observed in 15 floor workers (37.5%), meaning exposure to a high risk of working.

**Table 2:** Levels of parameters in employees and controls.

| Parameters | Workers | Controls | p.value |
|---|---|---|---|
| **Pb(µg/mL)** | 0.58±0.12 | 0.19 ± 0.05 | 0.008 |
| **Hg(ng/mL)** | 27.29±5.89 | 12.19± 2.89 | 0.000 |
| **NO (Umol/L)** | 42.63 ±9.58 | 29.87 ± 5.62 | 0.008 |
| **Catalase (pg/ml)** | 38.59±4.78 | 49.68 ± 7.89 | 0.007 |
| **SOD(ng/mL)** | 4.28±1.03 | 6.52 ± 1.67 | 0.008 |
| **Cp** | 3.17±0.92 | 2.62 ± 0.53 | 0.002 |
| **Tf** | 2.49±0.59 | 3.51 ± 0.83 | 0.009 |

Table 3 demonstrates the positive link that exists between lead and (Hg, NO, and CP). Furthermore, there is an inverse relationship between PB (catalase, SOD, and additionally Tf).

**Table 3:** Correlation between PB and other parameters in the present study

| pb with | r | p-value | Result |
|---|---|---|---|
| **Hg** | 0.39 | 0.041 | Increasing relationship |
| **NO** | 0.52 | 0.008 | Increasing relationship |
| **Catalase** | - 0.41 | 0.003 | Increasing relationship |
| **SOD** | - 0.58 | 0.000 | Increasing relationship |
| **Cp** | 0.47 | 0.005 | Increasing relationship |
| **Tf** | -0.40 | 0.009 | Increasing relationship |

In this study, it was investigated the role of heavy metals and their relationship with oxidant-antioxidant Status in municipal workers as shown in Table 1, and. This study has shed light on levels of pb, Hg, oxidant (NO), and antioxidant (catalase, SOD, Cp, and Tf). The results showed a highly significant increase in lead and mercury. These results may be due to not using protective clothing and washing the body after work, which leads to the skin absorbing these elements. Also, there was a significant increase in (NO and Cp). While in Table 3, A significant decrease was found in levels ( catalase, SOD, and Tf). The induced imbalance in antioxidant levels may lead to weakening of the Mechanisms of scavenging free radicals and thus increasing oxidative stress in a group of municipal workers. Oxidative stress results from exposure to the elements and a low level of essential minerals in blood serum. Consequently, the cell's redox state can be changed, destroying essential biomolecules such as DNA, fats, and proteins, as well as some of the liver, kidneys, and central nervous system, among other organs. (Salazar et al,2015; Singh et al, 2018). The element that is thought to be most stable in nature is lead. Lead can come from a variety of environmental sources, and people in general—and municipal workers in particular—are continuously exposed to lead from a variety of sources, including contaminated soil, water, air, and food through inhalation and the food chain. Their bodies end up having elevated levels of lead as a result. It contributes to the oxidative stress response by generating free radicals. Lead poisoning-induced OS is linked to multiple pathophysiological disorders, including oxidative damage to the brain, kidneys, heart, and reproductive organs. (Singh et al, 2018). To prevent this injury, the body has a powerful mechanism and system that uses different substances (antioxidants). We note the dominance of enhanced generation of ROS over intrinsic antioxidant defenses, leading to oxidative stress. It can be defined as a poor balance between free radical production and antioxidant capacity, resulting in increased oxidized products. Damage to cells also results from free radicals and is thought to play a major role in the aging process and in the development of diseases. Antioxidants preserve optimum health and well-being by acting as the body's first line of defense against harm caused by free radicals. As exposure to free radicals increases, the importance of antioxidants is growing. (Safa,2018).

# 5. Discussion

This research raises the importance of a high imbalance between oxidant and antioxidant mergers among municipal employees who are exposed to heavy metals, as shown (Tables 1,2). Workers exhibited significantly elevated concentrations of serum Pb (0.58 +/- 0.12 g/mL) and Hg (27.29 +/- 5.89 ng/mL) in comparison to controls (0.19 +/- 0.05 g/mL, p=0.008 and 12.19 +/- 2.89 ng/mL) and controls (p=0.000). This increase was followed by an increase in oxidative parameters, whereby NO was increased to 42.63 +/ - 9.58 m/L versus 29.87 +/ - 5.62 m/L in controls (p=0.008), and CP increased to 3.17 +/ - 0.92 compared to 2.62 +/ - 0.53 (p=0.002). Antioxidant defenses, in their turn, were lower; catalase reduced to 38.59 4.78 pg/mL against 49.68 7.89 pg/mL (p = 0.007), and SOD dropped to 4.28 1.03 ng/mL in comparison with 6.52 1.67 ng/mL (p = 0.008), and Tf was even lower 2.49 0.59 against 3.51 These results indicate that over time occupational exposure that 37.5 percent of the workers have worked at their places of work over 10 years may also be a factor contributing to oxidative stress. The inverse relations of Pb with catalase (r=-0.41, p=0.003) and Pb with SOD (r=-0.58, p=0.000) show that the accretion of heavy metals directly inhibits the enzymatic antioxidant defenses. These decreases are detrimental to the scavenging of free radicals and make the workers prone to cellular damage. Other comparable cases reported similar losses in catalase and SOD in fuel station employees in Hilla, and the losses of CP and NO, and an increase in antioxidants were reported in chronic smokers. The continuity exerted across occupations reveals that oxidative stress is a universal reaction to continual exposure to heavy metals. These findings confirm the significance of ineffective protective practices during waste collection works and justify special interventions, in particular, the use of protective components, exposure monitoring, and health screening, to reduce the causes of the long-term threats.

## 5.1 Potential Implications

The results of this study indicate that municipal workers have a high level of exposure to heavy metals and oxidative stress, which causes some health risks to such workers. Increased levels of Pb and Hg, along with low levels of antioxidant enzymes, indicate long-term predisposition to cardiovascular, neurological, and Derby diseases. These results underline the necessity of occupational health surveillance, regular monitoring of biomarkers, and more severe adaptation of protection measures, including safety equipment and hygienic behavior. Such findings could be used by policymakers to frame workplace safety policies, and healthcare professionals could adopt early diagnostic measures that ensure heavy metals-related complications are minimally impacted on the occupational group at risk.

### 5.2 Future Direction

Future studies ought to elaborate on this research by involving a larger sample size and in different municipalities to confirm the results. Longitudinal studies aimed at following employees over a longer period would find it easier to bring forth the causal effects of being exposed to heavy metals and the development of the disease. Detailed occupation profiling, taking into consideration specific job activities and exposure frequency, and environmental measurements, would elucidate high-risk activities. Comparing the data of occupational groups or regions might disclose the patterns of exposure and intervention needs. Furthermore, the investigation of protective nutrition strategies and genetic predisposition factors, and enhanced biomarkers could guide strategies aimed at reducing the effects of oxidative stress that impact long-term health outcomes in workers.

## 6. Conclusion

Based on the results, it is concluded that workers have higher levels of (Pb, Hg, NO, and CP) than compared with the group under control ($P<0.05$). We observed a notable decline in the proportions of (catalase, SOD, Tf) in the serum results compared to the control group ($P<0.05$). A positive relationship appeared between PB and (Hg, NO, and CP). Unlike the negative correlation between pb ( catalase, SOD, and Tf).

## References

[1] Amadi, C. N., Offor, S. J., Frazzoli, C., & Orisakwe, O. E. Natural antidotes and management of metal toxicity. Environ. Sci. Pollut. Res. 2019; 26, 18032–18052.
[2] Bradberry, S. M. Metals (cobalt, copper, lead, mercury). Medicine (United Kingdom),2016; 44, 182–184.
[3] Chandrasekaran, V. R. M., Hsu, D. Z. & Liu, M. Y. Beneficial effect of sesame oil on heavy metal toxicity. J. Parenter. Enter. Nutr. 2014;38, 179–185.
[4] Hadeel Rashid Faraj, Adnan Taan and Raid Maallak Hannon. Clinical Study For Serum Lipid Profile And Lipid Peroxidation In Patients With Gallstones In Thi-Qar Governorate – Iraq. Thi-Qar Medical Journal(TQMJ). 2018; Vol.(16).
[5] Kim, J.-H. & Kang, J.-C. Effects of sub-chronic exposure to lead (Pb) and ascorbic acid in juvenile rockfish: Antioxidant responses, MT gene expression, and neurotransmitters. Chemosphere 171, 2017; 520–527 .
[6] Kim, J. H. & Kang, J. C. The lead accumulation and hematological findings in juvenile rock fish Sebastes schlegelii exposed to the dietary lead (II) concentrations. Ecotoxicol. Environ. Saf. 2015; 115, 33–39.
[7] Killian, B.; Yuan, T.-H.; Tsai, C.-H.; Chiu, T.H.T.; Chen, Y.-H.; Chan, C.-C. Emission-related Heavy Metal Associated with Oxidative Stress in Children: Effect of Antioxidant Intake. Int. J. Environ. Res. Public Health, 2010; 17, 3920.
[8] Lee, J.-W. et al. Toxic effects of lead exposure on bioaccumulation, oxidative stress, neurotoxicity, and immune responses in fish: A review. Environ. Toxicol. Pharmacol. 2019; 68, 101–108.
[9] Iyer, S., Sengupta, C. & Velumani, A. Lead toxicity: An overview of prevalence in Indians. Clin. Chim. Acta 2015; 451, 161–164 .
[10] Neal, A. P. Mechanisms of heavy metal neurotoxicity: Lead and manganese. J. Drug Metab. Toxicol 2015;.6.
[11] Rehman, K., Fatima, F., Waheed, I. & Akash, M. S. H. Prevalence of exposure of heavy metals and their impact on health consequences. J. Cell. Biochem. 2018; 119, 157–184.
[12] Shaban, N.Z., Abd El-Kader, S.E., Mogahed, F.A.K. et al. Synergistic protective effect of Beta vulgaris with meso-2,3-dimercaptosuccinic acid against lead-induced neurotoxicity in male rats. Sci Rep , 2021; 11, 252.
[13] Salazar-Lugo R, Lozada U, Rosales M, et al. Heavy metals and its relationships with biomarkers of oxidative stress in chronic smokers. Rev SALUD Ambient. 2015; 15(2): 88–95.
[14] Safa W. Azize. Study of Heavy Metals and their effects on Oxidant / Antioxidant Status in Workers of fuel Station in Hilla city-Iraq.Research J. Pharm. and Tech. 2018, 11(1)
[15] Singh N, Kumar A, Gupta VK, Sharma B. Biochemical and molecular bases of lead-induced toxicity in mammalian systems and possible mitigations. Chem Res Toxicol. 2018; 31(10): 1009–1021.
[16] Wani, A. L., Ara, A. & Usmani, J. A. Lead toxicity: A review. Interdiscip. Toxicol. 8, 55–64 (2015).
[17] zaid, A. k. .; Sayer, S. A. . Association Abnormal Levels of Serum Interleukin-33, Interleukin-23 With Oxidant-Antioxidants Status in Patients With Acute Liver Failure. jsci 2022, 9, 94-99.