Vol.3No.3 (2025)
Journal of Social Signs Review
Print ISSN: 3006-4651
Online ISSN: 3006-466X

Journal of Social Signs Review

Occupational Health Risks of Lead and Cadmium Exposure: Haematological Effects in Automobile Workshop Workers from Northern KP, Pakistan

Wali Rahman
Department of Zoology, Faculty of Chemical and Life Sciences, Abdul Wali Khan University Mardan Pakistan. walirahmanuom@gmail.com
Dr.RuqiyaPervaiz*
Department of Zoology, Faculty of Chemical and Life Sciences, Abdul Wali Khan University Mardan Pakistan. Corresponding Author Email Address: ruqiyapervaiz@gmail.com
Dr.Hotaf HassanMakki
Faculty of Science, Universiti Teknologi Malaysia, Skudai 81310, Johor. Malaysia & Ministry of Education, Riyadh 14811, Saudi Arabia. tafomedo1428@gmail.com
Imran Hussain
Ecology, Ecotoxicology and Odonatology, Department of Zoology
University of Swabi, Swabi, Pakistan. hussain1996imran@gmail.com

Abstract

As ingesting or inhaling several heavy metals presents significant health risks, automobile workshop workers are more prone to this toxicity due to exposure to hazardous chemicals from older vehicles. Therefore, this preliminary study was conducted to determine the serum levels of lead (Pb) and cadmium (Cd) in automobile workshop workers and their effects on their haematological parameters. Blood samples were collected from 30 exposed and 30 control groups after obtaining informed consent. Serum Pb and Cd levels were estimated using graphite furnace atomic absorption spectrometry, while complete blood counts were performed for haematological analysis. A significantly increased mean value of Ld (exposed 10.914±2.48, control 5.79±1.833 P=0.036) was noted in the exposed group. The mean value of Cd (exposed0.393mg/L, control 0.322mg/L,P=0.22)was also higher in the exposed group. Similarly, the exposed group showed a significant increase in WBC (P=0.0024) and decreased Hb level (P=0.0029) compared to the control group. Furthermore, the difference in haematological parameters was more prominent in older people (age group 46-50). The study's findings underscore the urgent need for awareness and intervention in addressing heavy metal exposure in workers, highlighting the potential health risks and the importance of preventive measures.

Keywords: Heavy metals, lead, cadmium, haematological parameters, workplace, exposure, health risk

Journal of Social Signs Review
Print ISSN: 3006-4651
Online ISSN: 3006-466X

Introduction

Heavy metals have an atomic number higher than 20 and about 5 g cm-3elemental density, which is a significant concern. Their high distribution in numerous industrial, municipal, farming, and medical wastes underscores the urgent need foraction to prevent potential effects on the environment and human health. The severity of risks depends on various factors, including the period of exposure, mechanism of exposure, and chemical nature, plus the biology of exposed individuals in terms of genetics, health, nutritional status, etc. lead (Pb), cadmium (Cd), arsenic (As), mercury (Hg), and chromium (Cr) are the most significant concern due to their high cellular toxicity. Even after a brief exposure, this systematic toxicant can damage otherorgans ofthe body away from the siteof exposure. 1.

Although the risk of metal toxicity is common in natural and occupational environments, people working in industries are more prone to its hazardous effects 2. Research on chronic exposure to hazardous chemicals in working environments and their potential impacts on human health is rising, highlighting the crucial need for further investigation and understanding in this field. The importance of continuous research in this area cannot be overstated, as it is the key to developing effective preventive measures and interventions.

Anthropometric activities such as agricultural chemical and fertiliser applications, combustion of electronic devices, tobacco smoking, etc., release these hazardous metals into the atmosphere 3. Inhalation and ingestion of these heavy metals in the workplace account for personal exposure. Ingesting an overdose of these metals disturbs the digestive system 4. Moreover, in severe cases, it causes deadly pulmonary hypertension. Inhaling in high quantity can lead to severe complications such as chronic pneumonitis, alveolar inflammation and, consequently, lung cell dysfunction 5. The leading cause of chronic obstructive pulmonary disease has been known to be related to lungs prolonged exposure to these toxic metals. 6.

In addition to the lungs, prolonged exposure to these heavy metals causes damage to the kidneys and bones7. Human practices play a significant role in the contamination of heavy metals. Industrialisation and urbanisation have increased exposure to Pb, arsenic, aluminium, and mercury. The constant exposure to these non-biodegradable and long-lasting metals poses a perpetual danger to humanity. In developing countries, exposure to heavy metals accounts for 2% of the total health burden, and automobile workshop workers are at higher risk of them. In developed countries such as the United States, about half a million people are

Journal of Social Signs Review
Print ISSN: 3006-4651
Online ISSN: 3006-466X

affected by exposure to heavy metals 8. The most notorious among them is the exposure of Pb and Cd in the workplace environment.

Pb is a hazardous metal that can be present in various everyday items. Exposure to this metal may occur through petrol, tools, faucets, water supply pipes, pewter pitchers, storage batteries, varnishes and paint, and Pb bullets.

Lead exposure can have a wide range of health effects that can be mild and undetectable or may be severe enough to be life-threatening. In case of acute poisoning, it may cause fatigue, arthritis, headache, digestive system disturbance, hypertension, and nephrotic syndrome. Prolonged exposure can cause cognitive impairments, mania, muscular pain, nephrotic dysfunction, and, in extreme cases, death 9.

Lead (Pb) levels below 10 mg/L and cadmium (Cd) levels ranging from 0.03 to 0.12 mg/L are generally considered safe for adults 10. However, serious health issues, including gout, kidney failure, and encephalopathy, are associated with prolonged exposure. Short-term exposure to Pb may cause symptoms like muscle cramps, fatigue, anaemia, peripheral neuropathy, and hormonal imbalances11. Pb and Cd blood concentrations are reliable indicators of recent exposure to these metals 12.

Recent studies have demonstrated that exposure to Pb can lead to modifications in DNA methylation, disruptions in DNA methyltransferase activity, increased oxidative stress, metabolic syndrome, an elevated risk of cancer, and neurotoxic damage. Both children and adults are prone to experience cognitive impairments as a result of Pb exposure 13. Additionally, failure of reproductive organs in both sexes and cardiovascular disease may also be due to PB toxicity 14. Due to increasing awareness of its harmful effects on health, the blood Pbreference value (BLRV) was reduced from 60 μg/dL to 3.5 μg/dL between 1960 and 2021.

The Centers for Disease Control and Prevention set the BLRV at3.5g/dLto protect children from health concerns 15. Similarly, research indicates that Cd exposure can disrupt the protein synthesis pathway, glucose metabolism, and liver enzyme production 16. Although not an essential element for survival, Cd has profound health implications, particularly for the liver, kidneys, and bones. Like Pb, Cdexposure is also associated with oxidative stress and tissue damage 17. It has also been linked to a higher risk of cancer in various organs, a.e. breast, lung, urinary tract, nasopharynx, pancreas, and kidneys. It binds with metallothionein and causes oxidative stress in the tissues of various organs, such as the liver and kidneys. It also accumulates in mitochondria, promotes the formation of reactive oxygen species and causes oxidative stress. Cd exposure is shown to be associated with endocrine impairments such as notably the hypothalamic-pituitary-gonadal axis18.Neurological disorders, particularly loss of memory and impairments in the senses of smell and hearing, are also known to be associated with Cd exposure 18. According to the World Health Organization (WHO) estimates, approximately160 million people globally suffer from work-related disorders annually due to exposure to hazardous toxins 10.

Therefore, the present studyaims to investigate the blood serum Cd and Pb (Pb) levels and their effect on the haematological parameters of blood in occupationally expose dau to mobile workers in Dir Lower, Chakdara, KP, Pakistan. Chakdara is the central city of district Dir Lower, located in the north-western belt of KP province of Pakistan. It is a Gateway to the Malakand division. The elevation is 693m (2272ft). The area is comprised of the mountains of the Hindukushrange. Ithassummer and winter seasons. The temperature ranges from 34.46% to -2.3 from summer to winter, respectively. Geographically, Dir is bordered by Swat in the east, Malakand in the south, Bajaur in the southwest, Afghanistan in the west, and Chitral in the northwest.

Material and Methods

This research was done in Chakdara, the central city in the district Dir Lower. Chakdara is the Gateway to the Malakand division. Before sample collection, different auto shops were visited, and first-hand information was collected.

Thirty (30) automobile personnel (battery, radiator, and electrician), aged 20 to 55, were randomly selected for the exposed group. All individuals were from low socioeconomic status, were non-smokers, had no chronic disease, had no recent history of infection or flu, and had worked for at least two years at automobile workshops. Control participants were 30 healthy individuals (with no history of exposure) from comparable age groups at adjacent businesses in the same locality.

After obtaining the informed consent, each participant filled out the questionnaire comprising basic questions about their age, socioeconomic status, health, tobacco use and timeand duration of work. A trainedperson collected. The peripheral blood from selected people after obtaining written informed consent. The blood samples were added to two EDTA (anticoagulant) tubes immediately after collection and were labelled the same. One EDTA tube was then subjected to Complete Blood Count (CBC) test, while the second EDTA tube was subjected to blood digestion for heavy metals examination. The CBC test was done with a modern blood analyser machine. All the samples (from cases and control) for heavy metal analysis were sent to the Centralised Resource Laboratory at

Journal of Social Signs Review
Print ISSN: 3006-4651
Online ISSN: 3006-466X

the University of Peshawar to detect and quantify heavy metals. Serum Pb and Cd levels were estimated using graphite furnace atomic absorption spectrometry (GFAAS). The mean and standard deviation are calculated. SPSS version 20 was used for data analysis. $P < 0.005$ was considered a statistically significant level.

Results

By comparing the results obtained for both groups, increased Pb and Cd levels of exposed persons were seen. The mean serum value of Pb in the exposed group was 10.914 mg/L, significantly higher than that in the non-exposed group, 5.79 mg/L ($P = 0.036$). Similarly, the mean Cd value of exposed persons was 0.393 mg/L, slightly higher than the control (mean = 0.322 mg/L)($p = 1.22$). Results are shown as mean ± SD (n = 30). (Table 1).

Comparisons of haematological parameters of control and experimental groups also show differences; the Haemoglobin (Hb g/dL) level in the exposed group (14.07 ± 1.710) was significantly lower than in the control (10.52 ± 2.469) ($P=0.0029$). Similarly, there is a significantly lower value of (white blood cells) WBC (10^6/μL) in the exposed group (8.645±5.674) than that of the control(16.798 ±9.670)($p=0.0024$).(Table2).

The most significant difference in haemoglobin was noticed in the age groups 46-50 (14.8g/dL in control and 7.3g/dL in exposed) and 51-55 (control 15.45g/dL, exposed 8.9g/dL). Similarly, the age group 46-50 had the highest average WBC count (10.7×10^3/μL) in the exposed group compared to the control (6.61×10^3/μL) and the lowest value of (red blood cells) RBC count (3.45×10^6/μL) in exposed than control (6.70×10^6/μL). In contrast, the highest difference in the average values of platelets (control 326×10^3/μL, exposed 251×10^3/μL) was notedin the younger men in the age group of 26-30. (Table 3)

Discussion

Heavy metal toxicity is a significant health issue in developing countries,including Pakistan.Pb and Cd are among the most prominent environmental toxins that pose a threat to occupational exposure. Its adverse effects on human health,specifically on the urinary, respiratory, nervous, digestive and reproductive systems, are well established and are widely known for their carcinogenic properties in various organisms. The current study is the first investigation in the district Dir (lower), and the sampling was conducted among people working in automobile workshops in this region of KP. Additionally, thirty age-matched men with no prior history of exposure to heavy metals were recruited as the control group. The levels of P band Cd in the blood serum of the exposed people

Journal of Social Signs Review
Print ISSN: 3006-4651
Online ISSN: 3006-466X

confirmed their exposure. Although the Cd level is not significantly increased in the exposed group, it still has adverse hematological effects.

The mean levels of both Pb and Cd were higher in the exposed group than in the control. These occupationally exposed individuals in this study exhibited notably above the WHO-approved ranges ofPb(0-10 g/dl)andCd(0.03-0.12g/dl) (WHO, 1996). This result was expected as prior research in Gwagwalada, Abuja, Nigeria, revealed that battery recycling, painting, and those working in the automotive industry had higher blood concentrations of these heavy metals 3. Zhouetal. (2016) examined workers at seven manufacturing companies in different parts of Chinaand reported considerably high levels of Pb and Cd in their blood serum, accompanied by dyslipidaemia 19.

The current study also reports a lower level of Hb (7.3 g/dL) in these automobile workers. As shown by Dongre et al. in 2011, Hb levels decrease in automobile workers with increased bloodPb and Cd levels 20. Past research on two bird species, i.e. trumpeter swans and Canada geese, has shown that the MCHC (Mean corpuscular haemoglobin concentration) and haemoglobin concentration dramatically decrease with increasing blood Pb levels 21. Differences in blood parameters are directly or indirectly associated with the structure of damage to the RBC membrane. Therefore, acute and intensive Pb and Cd exposure produce high haematocrit, mean corpuscular volume, and mean corpuscular haemoglobin and a significant decrease in red RBC and MCHC in Tench fish Tinca tinca 22. According to Bakir et al., anaemia is more prevalent in people with severe occupational Pb exposure 23. However, although this study sample had mild to severe Pb poisoning, we did not report any anaemia in our sample.

Pb and Cd also had more significant effects on the WBC count, which was higher in the exposed group than in the non-exposed group. This may be because the exposed group is more exposed to dust and chemical vapours from vehicles without using protective measures and safety tools. Exposure to these hazardous particles causes the body to continuously fight inflammation and infection, which in turn stimulates the release of many WBC; as also revealed by Higuchi et al., heavy metal concentration causes an elevation in WBC count 24.

RBC concentration was also affected by the rise of Pb and Cd levels in the blood of exposed persons. The current examination indicated the decreased concentration of RBC in the exposed group compared to the control, as exposure to these toxic metals decreases the production of globin protein, which in turn decreases the production of RBC. These results parallel those indicated by Mannio et al. on exposure to tobacco smoke, indicating decreased serum RBC count may be because the heavy metals are lethal to erythrocytes and decrease their lifespan by making their membranes more fragile 25.

Heavy metal exposure also decreased the number of platelets in the blood, with the exposure period being inversely proportional to platelet count. However, in the current study, this decrease was not significant. Furthermore, the higherage group (50-55) showed more differences in the haematological parameters in the exposed and control groups in the current study. This maybe due to long-term exposure to heavy metals, significantly affecting body cell deterioration 26.

The study has several limitations, including the small sample size and the limited availability of data on confounding factors, such as dietary habits and secondary exposures. Future research is needed to investigate a large sample size and to address these potential confounding factors in more detail.

Conclusion

The health of automobile workshop workers is at high risk due to exposure to heavy metals. To effectively reduce exposure to heavy metals, it is crucial to implement a combination of administrative, engineering, and personal protective equipment controls in automobile workshops. These controls, which include training workers on safely handling, using, and disposing of Pb and Cd-containing materials, installing ventilation systems, and providing protective gear, must be strictly followed. Equally important is the government's enforcement of comprehensive environmental laws and occupational safety and health legislation, ensuring the safety and well-being of all workers.

List Of Abbreviations Used

Pb - lead. Cd - Cadmium, KP - Khyber Pakhtunkhwa, CBC - Complete blood count,WBC - White blood cells, RBC - Red blood cells. Hb - Haemoglobin, DNA-Deoxy Nucleic Acids. WHO - World Health Organization. BLRV - Blood Lead reference value. EDTA - Ethylenediaminetetraacetic acid, MCHC - Mean corpuscular haemoglobin concentration.

Acknowledgement. The authors would like to acknowledge all the participants for their sincere responses.

Funding.: No funding was received for this study.

Availability of Data

Data and materials used and analysed during the current study are available from the authors upon reasonable request.

IRB Approval

This study proposal was evaluated and Approved by the Advanced Study Research Board (ASRB /Dir/A&R/AWKUM/2022/9396) committee members of Abdul Wali Khan University Mardan, Khyber Pakhtunkhwa, Pakistan. All ethical standards regarding human subject use, informed consent from participants and following the ethical guidelines outlined in the Declaration of Helsinki to protect human rights and welfare are ensured in this study.

Competing Interests

The authors declare that they have no competing interests.

References

1. Tchounwou PB, Yedjou CG, Patlolla AK, Sutton DJ. Heavy metal toxicity and the environment. Molecular, clinical and environmental toxicology: volume 3: environmental toxicology. 2012:133-64.

2. de Burbure C, Buchet JP, Leroyer A, Nisse C, Haguenoer JM, Mutti A, Smerhovský Z, Cikrt M, Trzcinka-Ochocka M, Razniewska G, Jakubowski M. Renal and neurologic effects of cadmium, lead, mercury, and arsenic in children: evidence of early effects and multiple interactions at environmental exposure levels. Environmental health perspectives. 2006 Apr; 114(4):584-90.

3. Alli LA. Blood level of cadmium and lead in occupationally exposed persons in Gwagwalada, Abuja, Nigeria. Interdisciplinary toxicology. 2015 Sep 1;8(3):146-50.

4. Elinder CG, Nordberg M, Palm B, Björk L, Jönsson L. Cadmium, zinc, and copper in rabbit kidney metallothione in—relation to kidney toxicity. Environmental research. 1987 Apr 1;42(2):553-62.

5. Bernard A, Lauwerys R. Cadmium in human population. Experientia. 1984 Feb;40:143-52.

6. Ganguly R, Mathur A, Singh RP. Bioremediation of Heavy Metals from Ecosystem Nanotechnological Perspectives. In Bioremediation of Toxic Metal (loid) s 2022 Nov 30 (pp. 309-330). CRC Press.

7. Ogunfowokan AO, Kaisam JP, Balogun MO, Adelusola KA. Analysis of Cd, Cu, Pb, Zn, Hg and Mn in kidneys and liver from human cadavers–A case study in South Western Nigeria. Toxicological & Environmental Chemistry. 2008 Jul 1;90(4):653-62.

8. U.S Environmental Protection Agency (EPA) [accessed 4 March 2009];Cadmium Compounds. 2006 [Google Scholar]

9. Loh N, Loh HP, Wang LK, Wang MH. Health effects and control of toxic lead in the environment. Natural Resources and Control Processes. 2016:233-84.

10. https://www.who.int/publications/i/item/9241563176

11. Charkiewicz AE, Backstrand JR. Lead toxicity and pollution in Poland. International journal of environmental research and public health. 2020 Jun;17(12):4385.

12. UsudaK,KonoK,OhnishiK,NakayamaS,SugiuraY, KitamuraY, KuritaA, Tsuda Y, Kimura M, Yoshida Y. Toxicological aspects of cadmium andoccupational health activities to prevent workplace exposure in Japan: A narrative review. Toxicology and Industrial health. 2011 Apr;27(3):225-33.

13. Assi MA, Hezmee MN, Sabri MY, Rajion MA. The detrimental effects of lead on human and animal health. Veterinary world. 2016 Jun;9(6):660.

14. Nguyen TH, Won S, Ha MG, Nguyen DD, Kang HY. Bioleaching for environmental remediation of toxic metals and metalloids: A review on soils, sediments, and mine tailings. Chemosphere. 2021 Nov 1;282:131108.

15. Vergara-Murillo F. Biomarkers of chronic exposure to heavy metals in informal workers on the Colombian Caribbean coast (Doctoral dissertation, Universidad de Cartagena).

16. Genchi G, Sinicropi MS, Lauria G, Carocci A, Catalano A. The effects of cadmium toxicity. International journal of environmental research and public health. 2020 Jun; 17(11):3782.

17. Nawrot TS, Staessen JA, Roels HA, Munters E, Cuypers A, Richart T, Ruttens A, Smeets K, Clijsters H, Vangronsveld J. Cadmium exposure in the population: from health risks to strategies of prevention. Biometals. 2010 Oct;23:769-82.

18. Sharma H, Rawal N, Mathew BB. The characteristics, toxicity and effects of cadmium. International journal of nanotechnology and nanoscience. 2015 Jan;3(10):1-9.

19. Zhou T, Li Z, Zhang F, Jiang X, Shi W, Wu L, Christie P. Concentrations of arsenic, cadmium and lead in human hair and typical foods in eleven Chinese cities. Environmental Toxicology and Pharmacology. 2016 Dec 1;48:150-6.

20. Dongre NN, Suryakar AN, Patil AJ, Ambekar JG, Rathi DB. Biochemical effects of lead exposure on systolic & diastolic blood pressure, heme biosynthesis and hematological parameters in automobile workers of north Karnataka (India). Indian Journal of Clinical Biochemistry. 2011 Oct; 26:400-6.

21. Katavolos P, Staempfli S, Sears W, Gancz AY, Smith DA, Bienzle D. The effect of lead poisoning on hematologic and biochemical values in trumpeter swans and Canada geese. Veterinary clinical pathology. 2007 Dec;36(4):341-7.

22. Shah SL. Hematological parameters in tench Tinca tinca after short-term exposure to lead. Journal of Applied Toxicology: An International Journal. 2006 May; 26 (3): 223-8.
23. Baker EL, Landrigan PJ, Barbour AG, Cox DH, Folland DS, Ligo RN, Throckmorton J. Occupational lead poisoning in the United States: clinical and biochemical findings related to blood lead levels. Occupational and Environmental Medicine. 1979 Nov 1; 36 (4):314-22.
24. Higuchi T, Omata F, Tsuchihashi K, Higashioka K, Koyamada R, Okada S. Current cigarette smoking is a reversible cause of elevated white blood cell count: Cross-sectional and longitudinal studies. Preventive medicine reports. 2016 Dec 1;4:417-22.
25. Mannino DM, Albalak R, Grosse S, Repace J. Second-hand smoke exposure and blood lead levels in US children. Epidemiology. 2003 Nov 1;14 (6):719-27.
26. Al Bakheet SA, Attafi IM, Maayah ZH, Abd-Allah AR, Asiri YA, Korashy HM. Effect of long-term human exposure to environmental heavy metals on the expression of detoxification and DNA repair genes. Environmental pollution. 2013 Oct 1; 181:226-32.

Table1: Mean and standard deviation of Pb and Cd in serum of control and exposed groups.

Metals	Concentration (mg/L) Control group (Mean±SD)	Exposed group (Mean±SD)	p-value
Pb	5.79 ± 1.833	10.914 ± 2.485	0.036
Cd	0.322 ± 0.104	0.393 ± 0.0.169	1.22

Table 2: Haematological parameters in automobile workshop workers and control individuals from Dir lower KP-Pakistan

Haematological parameters	Value		P-value
	Control (n=30)	Exposed (n=30)	
Hb(g/dL)	14.07 ± 1.710	10.52 ± 2.469	0.0029
WBC(10^3/μL)	16.798 ± 9.670	8.645 ± 5.674	0.0024
RBC (10^6/μL)	4.889 ± 1.581	4.400 ± 0.591	1.0027
Platelets(10^3/μL)	207.88 ± 60.88	157.40 ± 47.54	0.443

Journal of Social Signs Review
Print ISSN: 3006-4651
Online ISSN: 3006-466X

Table3: The effects of Cd and Ld concentrations on the haematological parameters of control and exposed persons from Chakdara, Dir Lower, KP-Pakistan

Ageinyears	Cd/Pb (Control) mg/L	Cd/Pb (Exposed) mg/L	Hb (Control) (g/dL)	Hb (Exposed) (g/dL)	WBC (Control) 103/µL	WBC (Exposed) 103/µL	RBC (Control) (10^6/µL)	RBC (Exposed) (10^6/µL)	Platelets (Control) 10^3/µL	Platelets (Exposed) 10^3/µL
20-25	0.376/5.248	0.467/10.50	14.32	11	6.58	8.81	4.89	4.68	183.4	182.5
26-30	0.344/6.242	0.445/8.15	14.3	13.75	7.2	9.1	5.01	4.665	326	251
31-35	0.289/4.439	0.409/11.39	14.67	11.3	6.96	9.06	5.6	4.57	230	157.34
36-40	0.354/4.41	0.380/12.22	13.3	11.65	6.43	8.85	5.47	4.47	219	183.75
41-45	0.298/5.78	0.442/9.98	13.7	10.67	5.88	9.78	5.81	4.75	277.33	173.34
46-50	0.214/7.13	0.481/9.11	14.8	7.3	6.61	10.7	6.70	3.45	218	194
51-55	0.215/3.8	0.439/9.12	15.45	8.9	5.71	9.95	4.68	3.6	193.5	185