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Blood lead levels and renal, lipid, and hematological alterations in taxi drivers

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Abstract

Background: Taxi drivers are continuously exposed to traffic-related air pollution, including lead-containing particulate matter, fuel combustion by-products, and other environmental contaminants. Prolonged occupational exposure, together with sedentary work patterns, irregular dietary habits, and chronic work-related stress,

Aim of the study: The present study aimed to evaluated level of lead, hematological parameters, kidney function test, lipid profile in Taxi Drivers and control .

Materials and methods: The study started from January 2026 to May 2026 on study population age ranged from (21 – 60) years old. The study included a total of 60 participants: a control group of 20 individuals, and an experimental group consisting of 40 taxi drivers. The experimental group samples collected from taxi drivers working in Samarra, Salah AL-Din Governorate, Iraq.

Result: The present study demonstrated significant differences in BMI and lipid profile parameters between taxi drivers and healthy controls, (**$p < 0.05$**). Serum triglyceride, total cholesterol, LDL cholesterol, Total Protein and Globulin, urea, uric acid, creatinine, malondialdehyde (MDA), lead(Pb), Erythrocyte Sedimentation Rate (ESR), Packet cell volume(PCV), hemoglobin (Hb), Systolic Blood Pressure (BP) , and Diastolic Blood Pressure (BP) levels were significantly higher in taxi drivers than in controls (**$p < 0.05$**). While non-significant differences in the level of albumin and glutathione level at p- value > 0.05.

Conclusion: The findings of this study revealed that taxi drivers have a potential to induce both hematological and renal alterations. The hematological alterations include increased PCV and Hb.

Keywords: Lead; Taxi Drivers; Lipid Profile; Renal Function; Oxidative Stress

1. Introduction

The physiological integrity of living organisms is at risk due to the presence of xenobiotics in the environment, as these substances can enter biological systems through multiple exposure pathways, including inhalation, ingestion, skin contact, and diffusion[1]. Among other xenobiotics, gasoline is distinguished by its combination of volatile and combustible chemicals, which includes aliphatic, halogenated, and aromatic hydrocarbons. This complex petroleum product is produced from crude oil. Gasoline is a significant source of hazardous pollutants, including benzene, toluene, ethylbenzene, xylene, and heavy metals like lead (Pb)[2].

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The health consequences of exposure to petroleum distillates, particularly those that are contaminated with metals, are severe and require immediate action. The primary elimination pathways are urine excretion and exhalation, while occupational exposure primarily occurs through inhalation and dermal contact[3].

Heavy metals constitute a widespread environmental contaminant that presents significant chronic and acute health risks to both workers and the general populace. The contamination of food products by chemicals and non-essential elements, including heavy metals, is recognized to have numerous harmful effects on the bodies of humans and animals[4].

Heavy metals can disrupt biological functions by displacing vital metals from their designated places. The oxidative degradation of biological macromolecules is predominantly attributed to the binding of metals to DNA and nuclear proteins [5]. Symptoms frequently serve as initial symptoms of contamination, hence aiding in the identification of the contaminant. Symptoms resulting from metal poisoning encompass cognitive deficits in children, dementia in adults, central nervous system illnesses, hepatic diseases, emotional instability, sleeplessness, renal diseases, depression, and visual changes[5, 6].

Pb contact remains an important environmental and occupational health dilemma, particularly in urban centers with heavy traffic congestion and continuous outdoor air pollution. The World Health Organization has stated that Pb exposure can cause prolonged detrimental outcomes in adults, including elevated jeopardy of hypertension, cardiovascular problems, kidney damage, and anemia, indicating that Pb is still a relevant public health anxiety in both environmental and workplace landscapes [7]. A contemporary study by [8] further accentuates the growing concerns of occupational health and safety in various sectors, particularly in high-risk environments such as urban areas . Furthermore, atmospheric air pollution is a major contributor to cardiovascular morbidity and mortality, with the World Health Organization reporting that ischemic heart disease and stroke account for most outdoor air-pollution-related untimely deaths globally [9]. These conditions make urban workers who spend long hours on the road a particularly vulnerable population [7].

Lead (Pb)is a dangerous metal utilized throughout multiple industries. Humans are exposed to Pb through the consumption or inhalation of polluted food, water, soil, air, and other materials [10].Besides the central nervous system, which is among the most seriously compromised organs, Pb permeates soft tissues and detrimentally impacts the kidneys, liver, and hematological, reproductive, and cardiovascular systems [11].An imbalance in the formation and removal of reactive oxygen species (ROS) within tissues and cellular components drives lead-induced oxidative stress, resulting in damage to membranes, DNA, and proteins [12]. Pb induces oxidative stress in cells by affecting their antioxidant defence mechanisms. Pb has been discovered to alter antioxidant activity [13] One of its detrimental effects is the excessive generation of reactive nitrogen and oxygen species [14, 15].Minimal Pb exposure has been linked to atypical behavior, reduced auditory function, neuromuscular degeneration, learning deficits, and impaired cognitive abilities in both experimental animals and humans[11].

2. Materials and methods

2.1. Subject

The study started from January 2026 to May 2026 on study population age ranged from (21 – 60) years old. The study included a total of 60 participants: a control group of 20 individuals, and an experimental group consisting of 40 taxi drivers. The experimental group samples collected from taxi drivers working in Samarra, Salah al-Din Governorate, Iraq.

2.2. Samples collection and hematological parameters

Venous blood samples (10 mL) were collected overnight fasting under aseptic conditions. Using a Sysmex® Automated Hematology Analyser (Sysmex, Europe), one milliliter was transferred into EDTA tubes for the purpose of analysing hematological parameters (hemoglobin and hematocrit). Anemia was defined as a hemoglobin level that was less than 13 g/dL. The biochemical and physiological assay, which involved the measurement of Pb concentration, kidney function tests, oxidative stress biomarkers, lipid profile, and total protein, was conducted with the remaining 9 mL of blood serum, which was centrifuged at 3000 rpm for 5 min, frozen, and stored at -20 °C.

2.3. Biochemical and Physiological parameters

2.3.1. Determination of Pb in serum

In a glass container, 500 µL of blood serum was heated in a microwave for 5 minutes at 160 °C using an autosampler (DISCOVER SP-D, CEM, Bergamo, Italy) to dissolve 69% HNO3 (v/v). Once cooled, the resulting solution was diluted to 10 mL with a solution of HNO3 (v/v) equal to or greater than 2%. This was done to determine the Pb concentration. Microwave plasma optical emission spectrometry (MP-AES 4210, Agilent, Santa Clara, CA, USA) was used to analyse the materials following acid digestion. [16]

*2.3.2. Determination of biochemical param*eters

Total cholesterol, Triglycerides HDL-C, total protein, albumin, urea and creatinine were measured by using the kit that supplied from Biolabo company (France), and it was depend on enzymatic colorimetric method. While the concentration of LDL-C was calculated by the equations [17-22].

2.3.3. Determination of MDA and GSH in serum

The Buege and Aust thiobarbituric acid (TBA) method measured serum MDA levels. Peroxidation reactions are indicated by malondialdehyde, which is produced by polyunsaturated fatty acid breakdown. MDA levels are measured by reacting it with thiobarbituric acid to turn pink [23]. Absorbance was measured at 532 nm. Ellman's method detected reduced glutathione (GSH) [24]. This experiment used 1.0 ml plasma and 0.5 ml Ellman's reagent, which includes 19.8 mg of 5.5-dithiobisnitrobenzoic acid (DTNB) in 100 ml of 0.1% sodium nitrate. Additionally, 3.0 ml of 0.2 M, pH 8.0 phosphate buffer was added. After that, 412 nm light absorption intensity was measured.

2.3.4. Blood pressure measurement and hypertension

Upon arrival, respondents sat for 5 min before measuring. Auscultation (sphygmomanometer and stethoscope, Becton Dickinson, USA) was used three times to measure left upper arm blood pressure according to the American Heart Association technique and recommended average values[25].WHO defines hypertension as systolic blood pressure over 140 mmHg and/or diastolic over 90 mmHg. People receiving antihypertensive medication were also hypertensive[26].

2.4. Statistical analysis

Statistical analysis was conducted utilizing Graph Pad Prism (version 8.0) and SPSS software (version 26.0). Data were presented as mean ± standard deviation (SD). Correlation analysis among variables was conducted utilizing the Pearson correlation coefficient (r). A p-value less than 0.05 was deemed statistically significant.

3. Result

The present study demonstrated significant differences in BMI and lipid profile parameters between taxi drivers and healthy controls (29.30 ± 8.97 vs. 22.82 ± 2.56 kg/m^2, **p < 0.001**). Serum triglyceride levels were significantly higher in taxi drivers than in controls (171.45 ± 37.32 vs. 125.60 ± 17.68 mg/dL, **p = 0.0060**). Similarly, total cholesterol and LDL cholesterol levels were significantly increased in taxi drivers compared with controls (138.23 ± 28.84 vs. 101.90 ± 23.94 mg/dL, **p = 0.0078**; and 141.18 ± 31.77 vs. 100.90 ± 23.58 mg/dL, **p = 0.0062**, respectively). Conversely, HDL cholesterol was significantly lower in taxi drivers than in controls (40.53 ± 5.14 vs. 54.75 ± 8.81 mg/dL, **p = 0.0043**).

Table 1 Comparison of Body Mass Index and Lipid Profile Parameters between Taxi Drivers and Healthy Controls

Variable	**Taxi Drivers (n = 40)**	**Controls (n = 20)**	**p-value**
	Mean ± SD		
BMI kg/m^2	29.30 ± 8.97	22.82 ± 2.56	<0.001
Triglycerides mg/dL	171.45 ± 37.32	125.60 ± 17.68	0.006045
Cholesterol mg/dL	138.23 ± 28.84	101.90 ± 23.94	0.0078

HDL mg/dL	40.53 ± 5.14	54.75 ± 8.81	0.004332
LDL mg/dL	141.18 ± 31.77	100.90 ± 23.58	0.0062

The present study demonstrated increase level of Total Protein and Globulin in taxi drivers (6.24 ± 1.46, 1.69 ± 1.34), as compared with control. At p-value <0.05. While non-significant differences in the level of Albumin level at p-value >0.05

Table 2 Comparison of Total Protein , Albumin and Globulin Parameters between Taxi Drivers and Healthy Controls

Variable	**Taxi Drivers (n = 40)**	**Controls (n = 20)**	**p-value**
	Mean ± SD		p-value
Total Protein g/dL	6.24 ± 1.46	7.04 ± 1.32	<0.001
Albumin g/dL	4.58 ± 0.51	5.43 ± 0.71	0.2928
Globulin g/dL	1.69 ± 1.34	1.61 ± 1.03	<0.001

The present study demonstrated increase level of Urea , Uric Acid and Creatinine in taxi drivers (38.86 ± 13.64, 8.45 ± 1.93. 3.27 ± 1.35), as compared with control. At p-value <0.05.

Table 3 Comparison of kidney function test Parameters between Taxi Drivers and Healthy Controls

variable	**Taxi Drivers (n = 40)**	**Controls (n = 20)**	
	Mean ± SD		p-value
Urea (mg/dL	38.86 ± 13.64	34.16 ± 9.41	<0.001
Uric Acid (mg/dL	8.45 ± 1.93	6.34 ± 1.35	0.0027
Creatinine (mg/dL	3.27 ± 1.35	1.22 ± 0.26	0.0042

The present study demonstrated increase level of MDA, and Pb in taxi drivers (6.59 ± 1.32, 14.35 ± 4.64), as compared with control. At p-value <0.05. While non-significant differences in the level of Glutathione level at p-value >0.05.

Table 4 Comparison of MDA, GSH and Pb Parameters between Taxi Drivers and Healthy Controls

Variable	**Taxi Drivers (n = 40)**	**Controls (n = 20)**	
	Mean ± SD	Mean ± SD	p-value
MDA nmol/mL	6.59 ± 1.32	3.52 ± 0.81	0.0091
Glutathione µmol/L	45.97 ± 8.29	83.80 ± 3.90	0.0035
Pb (BLL) µg/dL	14.35 ± 4.64	3.35 ± 1.64	0.0020

The present study demonstrated increase level of ESR, PCV, Hb, Systolic BP , and Diastolic BP in taxi drivers (14.30 ± 9.38, 46.00 ± 3.76, 14.63 ± 1.27, 135.00 ± 14.85, 83.50 ± 14.42), as compared with control at p-value <0.001.

Table 5 Comparison of hematological and blood pressure Parameters between Taxi Drivers and Healthy Controls

Variable	**Taxi Drivers (n = 40)**	**Controls (n = 20)**	
	Mean ± SD		p-value
ESR mm/hr	14.30 ± 9.38	8.70 ± 8.07	<0.001
PCV%	46.00 ± 3.76	43.70 ± 1.59	<0.001
Hb g/dL	14.63 ± 1.27	14.03 ± 0.34	<0.001
Systolic BP mmHg	135.00 ± 14.85	120.00 ± 15.22	<0.001
Diastolic BP mmHg	83.50 ± 14.42	66.00 ± 10.46	<0.001

4. Discussion

Numerous epidemiological studies across various nations have demonstrated a correlation between specific health issues and exposure to benzene and/or benzene-containing mixtures[13]. The current study revealed that taxi drivers had markedly elevated BMI, triglycerides, total cholesterol, and LDL cholesterol levels, alongside considerably reduced HDL cholesterol concentrations. The findings can be attributed to the sedentary nature of cab driving, extended working hours, occupational stress, and detrimental lifestyle behaviours. The current study concurs with [27, 28], indicating that cab drivers are at an elevated risk of developing metabolic abnormalities due to extended sitting, inadequate physical exercise, poor eating practices, and unpredictable work patterns. Excess body weight is regularly associated with insulin resistance and lipid abnormalities, hence elevating the risk of cardiovascular disease. A study by [29] identified a correlation between the risk of Metabolic Syndrome and the elevated intake of fried foods purchased from street vendors and consumed on-site. This study's findings corroborate a strong association between dyslipidemia and the consumption frequency of hydrogenated fats, fast meals, cheese puffs, and crisps in both urban and rural regions of Iran[30]. Ultimately, the present investigation revealed that abstaining from the intake of fresh fruits heightened the probability of having aberrant HDL-C levels. While we could not delineate the type, color, and quantity of fruit referenced in our research, we could ascribe these notable interactions to the fibers and antioxidants present in fresh fruits and vegetables, which are chemicals demonstrated to reduce metabolic risks[31].

The immune system appears to be a particularly vulnerable target of Pb exposure. At low environmental concentrations, Pb does not inflict overt harm on primary immune cells nor does it lead to deficiencies detectable by standard tests; however, it negatively impacts the control and function of these immune cells [10]. A potential explanation for these findings is prolonged occupational exposure to lead and traffic-associated air pollution. Pb has been demonstrated to provoke oxidative stress and activate inflammatory pathways by enhancing the production of pro-inflammatory cytokines [32].Moreover, IL-6 serves as a principal mediator that promotes the hepatic production of acute-phase proteins during inflammatory responses, while albumin is classified as a negative acute-phase protein, typically remaining stable or diminishing solely under severe inflammatory or hepatic circumstances[33].. Total serum protein quantifies the levels of immunoglobulins. This study corroborates the findings of [34, 35], which reported a substantial reduction in total protein levels among petrol attendants exposed to petroleum vapours. The estimation of total protein holds little therapeutic significance due to the compensatory relationship between the albumin and globulin fractions. Albumin assists in regulating the colloidal osmotic pressure of blood. It comprises 50% of human plasma protein[36].It functions as a molecular taxi by transporting free fatty acids and hormones in plasma. Albumin contains a cysteine residue that increases its ability to neutralise peroxyl radicals [37].

The current investigation revealed markedly elevated blood urea, uric acid, and creatinine levels in taxi drivers. These results may due to early renal function impairment, potentially linked to prolonged work exposure to traffic-related air pollution and heavy metals, including lead. Lead is a recognized nephrotoxic metal that accumulates in the proximal renal tubules, and chronic inflammation, which ultimately results in decreased glomerular filtration and tubular failure[38]. The current study concurs with [39], which shown that kidney function levels were elevated among taxi drivers and linked with inflammation indicators. A recent meta-analysis revealed that adults with elevated blood lead levels exhibited significantly increased blood urea and creatinine, alongside diminished creatinine clearance[40][41]. The current study concurs with [42], which demonstrated significant increases in serum creatinine and blood urea levels in the exposed group, indicating early renal impairment associated with petroleum exposure. A study conducted [43] revealed no significant variations in serum creatinine levels among gasoline station workers.

The current investigation revealed markedly elevated blood Pb and MDA levels in taxi drivers relative to the control group, while GSH levels were dramatically decreased in taxi drivers. The findings indicate that cab drivers experience heightened oxidative stress, likely due to prolonged work exposure to traffic-related air pollution and heavy metals, especially lead. Individuals chronically exposed to lead demonstrate markedly elevated blood lead concentrations and increased MDA levels, indicating heightened lipid peroxidation and oxidative stress[38]. Fenga *et al.* (2015) examined drivers and workers exposed to traffic, finding that prolonged exposure to vehicle emissions heightened oxidative stress biomarkers and heavy metal accumulation. Lead, a significant environmental toxin, enhances the production of ROS, impairs mitochondrial function, and inhibits antioxidant enzymes. As a result, lipid peroxidation is intensified, resulting in elevated levels of MDA, a recognized indicator of oxidative damage to cellular membranes [32]. The findings can be attributed to the diminished protective function of antioxidant enzymes against oxidative stress in taxi drivers, indicating that exposure to PAHs or other factors may account for the reduced activity of endogenous enzymatic antioxidants [44]. Inhaling environmental particles can trigger the production of reactive species, leading to the activation of oxidative pathways. It may facilitate pulmonary inflammatory processes and the secretion of inflammatory markers into the bloodstream. Cell membrane lipids are a significant target of ROS. Consequently, they are susceptible to oxidative assault. Under pro-oxidant conditions, LDL cholesterol may undergo changes, leading to oxidized LDL[39, 45]. A research by [46]revealed significant hematological alterations in exposed workers compared to the control group. The current study concurs with [47], which noted significantly increased hematological indicators, including hematocrit, in cab drivers subjected to extended driving hours. Likewise, [47]indicated that heightened hematocrit levels in cab drivers correlated with an increased cardiovascular risk.

5. Conclusion

The present study demonstrated that taxi drivers had significantly higher blood lead levels than healthy controls, accompanied by dyslipidemia, oxidative stress, impaired renal function, and hematological alterations. These findings suggest that long-term occupational exposure to traffic-related pollutants may adversely affect the health status of taxi drivers. Regular health surveillance, monitoring of blood lead levels, and implementation of occupational preventive measures are recommended to reduce exposure and minimize the risk of chronic health complications.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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