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Impact of Chronic Gasoline Exposure on Blood Parameters and Liver Enzymes in Gasoline Station Workers

Miyada Khazaal Hassan [1]*, Shaimaa Hadi Humadi Al-Dulaimi[2] , Ahmed Attalah Hassan[2] Al-Fhdawi[2]

[1]*Department of Biology, Collage of Science, University of Baghdad, Baghdad, Iraq*
[2] *Al-Karkh First Directorate of Education, Ministry of Education Baghdad, Iraq*

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Abstract

Volatile organic compounds such as gasoline are linked with various deleterious health effects including blood and liver diseases. This study was designed to explore the impact of gasoline on blood parameters and liver enzymes. The study was conducted in Baghdad City from July to December 2023. It included 50 gasoline station workers who had been occupationally exposed to gasoline and 50 healthy, unexposed persons recruited as a control group. A complete blood picture test was conducted using a whole hematology analyzer to indicate white blood cell (WBC) counts, neutrophil, lymphocyte, monocyte, eosinophil, basophil, RBC, platelet counts, hemoglobin, and hematocrit, also the serum level of alkaline phosphatase (ALP), alanine amino transferase (ALT), and aspartate aminotransferase (AST) was determined in gasoline exposed workers and compared with control persons. The results indicated that workers exposed to gasoline showed significantly higher levels ($P \leq 0.05$) of Mean platelet volume (MPV) and Immature granulocytes (IG) compared to unexposed control individuals (11.24 ±0.23 versus 10.50 ±0.24) and (0.029 ±0.01 versus 0.013 ±0.01), respectively. However, there were insignificant differences in serum concentrations of other blood parameters including WBC, RBC, platelet, hemoglobin, and hematocrit between exposed workers and control persons. The serum concentration of ALP (IU/L) was significantly ($P \leq 0.05$) elevated in the gasoline-exposed workers compared with the control persons (24.30 ±3.26versus 17.70 ±2.01). In contrast, there were no significant differences in AST and ALP enzymes between gasoline-exposed workers and control persons. This study confirms that blood parameters and liver enzymes are useful bioassays that should be used to detect early impacts of gasoline exposure.

Keywords: Gasoline exposure, Gasoline station workers, Blood parameters, Liver enzyme.

تأثير التعرض المزمن للكازولين على مؤشرات الدم وأنزيمات الكبد لدى عمال محطات البنزين

ميادة خزعل حسن[1]* , شيماء هادي حمادي الدليمي[2], احمد عطاالله حسن الفهداوي[2]

[1] قسم علوم الحياة, كلية العلوم, جامعة بغداد ,بغداد, العراق

***Email:** miyada.k.765@sc.uobaghdad.edu.iq

[2] الكرخ مديرية التربية الأولى, وزارة التربية, بغداد, العراق

الخلاصة

ترتبط المركبات العضوية المتطايرة مثل البنزين بالعديد من التأثيرات الضارة على الصحة بما في ذلك أمراض الدم والكبد. تم تصميم هذه الدراسة لبيان تأثير البنزين على مؤشرات الدم وأنزيمات الكبد. أجريت الدراسة في مدينة بغداد في الفترة من تموز إلى كانون الاول 2023، وشملت 50 عاملاً في محطات بنزين تعرضوا للبنزين في العمل و 50 شخصًا سليمًا غير معرضين للبنزين كمجموعة سيطرة. تم إجراء اختبار صورة الدم الكاملة باستخدام محلل أمراض الدم الكامل للإشارة إلى عدد خلايا الدم البيضاء والعدلات واللمفاويات والوحيدات والحمضات والقاعدية وخلايا الدم الحمراء وعدد الصفائح الدموية والهيموجلوبين والهيماتوكريت ، كما تم تحديد مستوى الفوسفاتيز القلوي(ALP)) وألانين أمينو ترانسفيراز(ALT)) وأسبارتات أمينو ترانسفيراز (AST)في العمال المعرضين للبنزين ومقارنتهم مع السيطرة. أشارت النتائج إلى أن العمال المعرضين للبنزين أظهروا مستويات أعلى بكثير ($P \leq 0.05$) من متوسط حجم الصفائح الدموية MPV والكريات المحببة غير الناضجة GI مقارنة بالأفراد غير المعرضين (11.24 ± 0.23 مقابل 10.50 ± 0.24) و (0.029 ± 0.01 مقابل 0.013 ± 0.01) على التوالي. ومع ذلك لا توجد فروق معنوية في مستوى مصل مؤشرات الدم الأخرى بما في ذلك خلايا الدم البيضاء وخلايا الدم الحمراء والصفائح الدموية والهيموجلوبين والهيماتوكريت بين العمال المعرضين السيطرة. كان تركيز مصل الفوسفاتيز القلوي (IU / L) مرتفعًا بشكل ملحوظ ($P \leq 0.05$) في العمال المعرضين للبنزين مقارنة بالسيطرة (24.30 ± 3.26 مقابل 17.70 ± 2.01). في المقابل لا توجد فروق ذات دلالة إحصائية في إنزيمات AST و ALP بين العمال المعرضين للبنزين والسيطرة. تؤكد هذه الدراسة أن مؤشرات الدم وإنزيمات الكبد هي اختبارات حيوية مفيدة يجب استخدامها للكشف عن التأثيرات المبكرة للتعرض للبنزين.

1. Introduction

Gasoline is an industrial solvent chemical and environmental pollutant that may cause chronic gasoline poisoning among gasoline station workers. This aromatic hydrocarbon is widely used in many manufacturing industries. Despite its widespread use, gasoline poses a significant risk due to its carcinogenicity and toxic effect on multiple organ systems. It was shown to induce hematotoxicity in humans and many studies have reported hematological impacts at different gasoline concentrations including those <1 p.p.m. in the air [1, 2].

The International Agency for Research on Cancer (ARC) considered gasoline as a group 1 carcinogen, indicating much evidence of its carcinogenicity in humans [3]. Many hematological malignancies have been attributed to chronic gasoline exposure, such as leukemia and lymphoma. Gasoline has also been linked to non-cancerous blood syndromes, highlighting its toxic effects on the blood [4].

Hematotoxicity refers to the ability of hazardous materials to damage the normal functioning of the blood-forming organs, especially bone marrow where hematopoiesis occurs. Gasoline exposure can lead to bone marrow suppression, causing lowered production of blood cells, including erythrocyte, leucocyte, and platelets [5]. As a result, individuals exposed to gasoline may develop anemia, leukopenia, and thrombocytopenia after more than two days of occupational exposure to more than 60 ppm of gasoline, making them more susceptible to infections, bleeding disorders, and other complications [6].

The mechanisms underlying chemical blood poisoning by multiple modes of action. Gasoline is metabolized to reactive intermediates in the body, like gasoline oxide and phenol that cause an imbalance between reactive oxygen species (ROS) and gasoline intermediates which may lead to oxidative stress, DNA damage and inflammation, resulting in programmed

cell death or aberrant cell proliferation, finally leading to the development of hematological malignancies [5]. In addition, the results of other researchers indicated that workers who were directly exposed to gasoline have increased chromosomal damage levels and promote carcinogenesis risk [7,8].

Gasoline is also known to cause liver damage. One of the most important functions of the liver is metabolizing, detoxifying, and eliminating almost all hazardous materials from the body including gasoline and its metabolites. However, chronic exposure to gasoline can overwhelm the liver's ability to detoxify, causing the accumulation of reactive intermediates and oxidative stress [9].

Elevated amounts of liver enzymes alanine aminotransferase (ALT) and aspartate aminotransferase (AST) are mostly by releasing these enzymes from the liver cytosol into the blood, which refers to cellular degeneration or destruction in liver cells causing liver injury and inflammation. Gasoline exposure has been linked with increased levels of ALT and AST in the blood, revealing damage to liver cells [10].

A histological study, in the liver tissue of animals exposed to gasoline, has indicated focal necrosis and hypertrophy, cloudy swelling of hepatocytes, inflammation, and fatty acid alterations, further confirming its toxic effects on the liver [11].

Chronic exposure to gasoline is linked with many chemicals influencing blood and liver and increasing the risk of cancer [12, 13]. Therefore, a comprehensive knowledge of the health impacts of gasoline exposure is necessary for developing methods for risk assessment in those affected communities. The aim of this research is to explore the intricate relationship between gasoline exposure and its impact on blood parameters and liver enzymes AST, ALP and ALT delving into the underlying mechanisms and implications for human health.

2. Materials and methods

Ethics approval: This study was approved by the Ethical Committee, Department of Biology, College of Science, University of Bagdad and the Iraqi Ministry of Health, Baghdad, Iraq under the reference number CSEC/0322/0039 on March 15, 2022.

Firstly, 150 gasoline station male workers with an age range of 22-50 years old in Baghdad City in the period from July to September 2023 were recruited and then excluded: a) workers who have worked in the gasoline station for less than a year; b) workers with cancer, blood and immune diseases; c) workers who have taken medication within the past two weeks; d) workers who have undergone an X-ray examination during the previous month; and e) smoker workers. Finally, a total of 50 gasoline station workers were examined in this study [9]. The control included 50 healthy, unexposed persons with an age range of 22-50 years old.

2.1. Blood parameters

Five ml of venous blood samples were obtained from each worker and control. For determination of blood parameters, 2 ml of venous blood was transferred into anticoagulated tubes (EDTA)- from each worker. An automatic hematology analyzer (Sysmex, Japan) was used to determine hematologic parameters in blood samples including (WBC, neutrophil, lymphocyte, monocyte, eosinophil, basophil, red blood cells RBC, HGB, HCT, PLT, MCV, MCH, MCHC, RDW-SD, RDW-CV, PDW, P-LCR and PCT). Within two hours, these hematologic parameters were examined, and each sample was evaluated in duplicate. A rate amount of these various biochemical parameters was calculated in the statistical analyses [9].

2.2. Liver enzymes

For determination of liver enzymes including (alkaline phosphatase ALP, alanine amino transferase ALT, and aspartate amino transferase AST), the remaining 3 ml of venous blood

samples were stored in a gel tube and left at room temperature for 10 minutes to form the serum. After the centrifugation for 10 minutes at 3000 rpm, the serum was gathered and used to measure liver enzymes for 12 hours of collection [14].

2.3. Statistical Analysis

The program Statistical Analysis System [15] was applied to calculate the impacts of different factors (Comparison between exposure and non-exposure) in study blood samples. It was used T-test to significantly compare the means in this study.

3. Result and discussion

3.1. Blood parameters determination

A total of 50 male workers and 50 male controls (non-gasoline exposure persons) were respondent in this study. The hematologic parameters between workers are illustrated in Table 1. No significant differences were found in level of WBC, Neutrophil, Lymphocyte, Monocyte, Eosinophil, Basophil, red blood cells RBC, HGB, HCT, PLT, MCV, MCH, MCHC, RDW-SD, RDW-CV, PDW, P-LCR and PCT, between controls and exposed workers, while MPV and IG were significantly elevated in exposed workers than non-exposed persons ($P \leq 0.05$).

Table 1: Comparison between exposure workers and non-exposure persons in CBC parameters

Parameters	Mean ± SE		T-test	P-value	Normal ranges
	Exposure	Non-exposure			
WBC (10^9/L)	7.07 ± 0.31	7.36 ± 0.80	1.801 NS	0.737	4-11
Neutrophil (10^9/L)	3.94 ± 0.33	3.81 ± 0.49	1.257 NS	0.824	2.0 - 7.5
Lymphocyte (10^9/L)	2.52 ± 0.21	1.91 ± 0.26	0.718 NS	0.0934	1.0- 3.7
Monocyte (10^9/L)	0.579 ± 0.07	0.566 ± 0.06	0.199 NS	0.892	0.00-0.7
Eosinophil (10^9/L)	0.256 ± 0.05	0.194 ± 0.07	0.188 NS	0.497	0.00-0.4
Basophil (10^9/L)	0.043 ± 0.01	0.040 ± 0.01	0.018 NS	0.730	0.00-0.1
RBC (10^12/L)	5.18 ± 0.10	5.07 ± 0.11	0.323 NS	0.483	2.50 -5.50
HGB (g/dL)	15.61 ± 0.20	14.91 ± 0.34	0.828 NS	0.928	12.0 -16.0
HCT (%)	44.68 ± 0.64	43.71 ± 1.49	3.415 NS	0.558	36.7 – 52.3
PLT(10^9/L)	279.40 ± 23.45	274 ± 20.97	66.116 NS	0.865	50- 400
MCV (fL)	86.56 ± 1.60	84.75 ± 2.49	6.225 NS	0.548	86-110
MCH (pg)	30.20 ± 0.52	29.51 ± 0.95	2.284 NS	0.533	26-38
MCHC (g/dL)	34.89 ± 0.52	34.83 ± 0.48	1.490 NS	0.934	31.0- 37.0
RDW-SD (fL)	39.99 ± 0.87	40.86 ± 0.95	2.706 NS	0.508	37.0- 54.0
RDW-CV (%)	12.60 ± 0.27	13.21 ± 0.44	1.098 NS	0.258	11.0- 16.0
PDW (fL)	14.31 ±0.62	14.15 ± 0.63	1.868 NS	0.859	9.6- 17.0
MPV (fL)	11.24 ± 0.23	10.50 ± 0.24	0.722*	0.0452	9- 13
P-LCR (%)	36.03 ± 2.16	31.77 ± 1.87	6.026 NS	0.154	13.0- 43.0
PCT (%)	0.312 ± 0.02	0.288 ± 0.02	0.069 NS	0.471	0.17- 0.35
IG (10^9/L)	0.029 ± 0.01	0.013 ± 0.01	0.0152 *	0.040	0.00-7.00
*: ($P \leq 0.05$), NS: Non-significant					

The results indicated that gasoline exposure could stimulate alterations in some blood parameters in gasoline-exposure workers, including MPV and IG, which significantly

elevated gasoline-exposed workers in comparison with control. While the study has showed the blood cell counts, including red blood cells, white blood cells and neutrophils, raised in exposed workers but remained within normal ranges, and no significant differences appeared in the parameters (lymph., PLT, RDW-SD, RDW-CV, MCH, MCHC, P-LCR, MCV, WBC, PCT) among gasoline exposure and control persons. This study agrees with Shnaa and Magtooph, [16] who found no significant differences in (lymphocyte, PLT, MCH, MCHC, MCV, and WBC) between gasoline station workers of Nasiriyah city and unexposed persons. A former study carried out in Babil Province / Iraq agrees with the current study, which designed to examine the blood picture and indicate the potential impacts of gasoline exposure on workers at gasoline stations and contrast them with office un-exposed individuals [17].

The study of Mahmood and Omer disagrees with the current results. It included two groups, one group was exposed to gasoline fume for a period (3-4) years, and the other group was exposed for a period (8-10) years. They revealed elevation in MCHC, MCH, NUT, WBC, PLT and MCV to the second group [18].
Another study by Kebamo *et al.,* was inconsistent with this study. The results of RBC, hemoglobin, and hematocrit in workers at gasoline stations appeared to have significantly decreased in contrast with those of unexposed persons [19].

The results of [14] indicated that the erythrocyte count, hemoglobin, and hematocrit (HCT) were significantly decreased in gasoline station workers compared to the un-exposed group. The other blood image parameters revealed statistically insignificant differences between gasoline-exposed workers and control groups.

The reduction in the count of hemoglobin and RBC may be due to the impact of the end products of gasoline metabolisms and free radicals that shorten the life of red blood cells [19]. These free radicals may interact with the red blood cell membrane and the synthesis of heme protein in bone marrow [20]. In addition, the alteration in these results may be due to the toxic effect of gasoline on the blood, which causes a weakness in a hemopoietic system with inhibition in bone marrow resulting in pancytopenia [21].

The current results revealed elevated levels of MPV and IG. The raised MPV may refer to myelosis, and some researchers assume that circulating MPV concentration may reflect a substitute for the diagnostic measurement of bone marrow megakaryocytes [22]. High IG counts suggest an inflammation in the circulatory and respiratory systems (heart and lungs, which circulate blood and oxygen) or may point to a bone marrow condition [23].

In the current study, the statistical results revealed no significant differences in most blood parameters. This may be because the period of exposure to gasoline was not sufficient to affect those parameters, The standard of workplace exposure to gasoline is:- eight-hour time-weighted average (TWA) of 1 ppm (3.2 mg/m3), or may be due to the individual immune system, age group, life style and diet.

3.2. Liver enzymes determination

Alkaline phosphatase (ALP), alanine aminotransferase (ALT), and aspartate aminotransferase (AST) are biomarkers of liver function. There was a difference in the amount of ALP, ALT and AST concentrations for each person which can be caused by many factors. ALP, ALT and AST examinations were conducted at the laboratory. Based on the results in Table 2, the laboratory tests with blood samples showed no significant differences in the levels of ALP

and AST between exposed and non-exposed persons. However, the results also showed that ALT levels exceeded the normal limit and there was a significant difference between gasoline-exposure workers and control persons.

Table 2: Comparison between exposure workers and non-exposure persons in liver enzymes

Parameters	Mean ± SE		T-test	P-value	Normal ranges
	Exposure	Non-exposure			
ALP (IU/L)	83.20 ± 6.63	73.50 ± 4.57	16.935 NS	0.244	40- 150
ALT(IU/L)	24.30 ± 3.26	17.70 ± 2.01	6.034*	0.049	1-55
AST (IU/L)	23.70 ± 2.32	20.20 ± 1.80	6.191 NS	0.250	5-34
*: (P≤ 0.05), NS: Non-significant					

The impacts of acute and chronic exposure to gasoline could be determined by examining the enzymatic changes in many organs particularly the liver. Gasoline has formerly been shown to affect liver function [24]. Therefore, liver function was assessed by determining the enzymatic concentration of ALP, AST and ALT in workers' serum and control individuals. The data showed that serum ALT concentrations were elevated in workers exposed to gasoline compared to the control group. Many other researchers have reported increased liver enzymes in the serum of people exposed to oil products, gasoline and organic solvents [11]. Another researcher showed that gasoline intoxication raised liver enzymes [10].

In the current data, alterations in liver enzymes ALT were revealed in the gasoline-exposed group which is in agreement with previous reports [25]. In contrast, another study mentioned that the liver enzyme ALT, AST, and ALP were higher in exposed workers [26].

The results in Table 2 also agreed with the results of Abou-ElWafa *et al.,* [14], as they found a statistically nonsignificant difference in liver enzyme AST among petroleum station workers and control groups, but for ALT, it was significantly raised in exposed workers.

The elevated levels of liver enzymes in the serum may be attributed to excessive production or the leaving of enzymes from liver cells caused by the stimuli of hepatocyte damage or cell death [1].

The toxicity of gasoline may due to the action of reactive oxygen species (ROS), which can cause cell disorder. Free radicals overcome antioxidants, exerting harmful and lethal cellular effects by oxidizing DNA, membrane phospholipids, proteins, and cellular enzymes, thereby halting cellular respiration [27]. Therefore, it can be supposed that inhalation the gasoline results in their aggregation in liver tissue, which finally results in membrane lipid oxidation [28]. Oxidative stress and reduced endogenous antioxidants result in the release of liver enzymes AST, ALT, and ALP. As the ROS plays a main role in the toxicity of the liver, it was used to determine the impacts of antioxidants on liver enzymes [29].

4. Conclusion

This study revealed that some blood parameters and liver enzymes are altered in gasoline station workers compared to unexposed persons. These alterations involve increased MPV, GI and the liver enzyme ALT in gasoline station workers compared to the unexposed control group. It can be concluded that there might be a relationship between exposure to gasoline fumes and alteration in blood parameters and liver enzyme levels. Medical examinations, including pre-employment and periodic physical assessments of blood profiles and liver

enzyme levels should be implemented to detect early changes before chronic conditions develop. More prospective, long-term investigations with larger sample sizes of gasoline workers are required to obtain a clearer understanding and definitive picture of long-term impacts.

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Conflict of Interest:

"The authors state that they have no disagreements of interest."

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