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The effect of working in fuel stations on some biochemical variables

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Abstract
This study researches the physiological and biochemical effects of long-term work with fuel-related pollutants among the personnel of filling stations at Mosul with gasoline. This goal will be realized through the investigation of important biomarkers, such as liver enzymes (ALT, AST), serum albumin, creatinine, and lead levels, which will help evaluate the presence of a toxicological burden at an early stage. The sample consisted of 100 exposed workers which were divided on intervals of daily shift (18-hours and 8-hours), and contrasted with 30 non-exposed (healthy, non-smoking male) subjects. Quantification of enzymatic activity and biochemical levels was performed upon blood serum samples with the help of validated colorimetric assays. Duncan multiple range test was applied to predict the statistical significance at P 0.05. The findings indicated a remarkable increase in the level of ALT, albumin, creatinine and lead in the serum of exposed, workers than in the controls. Although the level of AST also went up, it did not reveal any statistically significant difference. A dose-dependency pattern was observed between the work periods and toxic biomarkers.
The main goal of the study was to see whether being near fuel filling stations affected the health of employees in this sector in the city of Mosul. This study measured certain variables that indicate the impact on the functions of some important organs in the human body.

Keywords: Fuel stations, blood serum, creatinine, workers

Introduction

Exposure to fuel vapors occupational is a serious health hazard especially in the aviation industry and the automobile industry. Individuals who work at fuel stations and in the armed forces are susceptible to volatile organic compounds (VOCs) such as benzene, toluene and xylene, which will cause diverse diseases (Yassin *et al*., 2024) [19].

Gasoline station consists of shops that sell liquid fuels (derived out of petroleum and alcohol and other automotive fuels and they have equipment that help in measuring of fuel and to store them). Such abatement is a process, which is linked to gasoline distribution and may be a significant emitter of volatile organic compounds (VOCs) (Geraldino *et al*., 2021) [8].

Science says that, petroleum is a carbon-based resource which is composed of a complex mix of hydrocarbon molecules also contains trace quantity of compounds like metals, oxygen, nitrogen and sulfur (Speight, 2016) [17] The complex mixture of hydrocarbons also includes paraffin, naphthenic, olefin and aromatic hydrocarbons. (Abdulameer & Hussein, 2023) [1].

Petrol has between 54 and 56 percent paraffin and isoparaffins (alkanes C 4 to C 12), 36-40 percent aromatics (mainly benzene, toluene, ethylbenzene and xylene), 6 percent olefins or alkenes), hitherto 5 percent naphthenic hydrocarbons or saturated cyclic hydrocarbons, and 1 percent other material. (Rahimi Moghadam *et al*., 2020) [14].

The highly dangerous aromatic petrol components are BTEX (Benzene, Toluene, Ethylene, and Xylene) (Abdulameer & Hussein, 2023) [1]. BTEX has been adopted as the method of assessing health consequences of gasoline exposure given that BTEX has been used as a proxy measure to quantify exposure to the whole fuel (Rahimi Moghadam *et al*., 2020) [14].

Benzene presents a great toxicological relevance because of high health hazard as it has been classified as Group 1 carcinogen by the International Agency of Research on Cancer (IARC) and it has no safe exposure concentration establishedthat benzene exposure, even less than the occupational limit (1 ppm), has health effects and exposures to it led to hematological and genotoxic effects and is highly linked with cancer in the body including chronic myeloid leukemia and lung cancer. In addition, despite absence of evidence of risks to cancer in toluene, ethylbenzene and xylene, workers exposed to BTEX chronically have exhibited adverse effects that have ranged in the form of fatigue, headache, dizziness, nasal congestion, runny nose, chest pain, epistaxis, anemia, muscle weakness, drowsiness, tight chest, tachycardia, petechiae and unconsciousness (Mendes *et al*., 2024) [12].

The toxicological studies show that the lightchain volatile compounds (benzene, toluene, ethylbenzene, and xylene (BTEX)) are the toxic compounds most toxic to the human being. They are the troublesome components of gasoline which are slowly evaporated to the air and which they may be in the vapor phase as well as in the water-soluble fraction because of their high-water solubility and vapor pressure (Ekpenyong & Asuquo, 2017) [7].

This research will be conducted to establish the effect of long-term exposure to fuel related pollutants e.g. volatile organic compounds (VOCs) and particulate matter on some biochemical and hematological parameters in fuel station workers. Through evaluation of parameters such as hemoglobin concentration, blood gases, enzymatic activity, and oxidative stress marker, the study aims at revealing manifestations of initial physiological disturbance that can steer to the long-term hazard to health. Findings will contribute in setting occupational safety standards and developing possible bio markers of exposure-related toxicity.

Materials and Methods

Sample Collection.

One hundred blood samples were collected from workers at fuel stations located on both the right and left sides of Mosul, according to Appendix 3-2 of the questionnaire. The samples were divided based on exposure to pollutants emitted during the fueling process into:

1. Exposed
2. Not Exposed

The samples were also divided based on the number of working hours into

Group 1 (18 hours)

Group 2 (8 hours)

The samples were compared to samples taken from 30 people who did not smoke or have any health issues to serve as controls. 5 ml of blood was collected from each participant, making sure to avoid blood samples that might have been hemolyzed and could result in false positive results. The last few milliliters of blood were added to Jell tubes that had tight, dry caps and no added anticoagulant. The tubes were stored at room temperature for 20 minutes and then the blood was separated by centrifuging the tubes for 15 minutes at 3000 rpm to get the blood serum. It was drawn using a micropipette, divided into parts and placed in dry, sterile plastic Eppendorf tubes. The serum was stored in a deep freezer at -20 °C until all the tests required in the current study were performed.

Measurement of Alanine Aminotransferase (ALT) levels

The activity of Alanine Aminotransferase (ALT) was measured using the colorimetric method used by Reitman and Frankel (1957) [15] using a ready-made analysis kit from the French company BioMerieux.

Basic Principle

One of the functions of this enzyme is that ALT in serum converts the amino acid alanine to pyruvate. ALT catalyzes the transamination of amino groups from the amino acid according to the following equation:

$$\text{L-Aspartate} + \alpha\text{-Oxaloglutarate} \xrightarrow[37°c]{AST} \text{Oxaloacetate} + \text{L-Glutamate}$$

The activity of this enzyme was determined in IU/L based on the standard curve of the ready-made analysis kit used to measure ALT activity. 3- Determination of Aspartate Aminotransferase (AST) Activity (E.C.2.6.1.1)

Measurement of Aspartate Aminotransferase (AST) Activity

Aspartate Aminotransferase (AST) activity was measured using a ready-made assay kit from the French company BioMerieux, based on the colorimetric method used by (Reithman and Frankel, 1957).

Basic Principle

The function of this enzyme is that the AST enzyme in serum converts the amino acid aspartate to oxaloacetate according to the following equation:

$$\text{L-Aspartate} + \alpha\text{-Oxaloglutarate} \xrightarrow[37°c]{AST} \text{Oxaloacetate} + \text{L-Glutamate}$$

The activity of this enzyme was determined in international units per liter based on the standard curve of the ready-made assay kit used to measure the AST enzyme.

Estimating Creatinine Concentration

The serum creatinine concentration was estimated using the Jaff method used by the researcher (Tietz, 1999) [18], using a ready-made analysis kit from the French company BioMerieux.

Basic Principle

Creatinine reacts with alkaline picrate to form a red complex of creatinine picrate. Serum contains proteins, and these proteins interact with this complex. The absorbance was determined at a 490 nm wavelength by using an ultraviolet-visible spectrophotometer.

Estimating Albumin Concentration

The serum albumin concentration was estimated using the colorimetric method, the Bromocresol green method, using a ready-made analysis kit from the French company Biolabo (Jennifer and Findar, 1982) [10].

Basic Principle

This method relies on estimating the concentration of albumin bound to the reagent 5, 5, 3, 3-tetrabromocresol green in a medium at pH 2.4. A green-colored bromocresol-albumin complex is formed. The intensity of the complex's color is directly proportional to the albumin concentration in the serum. The absorbance intensity was measured at a wavelength of 630 nm.

Estimating Creatinine Concentration

The serum creatinine concentration was estimated using the Jaff method used by the researcher (Tietz, 1999) [18], using a ready-made analysis kit from BioMerieux, France.

Basic Principle

Creatinine reacts with alkaline picrate to form a red-colored complex of creatinine picrate. Serum contains proteins, and these proteins interact with this complex. The absorbance was measured at a wavelength of 490 nm using an ultraviolet-visible spectrophotometer.

Statistical Analysis

Data analysis was conducted using a completely randomized design (C.R.D.). The different groups studied were identified by alphabetical order using Duncan's multiple range test at a probability level of ($P \leq 0.05$) (Kirkwood and Sterne, 1988) [11].

Results

Alanine aminotransferase (ALT) activity

The results in Figure (1) showed a significant increase in alanine aminotransferase activity, with the highest increase in the total blood of individuals exposed to the gases emitted from these power plants compared to the control group. Regarding working hours, the highest increase was during the 18-hour work period (21.84), and the lowest concentration was during the 8-hour work period (21.7).

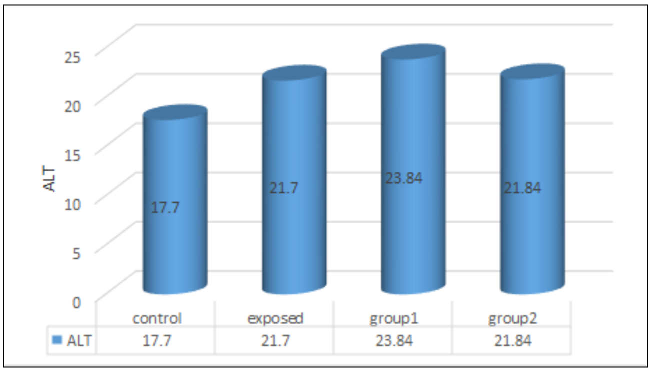

Fig 1: Alanine aminotransferase activity (U/L) in the serum of the studied groups

2- Aspartate aminotransferase (AST) activity

The results in Figure (2) showed a non-significant increase in aspartate aminotransferase activity, with the highest increase in the total blood of individuals (19.54), a 42% increase compared to the control group. As for working hours, the highest increase occurred during the 18-hour work period, at 17.38, representing 26% of the total workday, and the lowest was during the 8-hour work period, at 16.98, representing 23% of the total workday.

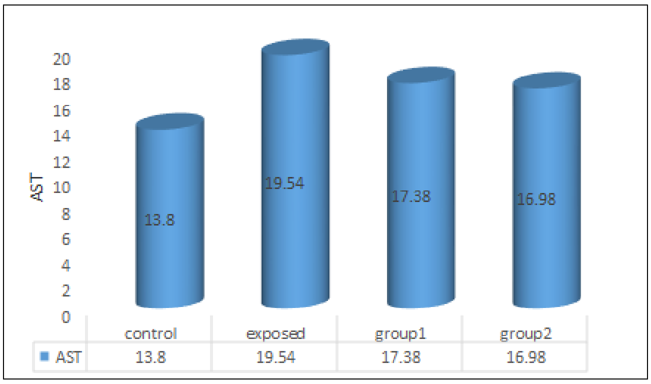

Fig 2: AST activity (U/L) in the serum of the studied groups.

Albumin Concentration

The results in Figure (3) showed a significant increase in albumin concentration in the blood serum, with the highest increase occurring in the total blood of working individuals compared to the control group. Regarding work periods by number of hours, the highest concentration occurred during the 18-hour work period, at a rate of (4.79), and the lowest concentration occurred during the 8-hour work period, at a rate of (4.67), respectively, compared to the control group.

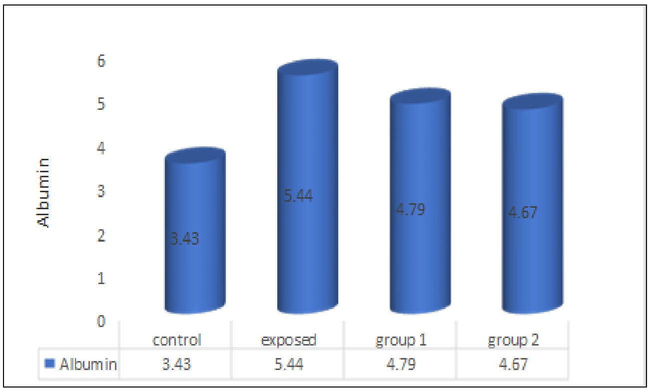

Fig 3: Albumin Concentration (mg/100ml) in the Serum of the Study Groups

4- Creatinine Concentration

The results in Figure (4) showed a significant increase in creatinine concentration in the total blood serum of workers at these stations, at a rate of (1.42) compared to the control group. The results of the 18-hour work period also showed a clear significant increase in the concentration of creatinine in the blood serum of workers at a rate of (1.24) compared to the control, while the results of the 8-hour work period showed a significant increase in the concentration of creatinine in the blood serum of workers in these stations at a rate of (1.20) compared to the control.

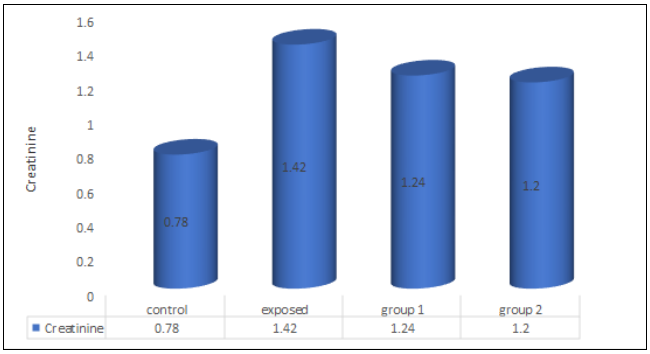

Fig 4: Creatinine concentration (mg/100ml) in the serum of the studied groups.

Pb Concentration

The results shown in Figure (5) demonstrate a significant increase in blood serum lead concentration among all workers, with a mean value of 11.60 µg/dL, compared to the control group. Specifically, workers at these stations who worked 18-hour shifts had an average serum lead level of 9.7 µg/dL, while those working 8-hour shifts had a concentration of 8.42 µg/dL—both significantly higher than the control group, which recorded a level of 2.73 µg/dL.

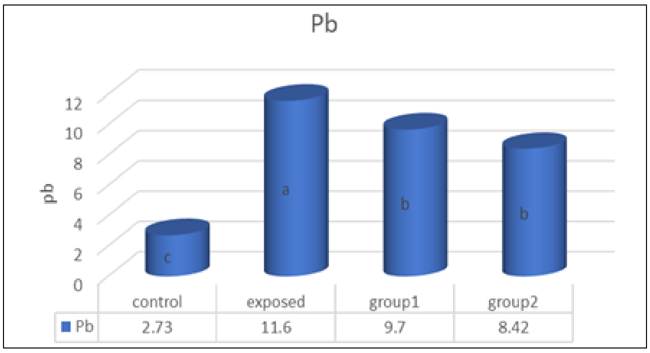

Fig 5: pb concentration µg/dl in the serum of the studied groups

Discussion

This increase in the activity of AST is due to damage to liver cells and tissues caused by living organisms. This increases the permeability of cell membranes due to changes in the chemical composition of cell membranes. This, in turn, leads to the release of these enzymes from the intracellular fluid to the extracellular fluid, leading to liver tissue damage due to direct exposure to pollutants at fueling stations (Atta *et al.*, 2019 [8]; Al-Qattan & Al-Shalash., 2024) [4]. The change in enzyme activity may be due to the complications experienced by workers in these places, which have a clear impact through changes in their systems. Several studies have also shown that liver enzyme activity was significantly higher in people working at fuel stations.

The reason for the increase in liver enzyme activity in the blood serum of people working in contact with the emissions emitted from these stations, which are massive, is attributed to hepatocellular damage, i.e., necrosis of liver cells, which leads to the release of these enzymes into the bloodstream. Tests to assess the activity of these enzymes are important tests for evaluating liver function. When the liver is exposed to many pathological conditions or any damage, this leads to an increase in the activity of these enzymes in the blood. These enzymes are found mainly in the liver, skeletal muscles, and heart (Turki, 2021). The liver plays an important role in metabolic processes, and it also plays an important role in detoxifying toxic substances such as carcinogens, heavy metals, and drugs, as it is a filter for the body. In addition to the secretion of many compounds in bile (Abdal Aziz *et al*., 2009; Al-Kattan,2018) [3].

The study by Saleem *et al*. (2022) [16] showed that volatile organic compounds, whose sources include vehicle and train exhaust emissions, are linked to the type of fuel used. These carcinogenic compounds ultimately accumulate in various organs, including the kidneys, leading to damage to the organs in which they accumulate.

The reason for the high albumin concentration in gas station workers is attributed to damage to liver function. This is due to oxidative stress resulting from the presence of various types of gaseous pollutants of petroleum origin in the atmosphere of these stations. This can lead to damage to liver tissue and kidney complications. These gaseous emissions, when inhaled, affect the kidney's ability to perform its primary functions and lead to damage to kidney tissue (Golli *et al*., 2016) [9]. The results of the current study are consistent with numerous studies, which have shown an increase in albumin concentration and its impact on kidney function, as well as its impact on cardiovascular disease (Podzolkov *et al*., 2020 [13]; (Al-Kattan,2012).

The results of the present study revealed a significant increase in accumulated lead concentration in the blood serum of the exposed workers. This indicates the presence of lead in the workers' occupational environments and suggests that extended durations and repeated exposure contribute to its accumulation in their bloodstream. Lead poisoning has received considerable attention due to its detrimental effects on human health, as accumulated lead disrupts multiple physiological functions. Measuring serum lead concentration is regarded as one of the most important diagnostic tests to assess the physiological status of the body and its exposure to industrial pollutants. This is particularly relevant given that lead is a primary component in many industrial applications. The elevated levels observed are primarily attributed to inhalation of polluted air—either from contaminated workplace environments or automobile exhaust during refueling activities—where it is absorbed through the respiratory system (Sultan, 2020) [5].

Simultaneously, the increase in vehicle numbers and the consumption of gasoline at fuel stations have led to growing environmental concerns, particularly in urban areas. Gasoline evaporation contributes significantly to total emissions of volatile organic compounds (VOCs). Refueling operations, in particular, play a major role in VOC release, in addition to air pollution caused by combustion gases from vehicle exhausts at the station sites. Health risk assessments have confirmed that inhalation exposure to hazardous VOCs poses a definitive carcinogenic threat (Zeng *et al*., 2022) [20].

Conclusions

Occupational addiction to fuel vapors, and the volatile organic compounds (VOCs), causes physiological imbalances, especially in the liver and kidney functions. The results emphasize the necessity to change occupational health policies up to much stricter ones, enhance the ventilation of fuel station settings, and introduce bio monitoring on a regular basis.

Conflicts of interest

The authors declare that they have no financial or personal relationships that could be perceived as creating a conflict of interest related to the research and information presented in this paper.

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