Iraqi JMS

Published by College of Medicine, Al-Nahrain University
P-ISSN 1681-6579
E-ISSN 2224-4719
Email: iraqijms@colmed.nahrainuniv.edu.iq
http://www.colmed-alnahrain.edu.iq
http://www.iraqijms.net\
Iraqi JMS 2025; Vol. 23(1)

Polycyclic Aromatic Hydrocarbons and Glutathione Levels in Basra Oil Company Workers (2024)

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Abstract

Background Polycyclic aromatic hydrocarbons are environmental pollutants prevalent in oil fields. This study examines their impact on human health in Basra.

Objective To assess polycyclic aromatic hydrocarbon levels in individuals exposed to oil fields and their correlation with serum glutathione (GSH) levels.

Methods A case-control study conducted from 15 January to 8 May 2024 involved 120 males aged 25 to 40 years. Group 1 consisted of 40 workers from Al-Rumaila field, Group 2 included 40 from West Qurna field, and Group 3 included 40 controls from the city center.

Results Group 2 had lower polycyclic aromatic hydrocarbon levels than Group 1, while Group 3 had none. GSH levels were significantly lower in Groups 1 and 2 compared to Group 3. Workers with over 10 years of exposure had higher polycyclic aromatic hydrocarbon levels and lower GSH.

Conclusion Polycyclic aromatic hydrocarbons significantly reduce GSH levels, posing health risks.

Keywords Environmental pollutants, glutathione, polycyclic aromatic hydrocarbons.

Citation Abdul-Khaleq MA, Abass HA, Al-Wasiti EA. Polycyclic aromatic hydrocarbons and glutathione levels in basra oil company workers (2024). Iraqi JMS. 2025; 23(1): 177-183. doi: 10.22578/IJMS.23.1.21

List of abbreviations: GSH = Glutathione, PAHs = Polycyclic aromatic hydrocarbons, ROS = Reactive oxygen species

Introduction

Polycyclic aromatic hydrocarbons (PAHs) are compounds resulting from burning carbon-containing fuels, such as coal, wood, diesel, and fats. For this reason, these substances are abundant in the air, water, and soil, increasing exposure and public health concerns [(1)]. There are several ways in which, humans are exposed to PAHs including through eating, breathing, or absorption through the skin, the source from which these compounds are emitted, in addition to the surrounding conditions and its release affect its toxicity and concentration in the environment [(2)].

Industrial processes and vehicle engine emissions are the main sources of polycyclic aromatic hydrocarbons (PAHs). Provided the necessary conditions to increase their concentration levels in the atmosphere. These compounds can stick to dust, and the body can convert dust into reactive chemicals that can bind to DNA, which causes mutations when inhaled, and this dust accumulates in the lungs [(3)]. In addition, eating grilled or smoked food exposes the person to polycyclic aromatic hydrocarbons through the diet, which is an important route of exposure [(4)].

Glutathione (GSH) is a tripeptide compound consisting of glutamine, cysteine, and glycine. It is an important antioxidant for many organisms, including humans. GSH is essential for maintaining the balance of oxidation and reduction in cells. In addition, when combined with enzymes such as GSH S-transferase, this enzyme detoxifies vital internal and external substances in the human body [5].

Oxidative stress caused by PAHs occurs due to the mechanism of production of reactive oxygen species (ROS) resulting from nutritional activation of cytochrome P450 enzymes of PAHs. Species inhibit the ability to affect health and cellular activities by causing lipid peroxidation, DNA damage, and depletion of antioxidants such as GSH [6]. When exposed to PAHs, this leads to the depletion of the GSH in the body, and this is harmful to the body because it reduces the cell's defenses against oxidative stress, increases the risk of oxidative stress, and causes several diseases such as cancer, cardiovascular disease, liver disease, and neurodegenerative disorders [7].

Depending on the quantity and concentration of PAHs and the period of exposure, it has varying effects on the concentration of GSH. Long-term exposure to a low concentration of PAHs can decrease the concentration of the hormone GSH, which weakens the antioxidant defense system and increases oxidative stress processes [8-10]. As for high acute exposure, it causes a small increase in levels of the hormone GSH to balance any sudden toxicity [9, 10].

The rationale for study

PAHs are prevalent environmental pollutants, particularly in regions with extensive oil industry activity. In Basra, where major oil fields like Al-Rumaila and West Qurna are located, workers are chronically exposed to these pollutants, potentially leading to significant health risks. While previous studies have established the toxicity of PAHs, there is limited research on their specific impact on antioxidant defense systems, particularly GSH, in populations exposed to oil field environments.

The objectives of this study were to measure the level of PAHs and GSH in the serum of workers in oil companies' fields (Al-Rumaila, West Qurna, and city center), and to correlate between the levels of these parameters.

Methods

In this study that conducted from 15 January to 8 May 2024, 120 male subjects aged 25-40 years were involved. The data was obtained from workers in oil companies in Basra Governorate It was stored in the refrigerator at Basra Teaching Hospital.

In this study, many PAHS reactive metabolites have been revealed such as Di(1,2,5-oxadiazole)[3,4-b;3,4-E]pyrazine, dipropoxy methane, di-tert-butyl peroxide, cyclododecene epoxide, butyl butoxy(hydroxy)acetate, butyl oxo acetate, isopropyl oxetan, 2-Nitro-1-octanol, furanmethanol, 3,4-Diacetyl furazan, isopropylsuLFTsonyl butane, 2,3-pentadione, ethyl propyl ketone, 2,2-dimethyl hexanone, isobutyl nitrite and 1-nitro butane.

Study Design

A case-control study was conducted, involving the collection of 120 blood samples from male workers in oil companies, divided into three groups based on their work location: Group 1 consisted of 40 workers from Al-Rumaila oil field, Group 2 included 40 workers from the West Qurna oil field, and Group 3 comprised 40 individuals from regions far from the city center (controls).

The study focused exclusively on males to maintain consistency in the sample population, as males predominantly occupy the jobs in these oil fields, which reduces variability due to gender differences.

To justify the selection of a 10-year exposure duration in this study; the 10-year duration was chosen based on the understanding that long-term exposure is necessary to observe significant biochemical and physiological changes associated with PAHs exposure.

Inclusion Criteria

Participants must have been working for 10 years, be in good health (physically and mentally), and be male participants only.

Exclusion Criteria

Workers with a history of liver diseases, Current smokers, Individuals with chronic medical conditions, Medication use.

Method of data collection

Blood samples were collected from participants using standard venipuncture procedures.

Data collection tool and questionnaire

Data collection was supplemented by a structured questionnaire designed to gather demographic information, work history, and exposure duration to oil field environments.

Consent of Ethics

In the study, venous blood was withdrawn from healthy people and working in oil companies. Written consent was sought and secured from all study members before their samples were collected. The Institutional Review Board (IRB) of the College of Medicine, Al-Nahrain University reviewed and approved the study proposal (Ref. No. 20231008 on 6/11/2023).

Statistical Analysis

The mean and standard deviation (SD) of the data are shown. The statistical package for the social sciences (SPSS version 25) was used for the statistical analysis. An unpaired t-test was used to ascertain the statistical significance between the groups. The thresholds of 0.001 and 0.05 were employed to determine statistically significant variations.

Results

Table (1) compares the demographic and health characteristics of technician groups working in the Al-Rumaila and West Qurna oil fields with a control group from Basra city. All three groups have an equal mean age of an equal mean age of 31.6±2.41 years, consist entirely of male technicians, and reside in Basra city. The groups differ in their exposure duration to occupational hazards; the control group from the city center has no exposure, while the mean exposure duration in Al-Rumaila and West Qurna fields is 10 years, respectively, as shown in table (1). All participants in the study are reported to be in good health.

Table 1. Demographic and Health Characteristics among study groups

Group	City Center	Al-Rumaila	West Qurna
Mean Age	31.6±2.41	31.6±2.41	31.6±2.41
Gender	Male	Male	Male
Occupation	Technicians	Technicians	Technicians
Mean Duration	Not exposed	10	10
Health Status	Healthy	Healthy	Healthy
Place of Residence	Basra city	Basra city	Basra city

Results showed that no PAHs or their metabolites were detected in the serum of the City Center group, as shown in table (2). On the other hand, the PAHs level recorded higher results within the group of Al-Rumaila (12.18±4.89 ppm), followed by the people who are working in the West Qurna (10.6±4.91

ppm). The difference between the two groups was highly significant ($P < 0.001$).

Table 2. Levels of PAHs among study groups

Parameter	City Center Mean±SD	Al-Rumaila Mean±SD	West Qurna Mean±SD	P value
PAH (ppm)	0.00±0.00	12.18±4.89	10.6±4.91	0.0001**

** t-student test, P value <0.001 is highly significant

Results of GSH obtained in this study are illustrated in table (3), showing that the level of GSH in serum of City Center and West Qurna group (7.96±0.97 µg/mL and 4.28±1.1 µg/mL, respectively) is significantly higher ($P < 0.001$) than the Al-Rumaila groups (3.26±1.29 µg/mL) while the difference between City Center and West Qurna groups is significant ($P > 0.05$).

Table 3. Comparison of GSH level among study groups

Parameter	City Center Mean±SD	Al-Rumaila Mean±SD	West Qurna Mean±SD	P value
GSH (µg/mL)	7.96±0.97	3.26±1.29	4.28±1.1	0.001*

* ANOVA test, P value <0.01 is significant

The averages of studied PAHs and GSH have been calculated according to the duration of exposure, and the results are summarized in table (4). For the Al-Rumaila field workers, the level of PAHs increased significantly ($P < 0.001$) in subjects who had been exposed for more than ten years (16.18±4.2 ppm) compared to those exposed for less than ten years (9.22±2.84 ppm). Correspondingly, an increase in GSH levels (3.5±1.35 µg/mL) was observed in the group exposed for more than ten years, while a lower level of GSH (3.07±1.24 µg/mL) was observed in those exposed for less than ten years ($P = 0.02$).

For the West Qurna field workers, PAH levels also increased significantly in subjects exposed for more than ten years (11.47±4.44 ppm) compared to those exposed for less than ten years (9.81±5.28 ppm, $P < 0.05$). However, no significant difference in GSH levels was observed between the two exposure groups. The GSH level was 4.22±1.1 µg/mL for those exposed for more than ten years and (4.33±1.12 µg/mL) for those exposed for less than ten years ($P = 0.92$).

The relation between serum PAHs and GSH levels for the City Center group showed no significant correlation ($r = 0.10$, $P = 0.48$). Similarly, for the West Qurna group, no significant correlation was observed ($r = 0.00$, $P = 0.828$), and for the Al-Rumaila group, no significant correlation was found either ($r = 0.00$, $P = 0.74$), as shown in figure (1).

Table 4. Levels of studied parameters according to exposure duration of Al-Rumaila and West Qurna groups

Group	Duration of exposure	n	PAH (ppm) Mean±SD	GSH (µg/mL) Mean±SD
Al-Rumaila	Less than 10 years	23	9.22±2.84	3.07±1.24
	More than 10 years	17	16.18±4.2	3.50±1.35
	P value		0.00005*	0.02*
West Qurna	Less than 10 years	21	9.81±5.28	4.33±1.12
	More than 10 years	19	11.47±4.44	4.22±1.1
	P value		0.03*	0.92

* P value <0.05 is significant

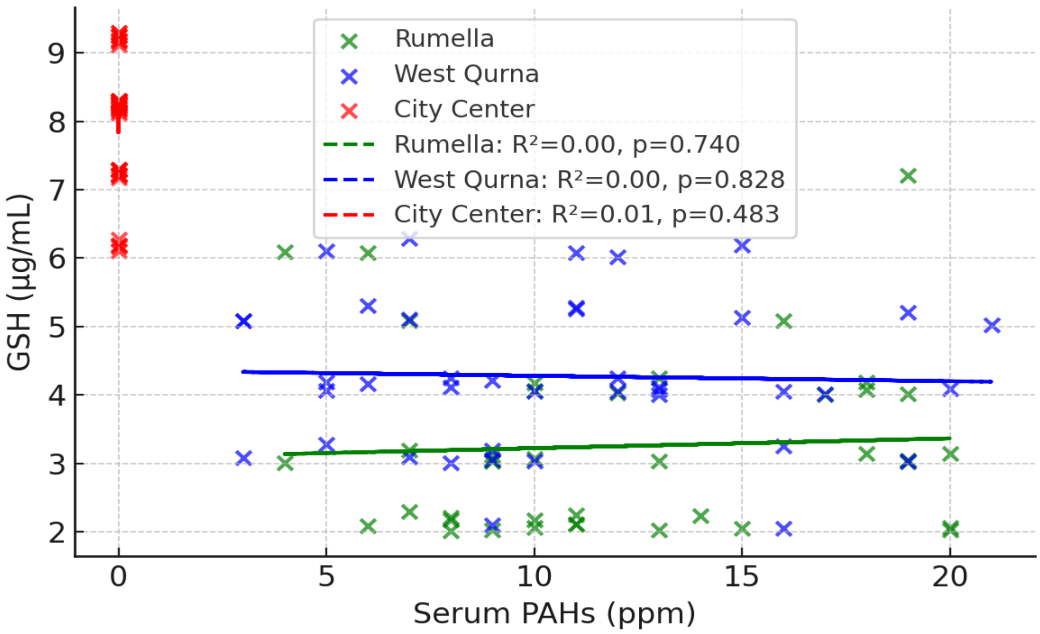

Figure 1: Correlation between PAHs and GSH level

Discussion

The findings showed that the blood levels of PAHs were much higher in those from more industrially exposed areas (Al-Rumaila and West Qurna) than in people from less exposed areas (City Center). This is in line with several studies that show higher quantities of PAHs in people exposed to contaminated settings, frequently associated with industrial activity. It is widely established that direct inhalation and cutaneous absorption of the surrounding environment contribute to increased PAH levels in such environments [11,12]. The results of this study are similar to a study in Pakistan of workers in industrial areas by (Rehman et al., 2020) [13], which showed a decrease in GSH levels in blood serum upon continuous exposure to PAHs due to toxic interactions with liver enzymes that cause oxidative stress.

One crucial observation is the comparable drop in GSH levels in those with increased exposure to PAHs. An oxidative load is suggested by decreased GSH levels in individuals exposed to higher amounts of PAHs. The oxidative stress caused by PAHs can be countered by consuming GSH, which is then depleted due to ROS produced during PAH metabolism [14,15].

The observed association between PAHs and GSH indicates a strong relationship that a large P value can support. These results are consistent with many studies proving that PAHs cause oxidative stress by generating ROS [16,17].

However, the results of this study disagreed with a previous study in China among residents of industrial areas undertaken, which did not observe a significant association between the studied groups; it was shown that despite the high levels of PAHs, there was no noticeable decrease in the levels of GSH in the blood serum, with effects on other liver functions [18].

Also, the results of this study are similar to study of workers in industrial sectors in regions of Europe; there was no decrease in GSH levels for workers exposed to PAHs, in addition to an effect on liver function [19].

In our opinion, the difference between previous studies regarding the decrease in GSH upon exposure to PAHs is due to the duration of exposure people have to these pollutants.

In conclusions, this study showed a significant inverse relationship between the levels of PAHs in the blood and GSH during the different exposure groups. Increased exposure to PAHs indicates that it reduces the levels of GSH, which is considered one of the basic antioxidants in the body. Their relationship is strongly related to the oxidative stress resulting from exposure. PAHs cause several harmful effects on health.

GSH plays an important role in defense against toxins or the harmful effects of PAHs and their metabolites, such as oxidative stress. Thus, the depletion of GSH leads to the accumulation of PAHs in the body, which leads to many diseases, including liver disease, that result from chronic exposure to these pollutants.

The Iraqis who lived far from the oil companies in Basra had higher concentrations of GSH compared to oil company workers because they were not exposed to PAHs and they do not have any harmful effects such as oxidative stress or health damage to the body. Thus, these biochemical parameters were lower than the exposed workers, and these people were still healthy and had no type of tumor.

The authors recommended that PAH emissions into the environment must be continuously monitored and controlled in industrial areas to reduce their negative effects on human health. To maintain the human body's ability to resist oxidative stress resulting from PAH pollutants, public health efforts must disseminate knowledge about the origins of PAHs and the benefits of dietary antioxidants.

Acknowledgement

The authors would like to thank the staff of Basra Oil Company, Basra, for their support and assistance to complete the study.

Author contribution

Abdul-Khaleq: designed outlines and drafted the manuscript. Abdul-Khaleq and Dr. Abass: performed the experiments and analyzed the data. Dr. Abass and Dr. Estabraq reviewed the scientific information evident in the manuscript. reviewed the scientific contents described in the manuscript. All authors read and approved the final submitted version of the manuscript.

Conflict of interest

The authors have no conflicts of interest to disclose.

Funding

Self-funding.

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Received Jul. 15th 2024
Accepted Aug. 29th 2024