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The effects of occupational exposure to petrol vapor on biochemical parameters of workers at Al zawiya oil refinery and Mellitah oil and gas refinery companies

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ABSTRACT

The oil refineries are the most important of chemical industries which produce Benzene and its metabolites that among the most dangerous compounds are toxic oxidizers causing many serious health risks to oil refineries workers. This study aimed to analyze the effects of exposure to petrochemicals on biochemical parameters among workers at Al Zawia oil refinery and Mellituh oil and gas refinery companies and compared with the unexposed group. **Methodology**: Analysis of plasma samples and their comparison with biochemical tests of kidney and liver function among two groups designated as exposed (100 petroleum refineries workers) and control subjects (100 non-oil civil servants), respectively. **Results:** The exposed group had a significantly elevated mean concentration of alkaline phosphatase ALP (u/L) as compared to unexposed (178.2 ± 84.3 versus 132.32 ± 52.7, p = <0.001). Also, the mean aspartate aminotransferase AST (IU/L) levels were significantly higher in the exposed group compared with the unexposed group (25.6 ± 7.4 versus 23.5 ± 7.5, P = 0.03). Similarly, the mean serum alanine aminotransferase ALT (IU/L) levels were increased significantly in the benzene exposed group compared with the unexposed group (22.3 ± 9.47 versus 18.87 ± 9.6, P = 0.01), and the mean± SD of serum creatinine (mg/dL) and blood urea nitrogen (BUN) (mg/dL) levels were significantly increased (0.98 ± 0.27 versus 0.70 ± 0.24, P = < 0.001), and (33.9 ± 9.3 versus 22.4 ± 9.1, P = <0.001) in the benzene exposed group compared with the unexposed group, respectively. **Conclusion:** occupational exposure to benzene caused significant alterations in biochemical parameters indicating that workers may be at a higher risk of developing hepatic or renal related disorders.

Introduction

Worldwide, huge numbers of people are exposed to petrol vapour as part of their occupation or environmentally (Carlos-Wallace et al. 2016). Petrol can be defined as a volatile liquid containing mixtures of particles and gases. Typically, there are more than 150 particulate chemicals in petrol, including minor quantity of organic compounds like aromatic and aliphatic hydrocarbons, metals such lead and minute quantity of other compounds (Zamanian et al., 2018). As the size of most particulate chemicals is less than 10 microns, and the size of numerous particulate chemicals is less than 1 microns, so an approximately all those particles is respirable (Peters et al., 2018, Abubakar et al., 2015). The oil and gas industry have harmful chemicals through processing and operating. Environmentally, this industry is the main source of volatile aromatic hydrocarbons (VAHs) (Attaqwa et al., 2020). These (VAHs) were considered as toxic oxidants that affect human health and environments. The environments levels of VAHs vapor can be increased significantly by the ambient temperature and the amount of petrol used in refinery operations (Periago et al. 2005, Rao et al. 2007and Ahmadi et al. 2019). The most abundant hydrocarbon compounds is benzene, toluene, ethylbenzene and xylene (o-, m- and p-), are commonly abbreviated as (BTEX) (Montero-Montoya et al., 2018). In petroleum refineries, among this group (BTEX), benzene is regarded as the most dangerous as it is involved in nearly each operation of petroleum refinery processes (Periago et al. 2005, Rao et al. 2007; Ahmadi et al. 2019). The health hazard of benzene exposure at the atmosphere of petroleum refineries has been announced by numerous organizations using guideline values (Edokpolo et al. 2015). Benzene was classified as a class one carcinogen and mutagen, which can contact animals and humans through several routs including inhalation, oral and dermal exposure. But, the main rout of benzene exposure at work place is via

inhalation (Attaqwa et al., 2020). The health consequences of benzene depend on duration of exposure. In which, the acute exposure to benzene cause dizziness, drowsiness, headache, fatigue, tremors and unconsciousness. While, more serious health outcomes occur on chronic benzene exposure including liver and kidney failure, central nervous system damage and cancer (Li et al., 2015; Elkhalifa, 2020). The toxicity of benzene can be described using several mechanisms. Many years ago, health hazardswere recognized among petroleum refineries workers in different ways. These hazards are problems in different parts of world. Therefore, series of studies were conducted to investigate the renal and hepatic function testes of exposed workers (Abou-ElWafa et al., 2015; D'Andrea et al., 2017 and Salem, et al., 2019).

The objective of this study was to investigate the effects of exposure to petrol vapor on selected biochemical parameters (liver enzymes, and kidney functions) among workers in the Zawia oil refinery and mellituh oil and gas refinery companies located west Tripoli (the capital city of Libya) in comparison to control. In order to evaluate and compare any hepatotoxic or nephrotoxic response among exposed workers.

Material and methods:

- **Study design and tool**

A comparative cross-sectional study was conducted among workers in AlZawia refinery and MellituhCompany in west Libya during the period from 1st of March. to30th of July2019. The questionnaire was used to collect the following information: sociodemographic; occupational profile of workers; usage of personal protective equipment; general health status; and respiratory complaints.

- **Study group**

The target group was the workers of Al-Zawiyaoil refinery and Mellitahoil and gas refinery companies in west Tripoli (the capital city of Libya). The workers in these two companies were either working in the field (Exposed group) or doing the offices work (Nonexposed group). A total of 200blood samples were collected from the two groups. A hundred blood samples from the first exposed group working inrefinery services for full time. The second group comprised a hundred of non-exposed workers working in services and offices at Al Zawia Medical Research Center**,** comparable to the exposed group in most of the variables except for the risk of exposure to petrol. The workers in two groups were interviewedand a blood sample was taken at the department of public health and community medicine during thework day. Ethical Consideration Approvals of the studied petrol refineries were obtained. Aconsent of participation in the study was obtained for both the exposed group and non-exposed voluntaries office workers at the two-refineries companies. The investigation was done for free.

- **The laboratory analysis**

Each participant gave a 3ml blood samplethrough venipuncture. The three ml of blood were kept in plastic test tube for the following investigations; some kidney function tests (including urea, and creatinine) and liver function tests (including Alanine aminotransferase (ALT), aspartate aminotransferase (AST) and Alkaline phosphatase (ALP). The two test tubes for each participant were sent to laboratory for analysis by 200 Mindray chemistry analyzer and 4040.

- **Statistical analysisof data**

The data of petrol exposed and unexposed subjects from the laboratory for all the investigations were reviewed andprocessed for statistical analysis. Descriptive statistics were used to express the data as means and standard deviations for each group. Paired t-test was used to assess the differences between the benzene exposed and unexposed groups:

P-values $\leq$ 0.05 were considered evidence of statistical significance.

Results

- **Demographic characteristics of the study subjects**: -

The subjects' demographics were shown in Table 1. A total of two hundred subjects were included in this study. A hundred subjects were exposed to petrol and the rest accounting a hundred were unexposed to petrol. The mean age for the exposed workers and the control group were (38.5 ± 9.5) years and (40 ±11.5) years, respectively. Length of employment for the exposed group was 10.4 ± 3.2.

Table1:Demographic characteristics of the study subjects (Mean± SD)

Variable	Unexposed group	Exposed group
Age (years)	38.5 ± 9.5	40.2 ± 11.5
Experience (years)	----	10.4 ± 3.2

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- **Laboratory analysis**

- Biochemical parameters

Liver Function Test (LFT)

The results were presented in Table 2. The results showed statistically significant differences in all liver function parameters between theexposed and unexposed subjects to petrol. The exposed group had a significantly elevated mean concentration of alkaline phosphatase ALP (u/L) as compared to unexposed (178.2 ± 84.3 versus 132.32 ± 52.7, p = <0.001).

The mean aspartate aminotransferase AST (IU/L) levels were significantly higher in the exposed group compared with the unexposed group (25.6 ± 7.4 versus 23.5 ± 7.5, P = 0.03). Similarly, the mean serum alanine aminotransferase

ALT (IU/L) levels were increased significantly in the benzene exposed group compared with the unexposed group (22.3 ± 9.47versus 18.87 ± 9.6, P = 0.01).

Table 2: The liver function test parameters of exposed and unexposed subjects to petrol (Mean ± SD)

Laboratory parameter (units)	Exposed group (n = 100)	Unexposed group(n = 100)	p Value
Alkaline phosphatase (u/L)	178.2 ± 84.3 ↑	132.32 ± 52.7	<0.001*
Aspartate aminotransferase (units/L)	25.6 ± 7.4 ↑	23.5 ± 7.5	0.03*
Alanine aminotransferase (units/L)	22.3 ± 9.47 ↑	18.87 ± 9.6	0.01*

SD, standard deviation,* Differences between petrol exposed and unexposed groups are significant.ALP Alkaline phosphatase, AST Aspartate amino transferase, ALT Alanine amino transferase.

Kidney Function Parameters (KFT)

The results were presented in Table3. The findings showed statistically significant differences in the tested two kidney function parameters between the exposed and unexposed subjects to petrol. The mean serum creatinine (mg/dL) levels were significantly increased in the petrol exposed group compared with the unexposed group (0.98 ± 0.27 versus 0.70 ± 0.24, P = < 0.001). The mean blood urea nitrogen (BUN) (mg/dL) levels were significantly increased in petrol exposed subjects compared with the unexposed subjects (33.9 ± 9.3 versus 22.4 ± 9.1, P = <0.001).

Table 3: The kidney function test parameters between benzene exposed and unexposed groups (Mean ± SD)

Laboratory parameter	Exposed group	Unexposed group	P-Value
Serum creatinine (mg/dL)	0.98 ± 0.27 ↑	0.70 ± 0.24	<0.001*
Blood urea nitrogen (BUN) (mg/dL)	33.9 ± 9.3 ↑	22.4 ±9.1	<0.001*

SD, standard deviation, *Differences between benzene exposed and unexposed groups are significant. Blood urea nitrogen (BUN), serum creatinine

Discussion

Benzene, which is a major organic component of crude oil and gasoline, this is known as one of the predominant toxic air pollutants in the atmosphere. Thus, a thorough knowledge of the health consequences of benzene exposure is important for determining approaches to estimates the risk that may help in early detection of pathological alterations caused by benzene exposure.Earlier, it has been approved that the other chemicals in addition to benzene in petroleum refineries affect the kidney and liver functions (Droz*et al*., 1989; D'Andrea*et al*., 2013 and D'Andrea*et al*., 2017).Many epidemiological studies in different countries shown an association between defined types of health problems and exposure to benzene and/or benzene containing blends. Therefore, this search study was directed to inspect the health consequences of occupational exposure to petrol components mainly benzene on the hematological and biological parameters of petrol refineries exposed group of workers compared to control unexposed group of workers (SajidJabbar& Ali, 2020). The results of medical lab analysis demonstrate these findings.

First,the liver cells may be damaged by benzene exposure and this damage can be determined by liver transaminase. The alanine transaminase enzyme (ALT) is an enzyme present in numerous tissues' mitochondria. Though, it is most commonly connected with the liver. So, it is a good biomarker of hepatocellular injury (Kim *et al*., 2008). While, the aspartate transaminase enzyme is present in eighty percent of tissues' mitochondria named (mAST) that primarily appears in blood as a result of sever cell necrosis and damage. While, the rest twenty percent is found in the cytoplasm named (cAST) appears in blood as a result of cell injury. Therefore, different liver function parameters should be measured to increase the sensitivity, like alkaline phosphatase (Kamiike*et al*., 1989 and Chang *et al*., 2013). More specifically, in this study the liver function wasexaminedby estimating the serum levels of ALP, AST and ALT among petrol exposed group and compared with the unexposed subjects. The findings showed that the serum levels of ALP, AST and ALT were significantly elevated in the petrol refineries workers than the comparison group. Similarly, both liver enzymes (AST and ALT) were increased among liquefied petroleum gas exposed group significantly than control group as mentioned in Sirdah*et al*., (2013) study in Gaza andSalem, *et al*., (2019) study in Tajoura, that come in line with our results.Also, comparable results were obtained by Ufelle*et al*., (2020) study in Nigeria, that stated the levels of ALP, AST and ALT were significantly higher in volatile petroleum hydrocarbons exposed group compared to unexposed group. These results also agree with the results obtained from the previous studies for Liquefied petroleum products or organic solvents exposures showed that long term exposure to benzene vapour increased the risk of liver dysfunction and reported a significant elevation of some liver enzymes in these subjects that may have been related to their exposure to benzene. The elevatedserum levels of these enzymes could be due to the overproduction or release of enzymes from the hepatic cells in response to stimuli of hepatocellular injury or cell death. However, the exact mechanisms for overproduction or release of these serum enzymes in benzene exposed subjects

still remain to be explained (Abou-ElWafa*et al*., 2015 and D'Andrea*et al*., 2014).

Second, Urea and creatinine are nitrogenous end products of metabolism; the determination of serum creatinine and serum urea nitrogen levels is of great value in helping to check the renal function in the clinical setting.

Kidney dysfunction has been investigated using blood urea nitrogen (BUN) and creatinine-based measures of renal function(Kirtane*et al*., 2005 and Aronson *et al*., 2008). This study showed that serum creatinine and blood urea nitrogen (BUN) levels were significantly increased in petrol workers in Al-Zawiyarefinary and Mellitahcompany, Libya, more than comparison group. Although, several previous studies reported similar findings done among petroleum station workers in Sulaimanicity (Kurdistan) and Mosul city (Iraq), in which serum levels of urea and creatinine were shown to be significantly elevated in exposed group than comparison group (Hussain*et al*., 2013; Al-Helaly*et al*., 2014) respectively. Also, kidney functions (urea, creatinine and uric acid) were increased among liquefied petroleum gas exposed group significantly than control group (Sirdah*et al*., 2013). Similarly, the urea and creatinine were higher in petrol station attenders in Egypt compared to control (Abou-ElWafa*et al.*, 2015). The mixtures of aliphatic and aromatic hydrocarbons contained in petrol affect different organs in body including kidney. Many previous studies on both animals and humans suggest that the kidney can affected by several chemicals (Ravnskov*et al*., 2005 and Qin *et al*., 2012).

However, in this study, the results showed that the occupational exposure to petrol vapor is accompanied with prepathological, subclinical and clinical changes in liver and kidney function. In many earlier published studies, the effect of exposure to benzene was well established and raised the hazard of carcinogenesis such as lung and blood cancers in exposed group in comparison to unexposed group (Linet*et al*., 1996, Zamanian*et al*., 2018 and Ahmadi*et al*., 2019).

Conclusion

Overall,the results of this study demonstrate that occupational exposure to petrol at oil and gas refineries caused significant alterations in biochemical parameters indicating that petrol refineries workers exposed to petrochemicals may be at a higher risk of developing hepatic or renal related disorders. Among the biochemical indices, serum levels of hepatic enzymes, creatinine and blood urea nitrogen were have been found to be increased significantly in the case of benzene-exposed subjects indicating hematic, hepatic and renal injury in this population.

Recommendations:

There should be the introduction of medical examination for workers before being started to their jobs at petrol refineries. Further clinical investigations and periodic medical checkup include hepatic, renal,pulmonary, cardiac, neurologic and other organ function tests should be performed to monitor the long-term health consequences for petrol-exposed subjects.Personal protective equipment should be used at work to decrease workplace petrol exposure.

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