The Effect of Benzene Exposure on Liver and kidney Function in OiLibya420 Gas Station Workers

Abstract:

Background: Exposure to benzene in the work causes health issues to the workers, it has negative impacts on the blood, liver and kidney. Also, it is classified as carcinogenic.

Methods: This study is a cross sectional, it involved 32 participants; 16 exposed to benzene and 16 non exposed. The sample collected by filling questionnaire and taking blood sample to test liver and kidney functions.

Result: This study found that means of AST and ALT levels of exposed workers were lower than control group, while the mean level of ALP was higher. Moreover, it did not found relationship between qualification, years of experience, age and level of liver enzymes of exposed participants, whoever, it reported a positive correlation between smoking and Bilirubin level.On the other hand, there is no statistical differences between two groups in the levels of Urea and Creatinine, but the mean of urea level was quite higher in the exposed group than non exposed. Besides, there are no associations between Urea and Creatinine levels and age, qualification, smoking and years of experience.

Conclusion: This study demonstrated a clear association between exposure to benzene and its effect on the liver. Therefore, suitable precaution should be taken to protect the workers in the gas station.

Key Words:ALP, ALT, AST, Benzene, Creatinine, Exposure, Liver and Kidney Functions, Urea.

Introduction:

Benzene is colorless liquid that are commonly used in industry[1]. It is classified as carcinogenic [2], and it has negative impacts on the workers' health, it effects on the eyes, skin, airway, nervous system and lungs[3]. Also, it can cause change in the blood counts[4], and blood cancers like leukemia [3]. Its toxicity is the most commonly caused by inhalation of benzene in surrounding air [5,6].

Benzene absorbs in the body after inhalation or oral exposure in workplace. Then, it transfers to the bloodthrough passive diffusion [7].After that, the absorbedbenzene is distributed everywhere in the body [8], and it is metabolized to a number of reactive types such as phenol, catechol andhydroquinone[9].

The first step of benzene metabolism is oxidation to the reactiveintermediate benzene oxide by cytochrome P450 enzyme in liver.Benzene oxide can undergo several phases; it could undergo to non-enzymatic rearrangementto form phenol. On the other hand, it could hydrolysis viaepoxide hydrolase to a dihydrodiol, also, its ring can open to form trans,trans- muconaldehide (ttMA) via the reactive

intermediatemuconaldehyde, or conjugation with glutathione to ultimately.Phenol and the dihydrodiols can undergo further metabolism to producing hydroquinone or catechol. The metabolite profile in the liver appears to be similar to that found in the kidney except that the relative percentages of muconic acid and unconjugated phenol were lower in the liver than in the kidney. The second step includes oxidation of hydroquinone to Benzoquinones, and that could turn back to hydroquinine or catechol by NAD(P)H dehydrogenase [quinone] 1 enzyme. benzoquinones are generally considered to be the most toxicity and phenolic conjugates are formed in the liver and it trans via the blood to the bone marrow where they hydrolyzed and oxidized to quinones [10].

The main way for Benzene elimination is exhaled via the lungs and its excretion rate dependent on dose and route of exposure [11], and more stable metabolites are secreted in urine (mainly phenol), therefore, the phenolic compounds (phenol, catechol and hydroquinone) are detected in human urine[12].These metabolites are playing the main role in benzene toxicity, which it leads to modifications of cytogenetic and induces the aberrations of chromosomal [13,14, 15].

Moreover, Benzene leads to increase in the liver enzymes (aspartate aminotransferase AST, alkaline phosphatase ALP, alanine aminotransferase ALT), and total changes in bilirubin and fatty liver and it could lead to neural and liver damage and kidney cancer [16].

Reviewing past literatures, exposure to benzene leads to a reduction in the levels of ALP, ALT and the albumin leveland an elevation in the levels of total protein in in people who exposed to benzene [17].

On the other hand, other previous studies observed that benzene exposure leads to increases in the levels of ALP, AST, and ALT of exposed participants [16, 18, 19, 20, 21], and increase in the level of creatinine [22], .and urea level of exposed groups [16,21, 23].

Aim: To determine whether benzene has an effect on liver and kidney functions on exposed workers at OiLibya420 Gas Station, Benghazi, Libya.

Material and methods:

Study site: This study was carried out at the OiLibya420 Gas Station in Benghazi, Libya.

Study design:it is cross-sectional design. It was conducted between July to august 2020.

Method of data collection: The data was gathers by two ways; the first way is using multiple choice questionnaire that contains questions regarding age, years of experience, and level of education. And the second way is taking blood samples test renal and liver functions

Target population and sample size

The samples included 32 participants; 16 exposed workers to benzene in filling station and 16 non exposed participants.

Statistical analysis

All date were coded and analyzed by using SPSS version 22. Frequency and percentage of some variables were calculated. Additionally, to identify the relationship between variables, this study uses Mann-Whitney and the Kruskal-Wallis tests.

Ethical consideration

This study began after sending preliminary letter to the manager of the OiLibya420 Gas Station and getting permission to take blood sample to do liver and renal function tests.

Limitation

The limitations of this study included small sample size; which were 16 exposed participants working in this petrol station, and this station is the biggest station in Benghazi, therefore, this study involved all the workers in this station.

Results and findings

The sample involved 32 participants; 16 exposed to benzene in OiLibya420 Gas Station and 16 non exposed to benzene.

Table 1 showsthat 9 out of 16 exposed workers had years of experience less than 5 years, while 4 workers had experience between 16 to 20 years. Moreover, 8 workers had preparatory qualification level, 4 had diploma, 3 had high school level and only 1 had Bachelor qualification level.Besides, the table shows that high percentage of participants are currently smokers (56.3%) and 6.3% was previously smoker, while 37.5% of them were never smoker.

Table 1: characteristics of workers who exposed to benzene in OiLibya420 Gas Station

Characteristics		No. (%) Exposed group
Years of experience	0-5	9 (56.3%)
	6-10	1 (6.3%)
	11-15	0 (0%)
	16-20	4 (25%)
	21-25	0 (0%)
	More than 26	2 (12.5%)
Qualification level	Preparatory	8 (50%)
	High school	3 (18.8%)

	Diploma	4 (6.3%)
	BSc	1 (25%)
Smoker	Never	6 (37.5%)
	Current smokers	9 (56.3%)
	Pervious smoker	1(6.3%)

Liver Function Test (LFT):

Table2 shows normal levels of AST for non-exposed group; However, the mean of AST levels was low for the group of cases compared to the normal range of AST in the human body (figure 1).

Table 2: AST levels of exposed and non-exposed groups

AST levels	Exposed group	Non-exposed group
Below normal level	1	0
Normal level	15	16
Above normal level	0	0
Mean level of AST	13.8	17.1

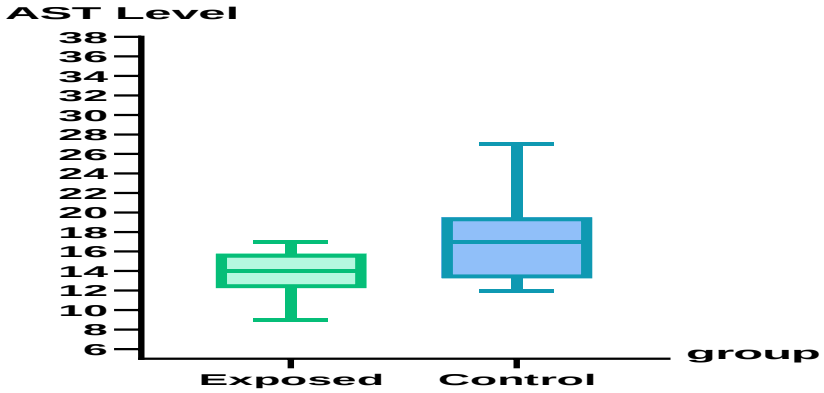

Figure 1: Means of AST enzyme level of exposed and non-exposed groups

Additionally, Table 3 shows acceptable levels of ALT in both groups compared to the normal level of ALT, whoever, it observed slightly deficient level in exposed group compared to non exposed group, which the mean of ALT of exposed group was lower than the mean of non exposed group, which were 14 and 20.3 respectively (Figure 2).

Table 3: ALTlevels of exposed and non-exposed groups

ALT levels	Exposed group	Non-exposed group
Below normal level	1	0

Normal level	15	16
Above normal level	0	0
Mean level of ALT	14	20.3

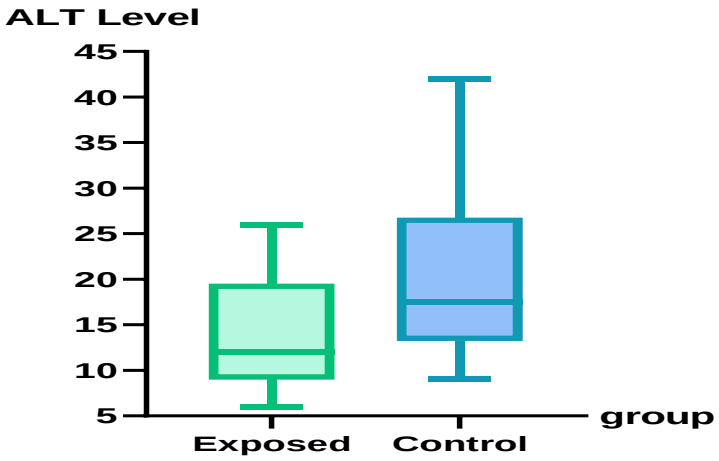

Figure 2: ALT enzyme level of exposed and non exposed groups

Also, the next table (4) represent the normal levels for the most participants in both groups and with the most tendencies to the upper limit of the normal level was observed in exposed workers (figure 3).

Table 4: ALPlevels of exposed and non-exposed groups

ALP levels	Exposed group	Non-exposed group
Below normal level	0	0
Normal level	14	16
Above normal level	2	0
Mean level of ALP	99.2	79.6

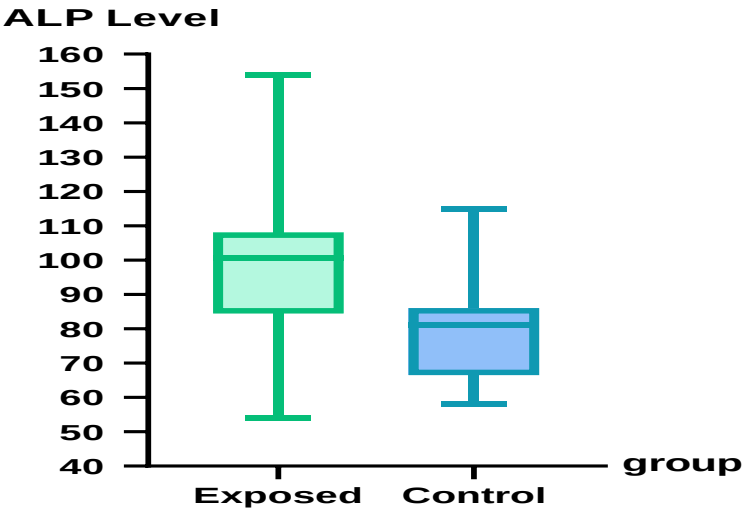

Figure 3: ALP enzyme level of exposed and non exposed groups

Table5 shows that bilirubin levels for both groups were approximately normal, and it shows the means of bilirubin between two group is quite similar (figure 4).

Table 5: Bilirubinlevels of exposed and non-exposed groups

Bilirubin levels	Exposed group	Non-exposed group
Below normal level	0	0
Normal level	15	16
Above normal level	1	0
Mean level of Bilirubin	0.59	0.51

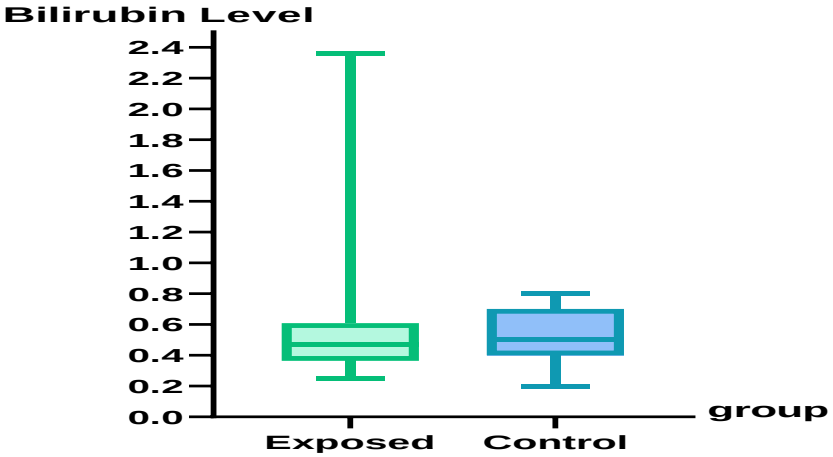

Figure 4: Bilirubin level of exposed and non exposed groups

The table 6 indicates that there is a statistical relationship of the level of liver enzymes (ALT, AST, ALP) between exposed and non-exposed, and the lack of relationship to the level of Bilirubin between the two groups.

Table 6:Association between liver function test and exposed and non exposed groups using Mann-Whitney Test

Liver Function Test	Mann-Whitney	Wilcoxon W	Z	Asymp. Sig.
AST	67.500	203.500	-2.295	0.022
ALT	74.000	210.000	-2.039	0.041
ALP	61.500	197.500	-2.510	0.012
Bilirubin total	114.000	250.000	-0.530	0.596

Furthermore, the table7 shows the absence of a relationship between the qualification and the level of enzymes (AST, ALT, ALP) in exposed and non-exposed groups. Also, the absence of a correlation between the qualification of both groups and their bilirubin level.

Table7:Association between liver function tests and qualification levels using Kruskal-Wallis Test.

Liver Function Test	Chi-Square	df.	Asymp. Sig.
AST	2.568	3	0.463
ALT	4.658	3	0.199
ALP	1.748	3	0.626
Bilirubin total	1.460	3	0.692

Besides, the table8 shows that there is no relationship between years of experience of workers and the level of liver enzymes (ALT, AST, ALP) and bilirubin, depending on the p-value.

Table 8:Association between liver function tests and years of experience using Kruskal-Wallis Test.

Liver Function Test	Chi-Square	df.	Asymp. Sig.
AST	5.601	3	0.133
ALT	4.456	3	0.216
ALP	0.964	3	0.810

Bilirubin Total	5.615	3	0.132

The next table 9 shows that workers' age is not correlated with levels of liver enzymes (ALP-ALT-AST) and bilirubin level, depending on the significant p value.

Table9:Association between liver function tests and workers ages using Kruskal-Wallis Test.

Liver Function Test	Chi-Square	df.	Asymp. Sig.
AST	5.672	3	0.129
ALT	1.698	3	0.637
ALP	0.145	3	0.986
Bilirubin Total	4.022	3	0.259

The table 10 shows no relationship between smoking and levels of liver enzymes (ALP-ALT-AST), while there is a relationship between the level of bilirubin and smoking,depending on the significant p value.

Table 10:Association between liver function tests and smoking usingKruskal-Wallis Test.

Liver Function Test	Chi-Square	df.	Asymp. Sig.
AST	2.402	2	0.301
ALT	2.166	2	0.339
ALP	0.225	2	0.894
Bilirubin Total	6.228	2	0.044

3.4 Renal Function Test (RFT):

Regarding the RFT, table 11 shows normal urea levels for both groups, with tendency to higher in exposed group (figure 5).

Table 11: Urealevels of exposed and non-exposed groups

Urea levels	Exposed group	Non-exposed group
Below normal level	0	0
Normal level	15	15
Above normal level	1	1

Mean level of Urea	29.6	27.6

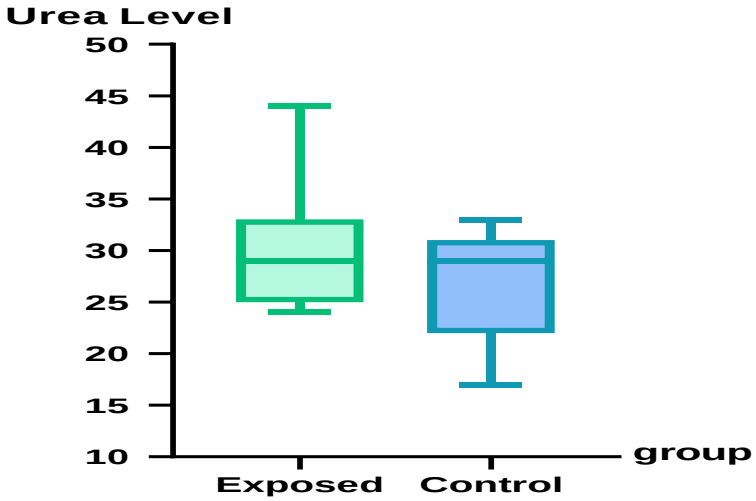

Figure 5: Urea level of exposed and non exposed groups

Regarding table 12, it represents the level of creatinine of two group was normal.it shows thatthe exposed participants have a less mean than the non-exposed (figure 5).

Table 12: Creatininelevels of exposed and non-exposed groups

Creatininelevels	Exposed group	Non-exposed group
Below normal level	0	0
Normal level	16	16
Above normal level	0	0
Mean level of Creatinine	0.86	0.89

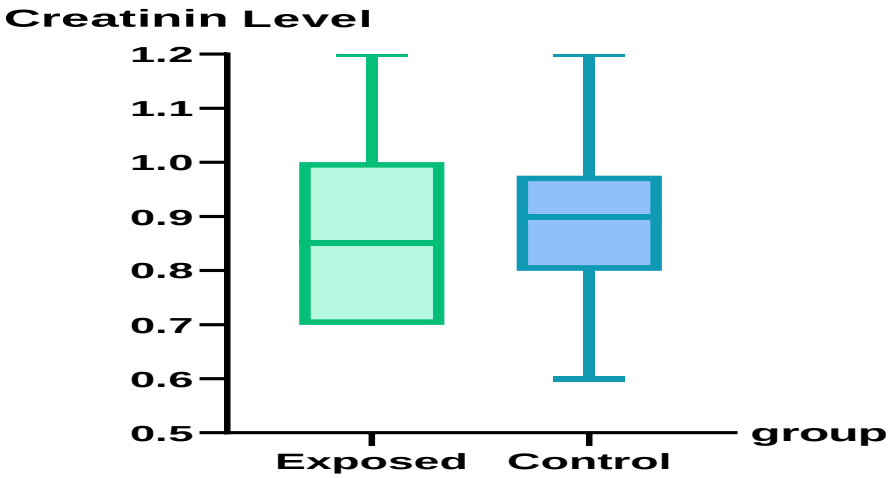

Figure 6:Creatinine Level of exposed and non-exposed groups

Table 13 Shows there is no statistical relationship between Urea and Creatinine levels among exposed and non exposed groups because p values were greater than 0.05.

Table 13: Association between renal function test and exposed and non exposed groups using Mann-Whitney Test

Renal Function Test	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig.
Urea	107.000	243.000	-0.795	0.427
Creatinine	112.000	248.000	-0.616	0.538

Besides, table 14 reported that there is no relationship between qualification level and Urea and Creatinine Levels of the exposedparticipants because p values are greater than 0.05.

Table 14:Association between renal function test and Qualification using Kruskal-Wallis Test

Renal Function Test	Chi-Square	Df	Asymp. Sig.
Urea	5.299	3	0.151
Creatinine	4.986	3	0.173

Additionally, table 15 shows that there is no statistical relationship between experience years of exposed workers and Urea and Creatinine levels because p values were greater than 0.05.

Table 15:Association between renal function test and years of experience using Kruskal-Wallis Test

Renal Function Test	Chi-Square	df.	Asymp. Sig.
Urea	4.290	3	0.232
Creatinine	5.913	3	0.116

Furthermore, table 16 reported that there is a statistical relationship between age and Urea levels of exposed workers because p value is less than 0.05. While, there is no relationship between age and Creatinine levels of exposed workers because p value was greater than 0.05.

Table 16: Association between renal function test and workers' age using Kruskal-Wallis Test

Renal Function Test	Chi-Square	df.	Asymp. Sig.
Urea	8.847	3	0.031
Creatinine	2.037	3	0.565

Furthermore, Table 17 shows there is no statistical relationship between smoking and Urea and Creatinine levels of exposed workers because p values are greater than 0.05.

Table 17:Association between renal function test and smoking using Kruskal-Wallis Test

Renal Function Test	Chi-Square	df.	Asymp. Sig.
Urea	0.419	2	0.811
Creatinine	0.678	2	0.713

Discussion:

The effects of benzene exposure on Liver Function Test:

The present study found that most of the enzymes responsible of liver function for both groupswere at an acceptable level for most participants, compared to the normal range in the body, with observe more tendencies to decrease in some enzymes among exposed participants. Also, it reported that there is a statistical difference in ALT, AST and ALP between exposed and non-exposed workers.Similarly, Akinosun et al. (2006) reported that ALP was lower in exposed individuals than non exposed workers in Nigeria, other parameters such as AST, ALT and total bilirubin were similar in both groups [24].Additionally, Nwanjo and Ojiako found a significant increase in the activities of ALP, ALT and AST in the workers in twenty petrol station attendants in Owerri, Imo State, Nigeria, while no significant change in the plasma bilirubin concentrations between exposed and non exposed groups [25].

Furthermore, the present study indicated no relationship between liver function and age of workers. In contrast, Neghab et al. (2015) found a positive relationship between age and levels of AST and ALT, and they did not found correlation between age and level ALP and Bilirubin [16].

Moreover, the present study indicated that there was no relationship between the workers' years of experience and the level of enzymes that responsible for liver function. This is contrast to the study conducted by Nwanjo and Ojiakoreported that found that levels of AL, ALT and AST were higher among exposed workers who had years of experience from 6 to 10 years [25].

Besides, the current study indicated that the level of enzymes responsible for liver function did not correlate with the educational qualification levels of workers. On the other hand, there is no study discussed the relation between workers qualification and liver function tests.

Regarding the smoking, this study indicated that there was no relationship between the level of liver enzymes (ALT, AST, ALP,) and smoking, while there was a correlation between the level of bilirubin and smoking. And this comes in disagreement with study carried out by Neghab et al., it found a positive relationship between smoking and the level of AST and ALT, and no correlation between smoking and the level of ALP and Bilirubin[16].

The effects of benzene exposure on Renal Function Test:

The present study reported that exposure to benzene could lead to elevate the urea levels, while no clear effect was found on creatinine.In line with previous studies, Bin-Mefrij & Alwake indicated that exposure to benzene causes increase in the levels of serum creatinine and urea[23].Besides, Neghab et al. found an elevation in the levels of blood urea and creatinine in exposed participants more than in non-exposed [16].Moreover, Mark & Reddy, 2014 indicated a remarkable increase in the levels of creatinine in the exposed benzene group compared to non exposed group [20].

Furthermore, the current study found a statistical relationship between Age and Urea levels of exposed workers, while there is no relationship between Age and Creatinine levels of exposed workers. In contrast, El-awad et al. reported no significant difference between renal function tests and workers age [22].

Additionally, this study reported no statistical relationship between experience years of exposed workers and Urea and Creatinine levels. Comparison with prior studies, Nwanjo & Ojiako observed an elevation in the concentration levels of urea and creatinine among group who exposed to fuel vapour for 6 to 10 years compared to the control group[25], and this is consistent with previous results of another study found that serum urea and mean serum creatinine concentration levels were higher among study participants who were exposed to gasoline and diesel fumes for more than 5 years [23].

Also,the current study found no relationship between qualification level of exposed workers and Urea and Creatinine Levels. On the other hands, there is no study tested this type of relationship before now.

Moreover, the present study indicated no statistical relationship between smoking and Urea and Creatinine levels among exposed workers, Moreover, there is no research test the association between smoking and effects of benzene on renal.

Conclusion:

This paper has highlighted the relationship between exposure to benzene and its effect on the liver and renal functions. Itfound a clear difference tin he level of liver enzymes (ALT, AST, ALP) between two groups. Besides, it did not findany relationship between age, years of experience, qualification level with liver function. While it concluded a positive relationship between the effects of benzene on bilirubin level and smoking.Additionally, it found no a relationship between the effects of benzene on RFT and workers' qualification level, experience years and smoking, whoever, it is found an obvious correlation between age and effects of benzene on Urea levels of exposed workers, while it found a negative relationship between Age and creatinine levels.

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