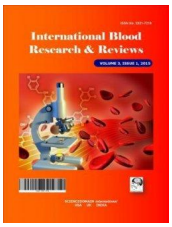

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Hematological Assessment of Benzene Exposure among Employees in Brega Oil Marketing Company (BOMC), Benghazi

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: Benzene is a toxic chemical and is a human carcinogenic. It is found in both the natural and industrial atmosphere. Its exposure can cause hematological health problems as a result of metabolite formation in the liver and bone marrow. The aim of this study is to evaluate the hematological health effects of benzene exposure amongst workers in loading and uploading stations at the Ras-Elmengar depository of BOMC, Benghazi, Libya.

Methods: This study was a cross sectional design with the study sample being 30 participants, 15 exposed workers and 15 non-exposed employees. They were asked to fill out a questionnaire about socio-demographic data and symptoms of benzene exposure. Blood samples were also taken from the participants by a laboratory technician to test the complete blood counts. The data from the blood test was analyzed using SPSS.

Results: The findings demonstrated a significant difference in CBC between the exposed and non-exposed groups. There was a reduction in WBC, RBCs and HCT of workers who were exposed to benzene. Moreover, there was a positive correlation between the hematological

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effects of benzene exposure and the BMI, years of experience and smoking habits of the workers.

Conclusion: The exposure to benzene has negative effects on the workers blood, and this effect is associated with work duration. Furthermore, it correlates with BMI and the smoking habits of the workers. Therefore, safety measures must be applied to protect the employees working at the company.

Keywords: Benzene; blood test; hematological effects; exposure.

1. INTRODUCTION

Benzene is a colourless and highly flammable liquid known as benzol. It is present in air, soil and water and it evaporates quickly into the atmosphere [1]. It comes from natural sources such as crude oil and industrial sources such as coal tar and petroleum. In addition, it is found in gasoline and cigarette smoking [2].

Benzene is considered a public health concern because it is classified as a human carcinogenic (group 1) [3] thus it can cause cancer [4].

It enters the human body through the skin, ingestion and lungs and passes into the bloodstream. Once in the body, it is either stored in fat tissue and bone marrow or it can be metabolized into other products in the liver and bone marrow, which are known as metabolites [5].

Some of these metabolites leave the body within 48 hours of exposure such as conjugated phenols exerted in the urine [5]. Other metabolites are bio-activated by myeloperoxidases and other heme-protein peroxidases to reactive semiquinones and quinones. Whereas, these products form reactive oxygen species (ROS) [6].

ROS involves superoxide radical anion, hydroperoxyl radical, hydrogen peroxide ($H_2 O_2$), and the highly reactive hydroxyl radical [6]. This could lead to reduced levels of all cellular elements in the bone marrow and the peripheral blood and it can be manifested as pancytopenia and plastic anemia [7]. It can also lead to bleeding which affects immune system function which can increase the chances of getting an infection [8].

Furthermore, chronic exposure to benzene leads to a decrease in the erythrocyte and leukocyte production which results in anemia [9]. It can also cause myeloid leukemia and thrombocytopenia [5].

Moreover, exposure to benzene can cause neurotoxicity [10], immunitoxicity [11] and it can cause damage to the liver and kidney [12].

The health surveillances of benzene in the human body include periodic tests for complete blood counts and t-muconic aid in the urine [9]. This study will focus on the hematological effects of benzene exposure.

1.1 Aim of Study

To assess the haematological effects of benzene exposure on the workers in loading and uploading stations at Ras-Elmengar depository of Elbrega Company and to evaluate its relation to BMI, smoking and the years of experience of the workers.

2. MATERIALS AND METHODS

A cross-sectional study was conducted in Ras-elmengar depository of BOMC, Benghazi, Libya. The sample consisted of 30 participants and they were divided into two groups; group A consisted of 15 workers at the loading and uploading units of benzene. They worked three different shifts. Whereas group B consisted of 15 non exposed workers who worked in offices.

The sample was homogenous, where all the workers were male. The data was collected by using multiple choice questionnaires and taking blood samples from the participants after getting approval permission from the company.

The questionnaire included six socio-demographic questions and eight questions about acute health effects on benzene exposure.

A specialized technician took blood samples from the participants using a vacuum with EDTA. The samples were then analyzed using Sysmex xp-300 device to test for Complete Blood Counts (CBC). To assess the differences between the two groups; this data was collected from 4 to 22 of June 2017, then analyzed by statistical package for social sciences SPSS software version 22.

Exclusion sample criteria included workers who had blood health problems before they started working such as blood cells disorders, bleeding disorders and blood cancers. However, inclusion criteria included all workers that were exposed to benzene.

3. RESULTS

Table 1 presents the demographic information of the participants. All the participants were men and the largest proportion of the exposed and non-exposed group were between 41 and 50 years old. A large amount of group participants (non exposed) were overweight with a body mass index 30 or more. Whilst the majority of group A participants (exposed workers) had a normal weight with a BMI 25-29.99.

Table 2 shows the blood values of the workers exposed to benzene. These values are classified into three categories; below normal, normal and above normal. The study found that 5 out of the 15 workers exposed to benzene have a low red blood cell count and 6 workers had a low white blood cell count. In addition, 10 of the exposed

Table 1. Participants' demographics

Variables		Group A (Exposed group)	Group B (Non exposed group)
Gender	Male	15	15
	Female	0	0
Age	20-30	2	2
	31-40	3	4
	41-50	9	6
	51-60	1	3
	More than 61	0	0
Body Mass Index (BMI)	18.5 – 24.99	4	4
	25- 29.9	6	4
	30 or more	5	7
Years of work	0-5	3	3
	6-10	3	0
	11-15	2	1
	16-20	2	2
	21-25	3	5
	More than 26	2	4
Smoking habits	Never	4	4
	Current smoker	9	7
	Previous smoker	2	4

Table 2. Complete blood counts of benzene exposed workers (Group A)

Blood parameters	Category	Frequency
RBC	Below normal	5
	Normal	10
	Above normal	0
WBC	Below normal	6
	Normal	7
	Above normal	2
HCT	Below the normal	10
	Normal	5
	Above normal	0
HB	Below normal	0
	Normal	15
	Above normal	0
PLT	Below normal	0
	Normal	15
	Above normal	0
MCV	Below normal	0
	Normal	15
	Above normal	0

workers had a lower haematocrit value. On the other hand, the values of haemoglobin, platelets and corpuscular volume (MCV) were normal amongst the exposed group.

According to Table 3, the current study suggested that there was no difference in HGB, HCT, PLT and MCV between the exposed and the unexposed groups. However, there was a significant difference between them in RBC and WBC counts as the P values were less than 0.05.

Table 3. Haematological parameters of exposed and non-exposed group using chi-squared t test

Parameter	Mean	P value
RBC	4.8	0.01
HGB	14.5	0.07
WBC	7.09	0.02
HCT	43.5	0.06
PLT	276.4	0.06
MCV	89.2	0.06

Furthermore, the symptoms of benzene exposure were more apparent among group a compared to group B. The most common symptom being exhaustion and dizziness (see Fig. 1).

Additionally, the ANOVA test was used to compare the association between the hematological effects of benzene between two groups and the demographic variables which are age, BMI, level of education, smoking habits, and years of experience.

Furthermore, Table 4 demonstrates that there is a significant association between hematological effects of benzene (on exposed versus non-exposed group) and the workers BMI as the P values for all the blood parameters was less than 0.05.

According to Table 5, there is a positive relationship between work duration and the effects of benzene on the exposed workers blood as the P value < 0.05.

Moreover, Table 6 indicates that smoking habits were significantly correlated to the hematological effects of benzene as the P values were less than 0.05.

4. DISCUSSION

The study showed a decline in the counts of WBC, RBC and HCT. These results come in agreement with past studies conducted by Rothman et al. [13] and Ibrahim et al. [14]. Which found a significant decrease in the total RBC and WBC as well as a decrease in platelet levels. Whereas, Qu et al. (2003) indicated that exposure to benzene leads to a decrease in the levels of RBC, WBCs, and neutrophils [15].

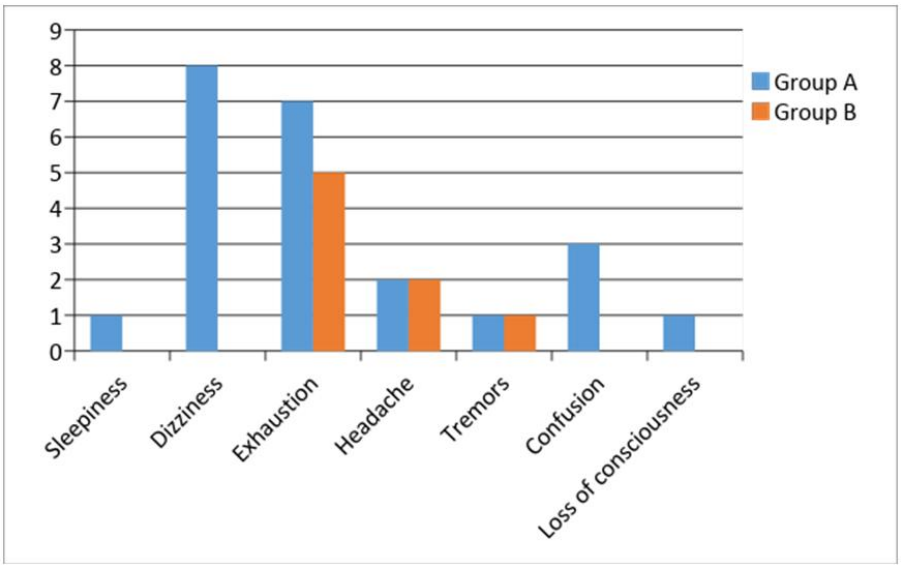

Fig. 1. Frequency of benzene exposure symptoms amongst the exposed and non-exposed groups (group A and B)

Moreover, Agabeldour et al. [16] found that there was a drop in Reticulocytes, HCT and red cell indices in workers exposed to benzene [16]. Furthermore, Kirkeleit et al. [17] found a clear relation between chronic benzene exposure and hematological effects. There was a reduction in neutrophil, lymphocyte and platelet counts of peripheral blood [17]. Conversely, Liao [18] studied the effects of benzene on the workers blood over 5 years from 2001 to 2005. He suggested that there is no relation between benzene exposure and blood parameters. He found that there was no difference in CBC between workers exposed and non-exposed to benzene. However, he found that the level of eosinophils was higher among the exposed group [18]. Furthermore, Fig. 1 showed that exposed workers all showed acute symptoms of occupational exposure to benzene, this comes in agreement with IPCS [19]. This study reported that human exposure to high doses of benzene during short periods of time could cause certain associated symptoms such as drowsiness, loss of consciousness, headaches, dizziness, confusion and tremors.

Table 4. Association between hematological effects of benzene (group A and B) and the workers BMI using ANOVA test

	ANOVA	P- value
RBC	255.751	0.000
HGB	211.667	0.000
WBC	8.861	0.006
HCT	248.921	0.000
PLT	12.251	0.002
MCV	1877.294	0.000

Table 5. Association between hematological effects of benzene (group A and B) and the workers years of experience using ANOVA test

	ANOVA	P- value
RBC	484.277	0.000
HGB	3994.696	0.000
WBC	11.194	0.002
HCT	459.255	0.000
PLT	62.546	0.000
MCV	2646.956	0.000

In addition, the current study demonstrated that the BMI of the workers was significantly associated with the effects of benzene on peripheral blood (Table 4). The reason for this could be that benzene tends to preferentially accumulate in fat-rich tissues of the human body. These findings are in agreement with the Kamal and Rashid study in 2014 [20]. They found a significant correlation between the effects of benzene exposure and the workers BMI. On the other hand, Rothman et al., [21] did not find any significant change between the blood parameters of exposed workers and their BMI [21].

Table 6. Association between hematological effects of benzene (group A and B) and workers smoking habits using ANOVA test

	ANOVA	P- value
RBC	507.879	0.000
HGB	400.033	0.000
WBC	13.806	0.001
HCT	455.115	0.000
PLT	44.314	0.000
MCV	2764.725	0.000

Additionally, the findings of the present study showed a significant association between the years of experience and the effects of benzene on the peripheral blood of the exposed workers. In more details, it demonstrated that an increase in the years of the workers experience causes an increase in the effects of benzene exposure on the blood (Table 5). Similarly, a study reported by Kamal & Rashid [20] in Pakistan indicated a positive association between blood and the years of experience [20]. In comparison, Kozlova and Volkova (1960) indicated that the extent of the hematological effects of benzene correlated with exposure duration. The changes in severity of the blood counts were observed amongst workers exposed to high benzene levels for a long period of time [22].. Whereas, Ibrahim et al. (2014), demonstrated that benzene exposure duration did not statistically correlate with the blood and urine parameters of the exposed workers [14].

Furthermore, the results of the current study demonstrated a positive relationship between smoking habits and the hematological effects of benzene exposure. There was a clear difference between workers that smoked and those that did not (Table 6). The reason for this could be because of the benzene content in cigarettes, which increases the level of benzene exposed to the workers [23]. Moreover, Kamal & Rashid [20] indicated that smoking habits have a positive correlation with hematologic effects of benzene [20]. Whereas, Hajimiragha et al. [24] and Pekari et al. [25] showed that cigarette smoking is a potential factor of low benzene monitoring [24] [25]. Alternatively, Rothman et al., [21] carried

out study on benzene poisoning and its risk factors and they found that the smoking status was not significantly associated with benzene poisoning [21]. Furthermore, another study reported that current smokers have a higher WBC count, which is elevated in order to fight inflammation and coronary heart disease (CHD) [26,27].

5. CONCLUSION

The present study indicates that there is a drop in RBC, WBC and HCT counts of the workers who were exposed to benzene. In addition, it indicates that the years of experience, BMI and the smoking habits of the workers are significantly correlated to the effects of benzene on the blood. Therefore, this study recommends a periodical health examination of the workers as well routinely complete blood count tests in order to detect the early hematological effects of benzene exposure.

CONSENT

As per international standard or university standard, patient's written consent has been collected and preserved by the authors.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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