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Occupational Exposure to Benzene and Changes in Hematological Parameters in East Tripoli, Libya

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Background and Objective: Occupational exposure to the high levels of benzene and its metabolites causes many serious health hazards to petrol station workers. However, there is the biological effect of benzene metabolites on the hematopoietic system has been known for over a century. This study was designed to analyze effects of chemical exposure on hematological parameters profile among workers at filling stations and compared them with office's workers in east Tripoli city/Libya. Methods: 31 blood samples (exposed group) and another 31 blood samples (unexposed to benzene) were collected from petrol stations. Full analysis of blood picture was performed using fully automated hematology analyzer. Results: Benzene exposed subjects had significantly higher levels of WBC (×10(3) per µL) count (7.8 ± 2.5 versus 6.5 ± 1.3, P = 0.007) and platelet (×10(3) per µL) count (282.2 ± 126.6 versus 221.9 ± 44.7, P = 0.006) compared with the unexposed subjects. While mean Red Blood Cells (RBCs) count, hemoglobin, Hematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC) levels were significantly lower in petrol station workers than the comparison group. Conclusion: Our results found that occupational exposure to benzene caused significant alterations in hematological parameters indicating that these petrol stations workers may be at a higher risk of developing blood related disorders. Therefore, workers should be protected from exposure to benzene by wearing protective devices and given attention at periodic medical examination.

Keywords: Benzene, Hematological disorders, Health risk, Petrol stations.

1. Introduction

Millions of people in the worldwide are exposed to Petrol vapour, either in occupational settings or environmentally (Carlos-Wallace et al. 2016). Petroleum refineries and service stations are major sources of Volatile Aromatic Hydrocarbons (VAHs) in the environment (Edokpolo et al. 2015). The volume of Petrol used in fueling operations and the ambient temperature, can increase significantly the environmental levels of aromatic hydrocarbon vapours (Periago et al. 2005). Benzene is a major VAH emitted during dispensing, loading, unloading and transportation of petrol, and subsequently, the occupational risk of Petroleum service station workers. (Periago et al. 2005, Edokpolo et al. 2014 and Edokpolo et al. 2015). The evaluation of the health risk resulting from benzene concentrations in petroleum station environments has been introduced by using guideline values developed by various organizations (Edokpolo et al. 2015). Benzene penetrates the body through inhalation of contaminated air or direct dermal contact. It is immediately absorbed into the body when inhaled into the lungs and excreted as metabolites in the urine. These toxic effects are thought to arise from metabolism of benzene to various metabolites. Earlier investigations indicated that benzene-induced toxicity involves several molecular mechanisms such as oxidative stress which disturbs the antioxidant defense system and produces alteration in tissue or tissue components, DNA damage, cell cycle disruption, and programmed cell death (Kim et al., 2006; Uboh et al. 2009; Renaud et al., 2012 and D'Andrea et al., 2014). Research that linked occupationally benzene exposed workers, it was observed and reported that petrol vapors induced to change blood chemistry and elevated risks of hematotoxicity including leucopenia, thrombocytopenia, anemia, pancytopenia, and even leukemia. Benzene was classified by the International Agency for Research on Cancer (IARC) as carcinogenic to human. (Yoon, et al., 2018; Uboh FE et al., 2009 and Li et al., 2019). The routine assessment of patients' hematological profile involving the measurement of their white blood cell (WBC) counts, platelet counts, hemoglobin, hematocrit and other indices is used to monitor and increase the status of a patients' health including the detection of any changes as a consequence of toxicant exposure, infection, or diseases such as cancer. Since benzene exposure is linked to the development of multiple hematological malignancies (D'Andrea et al., 2014).

The objective of this study was to investigate the effects of petrol vapour inhalation on selected hematological parameters (blood picture) to evaluate and compare any hematotoxic response of benzene exposure among workers at the Libyan petroleum stations in east Tripoli City than the comparison group.

2. Material and methods:

A comparative cross-sectional study was conducted upon petrol station workers at east Tripoli city during the period from April 1, 2018, to May 31, 2018.

- Subjects

- The Study Group: There are 7 petrol stations in east Tripoli city as detected by "Google Earth." The study included 31 petrol station workers agreed to participate in the study. All workers are males working either in fueling service for 24 hours/day for three days in one

week or in car maintenance and wash and oiling services for 8 hours/day from 9 a.m. to 5 p.m. The petrol station workers were interviewed and a blood sample was taken at the national heart center, Tajoura at 10 a.m. where their workload at this time is relatively light. The group comprised 31 male service and office workers at the Primary Health Care Center, Tajoura, comparable to petrol station workers in most of the variables except for the risk of exposure to petrol. They were interviewed and examined at the department of public health and community medicine during the work day. Ethical Consideration Approvals of the studied petrol stations and Primary Health Care Center authorities were obtained. An informed consent of study subjects to participate voluntarily in the study with a full right to withdraw, as they were willing to make a health check for free, was obtained with assurance of confidentiality and anonymity of the data.

Each participant was subjected to the following:

Interview: a questionnaire was used to collect the following information: sociodemographic; occupational profile of workers; usage of personal protective equipment; general health status; and respiratory complaints. Laboratory investigation: a 5 mL blood sample was taken from each participant through venipuncture which was collected in containing ethylene diamine tetraacetic acid (EDTA) tubes for complete blood picture.

- Data analysis

Medical charts of the benzene exposed and unexposed subjects were reviewed and the clinical data was processed for statistical analysis. Clinical data such as WBC counts, platelet counts, Mean Red Blood Cells (RBCs) count, hemoglobin, Hematocrit (HCT) , mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC) levels were assessed and compared between the benzene exposed and unexposed subjects.

- Statistical analysis

Data from all laboratory examinations in this study was systematically collected from the subjects' medical charts and subjected to statistical analysis. Descriptive statistics were used to assess patient which included means and standard deviations for each group. Variables included were WBC, platelets, hemoglobin, Red Blood Cells, hemoglobin, Hematocrit, mean corpuscular volume, mean corpuscular hemoglobin and mean corpuscular hemoglobin concentration. t-test was used to assess the differences between the benzene exposed and unexposed groups: P-values ≤ 0.05 were considered evidence of statistical significance.

3. Results:

A total of 62 subjects were included in this study. 31 were unexposed and 31 were exposed to benzene. The subjects' demographics are shown in Table 1. The mean age for the Petrol station workers and the corresponding values for the control group were 39.5 ± 12.2 years and 42 ± 15.3 years, respectively. Length of employment for the exposed group was 10.4 ± 3.2.

Table1:- Demographic characteristics of the study subjects

Variable	Unexposed group (n = 31) (Mean ± SD)	Exposed group (n = 31) (Mean ± SD)
Male	31	31
Age (y)	42 ± 15.3	39.5 ± 12.2
Length of exposure or employment (y)	10.4 ± 3.2	----

SD, standard deviation.

The results presented in Table 2 show the differences in hematological markers between the unexposed and exposed subjects to benzene. Subjects who were exposed to benzene experienced significantly increased mean WBC counts (× 103 per μL) compared with the unexposed subjects (7.8 ± 2.5 versus 6.5 ± 1.3, P = 0.007). Similarly, the mean platelet counts (× 103 per μL) in the benzene exposed group was significantly elevated compared with the unexposed group (282.2 ± 126.6 versus 221.9 ± 44.7, P = 0.006). Mean RBCs count (million cells/mcL) levels (5.35 ± 0.63 versus 5.66 ± 0.68, P = 0.03), The mean hemoglobin (g/dL) levels (14.02 ± 3.7 versus 14.7 ±3.8, P = 0.03), and the percent anemic, and HCT level (42.09 ± 5.8 versus 44.3 ± 2.8, P = 0.03) were significantly lower in petrol station attendants than the comparison group. All other blood picture parameters showed significant difference between both groups as shown in (Table 2).

Table 2: Comparison of hematological indices (Complete blood picture) between exposed and unexposed subjects to benzene

Parameter (units)	Exposed group (Mean ± SD) (N = 31)	Unexposed group (Mean ± SD) (N = 31)	P Value
WBC (× 10^3 per μL)	7.8 ± 2.5	6.5 ± 1.3	0.007*
Platelets (× 10^3 per μL)	282.2 ± 126.6	221.9 ± 44.7	0.006*
RBCs (million cells/mcL)	5.35 ± 0.63	5.66 ± 0.68	0.03*
Hemoglobin (g per dL)	14.02 ± 3.7	14.7 ±3.8	0.03*
Hematocrit (%)	42.09 ± 5.8	44.3 ± 2.8	0.03*
MCV (fem to liter)	77.45 ± 8.80	80.23 ± 5.0	0.03*
MCH (pg/cell)	25.52 ± 5.05	26.89 ± 1.9	0.007*
MCHC (gm/dL)	32.71 ± 5.7	33.44 ± 5.78	0.008*

*Differences between benzene exposed and unexposed groups are significant.

WBC White blood cells, RBC Red Blood cells, MCV mean corpuscular volume, MCH mean corpuscular hemoglobin, MCHC mean corpuscular hemoglobin concentration. Cells/mcL = cells per microliter, and pg/cell = picograms per cell.

4. Discussion:

The association between exposure to benzene or benzene-containing mixtures and certain types of health disorders has been shown in epidemiological studies in different countries. 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 environment. Environmental exposure to benzene has long been known as a carcinogen of human blood components. In addition, occupational exposure to benzene may cause non-carcinogenic effects including hematologic, hepatic, neurologic, renal, and immunologic dysfunctions. However, the

precise mechanism of the toxic effects of the benzene is not fully understood. (Lan et al., 2004; D'Andrea et al., 2014; Abou-ElWafa et al., 2015 and D'Andrea MA et al., 2017). 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. Therefore, we conducted this study assessing the alterations in the hematological functions through petrol station workers following their exposure to benzene vs. unexposed smoking subjects. To the best of our knowledge this is the first study that has investigated the changes in the hematological functions of petrol station attendants as a result of their workplace occupational exposure in Libya. The findings of this study indicate that benzene exposure resulted in significant increase in their mean WBC and platelets counts of petrol station attendants than those of the comparison group. while the mean hemoglobin level and (RBCs) Red blood cells count were significantly lower between both groups. Similarly, in hematological assessment of gasoline exposure among petrol filling workers in Zawia and Mellituh, Libya their mean hemoglobin level, WBCs, and Platelets counts were significantly higher than those of comparison group (Salem, et al., 2022). In this study, mean HCT value mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC) were significantly lower in petrol station attendants than comparison group. Although several earlier studies did not detect decreased blood cell counts on routine monitoring of workers exposed to low level of benzene (Qu et al., 2002, Tsai et al., 2004, Abou-ElWafa et al., 2015 and Salem, et al., 2022).

The results of workers exposed to petroleum vapour of Gaza governorates were found to have significantly higher values of RBC, hemoglobin, HCT, MCH, MCHC, and platelets than comparison group while the mean WBCs count was significantly lower (Sirdah M. M. et al., 2013). These results showed a significant effect of petroleum vapour exposure on the haematological parameters of petroleum station workers compared to comparison group. Our results agree with the results of previous studies of subjects exposed to petroleum vapour (D'Andrea et al., 2014; Abou-ElWafa et al., 2015; D'Andrea et al., 2017 and Salem, et al., 2022). Nonetheless, the findings of this study reveal that occupational exposure to benzene is associated with subtle, sub-clinical, prepathologic changes in the parameters of hematologic function. These effects may lead to the impairment in the function of blood and other organ functions. Several previously published studies had shown that benzene exposure elevated the risk of carcinogenesis including hematological and lung cancers among benzene-exposed workers as compared to unexposed workers in China (Linet et al., 1996, Zamanian Zet al., 2018 and Ahmadi Zet al., 2019). There should be the introduction of initial periodic medical checkups and routine blood tests for petrol station attendants are necessary to detect any long-term toxic effects. Thus, addition studies on the health effects of benzene exposure are required to determine its long-term health effects in those affected populations.

5. Conclusions:

In conclusion, the results of this study found that occupational exposure to benzene caused significant alterations in hematological indicating that these petrol stations workers exposed to chemicals may be at a higher risk of developing blood related disorders. Among the

hematological indices, WBC counts and platelet counts have been found to be increased in this population. These effects may lead to the impairment in the function of blood and other organ functions. Therefore, workers should be protected from exposure to benzene by wearing protective devices and given attention at periodic medical examination. However, further studies are needed to understand the other potential detrimental long-term human health effects of the benzene exposure from the petrol stations in east Tripoli City, Libya.

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