Impact of benzene exposure on lung functions of fuel stations workers in Basra City, Southren of Iraq

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Abstract

Benzene exposure may affect many systems of the body especially respiratory system. Respiratory system is affected greater than the other system because the benzene is highly volatile and inhaled deeply into respiratory passageways reaching the alveoli where gas exchange occurs. This study is to show the effect of benzene on respiratory function of fuel station workers in Basra City and its role in causing respiratory diseases and problems. The study includes two groups which are apparently healthy: workers from different fuel stations (n=53) and other group includes pharmacy college staff members (n=60).The respiratory function is evaluated by measuring different pulmonary function tests: FEV1,FVC,FEV1%,PEF,MVV and ELA. The measurement was performed by using Micro Medical Lab Spirometer before 12:00pm. Data statistical analysis showed that there are significant decreases in FEV1, FVC, FEV1%, PEF of fuel station workers ($p<0.05$). The significant decrease in FEV1% suggested that alteration in the respiratory function is an obstructive pattern. In conclusion all findings in the study indicate that benzene and the additives may cause respiratory function problems and most of these are obstructive diseases.

Key words: fuel stations, benzene, respiratory system and lung functions tests.

Introduction

Fuel stations are well known source of pollution of air ,in which there are complex combinations of different petroleum products and vapours . Petrol vapours consist of a complex mixture of hydrocarbons. About 95% aliphatic and cyclic compounds, 2% aromatic compounds. Benzene is about 1-5 %. Benzene is a volatile colorless and highly flammable liquid. It is found in air from the burning coal emission; service stations of gasoline; motor vehicles exhaust and evaporations [1].

Workers in fuel stations are in continuous and constant exposure to evaporations and car exhaust from the cars that enter the gas stations and increased exposure to dust from the passing vehicles exhausts on the streets. All these reasons make the workers are highly susceptible to damages and complications of respiratory airways and lungs[1,2].

The effect of the exposure to benzene varies with the duration of exposure and amount of inhaled benzene. The effect increases by increasing the quantity of benzene to about 10.000-20.000ppm for short time. Although benzene has an effect on the physiology of different systems of the body, respiratory system is particularly highly affected because of being a main rout of exposure by inhalation[3,4]. Benzene is inhaled deeply into the lungs through the nasopharyngeal, trachea, bronchi, and bronchioles

reaching to the alveoli where gas exchange occurs. It causes carcinogenic affects the epithelial cells lining the respiratory system including: terminal bronchioles, respiratory bronchioles and alveoli. Benzene passes through the respiratory membrane into the bloodstream, due to its solubility in the water. Benzene is transported by passive diffusion then absorbed into the blood. Once it enters the blood it is transported throughout the body to major receptors of the target organs by circulation[4].

Aim of this study is to determine the effect of petroleum products on the respiratory system efficiency of fuel stations workers in Basra City by evaluation of their lung function tests such as :Forced Expiratory Volume at the first second of expiration (FEV1), Forced Vital Capacity(FVC), FEV1 to FVC ratio(FEV1%), Peak Expiratory Flow(PEF), Maximum Voluntary Ventilation(MVV) and Estimated Lung Age(ELA). And also to find out the possibility to consider the exposure to the petroleum products of being a main causative factor to many respiratory diseases such as COPD like asthma and chronic bronchitis.

Materials and methods

Two groups of subjects are involved in the study: 53 subjects who work in petroleum fuel stations for the period (1-3years). They are in a continuous exposure to petroleum products and vehicles vapors (figures1,2). The other group is 60 healthy subjects from Pharmacy College staff members as a control group. The subjects of both groups are within the range of age 30-45 years. All subjects are apparently healthy; nonsmokers; without having any respiratory diseases or problems such as asthma, emphysema and chronic bronchitis; and without having anatomical and clinical disorders which may affect respiratory system function. These influential informations are recorded for each subject via a questionnaire in order to exclude the improper subject from the study.

Lung function tests: FEV1, FVC, FEV1%, PEF, MVV and ELA are measured for each subject by using the third generation of micro-medical lab spirometer. The spirometry for each subject is repeated three times to record the best reading because the maneuver depends on subject's cooperation and accuracy. Lung function tests for each subject are measured at workplace before 12:00pm.

Data statistical analysis was performed by using t-test, statistical package SPSS(Statistical Packages for Social Science[5]. Data expressed by mean ±SD. The comparisons between the two groups were tested at the level of 0.05 of significance[1].

Figure(1): Fuel station workers

Figure (2):Benzene and vehicles vapor exposure

Results

Table (1): The differences between petrol stations workers and control group in age, ELA , the number and period of exposure.

Groups / Parameters	Fuel station workers	Control group
Age(mean)	37.5	37.5
Estimated Lung Age(mean)	55.5	42.5
No.of group	53	60
Period of exposure(years)	1-3	0

The overall description of the two groups are shown in the table1. The mean value of the age of both groups is 37.5.The number of fuel station workers, who work for 1-3 years, is 53, while the number of control subjects is 60. The mean values of estimated lung age are 55.5 and 42.5 for fuel stations workers and control subjects respectively.

Table(2): The comparison between fuel station workers and control group in lung functions tests.

Groups / Parameters	Fuel station workers (mean ±SD)	Control group (mean ±SD)	P value	Significance
FEV1(L)	1.78±0.61	2.81±0.38	0.021	S*
FVC(L/sec)	2.48±0.53	3.93±0.49	0.033	S*
FEV1%	71±0.56	87±0.44	0.024	S*
PEF(L/sec)	6.32±0.9	9.19±1.5	0.013	S*
FEF50(L/sec)	3.22±1.64	5.08±1.2	0.028	S*
MVV(L/min)	98.3±20.1	122.7±24.3	0.072	NS**
Estimated Lung age	55.5±11.2	42.5±9.6	0.011	S*

* Significant at level 0.05 ,** Non significant

Table 2 shows the comparison between the two studied groups: fuel stations workers and the other group non exposed subjects in several lung function tests FEV1, FVC, FEV1%, PEF, FEF50, MVV and estimated lung age. Data analyses illustrated that

there is a significant difference at level 0.05 of significance in FEV1. The mean values for the fuel station workers and control subjects respectively are 1.78±0.61 vs. 2.81±0.38 ,p value is 0.021.

The table also shows significant differences between the two groups in FVC mean values 2.48±0.53 vs. 3.93±0.49, p value is 0.033 and FEV1% mean values 71±0.56 vs. 87±0.44, p value is 0.024. The difference in PEF mean values is also significant at the level of 0.05. These are 6.32±0.9 vs.9.19±1.5 for fuel stations workers and control group respectively, p value is 0.013. On the other hand, the only non significant difference is that for MVV mean values 98.3±20.1vs. 122.7±24.3,p value is 0.072.

Data analysis for the values from best loop illustrates that there is a significant difference in FEF50 values 3.22±1.64 vs.5.08±1.2 for fuel station workers and control group respectively, p value is 0.028, (table 2). The same table shows also there is a significant difference between the two groups; p value is 0.011 in ELA values 55.5±11.2 vs.42.5±9.6.

Table (3): The percentage of the respiratory cases of the fuel stations workers and control group.

Groups / Percentage of the Respiratory cases	Fuel station workers	Control group
Normal	22	69
Obstruction: 1-Mild 2- moderate to sever	 27 8	 11 0
Restriction: 1-Mild 2- Moderate to sever	 10 0	 7 0
Obstruction with possible restriction	33	13

The interpretation of the pulmonary function tests mean values is clarified in the table 3. The table shows that the highest percentage of the respiratory cases for the control group is the normal case (69%), while the highest percentage case for the fuel station workers is the obstruction with possible restriction (33%) and the normal cases is

22%. On the other hand the obstruction with possible restriction represents 13% for the normal group.

Mild obstruction percentage in the fuel stations workers (27%) is higher than that of the normal group (11%). The percentage of the mild restriction is also higher in the fuel station workers (10%) than that of the normal group (7%). No moderate obstruction or moderate restriction cases were recorded in the normal group .While moderate obstruction is only 8% in the fuel workers group.

Discussion

Data analysis showed that there are significant decreases in FEV1and FVC and PEF at level 0.05 of significance. These results are in agreement with other studies [1, 3and 6]. The significant decrease reveals the harmful effect of benzene exposure on respiratory system physiology. These results could be explained by the finding and evidences of several studies that have found an increase in the incidence and sensitivity of respiratory system to chronic bronchitis, bronchial asthma and lung cancer [6,7]. That is the benzene as a carcinogenic affects the epithelial cells lining the respiratory system including terminal bronchioles, respiratory bronchioles and pulmonary alveoli[8]. Other studies have found that inhalation of petroleum products like benzene and gasoline leads to lung function tests impairment .The impairment of lung function test depends on the pollutants level of benzene derivatives in the blood[1, 9]. It is found that workers in petrol pump stations are exposed to further pollutants such as carbon dioxide (CO_2) , carbon monoxide (CO), nitrogen dioxide (NO_2) and sulpher dioxide (SO_2),in addition to the additives used to the hydrocarbons. These pollutants have the ability to reach the deep part of the lungs and can alter the surfactant concentration which lead to change its prosperities .This changing may contribute to the closer of small airways [8,9]. Other study found that chronic exposure to the hydrocarbons lead to chronic inflammation of respiratory regions which may result in a significant decline in pulmonary functions[3,10].

FEV1% mean value decreased significantly in the recent study. This agrees well with other study [2], but it disagrees with the other study [1], which showed that changing was insignificant. Also the mean value of FEF50 was significantly declined. This finding is consistent with our study but inconsistent with the other [11], which found that changing was insignificant. On the other hand MVV was decreased insignificantly. The finding is consistent with other studies [1,2] and inconsistent with other studies[3,10].

Estimated lung age (ELA) which is the same age when the respiratory function of the person is normal .It reflects the efficiency of pulmonary function tests .This parameter was significantly increased but was not discussed by other studies.

Respiratory interpretation (table 3) showed that fuel station workers group has higher percentage of mild obstruction (27%) than normal group (11%) ,while the highest percentage of the fuel station workers obstruction with mild restriction (33%).This result is in disagreement with the finding of other study [1] which has concluded that restrictive cases were mostly restrictive pattern ,because FEV1% did not change significantly ,while in this study the FEV1% is significantly declined.

Conclusion

The continuous exposure to benzene in the petrol stations for more than one year may cause problems to the respiratory system including lung function tests deterioration as reflected by significant decrease in FEV1, FVC, FEV1%, PEF and a significant increase in estimated lung age .The significant decline I FEV1% indicates that respiratory disorder is obstructive pattern.

Recommendations

- Cooperation between the local government and environmental agencies to establish a program for periodic inspection and checking of fuel station.
- Putting an educational program by the administration of each fuel station for enlightenment and education of workers e.g., wearing protective masks and reducing the continuous and constant exposure to benzene as much as they can.

References

1. Begum S and Rathna MB. Pak J Physiology. **2012**;8(1)
2. Aprajita , Panwar NK and Sharma RS. Journal of Clinical and Diagnostic Research . **2011**,October;5(5):1046-1050
3. Sharma N ,Gupta N and Gupta R . JK Science .**2012**,January-March ;14(1):5-8
4. Gusserhoven C . Principle and Environmental Toxicology .**2000** November.
5. SPSS Statistical Package of Social Science .Version 15,USA.**2006**
6. Kesavachandrani C,Rastogi Sk,Anand M ,Mathur N and Dhawan A. Current Science. **2006**;90:1177.
7. Ferreo A,Lniguez C ,Esplugues A,Estarlich M and Ballesteros F.J-Pollution Eff.Cont. **2014**,2:2
8. Weaver CV ,Liu SP,Lu JF,Lin BS. Cell BiolToxicol. **2007**,May23(3):201-2.
9. Souza MB,Saldiva PHN,Pop Ca,Capelozzi LV. Chest. **1998**,113:1312-8.
10. Madhuri BA ,Chandrashekaran and Ambarecsha K. Int Biol Med Res. **2013** (2) : 1712-14
11. Rudell B,Ledin MC ,Hammastrorn U, Srjernberg N ,Lundback B and Sandstrom T. Occup Med.**1996**,53:658-62.