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Pulmonary Misfortune Ensuing to Petroleum Related Employments

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Abstract

Background: toxic gases and fumes prompted from petrol and gas stations imply their disabling and deadly risks on human lungs. **Aim of Work:** The aim of this work was to assess the pulmonary function derangements in petrol pump workers at Al-Medina Al-Munawara city. **Patients and Methods:** This cross sectional study was conducted on 189 cases out of them in control group (group I) with age and sex matched healthy adult males gathered from nonsmokers students and employees in Taibah University. The study group (group II) comprised of 89 males who were working in different petrol pump stations. History, clinical examination and pulmonary functional assessment were carried out by using portable spirometry, Co detector and puls oximeter. **Results:** The study's results showoed that the lung function parameters (FEV1, FVC, PEFR, FEFR25% - 75%) were significantly reduced in petrol pump workers (Group II) as compared to the values for these parameters in subjects belonging to Group II (Control group), Similar findings were observed in previous studies on pulmonary functions in petrol-pump workers. This finding specified the restrictive nature of pulmonary involvement in the study group. Measurement of the exhaled CO was slightly higher in Group II than Group I. **Conclusion:** Fuel vapors and fumes in petrol stations showed direct incapacitating impact on workers pulmonary functions regarding spirometric measurements showing predominantly restrictive pattern and to less extent obstructive. Exhaled CO level was higher in addition to hypoxemia identified in these cases.

Keywords

Petrol Pump Workers, Pulmonary Function Test, Inhalation Injury, Fuel

Vapors, Pollutants

1. Introduction

Over the last four decades there has been an increasing global concern over the public health impacts attributed to the environmental pollution causing a wide problem. The main causes for air pollution in Al Medina Al Munwara are due to religious tourism furthermore urban population, increasing industrialization, improvement in the quality of the life and rising demands for energy and motor vehicles plying on roads are increasing each day. This has led to an increase in petrol pump stations and petrol pump workers and also exposure of petrol pump workers to vapors of petrol and gases from exhaust of automobiles [1].

Petrol vapors and gases from automobile exhaust have a deleterious effect on the respiratory system. A long term exposure to the air pollutants leads to effects of respiratory functions. Air pollutants and chemicals like benzenes, lead, CO_2, NO_2, CO, etc. play a role in the pathogenesis of a lot of respiratory diseases [2].

About 95% of components in petrol vapors are aliphatic (an organic and cyclic compound contains carbon and hydrogen substances, such as hexane) and less than 2% are aromatics (an organic and stable ring compound contains carbon and hydrogen substances, such as benzene). Prolonged exposure to air pollution and petroleum vapors causes bronchoconstriction [3].

Mucosal irritation and alveolar swelling lead to obstructive and restrictive disorders of lungs. Many studies have been done which show the effect of polluted environment on the respiratory tract [4] [5].

Health problems related to the pollutants are closely linked to the nature and level of exposure to hazardous pollutants. In the same way, urban life and its vehicular density are contributing to it. Petroleum product and its exhaust are causing significant health problems with the symptoms like chronic cough, breathlessness and wheezing [6] [7]. In high concentration, they cause marked systemic pulmonary inflammatory response. Occupational exposures to such product cause impairment of functions of various parts of the body [8].

Petrol pump workers (packing employees) are continuously exposed to the organic (is a chemical compound contains of carbon molecules that are bound to hydrogen, such as hydrocarbons) and inorganic (is a chemical compound that lacks of carbon-hydrogen bond, such as carbon dioxide) substances present in the petrol. Their average daily exposure exceeds about 10 h/day. Duration of exposure may vary depending on their occupation period.

Aim of Work

The aim of this work was to assess the pulmonary function derangements in petrol pump workers at Al-Medina Al-Munawara city.

2. Patients and Methods

Patients:

This cross sectional study was conducted at Al-Medina Al-Munawara city with 4 month duration from 2019/01/06 up to 2019/04/21. There were 100 cases in control group (group I) with age and sex matched healthy adult males gathered from nonsmokers students and employees in Taibah University. The study group (group II) is comprised of 89 males who were working in different petrol pump stations.

Inclusion Criteria

- Willing to participate in the study;
- Worked in the petrol pump for >3 year;
- Able to perform spirometry;
- Non smokers.

Exclusion criteria

- Not willing to participate in the study;
- Unable to perform Spirometry;
- History of any other respiratory illness;
- History of smoking—current or past.

Methods:

All cases were subjected to the following:

1) Clinical assessment: full history taking from males who were working in different petrol pumps. Their age, smoking habits, duration of exposure, physical status and health conditions were recorded.

2) Pulmonary function test (PFT):

For pulmonary function test, discovery 2, Future Med. portable Spirogram device was used (Figure 1). Pulmonary function test was recorded at the visit to petrol pump around morning 9 am. PFT of the control group was done in the workroom of College of medical rehabilitation sciences Taibah University. All the subjects were made familiar with the instrument and the procedure for performing the test. The data of the subject as regards to name, age, height, weight, sex.

Figure 1. Discovery 2, Future Med. portable Spirogram (Futuremed America. Inc., 15,700 Devonshire St., Granada Hills, CA 91344-7225, USA.

The tests were performed in sitting position for three trials. Three consecutive readings were taken and the best reading amongst the three was selected. We followed the guidelines of American Thoracic Society [9].

Lung function parameters studied were forced vital capacity (FVC), Forced expiratory volume in 1 section (FEV1), FEV1 as percentage of FVC in % (FEV1 (%)), Peak expiratory flow rate in liters/sec (PEFR), Forced expiratory flow rate during 25% to 75% of expiration (FEF25% - 75%) [10].

Carbon Monoxide (CO) Monitoring

Breath carbon monoxide is the level of carbon monoxide in a person's exhalation. It can be measured in a breath carbon monoxide test, generally by using a CO Detector (**Figure 2**). It's used for motivation and education for smoking cessation and also as a clinical aid in assessing carbon monoxide poisoning [11]. CO detector measures carbon monoxide in parts per million (ppm) in breath. This detector has become increasingly popular given that they allow for noninvasive testing and is inexpensive to use [12]. CO detector function is based on the detection of carbon monoxide gas with an electrochemical gas sensor [13].

3. Results

3.1. General Characteristics in Both Groups

The mean values (±SD) of age, height and weight in control group were 34.17 ± 5.14 yrs., 170.84 ± 8.31 cm and 68.14 ± 8.48 kg, respectively. While in group B the mean values (±D) of age, height and weight were 35.92 ± 9.60 yrs., 169.27 ± 8.02 cm and 69.13 ± 11.82 kg, respectively.

There was no statistical significant difference between the two groups as regards age (t = −1.536, p = 0.127), height (t = 1.318, p = 0.189) and weight (t = −0.657, p = 0.512) (**Table 1**).

Figure 2. CO check device.

Table 1. General characteristics of the two studied groups.

	Control Group (I) (n = 100)	Study Group (II) (n = 89)	t Value	p Value
Age (yrs.)	34.17 ± 5.14	35.92 ± 9.60	−1.536	0.127
Height (cm)	170.84 ± 8.31	169.27 ± 8.02	1.318	0.189
Weight (kg)	68.14 ± 8.48	69.13 ± 11.82	−0.657	0.512

Data are expressed as mean. p > 0.05 = not significant.

3.2. Ventilatory Function Tests

There was a statistical significant decrease in the mean value of FEV1 in study group (62.12 ± 8.22) when compared with its corresponding value in control group (83.58 ± 7.14) with t value = 19.039 and p value = 0.001 (Table 2).

There was a statistically significant decrease in the mean value of FVC in study group (58.60 ± 9.62) when compared with its corresponding value in control group (93.69 ± 10.31) with t value = 24.103 and p value = 0.001 (Table 2).

There was no statistically significant difference in the mean value of FEV1/FVC in control group (84.52 ± 6.58) and study group (84.63 ± 13.70) with t value = −0.069 and p value = 0.945 (Table 2).

There was a statistical significant decrease in the mean value of PEFR in study group (64.85 ± 15.27) when compared with its corresponding value in control group (99.97 ± 8.06) with t value = 19.422 and p value = 0.001 (Table 2).

There was a statistically significant decrease in the mean value of FEF25% - 75% in study group (3.09 ± 1.03) when compared with its corresponding value in control group (3.59 ± 0.49).

There was no statistically significant difference in the mean value of heart rate in control group (74.15 ± 7.94) and study group (74.54 ± 9.67) with t value = −0.300 and p value = 0.764 (Table 3, Figure 3).

There was a statistically significant decrease in the mean value of SPO_2 in study group (95.96 ± 2.14) when compared with its corresponding value in control group (96.59 ± 1.72) with t value = 2.227 and p value = 0.027 (Table 4).

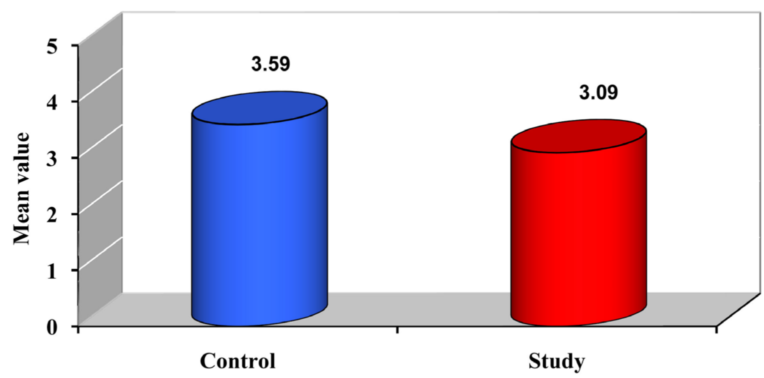

Figure 3. Mean values of FEF 25% - 75% test in the two studied groups.

Table 2. Ventilatory function tests of the two studied groups.

	Control Group (I) (n = 100)	Study Group (II) (n = 89)	t Value	p Value
FEV1	83.58 ± 7.14	62.12 ± 8.22	19.039	0.001*
FVC	93.69 ± 10.31	58.60 ± 9.62	24.103	0.001*
FEV1/FVC	84.52 ± 6.58	84.63 ± 13.70	−0.069	0.945
PEFR	99.97 ± 8.06	64.85 ± 15.27	19.422	0.001*
FEF25% - 75%	3.59 ± 0.49	3.09 ± 1.03	4.116	0.001*

Data are expressed as mean. p > 0.05= not significant. *p < 0.05 = significant.

Table 3. Mean value of heart rate in the two studied groups.

	Control Group (I) (n = 100)	Study Group (II) (n = 89)	t Value	p Value
HR	74.15 ± 7.94	74.54 ± 9.67	−0.300	0.764

Data are expressed as mean. $p > 0.05$ = not significant.

Table 4. Mean values of SPO_2 and exhaled CO in the two studied groups.

	Control Group (I) (n = 100)	Study Group (II) (n = 89)	t Value	p Value
SPO_2	96.59 ± 1.72	95.96 ± 2.14	2.227	0.027*
Exhaled CO	0.28 ± 0.04	0.33 ± 0.15	−2.828	0.005*

Data are expressed as mean. *$p < 0.05$ = significant.

There was a statistical significant increase in the mean value of carbon mono-oxide in study group (0.33 ± 0.15) when compared with its corresponding value in control group (0.28 ± 0.04) with t value = −2.828 and p value = 0.005 (**Table 4**).

Correlation between History of Exposure and Different Parameters in Study Group

In study group, there was negative correlation between history of exposure and FEV1/FVC (r = −0.249; p = 0.019). There was positive correlation between history of exposure and PEFR (r = 0.284; p = 0.007) (**Table 5**, **Figure 4** and **Figure 5**).

4. Discussion

Noxious substances may be delivered airborne to the respiratory tract in molecular (gases and vapours) or particulate form. Those with high solubility are largely dissolved in the secretions lining the upper respiratory tract, those with low solubility penetrate to the gas exchanging tissues and exert their dominant effect there. However, with overwhelming exposures adverse effects will occur at all levels of the respiratory tract and dose becomes a more important determinant of outcome than solubility. Many adverse effects may follow the inhalation of irritant or toxic gases and aerosols. Most are manifested in the lung itself, but some are manifested in other organs after the lung provides a route for absorption. Several adverse health problems such as inflammation of the eyes and nose, throat irritation and breathing problems are common. Irreversible effects, e.g. cancer, birth defects, brain and nerve damage, long term injury to the lungs and breathing passages are caused by some chemicals found in the polluted air [14].

The study's results show that the lung function parameters (FEV1, FVC, PEFR, FEFR25% - 75%) are significantly reduced in petrol pump workers (Group I) as compared to the values for these parameters in subjects belonging to Group II (Control group) (**Table 2**, **Figure 3**). Similar findings were observed in previous studies on pulmonary functions in petrol-pump workers resembling to studies undertaken by Chidri SV, Patil S *et al.* [15]; Sharma H, Agarwal *et al.* [16]; Balamurugan Santhalingam *et al.* [17]; Praveen Bhardwaj *et al.* [18]; Sumathi *et al.* [19].

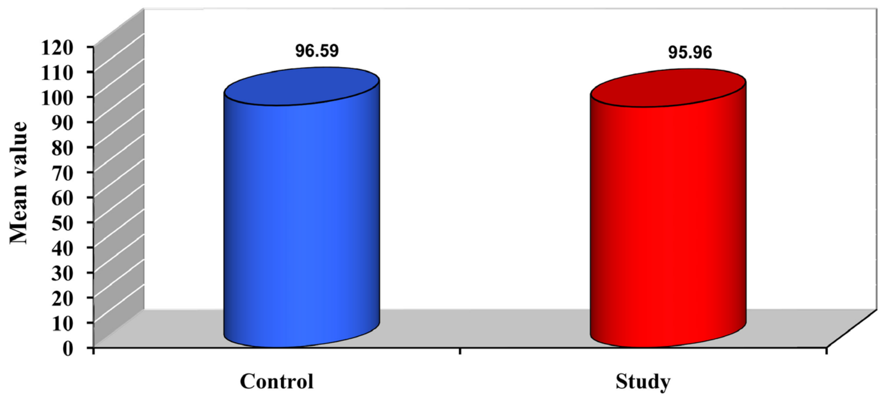

Figure 4. Mean values of SPO_2 in the two studied groups.

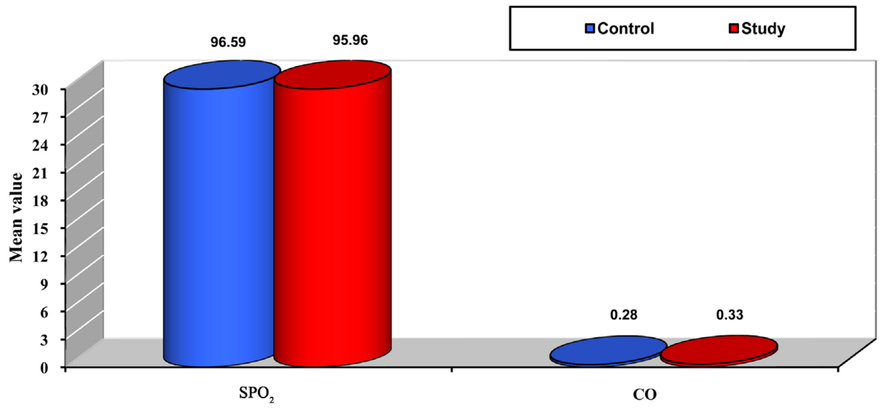

Figure 5. Mean values of CO in the two studied groups.

Table 5. Correlation between duration of exposure and different parameters in study group (n = 89).

	Duration of Exposure	
	Pearson Correlation Coefficient	p Value
FEV1	−0.032	0.765
FVC	−0.186	0.081
FEV1/FVC	−0.249	0.019*
PEFR	0.284	0.007*
FEF25% - 75%	−0.038	0.723
SPO_2	0.049	0.648
HR	−0.113	0.290
Carbon mono oxide	0.152	0.155

$P > 0.05$ = not significant. *$p < 0.05$ = significant.

In an earlier study conducted by Sandip M Hulke *et al.* 2012 [20], a significant reduction was seen in the FEV1 (Forced expiratory volume in 1 sec), FVC (forced vital capacity) in petrol pump workers who were exposed to more than 5 years. Flow rates *i.e.* FEF25% - 75%, PEFR and PIFR also decreased significantly in the workers exposed more than 10 years. However, in this study, FEV1 (%) showed non-significant change, thus suggesting a restrictive type of lung disease.

Previously studies have been performed in petrol pump workers and petrol filling workers [6] [7] [8] [21]. In these studies, lung function impairment was seen. In a study done in petrol pump workers, a restrictive type of lung disease was seen, as in ours. In a study by Meo SA *et al.* [22], in the subjects exposed to crude oil spill into sea water, significant reduction in forced vital capacity (FVC), forced expiratory volume in the first second (FEV(1)), forced expiratory flow (FEF (25% - 75%)) and maximum voluntary ventilation (MVV), however this impairment was reversible and lung functions parameters were improved when the subjects were withdrawn from the polluted air environment. Similar findings were observed in cats following long-term exposure to diesel exhaust [23]. However, previous work involving animal exposures to diesel exhaust and pulmonary function tests has shown varying results [6] [21]. In our study also the lung function impairment was seen in some lung function parameter; however our study was different from other studies in the aspect that we had compared our subject according to the duration of occupation and we found significant change in some lung function parameter with exposure of more than 5 years.

Since petrol pumps are located on busy roads, these workers in addition to petrol/diesel vapor are exposed to other pollutants. The flow rates at low volumes *i.e.* FEF25% - 75% indicate flow rates in small airways *i.e.* those with internal diameters of less than 2 mm. These are reduced at low lung volumes both in restrictive and obstructive diseases. The decrease in FEF25% - 75% suggests greater involvement of small airways. The male petrol-pump workers with more than five years of service showed significantly decreased values for FEV1, FEF25% - 75%, PIF and ERV when compared to male workers with less than five years of service. These findings correlated well with a previous study indicating that the decrements in pulmonary function are worsened by increased years of exposure.

Our finding indicates the restrictive nature of pulmonary involvement in the study group. In this study also we measured the CO and O_2 and there was a slight increase in CO percentage and a slight decrease in O_2 that was corresponding with Bol, Koyuncu *et al.* research [24].

It can be concluded that the subjects in Group II have a better lung function as they are not exposed to petrol/diesel fumes. In human lung, the major site of impact and injury for the particulate matter is at the level of terminal bronchioles and the adjacent 1st generation respiratory bronchioles. These particulate matters are usually not seen deposited in the larger bronchi as they are probably cleared from this area rapidly. Petrol is a combination of complex hydrocarbons.

On emission, particles of size 0.02 nm are generated. Due to the large surface area, these particles carry various toxic particles, which remain in the atmosphere for a longer period and get deposited in the small airways of the lung.

In addition, as these petrol pump workers are in bad need of wearing any protective gear, this exposes that they have more lung function abnormalities.

Further, most of the petrol pump workers belong to the lower socioeconomic class predisposing them to various illnesses. This study had excluded those petrol pump workers who had or have a history of smoking or respiratory diseases and how exposure less than 3 years.

It can be easily postulated that these persons who smoke will be having an even more amount of respiratory dysfunction compared to the nonsmoking petrol pump workers.

Periodical lung function measurements like Spirometry should be undertaken for the workers at the petrol pumps.

5. Conclusions

Fuel vapors and fumes in petrol stations showed direct incapacitating impact on workers pulmonary functions regarding spirometric measurements showing predominantly restrictive pattern and to less extent obstructive. Exhaled CO level was increased in all studied cases in addition to hypoxemia observed in these cases. The average duration of daily exposure is about 10 hrs/day.

From our work, we can advise firstly, further studies to be performed in different cities to support our findings with larger data, and studies recommending various measures to prevent the same ill effects in petrol pump workers. Secondly periodic medical checkups, as well as pre-employment check-up and protective masks, can also reduce exposure to pollutants. Control strategies to reduce benzene concentration in air emission, and improvement in engine design, soot filters and fuel modification such as use of biodiesel can also go a long way in reducing exposure hazards.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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