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Estimation of Pulmonary Functions and Cardiovascular Indices among Workers in Al-Samawa Oil Refinery

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Abstract

Background: Oil refinery employees suffer from exposure to fumes from petrol that contain harmful chemicals that can hurt the lungs and cardiovascular system. This research aimed to assess workers' health at the Al-Samawa oil refinery in Iraq, specifically their pulmonary function and cardiovascular wellness.

Methods and Results: Sixty workers at the Al-Samawa oil refinery, with a mean exposure duration of 8.7±4.23 years, were compared to sixty non-exposed healthy participants (the control group) of the same age, height, and weight.

Workers at the Al-Samawa oil refinery were divided into three subgroups of twenty each based on their work: production workers (PW), operation workers (OW), and technical workers (TW). Pulmonary function was evaluated using a spirometer, and blood pressure was recorded using a digital wrist cuff monitor. The current study demonstrated that there was a highly significant drop in the mean values of FVC, FEV_1, FEV_1/FVC%, PEFR, and $FEF_{25-75\%}$ of employees at the Al-Samawa oil refinery, in comparison with the control. According to our findings, the mean values of FVC and FEV1 among PW and OW were significantly lower than the control values. In addition, among OW and TW, FEV_1 and FEV_1/FVC significantly decreased, compared to control. Furthermore, the mean values of PEFR and $FEF_{25\%-75\%}$ in OW were significantly lower than the control. Mean FVC, PEFR, and $FEF_{25\%-75\%}$ values were significantly lower in OW than in PW and TW. Furthermore, the mean values of FEV1 and FEV1/FVC in OW were significantly lower than in PW. Systolic BP and diastolic BP were significantly higher in the Al-Samawa oil refinery workers than in the control.

Conclusion: The Al-Samawa oil refinery workers have impaired respiratory functions. In addition, the lung function of those working in the operations department was significantly lower than that of individuals working in other occupations. Exposure to petrol vapors in the workplace is associated with increased BP.**(International Journal of Biomedicine. 2023;13(4):329-333.)**

Keywords: pulmonary functions • blood pressure • air pollution • petrol

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Abbreviations

BMI, body mass index; **BP**, blood pressure; **DBP**, diastolic BP; **FEF**, forced expiratory flow; **FVC**, forced vital capacity; **FEV_1**, forced expiratory volume in the first second; **OW**, operation workers; **PM**, particulate matter; **PCBs**, polychlorinated biphenyls; **PAHs**, polycyclic aromatic hydrocarbons; **PEFR**, peak expiratory flow rate; **PW**, production workers; **SBP**, systolic BP; **TW**, technical workers.

Introduction

Air pollution continues to get much attention worldwide because it hurts people's health and well-being. Some diseases and conditions, such as asthma, chest pain, lung cancer, loss of breath, and sore throat, have been linked to air pollution.[1]

Oil refinery employees suffer from exposure to fumes from petrol that contain harmful chemicals that can hurt the lungs and cardiovascular system. Petrol is dangerous because it contains various toxic chemicals, including volatile aliphatic and aromatic hydrocarbons known as BTEX (benzene, toluene, ethylbenzene, and xylene.[2] Although oil refineries are the primary producers of volatile aromatic hydrocarbon emissions, they generate excessive air, water, and land pollution in the surrounding areas.[3] Refineries and petroleum plants are the most prominent industries that release volatile organic compounds.[4] Refineries and petrochemical companies generate many kinds of harmful pollutants that are

released into the environment. These include volatile organic compounds, metals, polycyclic aromatic hydrocarbonss, and polychlorinated biphenyls. Wheezing and other symptoms of respiratory diseases were found to have a higher prevalence in the data collected from locations close to petrochemical industries.[5]

Refinery employees are especially at risk from chemical pollution because they inhale high amounts of benzene.[6] In hot countries like Iraq, oil refinery workers are more likely to be exposed to benzene gas, raising stress about their health. Higher atmospheric temperatures make it more probable that one will inhale or absorb these dangerous pollutants through the skin.[7] In addition, refined petroleum compounds are prevalent and have been shown to harm several human biological systems.[8] Residents who were exposed to petrochemical pollution reportedly had respiratory problems.

The human body reacts differently to these chemical molecules, and one impact is the provocation of several occupational cancers.[9] Several human and animal investigations have shown that the exhaust emissions from petrol, kerosene, and petrol include chemical compounds like cadmium, benzene, and volatile nitrates that are toxic to bone marrow, the lymph nodes, and the spleen.[10] Pollutants from petroleum products have been observed to alter liver enzyme levels and the production of hormones in the pituitary gland.[11] There is a greater possibility that refinery workers might get asthma, chronic bronchitis, or COPD because of their jobs.[12] Volatile organic compounds have a wide variety of adverse short-term and long-term effects on human health, some of which include irritation of the respiratory tract, digestive problems, dysfunction of the central nervous system, narcosis, effects on growth, and carcinogenicity.[13]

Air pollution has been linked to cardiovascular illnesses, including arrhythmias, ischemia, infarction, atherosclerosis, and hypertension.[14] Exposure to CO, PM2.5, and PM10 increases the risk of raised blood pressure (BP).[15] Multiple studies have found that exposure to NO_2, SO_2, metals, PM10, O_3, and polycyclic aromatic hydrocarbons increases the risk of lung and cardiac disease, eye irritation, and coughing.[16,17] Exposure to vehicle pollution for a long time affects lung function, elevates BP, reduces immunity, and increases the chance of developing lung cancer.

The findings of this study will assist the Al-Samawa oil refinery in evaluating its workers' health and taking steps to enhance the daily lives of those working in the oil sector. Few studies have investigated cardiovascular indices and lung function tests in oil refinery workers. Therefore, this research aimed to assess workers' health at the Al-Samawa oil refinery in Iraq, specifically their pulmonary function and cardiovascular wellness.

Materials and Methods

A cross-sectional design was selected for the study. This research was carried out at the oil refinery at Al-Samawa, which is in the southern Al-Muthanna province of Iraq, approximately 280km southeast of Baghdad. The refinery was mainly owned by the Midland Refineries company of the Ministry of Oil in the Republic of Iraq. The period for data collection was from December 2022 to February 2023.

The employees at the refinery face direct and indirect danger due to the pollutants in the air in the workplace. Sixty workers at the Al-Samawa oil refinery, with a mean exposure duration of 8.7±4.23 years, were compared to sixty non-exposed healthy participants (the control group) of the same age, height, and weight (Table 1). Workers at the Al-Samawa oil refinery were divided into three subgroups of twenty each based on their work: production workers (PW), operation workers (OW), and technical workers (TW). Pulmonary function was evaluated using a spirometer, and BP was recorded using a digital wrist cuff monitor. Employees in the three exposure groups and the control had no previous illnesses related to their respiratory, allergic, or cardiovascular systems. They worked six days a week, for 8-10 hours a day.

BMI (kg/m^2) was calculated by measuring the employees' and controls' heights and weights on a properly calibrated scale.[18] All the lung function measures were carried out at the participant's place of employment by a portable Spirolab III, a computerized diagnostic spirometer (MIR, Rome, Italy).[19] The individual was seated throughout the examination, and a nose clip was used to place a mouthpiece in his mouth after it had been firmly ringed by his lips. The participants in the test were always given instructions that were very clear and accurate, and those instructions were to inhale as deeply as possible and then to expel as forcefully and quickly as possible into the mouthpiece. The test was administered three times, each following an acceptable rest period, and the findings were obtained using a spirometer.[20] FVC, FEV1, FEV1/FVC ratio, FEF, and $FEF_{25-75\%}$ were recorded.

Table 1.

Physical characteristics of Al-Samawa oil refinery workers compared to physical characteristics of control group.

Variable	Control (n=60)	Oil refinery workers (n=60)	*P*-value
Age, yrs	37.90 ± 6.16	38.64 ± 6.12	0.551
Weight, kg	76.44 ± 9.84	77.52 ± 9.52	0.542
Height, cm	171.94 ± 5.37	172.16 ± 5.34	0.822
BMI, kg/m^2	25.90 ± 2.81	26.16 ± 2.86	0.616

Workers at the Al-Samawa oil refinery got their BP measured using a computerized wrist cuff monitor. Two measures of the individual's BP were taken during one working day, with the average of those two readings recorded after each measurement.

Statistical analysis was performed using the statistical software package SPSS version 21.0 (SPSS Inc, Armonk, NY: IBM Corp). For the descriptive analysis, results are presented as mean (M) ± standard deviation (SD). For data with normal distribution, inter-group comparisons were performed using Student's t-test. Multiple comparisons were performed with one-way ANOVA and Tukey HSD post-hoc test. A value of $P<0.05$ was considered significant.

Results

The current study demonstrated that there was a highly significant drop in the mean values of FVC, FEV1, FEV1/FVC%, PEFR, and $FEF_{25-75\%}$ of employees at the Al-Samawa oil refinery, in comparison with the control (Table 2).

Table 2.

Lung function parameters in oil refinery workers and the control group.

Parameter	Control group	Oil refinery workers	*P*-value
FVC (L)	4.60 ± 0.37	3.98 ± 0.62	<0.0001
FEV_1 (L)	3.71 ± 0.29	3.09 ± 0.38	<0.0001
FEV1/FVC (%)	87.60 ± 3.16	74.90 ± 3.36	<0.0001
PEFR (L/s)	6.82 ± 1.53	5.68 ± 1.29	<0.0001
$FEF_{25\%-75\%}$ (L/s)	3.87 ± 1.77	3.30 ± 1.25	0.0438

According to our findings, the mean values of FVC and FEV_1 among PW and OW were significantly lower than the control values (Table 2). In addition, among OW and TW, FEV_1 and FEV_1/FVC significantly decreased, compared to control. Furthermore, the mean values of PEFR and $FEF_{25\%-75\%}$ in OW were significantly lower than the control. Mean FVC, PEFR and $FEF_{25\%-75\%}$ values were significantly lower in OW than in PW and TW. Furthermore, the mean values of FEV_1 and FEV_1/FVC in OW were significantly lower than in PW (Table 3).

Table 3.

Lung function parameters in the subgroups of oil refinery workers.

Variable	Control group (1)	Oil refinery workers			Statistics One-way ANOVA and Tukey HSD post-hoc test
		PW (2)	OW (3)	TW (4)	
FVC (L)	4.53 ±0.39	3.94 ±0.29	3.58 ±0.71	4.35 ±0.27	F=28.3672, P=0.0000 P_{1-2}=0.0000, P_{1-3}=0.0000, P_{1-4}=0.3726, P_{2-3}=0.0457, P_{2-4}=0.0167, P_{3-4}=0.0000
FEV_1 (L)	3.67 ±0.33	3.21 ±0.29	2.73 ±0.74	3.10 ±0.57	F=24.3087, P=0.0000 P_{1-2}=0.0010, P_{1-3}=0.0000, P_{1-4}=0.0000, P_{2-3}=0.0070, P_{2-4}=0.8742, P_{3-4}=0.0590
FEV_1/FVC (%)	81.54 ±5.16	81.26 ±4.19	68.80 ±4.85	65.88 ±5.95	F=69.1823, P=0.0000 P_{1-2}=0.9965, P_{1-3}=0.0000, P_{1-4}=0.0000, P_{2-3}=0.0000, P_{2-4}=0.0000, P_{3-4}=0.2746
PEFR (L/s)	6.81 ±1.46	5.83 ±0.81	4.44 ±0.64	6.05 ±1.02	F=20.2432, P=0.0000 P_{1-2}=0.0102, P_{1-3}=0.0000, P_{1-4}=0.0714, P_{2-3}=0.0020, P_{2-4}=0.9373, P_{3-4}=0.0002
$FEF_{25\%-75\%}$ (L/s)	3.87 ±0.79	3.55 ±0.74	2.18 ±1.27	3.54 ±1.34	F=14.8800, P=0.0000 P_{1-2}=0.5893, P_{1-3}=0.0000, P_{1-4}=0.5643, P_{2-3}=0.0001, P_{2-4}=1.0000, P_{3-4}=0.0002

SBP and DBP were significantly higher in the Al-Samawa oil refinery workers than in the control (Table 4).

Table 4.

Blood pressure in oil refinery workers and control group.

Blood pressure	Control group	Oil refinery workers	*P*-value
SBP, mmHg	122.89 ± 3.74	128.33 ± 8.57	<0.0001
DBP, mmHg	81.17 ± 2.04	89.17± 4.92	<0.0001

Discussion

According to the findings, the employees at the Al-Samawa oil refinery had a significant decrease in FVC, FEV_1, FEV_1/FVC%, $FEF_{25\%-75\%}$, and PEFR compared to the control. These results corroborated the findings of Sajid et al.,[21] which showed that workers exposed to petrochemical compounds have a reduction in pulmonary function. Acute exposure to a polluted environment also changes lung functioning, as mentioned in Kodidala et al.[22] Additionally, the decrease in lung function measurements in oil refinery workers, compared to control, may indicate airway irritation from gaseous pollutants due to increased mucus production from goblet cells.

The research by Tanyanont et al.[23] was carried out in Thailand to investigate the effects of volatile organic compounds on the respiratory systems of people living near petrochemical production. Wheezing and other upper respiratory symptoms were more prevalent in samples from people close to petrochemical industries. BTEX contains monoaromatic hydrocarbons, which have been linked to severe health effects, such as asthma, nausea, and nasal, oral, and eye irritation.[24] Ramirez et al.[25] observed that individuals who live near refineries and are engaged in oil spill cleanup efforts suffered from several health issues, including skin, eye, and mucous membrane irritation, in their study on the pollution produced by crude oil extraction-refining and their impacts on human health.

Long-term contact with petroleum products significantly affects some people's lung function.[26] Some research shows that breathing in BTEX-H[n-hexane] can lead to adverse lung effects, such as asthma.[27] In an Italian study, SO_2 from oil refineries was highly linked to decreased lung function and increased airway inflammation.[28]

Similar to our results, Meo et al.[29] noticed that employees of oil refineries had significantly decreased lung function measurements, compared to their matched controls.

Workers in the Al-Samawa oil refinery operations department may have been exposed to a higher concentration of air pollutants than those in other departments, as measured by the low values of pulmonary function parameters. The petrochemical company generates several compounds from hydrocarbons and other petroleum refining products. Long-term exposure to petrochemical compounds and their vapors has been related to several diseases, including lung damage.[30]

Exposure to gases produced by refineries, power stations, and other factories has been linked to an increased risk of developing various illnesses, including cancer, heart disease, pneumonia, and mortality at an earlier age.[31] The acute and chronic toxicity of volatile organic compounds includes symptoms such as eye, nose, and throat irritation, headaches, nausea, dizziness, fatigue, and shortness of breath.[32] It has been established that emissions from petroleum refineries contribute to diseases, illnesses, and even mortality in persons close to petrochemical factories or petroleum refineries.[33]

SBP and DBP were significantly higher in the Al-Samawa oil refinery workers than in the control. Darwish et al.[34] stated that among the Aden refinery company workers, allergic conditions were the most frequently observed disease. Furthermore, hypertension was the second most common ailment (42.2%). Therefore, it is possible that this finding can be related to the observation that workers of the Al-Samawa oil refinery are significantly exposed to gaseous pollutants in their work environment, which causes vasoconstriction in the arterioles and increased vascular resistance, which ultimately leads to an elevation in BP. Increases in BP in fuel station workers have been attributed to the pressure effects of petrol fumes or particles.[35] Petroleum products should be recognized as possibly contributing to cardiovascular problems.

Polycyclic aromatic hydrocarbons, sulfur oxides, particulate matters, volatile organic compounds, polychlorinated biphenyls, nitrogen oxides, and O_3 are all air pollutants linked to an increased risk of cardiovascular illness.[36] A study of workers at Italian petroleum, gas, and energy companies found that those age 45 and above had a significantly greater risk of hypertension, hyperglycemia, and lipidemia.[37]

Conclusion

The current study has demonstrated significant declines in pulmonary function parameters in oil refinery workers exposed to petroleum refinery products in the workplace. This study concludes that the Al-Samawa oil refinery workers have impaired respiratory functions. In addition, the lung function of those working in the operations department was significantly lower than that of individuals working in other occupations. Exposure to petrol vapors in the workplace is associated with increased BP.

Ethical Considerations

The study protocol was reviewed and approved by the Ethics Committee of the University of Kufa**.** Written informed consent was obtained from all the participants.

Competing Interests

The authors declare that they have no competing interests.

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