Volume 2 • Issue 1 • 2020

Research Article

Journal of Medical Research and Case Reports

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Pulmonary Function Status among Petrol Filling Workers in Jimma Town, Southwest Ethiopia, 2018

Leyla Temam[1], Samuel Tadesse[2] and Almaz Ayalew[2]*

[1]*Wochamo University*

[2]*Jimma University, Institute of Health, Faculty of Medical Sciences, Department of Biomedical Sciences, Ethiopia*

***Corresponding Author:** Almaz Ayalew, Jimma University, Institute of Health, Faculty of Medical Sciences, and Department of Biomedical Sciences, Ethiopia.

Received: January 28, 2020; **Published:** February 04, 2020

Abstract

Background: Petroleum has disastrous effects on human health, especially on the respiratory system due to its high accessibility and excellent absorption surface. Despite working at the petroleum station has serious health effects on respiratory system, in Ethiopia; there are no published data available to assess pulmonary function test among petrol filling workers.

Objective: To Assess Pulmonary Function Status of Petrol Filling Workers in Jimma Town, South West Ethiopia, 2018.

Methods: A comparative cross-sectional study was conducted with a total of 132 study participants (66 petrol fill workers and 66 controls) were employed in the study. An interview administered pre tested structured questionnaire (BMRC) was used to collect data. Lung function was measured using a digital portable spirometer. Descriptive statistics, independent sample t-test and p value of less than 0.05 was considered significant

Result: The study revealed that the there is significant reduction ($p<0.05$) in FVC, FEV1, FEV1%, FEF25-75% and PEFR was found in the study group (Petrol fill workers) as compared to the controls. The prevalence of abnormal lung function is 37.9 and 15.2 among petrol fill workers and controls respectively.

Conclusion: This study concluded that petrol fill workers are at greater risk of pulmonary function impairment. Creating awareness about proper utilization and effect of petroleum exposure.

Keywords: *Pulmonary function status; Petroleum filling workers*

Introduction

Background

World Health Organization (WHO) defines healthy work place as a place where everyone works together to achieve an agreed vision for the health and well-being of workers and the surrounding community [1]. Petrol station is as a facility where fuel and lubricants for automobiles are sold [2]. Petrol filling station workers are exposed to both petrol/diesel vapors and the vehicular exhaust [3,4].

Petroleum pump stations are not only an indispensable in modern technological society, but also lifeblood to modern appliances. However, they pose numerous risks and threats to employees and the environment. Anyone of the petrol stations presents a wide range of challenges to the health and safety of people and their environments [5]. Because of the multitude of hazards in such workplaces and the overall lack of attention given to health and safety by many employers, work-related accidents and diseases continue to be serious problems in all parts of the world [6].

Petroleum is a complex mixture of hydrocarbons that occurs in the earth in liquid, gaseous, or solid forms. It is a naturally-occurring brown to black flammable liquid which was formed from the remains of tiny sea plants and animals that died millions of years ago. It consists of hydrocarbons(aromatic, saturated and unsaturated) and non-hydrocarbons (N, S, O_2, vanadium and nickel [7–9].

Common cellular mechanism by which most air pollutants exert their adverse effects is their ability to act directly as prooxidants of lipids and proteins or as free radicals generators, promoting oxidative stress and the induction of inflammatory responses [10]. The effect of vanadium compounds on the function of alveolar macrophages may result in an impairment of the lung's resistance to secondary bacterial infection, bronchitis and pneumonitis in human [11].

Petrol (or gasoline) and diesel fuel are a distillate of petroleum [12,13]. About 95% of components in petrol vapor are aliphatic and acyclic compounds and less than 2% are aromatics [14–16]. However, The exact mixture of which types of hydrocarbons are present in petrol depends entirely on the specific sample of gasoline (what type of oil it was made from, which company refined it and what additives were used [17]. Aromatic hydrocarbons are added to gasoline for maintaining high octane number and for best anti-knock properties. Refined petroleum products generally contain 2–3% benzene by volume [18].

Among the numerous constituents of petroleum products, gasoline constituents (benzene, toluene, ethyl benzene and xylene (BTEX) are designated as the most toxic compounds to humans [19]. Components of car-exhaust as a result of internal combustion of petrol, which are harmful, are CO_2, NO_2, SO_2, benzene, formaldehyde and polycyclic hydrocarbons; these substances are known to produce harmful effects on health by interacting with molecules crucial to the biochemical or physiological processes of the human body [20].

In the occupational context, the lung is most exposed organ as toxic materials in the workplace usually gain entry to the body via an airborne route [21]. Occupational diseases in gasoline-filling workers have been recognized for many years, and affect workers in different ways, such diseases are still problems in all parts of the world [22]. It is a well-known fact that the polluted air causes ill effect on the health. Epidemiological studies have shown that a sudden increase in air pollution has often been associated with immediate increase in morbidity and mortality [23]. Globally, 3 million deaths were attributable to ambient air pollution in 2012 in which petroleum is one of the contributors to ambient air pollution. About 87% of these deaths occur in low and middle income countries (LMICs), which represent 82% of the world population. About 211 000 deaths occur in Sub-Saharan Africa [24]. Many studies have been done which shows the effect of polluted environment on the respiratory tract [25].

Atmospheric concentration of gasoline vapor (approximately 2000 parts per million) is not safe when inhaled even for a brief period of time (seconds). During fuelling of vehicles, the concentration of gasoline vapor in the air is between 20 and 200 ppm [26]. Several epidemiological studies on human populations exposed to petroleum vapors have shown that there is an increased incidence of diseases [27]. In addition to these workers are also at a risk of inhaling automobile exhaust fumes. The combined effects of the two may result in accelerated decline of lung function. High ambient air concentrations of solvents and pollutants had well defined and marked systemic pulmonary inflammatory response with decreased forced vital capacity(FVC), forced expiratory volume in the first second (FEV1), inspiratory and expiratory flow rates [10,28]. A study conducted in Zambia shows a higher prevalence of lung function impairment among fuel attendants (29.0%) than non-exposed participants (7.4%) with significant reduction parameters (FEV1, FVC and PEF) when compared with the non-exposed group (p values 0.004, 0.010 and 0.031, respectively [29].

Petrol pump workers spent 8-12 hours at their work place. Most of them are not using protective devices. This makes station workers to likely have grave ill effects on their health [30–33]. Despite working at petroleum station has such serious health effect on body systems especially on respiratory system, in Ethiopia, there is no published article conducted to assess the pulmonary function status of petrol filling workers. Hence, this study aims to evaluate the Pulmonary Function Status among Petrol Filling Workers in petroleum station.

Methods and Materials

Study Area and Period

The study was conducted in Jimma town from April 2 to May 2, 2018. There are 12 filling stations in the city which are owned by private companies.

Study design

Comparative cross-sectional study was employed

Population

Source Population

Exposed Group: All petrol filling workers of Jimma town in 2018.

Control Group: All security guards were selected from Jimma town population.

Study Population

Exposed Group: All petrol filling workers of Jimma town who was available during data collection period.

Control Group: non-smoking, age, sex, height, weight and educational status matched security guards were selected from Jimma town population.

Inclusion and Exclusion Criteria

Inclusion Criteria

- For study group: the person working in the petrol pump station for > 1year.
- For control group: non-smoking, age, sex, height, weight and educational status matched security guards who have no history working in petroleum station or any other petrochemical industries were included in the study.

Exclusion Criteria

Subjects with history of diabetes mellitus, hypertension, pulmonary tuberculosis, asthma, chronic bronchitis, and those who were drug addicts, cigarette smokers and those who had undergone major abdominal or chest surgery were excluded from the study.

Sample Size Determination

Using double proportion formula the calculated sample size was 110. However, because of manageable sample size all petrol filling (81) workers working in 12 stations and the same number of (81) non- petrol filling workers were employed in the study. Therefore the final sample size will be 162.

Data Collection Procedures

Interview administered standardized questionnaire based on British Medical Research Council questionnaire was administered to each participant to obtain information on social demographic characteristics and use of personal protective equipment (PPE). Data was collected by qualified data collectors and supervised by the investigator.

Measurement of Respiratory System Variables

Spirometry

Using the digital spirometer Forced vital capacity (FVC), Forced Expiratory Volume in one second (FEV_1), FEV_1 /FVC ratio, FEF25-75 % and Peak Expiratory Flow Rate (PEFR) was measured.

The subjects were taken 10-15 minutes of rest before performing the Spirometry. Before performing the actual procedure, the participants were made to sit in upright position in a plastic chair with arm rest and feet in dependent position in order to avoid falling due to syncope. Participants were introduced to the instruments, and procedures were explained. Demonstration, handling, and use of instruments were explained. The Test was repeated three times and for each pulmonary parameter. The best result was considered for analysis. All pulmonary function tests were carried out at a fixed time of the day to minimize diurnal variation. All spirometer measurements were based on the American thoracic society guideline.

Study Variables

Dependent variables

Pulmonary function status (pulmonary function test)

Independent Variables

- Age, Sex, Educational status, Duration of work per years
- Duration of working hours per day, Use of personal protective device

Data Analysis Procedures

Data was entered in to EPI- data software and transferred to SPSS version 21 (SPSS Inc, Chicago, USA) software for analysis. Descriptive statistics was used to summarize service year and anthropometric measurements of subjects.

Independent sample t-test was used to compare the mean respiratory scores of exposed and non- exposed groups.

Data Quality Management

The questionnaire was translated to Afaan Oromo (local language) and re translated back to English ,to keep consistency of question and administered to all control and exposed participant. Pre-test was conducted on (5% of study population) petroleum station workers of Agaro town. Based on the findings of the pre-test some modification and developments of the tool was done. Two days training was given to data collectors. Data collectors were instructed to check the completeness of each questionnaire whether each and every question is completely answered and also the supervisor rechecked the completeness of the questionnaire immediately after submission.

Ethical Consideration

Ethical clearance was obtained from Institute of Health Science Ethical Review committee of Jimma University to conduct the study and permission letter from fuel station owners was taken. Prior to data collection each study subject or participant was adequately informed about the purpose of the study and the importance of their participation to confirm willingness for participation. Participant's confidentiality was maintained.

Results

Pulmonary function status

An independent sample t-test was used to compare Spirometric measurement of pulmonary function (FVC, FEV1, FEV1%, FEF25-75% and PEFR) of exposed and non –exposed group. Accordingly, FVC, FEV1, FEV1%, PEFR& FEF25-75% were higher in control respondents than in exposed respondents and the mean difference was found to be statistically significant ($p< 0.05$) as shown in Table 1.

Parameter	Petrol fill workers Mean ±SD	Non- exposed Mean ±SD	t- value	P value
FVC	3.5588 ± 0.70967	3.9502 ± 0.77122	-3.034	0.003*
FEV1	2.8685 ± 0.76563	3.3253± 0.67315	-3.640	0.000**
FEV1%	80.4091 ± 11.35982	84.3788 ± 9.18655	-2.207	0.029*
FEF - 25-75%	3.7709 ± 1.08956	4.3332 ± 1.15066	-2.883	0.005*
PEFR	6.5936 ± 1.89880	7.5518 ± 2.31046	-2.603	0.010*

SD: standard deviation, CI: confidence Interval,
* p value < 0.05, **p value < 0.001

Table 1: *Comparisons of Spirometric measurements among petrol fill workers and controls in Jimma Town, South West Ethiopia, 2018.*

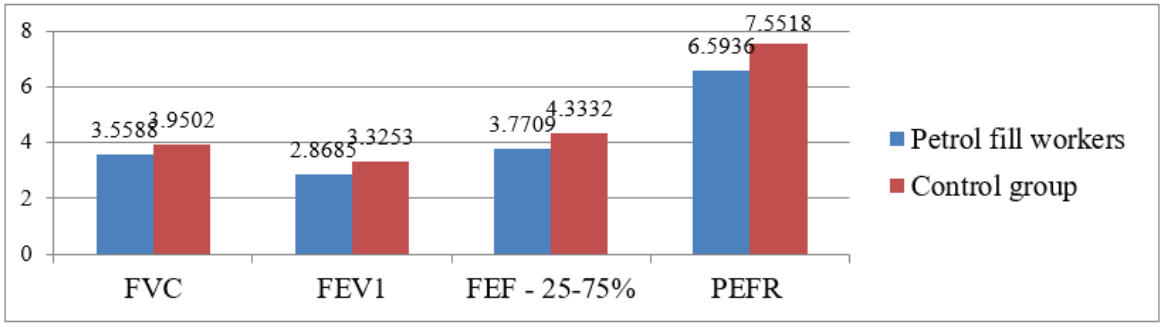

Figure 1: *Comparison of the observed (actual) mean respiratory score of petrol fill workers and control group in Jimma Town, South West, Ethiopia, 2018.*

An increase in duration of exposure to volatile organic compounds results in decrease pulmonary function parameters. As presented in table below FVC (vs), FEV1 (vs), FEV1%, FEF - 25-75 %,(L/s) and PEFR (L/s) shows significant difference (p<0.05).

Parameters	<=5 Years	>5 years	P value
FVC	3.7512 ± 0.65622	3.2432 ± 0.69232	0.004*
FEV1	3.1110± 0.66253	2.4708 ± 0 .76866	0.001*
FEV1 %	83.3415± 8.18416	75.6000± 14.10969	0.006*
FEF - 25-75%	4.0573 ± 0.96932	3.3012 ± 1.13104	0.005 *
PEFR	7.1195 ± 1.70548	5.7312 ± 1.91568	0.003*

Table 2: *An independent sample t-test for association duration of exposure and lung function in Jimma Town, South West, Ethiopia, 2018.*

Regarding their working hour's pulmonary functions doesn't show any significant difference among petrol fill workers. (Table 3)

Parameters	8 hours	>8 hours	P value
FVC	3.4590 ± 0.74711	3.7030 ± .63778	0.172 NS
FEV1	2.7162 ± 0.76209	3.0885 ± 0.72908	0.051 NS
FEV1 %	78.6154 ± 10.85215	83.0000 ± 11.77677	0.124NS
FEF - 25-75%	3.5654 ± 1.15578	4.0678 ± 0.92769	0.065 NS
PEFR	6.4403 ± 1.95385	6.8152 ± 1.82973	0.435 NS

NS= Not significant

Table 3: *An independent sample t-test for association working hours and lung function in Jimma Town, South West, Ethiopia, 2018.*

The type of lung disorder mostly evident in exposed is restrictive. About 3(4.5%), 16(24.2%), 6(9.1%) and 4(6.1%), 4(6.1%) 2(3%) develop obstructive, restrictive and mixed type of lung disorder in petrol fill workers and controls respectively. FVC and FEV1 are affected in the above lung dis orders but FVC is more affected in restrictive and FEV1 more affected in obstructive.

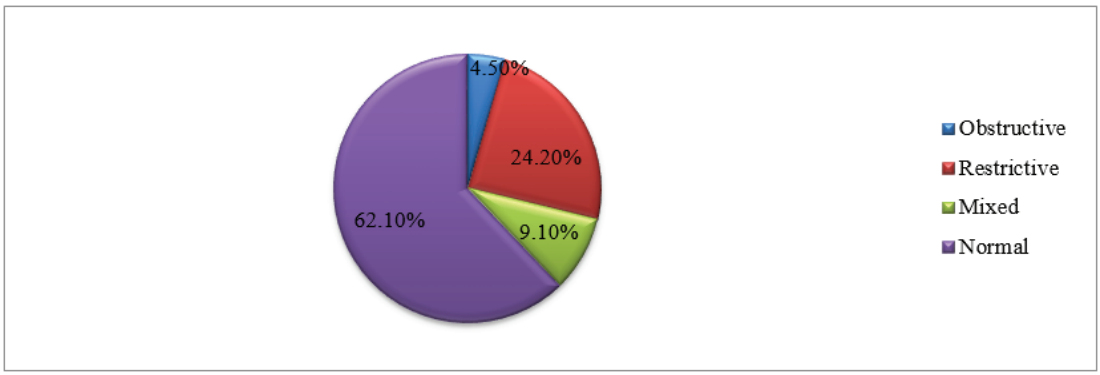

Figure 2: *Lung function pattern among petrol fill workers in Jimma Town, South West, Ethiopia, 2018.*

Discussion

The result of this study suggested decrease in pulmonary function in petrol fill workers when compared to controls. There is a high prevalence of lung function impairment among petrol fill workers (37.9) in comparison to controls (15.2). The prevalence lung function impairment among fuel station workers observed in this study is slightly higher than the prevalence which is observed in Ndola, Zambia (29%). This may be due to the minimum duration of service in this study is one year. However, 56.5% of the petrol attendants in Ndola, Zambia had been exposed for <1 year and the maximum duration of service was five year. Long term exposure to fuel has been associated with lung function impairment [27,29,34].

FVC: In this study there was significant (p=0.003) decrease in the mean value of FVC (3.5588) in petrol fill workers in comparison with controls (3.9502). Begum S et al. in Mysore city found similar finding where the mean of FVC decreased significantly(p= 0.000) in petrol fill workers in comparison to controls [23].

FEV1: in this study there was highly significant decrease (p=0.000) in petrol pump workers (2.8685) when compared to controls (3.3253). Mehta et al. in Anand district observed similar finding where the mean value of FEV1 (1.3782±0.7769) are significantly lower (p<0.001) in petrol fill workers in comparison to controls (2.0090±0.5653) [24].

FEV1%: in this study there was a significant (0.029) decrease in FEV1 in in petrol pump workers (80.4091) when compared to controls (84.3788). Meo et al. observed similar finding where the mean FEV1% is significantly (0.013) decreased in petrol fill workers (67.19±3.15) in comparison to controls (76.66±2.01) [25].

FEF25-75%: The flow rates at low volumes i.e. FEF25-75% indicates flow rates in small airways i.e. those with internal diameters of less than 2mm[35]. In this study there is a significant (p=0.005) decrease in FEF25-75% in in petrol fill workers(3.7709) in comparison to controls(4.3332).this study coincides with study conducted by Salvi S R et al. who observed that there was a significant(0.000) decrease in FEF25-75% in in in petrol fill workers(1.67 ± 0.40) when compared to controls (4.28 ± 0.81) [36]. This study is also in agreement with studies done by Vyas et al. [6] .

PEFR: in this study there is a significant decrease (0.010) in PER in in petrol pump workers (6.5936) when compared to controls (7.5518). Similar observations were reported by P. Bhardwaj et al. who concluded that there was a significant (0.029) decrease in PEFR petrol fill workers (3.80±1.68) in comparison to controls (4.09±1.34) [26].

The present study also shows that pulmonary function (FVC, FEV1, FEV1%, FEF - 25-75% and PEFR) decreases significantly if the duration of service is more than five years compared with less than five years. D.Chakraborty et al also observed statistically significant decline in the values of FVC, FEV1 and PEFR in exposed group with increase in the duration of exposure [33].

In general it was observed that the mean value FVC, FEV1, FEV1%, FEF25-75% and PEFR were significantly reduced in petrol fill workers when compared to their matched controls. The type of lung function impairment which is more evident in this study is restrictive. The higher lung function impairment can be explained on the basis that petroleum hydrocarbons cause an increase in lung tissue malondialdehyde (MDA), an index of lipid peroxidation [3].

Conclusion

The present study concluded that inhalation of volatile organic compounds causes' lung function impairment in petrol fill workers.

Exposure to petrol showed significant reduction in the mean values of lung function parameters like FVC, FEV1, FEV1%, PEFR and FEF25-75% in petrol fill workers compared to controls.

The type of lung function impairment mostly evident among petrol fill workers in this study is restrictive.

Limitation

Most important limitation of this study is air analysis & urine analysis was not done so that the quantity of fuel vapor inhaled by the subject is not known.

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