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A Study to Find out Comparative Effects of Incentive Spirometer and Nasofilter on Pulmonary Function among Petrol Filling Workers: An Interventional Comparative Study

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Abstract: ***Background: It is well known as well as many researches have been done on how pulmonary functions are affected by air pollution and other toxic gases. Prolonged and continuous work in polluted air may lead to damage in pulmonary system like restrictive lung changes (fibrosis), increases secretion production, and inflammatory changes. Pulmonary function testing is a valid and reliable to measure any minute changes in lung volumes and capacities. PFT is also a valuable diagnostic tool to quantify changes of respiratory system before it reflects as symptoms. So, it gives an early alarm sign before permanent changes set in lungs. Petrol filling workers are asymptomatic but they have to work continuously in polluted air and exposed to toxic gases such as gasoline, hydrocarbons and carbon dioxide from unlimited vehicular sources. Incentive spirometer is widely used to improve lung functions. The device 'Nasofilters', a Nano - respiratory filter gives protection against the finest particulate pollutants in the air for at least eight hours and hence reduces risk of respiratory diseases. The first prototype of Nasofilters was developed in 2016. Aims: to find out comparative effects of incentive spirometer and nasofilter on pulmonary function among petrol filling workers. Methodology: 40 subjects were divided into the group of 10 each out of which Group A was controlled group, Group B used spirometer, Group C was given Nasofilters and Spirometer training twice a day for 4days/week for 4 weeks and Group D was given only Nasofilters during working hours. SF - 36 questionnaire, FVC, FEV_1, FEV_1/FVC and PEFR were taken as outcome measures. The data were analysed by One - way ANNOVA and Post hoc Bonferroni test through SPSS. The test result shown significant difference in all the groups when compared to controlled group. The result of this study shown that there was significant improvement in pulmonary function and health related quality of life. Conclusion: It was observed that pulmonary functions improve in group who received both incentive spirometer and nasofilter. Nasofilter prevents entry of harmful particles in respiratory pathway and incentive spirometer improves lung functions.***

Keywords: nasofilter, petrol filling worker, pulmonary function

1. Introduction

India is a rapid developing country and automobiles running on the roads are increasing day by day. Number of petrol pumps are also increasing due to increasing in number of vehicles. Petrol pump fillers are very much exposed to petrol vapours and gases exhaust for many months to many years. This continuous exposure may lead to some structural changes in respiratory system and causes symptoms like cough, breathlessness and wheezing.

Petrol is a complex combination of hydrocarbons. Aliphatic and acyclic compounds make up to 95% of the petrol components and less than 2% are aromatics. Diesel exhaust fumes are a complex mixture of particulate and gas phase pollutants. Carbonaceous core and adsorbed organic compounds are highly respirable components. Gas phase components, particularly SO_2, may subsequently undergo gas to particle reactions and form secondary particulate. The carbon core is defined as elemental carbon (EC) and adsorbed organics as organic carbon (OC). When inhaled, these cause damage to the airways and the lungs. The particles increase the toxicity of the chemicals present in the smoke. Chemicals like benzenes and other air pollutant like lead, NO_2, CO_2 etc. . . are also responsible for respiratory disease. These compounds when inhaled for long term or in high concentration leads to mucosal irritation and alveolar swelling which leads to obstructive and restrictive lung disorders.

Moreover, this petrol pump station didn't have the provision of self service and petrol pump workers are employed for fuelling purpose. These fuel fillers work continuously for 8 - 12 hours or more to meet the demands of society without maintaining personal hygiene and without using any personal protective equipment's like gloves. Apart from filling fuel these fillers are also responsible for all sorts of other workers like checking fuel tanks on daily basis, loading and unloading of the fuel and checking pressure in tires of vehicle post or pre filling. It is also observed that most of these workers comes from extremely rural area and avoid going home on frequent basis to meet their finical needs and prefer to stay at petrol pump station which make them more prone to exposure to various dangerous chemical constituent of petrol and gasoline for long term.

The rising number of vehicles has sharply increased the level of air pollution in various cities of India. A Health Survey done by the Centre for Science and Environment (CSE), New Delhi, has shown that 141 (80%) cities in India exceed the PM_{10} (pollutants that emit particulate matter of less than 10 micrometres in size) standard, 90 cities have a critical level of PM_{10} and 26 cities have the most critical level, exceedingly thrice the standards.

Particulate matter (PM) is a complex mixture of suspended solid and liquid particle in semi equilibrium with surrounding gases. The particles larger than 10 µm in diameter are deposited almost exclusively in the nose and throat whereas those smaller than 1 µm reach the lower regions of the lung. The intermediate size range gets deposited between these two extremes of the respiratory tract. Outdoor (ambient) PM size ranges from approximately 0.001 - 100 µm in aerodynamic diameter. PM is considered as the single best indicator of potential harm.

PM_{10} consist of PM with a diameter up to 10 µm. PM10 deposit relatively quickly with a lifetime of less than 2 days, and exposure may lead to adverse responses in the lungs triggering an array of cardio - pulmonary problems.

Nuclei mode or ultra - fine particles (UFP) are particles smaller than 0.1 µm. Exposure to high doses of UFP can cause severe pulmonary inflammation and haemorrhage, high degree of alveolar and interstitial oedema, and disruption of epithelial cells.

Oxides of nitrogen (NOx) Nitrogen oxides are formed during combustion processes at high temperatures from the oxidation of nitrogen in air. Oxides of nitrogen are immunotoxin and increase the susceptibility to respiratory tract infection such as influenza, irritation of the lungs.

Carbon monoxide (CO) higher concentration of CO may result in production of carboxyhaemoglobin (COHb). This impairs the transport of oxygen.

Spirometry is a reliable non - invasive and valid tool to assess lung function in the initial asymptomatic stages of respiratory dysfunction, as compared to other tools. It has been documented that only spirometry enables the detection of chronic obstructive pulmonary disease (COPD) and other risk to develop respiratory disease — five to ten years before shortness of breath develops. Petrol pump workers, who are asymptomatic, may have abnormal lung function.

The device 'Nasofilters', a Nano - respiratory filter gives protection against the finest particulate pollutants in the air for at least eight hours and hence reduces risk of respiratory diseases. The first prototype of Nasofilters was developed in 2016. It is a use - and - throw, biodegradable product and gives negligible breathing resistance.

Nasofilters involved assembling millions of small - sized pores to create a thin flexible membrane, which could capture very small particles with high efficiency. This allows filters to be used for long hours while maintaining good breathability and comfort. The filters aim to provide relief to common users from air pollution and to protect people, who are prone to allergies, and safeguard those, who are exposed to job related industrial particulate pollutants. The filter can stick to user's nasal orifice and would restrict entry of foreign particulate matter including $PM_{2.5}$ particles, bacteria and pollen allergens.

2. Need of Study

To prevent the occupational health - related hazards like restrictive changes in lungs among petrol pump filling workers.

To improve the quality of life of petrol pump workers.

Aims

- Effects of incentive spirometer and Nasofilters on pulmonary function in petrol pump workers.
- To improve the quality of life of petrol pump workers.

Objectives

- To check the effect of incentive spirometer on FEV_1, FVC, FEV_1/FVC, PEFR with control group in petrol filler workers
- To check the effect of incentive spirometer and Nasofilters on FEV_1, FVC, FEV_1/FVC, PEFR with control group in petrol filler workers.
- To check the effect of Nasofilters on FEV_1, FVC, FEV_1/FVC, PEFR with control group in petrol filler workers.

Materials

In this study, materials to be used are Watch, Incentive Spirometer, Nasofilters, Computerized Spirometer, Chair, Table, Laptop, Sterillium, weighing machine, Measuring tape and Cotton.

Inclusion Criteria:

- Workers at petrol pump as fillers for > 1 year for at least 8 hours/day.
- Age – 20 to 55 years.
- Non - smokers.
- Normal healthy individuals screened by SF 36 Questionnaire.

Exclusion Criteria:

- History of hospitalization in last 6 months
- Uncontrolled vitals
- Uncooperative or no willingness to participate
- Methodology:
- Study Design: Randomized Control Trail
- Blinding: Participate blinding (Single Blinding)
- Number Of Subjects: 40
- Study Setting: Various Petrol Pumps of Rajkot
- Study Duration: 1 Month

3. Methodology

Total 40 Subjects were Selected Based on Inclusion and Exclusion Criteria with Signed Informed Consent. And they are divided in four different groups – group – A, group - B, group – C, and group - D.10 subjects are included in each group. Group - A is considered as control group and others were experimental group.

In Group A, 10 subjects were included and they are not receiving any kind of Intervention. They are considered as control group. Only pulmonary function testing was done.

In Group B, 10 subjects were included and they were receiving Respiratory Muscle Training by Incentive Spirometer For 15 Minutes Twice a Day For 4 Days/ Week For 4 Weeks.

In Group C, 10 subjects were included and they were using Nasofilter 8 hours daily during working hours And Respiratory Muscle Training by Incentive Spirometer For 15 Minutes Twice a Day For 4 Days/ Week For 4 Weeks.

In Group D, 10 subjects were included and they were only using Nasofilters During Working Hours.

Spirometry was done in a sitting position using the computerized pulmonary function testing (PFT) machine (RMS Helios 401) and the guidelines of the American Thoracic Society were strictly followed. Spirometry training was given using Respiratory Flow respiratory exerciser.

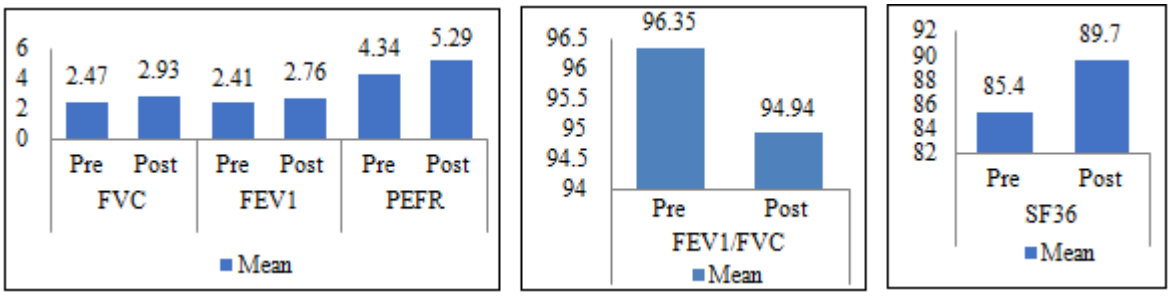
Nasofilters was carefully peeled off from the release paper, holding one of its edges. Then it was hold by both hands of the researcher with index fingers on the top and thumbs down. It was than pasted on the nasal orifice of the subject and pressed all around the circumference. The release paper was removed gently towards the sides from the centre.

Outcome Measures:
All the following outcome measures were taken pre and post intervention: FVC; $FEV_{1;}$ FEV_1/ FVC; PEFR using Computerized Spirometer and SF - 36 Questionnaire

4. Data Analysis

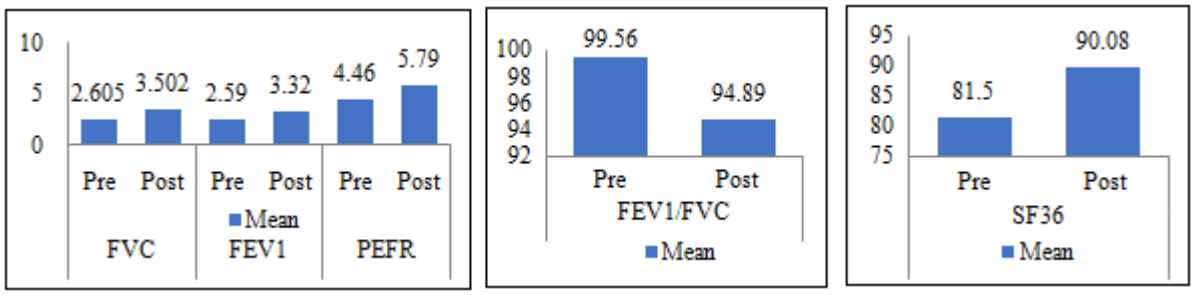
40 subjects were received 4 weeks (4days/week) of training and pre and post data were analyzed using version SPSS 22. Comparison of pre and post data within group was done by using Paired t - test. Comparison of pre score of study variables of all the groups and post score of study variables was done by using One Way ANOVA. Intra - groups comparison of pre score and post score was done by using Post hoc Bonferroni test.

Comparison of variables in Group A.
Interpretation: Pre and post data of FVC, $FEV_{1,}$ PEFR and SF - 36 shows high significance with low standard deviation, whereas FEV_1 / FVC is non - significant with high standard deviation.



Graph 1 for Comparison of Pre and Post Variables in Group A

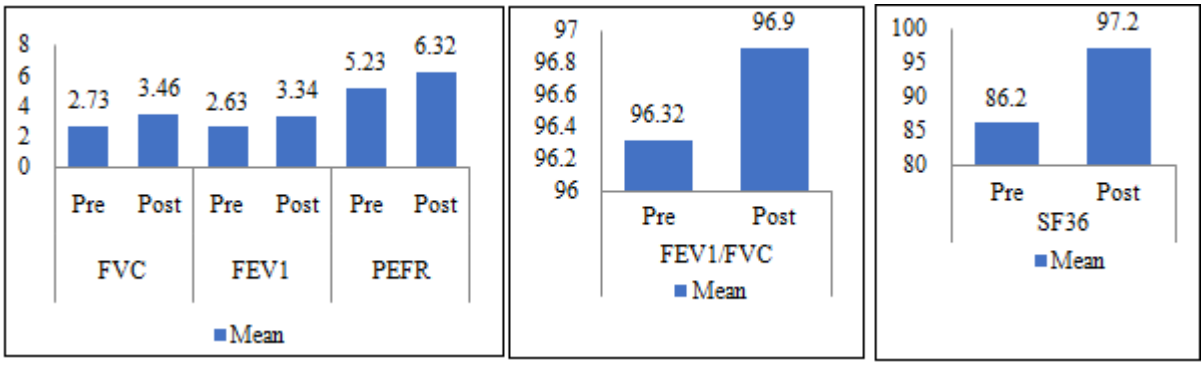
Comparison of variables in Group B.
Interpretation: Pre and post data of FVC, $FEV_{1,}$ of FEV_1 / FVC, PEFR and SF - 36 shows high significance with low standard deviation.



Graph 2 for Comparison of Variables in Group B

Comparison of variables in Group C.

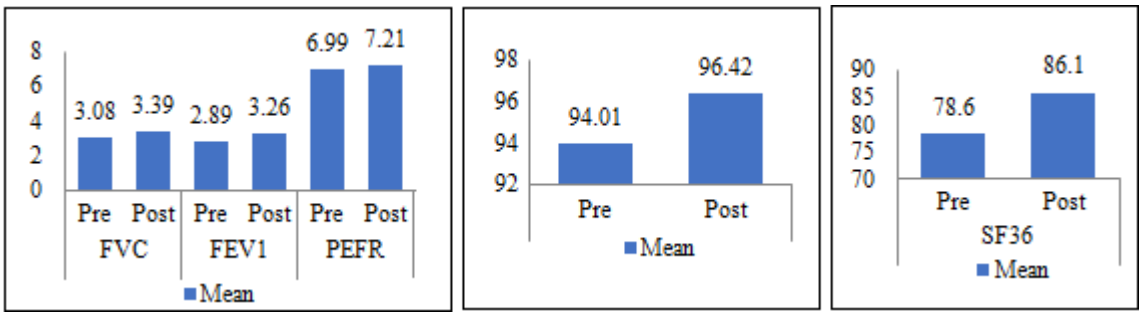
Interpretation: Pre and post data of FVC, $FEV_{1,}$ PEFR and SF - 36 shows high significance with low standard deviation, whereas FEV_1 / FVC is non - significant with high standard deviation.



Graph 3 for Comparison of variables in Group C

Comparison of variables in Group D

Interpretation: Pre and post data of FVC, FEV_1 and SF - 36 shows high significance with low standard deviation, whereas, PEFR and FEV_1 / FVC is non - significant with high standard deviation.



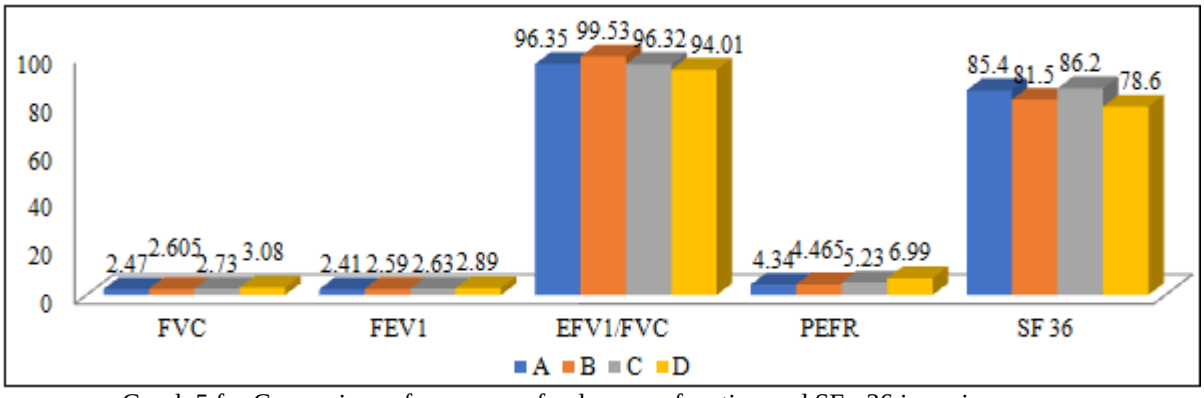
Graph 4 for Comparison of variables in Group D

Comparison of pre score of SF - 36 Questionnaire in various group
Interpretation: There is significant difference in SF - 36 of pre score in various groups

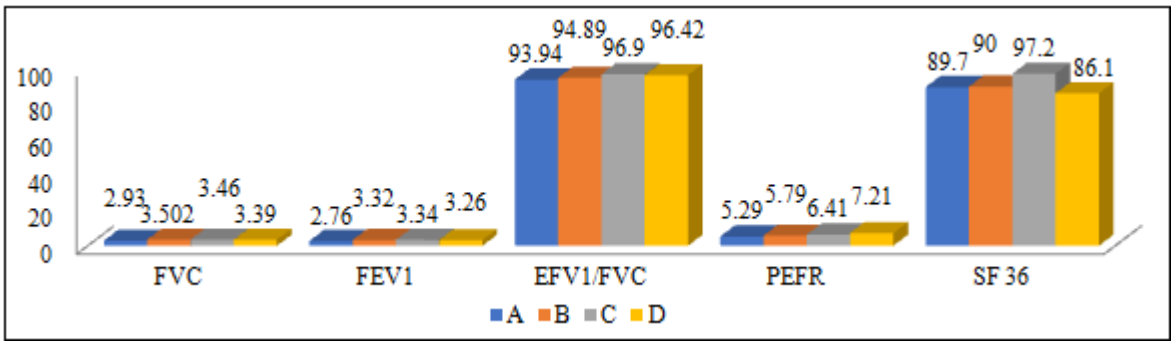
Comparison of post score of SF - 36 Questionnaire in various group
Interpretation: There is significant difference in SF - 36 of post score in various groups.

Comparison of pre score of pulmonary function variables in various group
Interpretation: There is significant difference in FVC, FEV_1/FV and whereas FEV_1 was found to be non - significant.

Comparison of post score of pulmonary function variables in various group
Interpretation: There is significant difference in FVC, FEV_1/FV and whereas FEV_1 was found to be non - significant.



Graph 5 for Comparison of pre score of pulmonary function and SF - 36 in various group



Graph 6 for Comparison of post score of pulmonary function and SF - 36 in various group

Intra - groups comparison of pre score of pulmonary function variables

Interpretation: The pre score of pulmonary variables of Group A is compared with other group, only FVC and PEFR of group D shows significant difference whereas FEV_1/FVC didn't show significant difference.

Intra - groups comparison of pre score of SF - 36

Interpretation: The pre score of SF - 36 of group A shows a significant difference when compared with group D. When compared with rest of the groups the difference found to be non - significant.

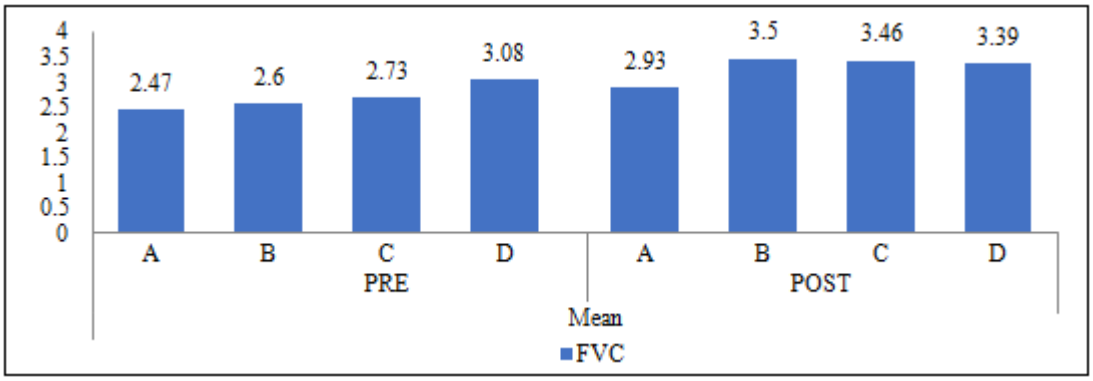
Intra - groups comparison of post score of pulmonary function variables

Interpretation: The post score of FVC, FEV_1 of group A shows a significant difference when compared with group B and Group C, whereas Pre score of PEFR of group A shows significant difference with group D only.

Intra - groups comparison of post score of SF - 36 questionnaire

Interpretation: The pre score of SF - 36 of group A shows a significant difference when compared with group C and group D. When compared with rest of the groups the difference found to be non - significant.

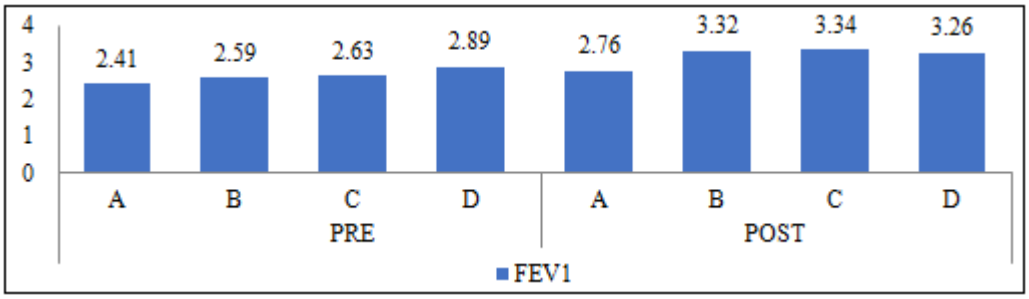
Comparison of Pre and Post FVC of various groups



Graph 7 for Comparison of Pre and Post FVC of various groups

Interpretation: The mean pre value of FVC was seen to be high in Group D followed by Group C, group B and group A whereas the mean post value of FVC was seen high in Group C followed by group B, group D and group A.

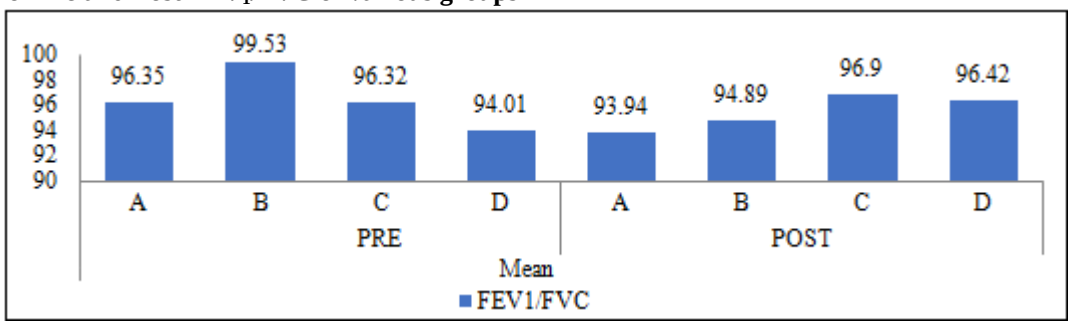
Comparison of Pre and Post FEV_1 of various groups



Graph 8 for Comparison of Pre and Post FEV_1 of various group

Interpretation: The mean pre value of FEV_1 was found to be high in Group d followed by Group C, group B and Group A, whereas mean post value was higher in Group C followed by Group B, Group D and Group A.

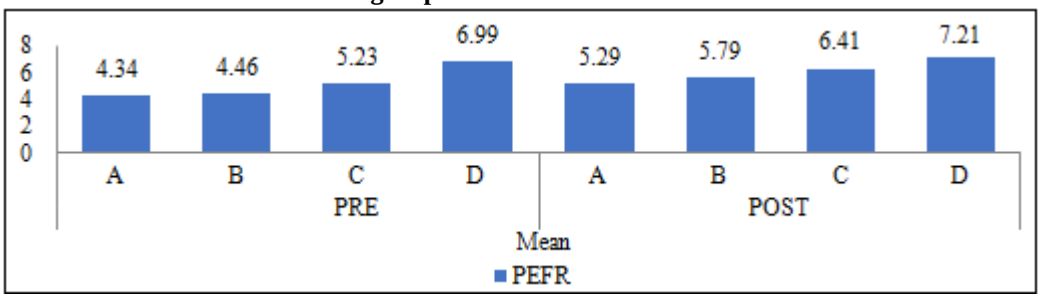
Comparison of Pre and Post FEV_1/FVC of various groups



Graph 9 for Comparison of Pre and Post FEV_1/FVC of various groups

Interpretation: The mean pre value of FEV_1/FVC was found to higher in Group B followed by Group A, Group C and Group D, whereas mean Post value was higher in Group C followed by Group D, Group B and Group A.

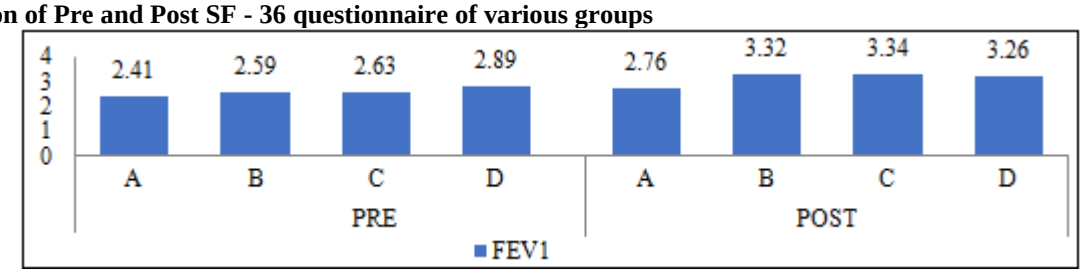
Comparison of Pre and Post PEFR of various groups



Graph 10 for Comparison of Pre and Post PEFR of various groups.

Interpretation: The mean pre value of PEFR was found to be high in Group D followed by Group C, Group B and Group A. The mean post value of PEFR follows the same pattern.

Comparison of Pre and Post SF - 36 questionnaire of various groups



Graph 11 for Comparison of Pre and Post SF - 36 questionnaire of various group.

Interpretation: The mean pre value of SF - 36 questionnaire was seen higher in Group C, followed by Group A, Group B and Group D, whereas the mean post value of SF - 36 was seen higher in Group C followed by Group B, Group A and Group D.

5. Discussion

Petrol filling workers are more exposed to petrol vapours like acyclic compounds. These compounds increase risk of cancer and other cardio respiratory disorders. Inhaled hydrocarbons and other metals are responsible for some serious changes like chronic inflammation of lung tissues. Work opportunity may lead some dangerous effects later on. Some researchers have indicated that increased airway resistance, increasing closing volume and reversible decrease of FVC On Exposure to these toxic compounds for a longer duration, the petrol pump workers present with impaired lung function.

Comparison of FVC among Groups

Forced vital capacity (FVC) is increased in group using groups with Spirometer and group using Nasofilters and spirometry which indicates that prevention of inhalation of toxic particles prevents further deterioration of lung function. Moreover, strengthening of respiratory muscles are able to alleviate particles from airways.

Comparison of FEV_1 and PEFR among Groups

Collection of the brunt particles over the time causes restriction for the air to remove from the lungs. interventions like spirometry and nasofilter with group using none of them it was found that group using nasofilter and nasofilter and spirometry showed significant difference in FEV1 and PEFR.

Comparison of FVC/FEV_1 among Groups

Post reading shows reversal of restrictive pattern of lung function which shows that long term respiratory training and prevention of inhalation of fumes both are useful to prevent further damage as well as may reverse lung injury.

Comparison of SF - 36 among Groups

Both strengthening and preventive measure i.e., Spirometry and nasofilter respectively was used it showed maximum improvement in quality of life in SF - 36.

Change from restrictive to normal variety of lung function.

Studies done on distribution of particulate matter in human lungs have shown terminal bronchioles and adjacent first - generation respiratory bronchioles as the major site of impact. Particles are accumulated in bronchioles and cause multiple structural changes shows restrictive pattern in pulmonary function testing. Aging may contribute further restrictive changes. Several studies shows that estimated rate of decline in FEV1 is 25–30 ml/year starting at the age of 35 – 40 years and can double to 60 ml/year after the age of 70 years.

Unlike in India, the petrol pump workers either use rubber hood over the delivery station or those stations are self - service stations in USA and United Kingdom to restrict the exposure to harmful petrol/ diesel vapours. Occupational exposure to volatile organic compounds has also been restricted by installation of petrol vapor recovery system in many countries. In New South Wales the department of Environment, Climate change and water, has published standards and practice guidelines for vapor recovery at petrol pumps. The stage - I (vapor recovery) system limits the emissions of volatile organic compounds that result from unloading petrol from a road tanker into petrol pump storage tanks. The stage - II (vapor recovery) system is designed to capture the vapor displaced when vehicles are refuelled at petrol pumps. Some countries like USA have had a stage I system for many years and now upgrading to stage II. A study done by an Italian oil company, Agip Petroli estimated that use of recovery system is capable of reducing emission of benzene by 80% and 50% during “fuel in flow” and during removal and replacement of the nozzle and closure of the vehicle tank. Although the installation of vapor recovery system is not mandatory in states of India there are some states like Delhi where these vapor recovery stations are installed to restrict the exposure of petrol pump workers.

6. Conclusion

Many restrictive changes occur due to working in petrol pump station specially among petrol fillers. These changes are mixed type but more are restrictive in nature. Person cannot able to breath fully due to some structural changes in respiratory system.

Use of both incentive spirometer and nasofilter are effective to prevent further respiratory damage and also reverse the changes and normalise the pattern.

Further studies are required to investigate the effects on pulmonary function for longer period of time and having large sample size.

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