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An Investigation of Pulmonary Function Test in Wood Factory Employees at Tertiary Care Centre

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Abstract

Introduction

Among wood factory workers, the implementation of regular Pulmonary Function Test (PFTs) can aid in early detection of respiratory abnormalities and facilitate timely interventions to prevent the progression of occupational lung diseases. Monitoring parameters such as FEV1/FVC ratio, PEFR, and Maximum Voluntary Ventilation (MVV) can provide valuable insights into airway obstruction, lung function impairment, and respiratory muscle strength. Studies have shown that wood factory workers exhibit decreased lung function parameters compared to non-exposed populations, indicating the detrimental effects of wood dust exposure on respiratory health.

MATERIALS AND METHODS

This is a cross sectional study was conducted in the Department of Physiology, Index Medical College diagnosed with COPD using Spirometry was recruited for the study. Details of the subjects collected at one point of time in the study period. Lung function tests FEV_1 (Forced Expiratory Volume in 1 second), PEFR (Peak Expiratory Flow Rate) and FVC (Forced Vital Capacity) for pulmonary impairment of each subject (study group and control group) was performed using a Spiro meter by following standard protocols.

RESULTS

The present study was done in 220 participants (study group-n=110, Control group n= 110). In our study, the most of workers age group is 18-30 years i.e., 57 out of 110, followed by 31-40 years, i.e., 41 out of 110 in study group and in control group 18-30 years i.e., 59 out of 110, followed by 31-40 years, i.e., 40 out of 110. In study group out of 110, 67 subjects were male and 43 were female subjects. In control group 68 were male and 42 were female subjects. The Mean weight of participants of study group is 59.4±10 and their mean height is 156±8.3. The Mean weight participants of control group are 61±10.2 and their mean height is

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161.6±6.8. The parameters of Pulmonary Function Test were significantly decreased ($p < 0.0001$) in study group as compare to control group. Different stages of COPD stage I –IV were 14.5%, 45.4%, 30.9%, 9.0% respectively in study Group.

CONCLUSION

We conclude from this study that workers exposed to wood dust have more respiratory symptoms than control subjects and that such exposure increases the risk of airflow obstruction. So, we recommend that workers should learn to use protective facemasks at sites and use other measures to reduce dust flow into the environment.

Keywords: Wood factory workers, Pulmonary Function Test, Forced Expiratory Volume

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Introduction

Among wood factory workers, the implementation of regular PFTs can aid in early detection of respiratory abnormalities and facilitate timely interventions to prevent the progression of occupational lung diseases. [1] Monitoring parameters such as FEV1/FVC ratio, PEFR, and Maximum Voluntary Ventilation (MVV) can provide valuable insights into airway obstruction, lung function impairment, and respiratory muscle strength. [2]

Studies have shown that wood factory workers exhibit decreased lung function parameters compared to non-exposed populations, indicating the detrimental effects of wood dust exposure on respiratory health. [3] Additionally, PFTs can help assess the effectiveness of control measures such as ventilation systems, personal protective equipment, and work practices aimed at reducing occupational exposures and protecting workers from respiratory hazards. [4]

The elevated inhalable wood dust exposure, lack of awareness of potential, lack of proper ventilation, hazardous effects of wood dust and lack of proper preventive equipment's during working hours increased potential lung damages among workers. [5]

According to Indian factories act 1948 and state factory rules company consultant are using spirometry for periodic medical surveillance to monitor lung functions and respiratory health of workers. PFT parameters like FEV1/FVC ratio, PEFR and MVV have potentially changed in such workers. [6]

Present study was done in wood factories of Indore. Area so naturally humid environment and dust particles stay more in environment which damage more as compare to dry air area. [7] On basis of such background, we have conducted study on such parameters for wood workers and compared with healthy individuals not involved in such factories. [8]

This study aims to provide an extensive overview of pulmonary function tests and their relevance in assessing the respiratory health of wood factory workers. It will explore the importance of PFTs in detecting early signs of respiratory impairment, identifying occupational lung diseases, and guiding preventive measures to safeguard the well-being of workers in this industry.

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MATERIALS AND METHODS

This is a cross sectional study was conducted in the Department of Physiology, Index Medical College diagnosed with COPD using Spirometry was recruited for the study. Details of the subjects collected at one point of time in the study period.

Inclusion criteria

1. Male subjects aged 40-80 years.
2. Construction workers.
3. Ability to comply with the requirements of the protocol and be available for study visits.
4. Willing to participate in the study.

Exclusion criteria

1. Subjects aged < 40 and >80 years.
2. Except COPD other pulmonary diseases such as Bronchial asthma, asthma- COPD overlap, Interstitial lung disease, bronchiectasis, cystic fibrosis, lung tumor, pulmonary TB, Pneumonia, etc.
3. Any acute peripheral artery diseases i.e. thromboembolic peripheral artery disease.

Parameters

1. Anthropometric Parameters
2. Spirometric analysis

Study Instruments:

1. Spirometry analysis was performed by RMS HELIOS 401Spirometer

Methodology

Ethical approval was obtained from the institute's ethics committee before starting the study. Anthropometric and Spirometric was done. Written Informed consent was taken after explaining the duration, type and purpose of study.

Study Protocol

Anthropometric

The following parameters were assessed from each subject: Height, Weight, BMI, neck circumference, waist circumference (WC), hip circumference.

Spirometry

1. Patients aged between 40-80 years attending OPD with history suggestive of COPD was screened with spirometry for diagnosis of COPD as per GOLD criteria of COPD.

2. Detailed history of risk factors of development of COPD was taken along with the detailed history of risk factors of development of Peripheral artery diseases.

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3. Detailed examination with special emphasis on peripheral pulse, respiratory and cardiovascular system was carried out.

4. Patients fulfilling the inclusion criteria were consider for the study.

5. Spirometry was done in all patients including pre-and post-bronchodilator after 200 mcg of salbutamol inhalation by Metered Dose inhaler (MDI).

6. Study population was categorized according to GOLD criteria of COPD.

- **Grade 0**, Category 0 = No symptoms.
- **Grade I**, Category 1 = Mild claudication.
- **Grade I,** Category 2= Moderate claudication.
- **Grade I,** Category 3= Severe claudication.
- **Grade II,** Category 4= Rest pain.
- **Grade III,** Category 5= Minor tissue loss; Ischemic ulceration not exceeding ulcer of the digits of the foot.
- **Grade IV,** Category 6= Major tissue loss; severe ischemic ulcers or frank gangrene.

Lung function tests FEV_1 (Forced Expiratory Volume in 1 second), PEFR (Peak Expiratory Flow Rate) and FVC (Forced Vital Capacity) for pulmonary impairment of each subject (study group and control group) was performed using a Spiro meter (RMS-HELIOS 702) by following standard protocols.

The interpretation of flow–volume curves

1. It was less well understood in primary care as it may not be taught in basic spirometry courses.

2. Nevertheless, the curve was a most helpful addition when interpreting lung function results, and provides a quick and simple check on whether or not airway obstruction was present.

3. It was also a tool for identifying the early stages of airway obstruction and provides additional help in the interpretation of a mixed pattern of obstruction and restriction.

4. In the simplest terms, it was adequate to look at the shape of the curve and compare it with the shape of the predicted curve–usually a dotted line–constructed by the spirometer.

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5. A normal trace was had a rapid rise to maximal expiratory flow and then an almost linear, uniform decline in flow until all the air was expelled–the point of intersection with the X-axis was the FVC.

6. In airflow obstruction, there was a concave dip in the second part of the curve which were become more marked with increasing obstruction. These were seen in COPD and asthma and any other disease-causing airflow obstruction.

7. In more severe emphysema where loss of airway elasticity causes the airways to collapse when forced exhalation occurs (dynamic compression), there was characteristic sudden fall in flow after maximal expiratory flow was reached–the "steeple" pattern.

8. In restrictive lung abnormalities, the shape of the flow–volume curve was normal but there was a reduction in lung volume which moves the FVC point to the left compared with the predicted curve.

Measuring FEV1, FVC, and Flow–Volume Curves

1. Attached a clean, disposable, one-way mouthpiece to the spirometer.

2. Instructed the patient to breathe in fully until the lungs feel full.

3. The patient should hold their breath long enough to seal their lips tightly around the mouthpiece.

4. Instructed to blast the air out as forcibly and fast as possible until there was no more air left to expel.

5. The operator should verbally encourage the patient to keep blowing and keep blowing during this phase.

6. Observed the patient to make sure a good mouth seal around the mouthpiece was achieved.

7. Repeated the procedure at least twice until three acceptable and repeatable blows were obtained. Maximum of 8 efforts.

8. There should be three readings, of which the best two were within 150 mL or 5% of each other and best.

9. The numbers appeared as a table of actual and predicted figures together with volume–time and flow–volume traces.

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10. The best readings of FEV1 and FVC were usually recorded.

11. The use of a nose clip was uncommon in primary care but it can be helpful; alternatively, asked the patient to pinch their nose if they were having difficulties with blowing correctly.

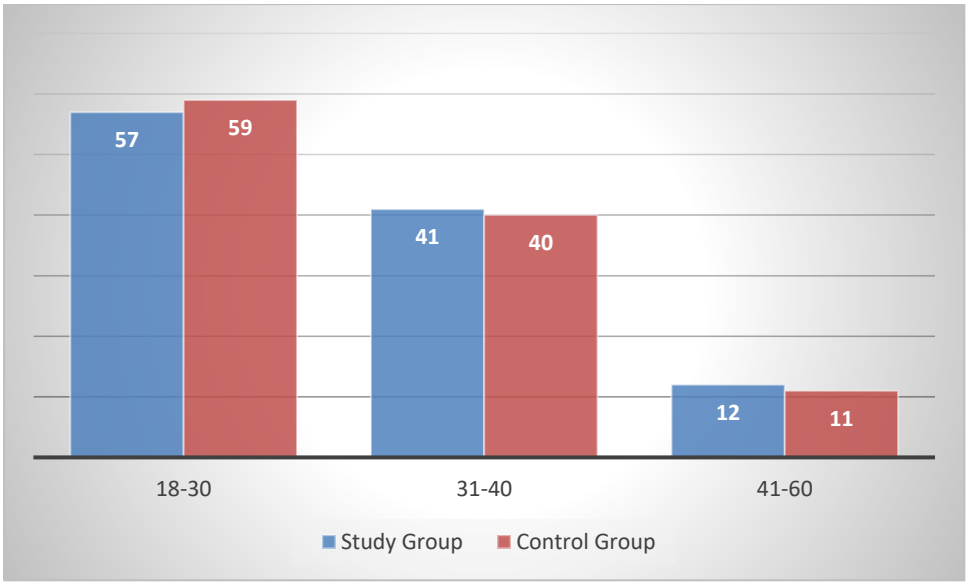
Spirometers with real-time traces and printouts were preferred as they provide helpful information about the quality and acceptability of the blows.

Statistical analysis

To study population characteristics the Chi-squared test and the independent sample t-test were used to test differences between individuals with or without COPD. The following potential confounders were considered: age, sex, smoking status, smoking duration in pack-years, BMI, hypertension, ethnicity and diabetes mellitus. The study questionnaire was administered to participan after obtaining their written consent which included information regarding their perception towards newer methods of Teaching. The ethical committee approval was taken prior to commencement of the study. The data was analyzed statistically. The information obtained was coded and entered in a excel sheet and analyzed. The suitable percentage and proportions were calculated in interpretation of the result obtained.

RESULTS

Graph 1: Distribution of different age groups of patients



The present study was done in 220 participants (study group-n=110, Control group n= 110). In our study, the most of workers age group is 18-30 years i.e., 57 out of 110, followed by 31-40 years, i.e., 41 out of 110 in study group and in control group 18-30 years i.e., 59 out of 110, followed by 31-40 years, i.e., 40 out of 110.

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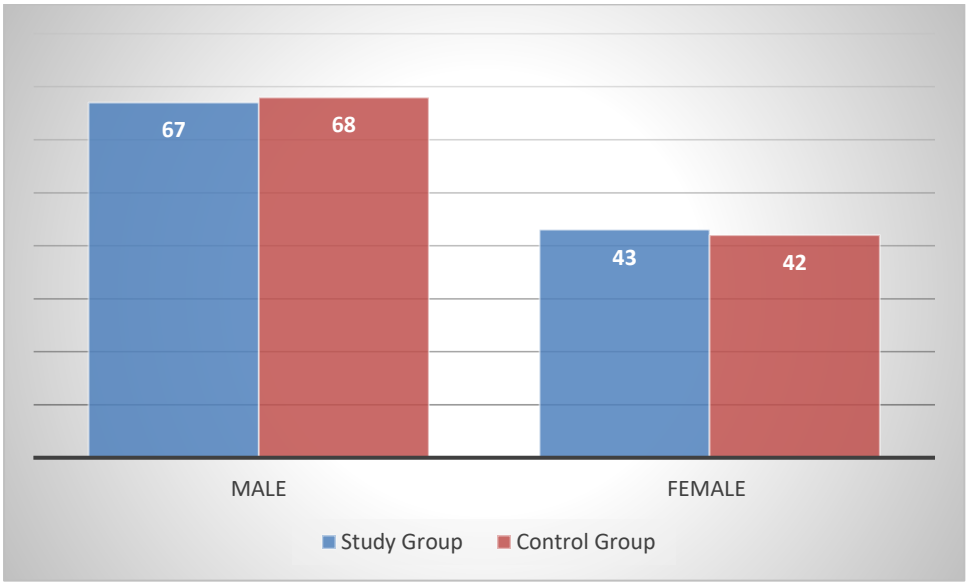
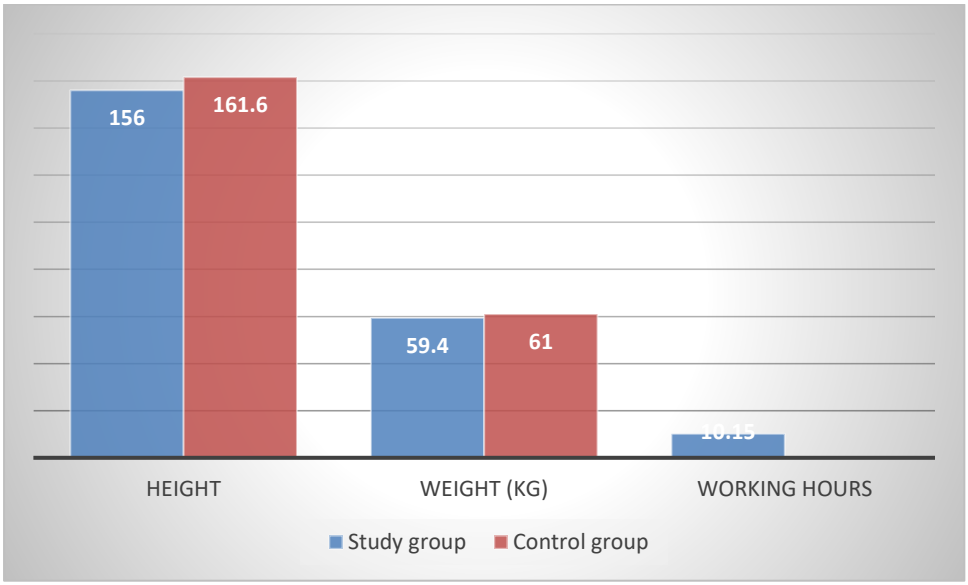
Graph 2: Distribution of gender



In Graph 2, in study group out of 110, 67 subjects were male and 43 were female subjects. In control group 68 were male and 42 were female subjects.

Graph 3: Anthropometric measurements of Construction workers



The Mean weight of participants of study group is 59.4±10 and their mean height is 156±8.3. The Mean weight participants of control group are 61±10.2 and their mean height is 161.6±6.8 in Graph 3.

Graph 5: PFT Data of Construction workers and Healthy individuals

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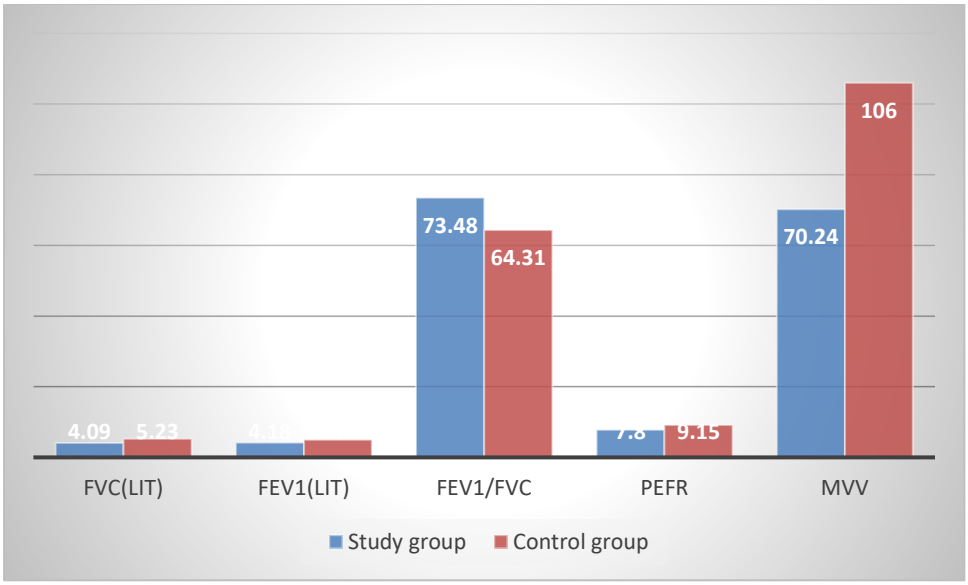
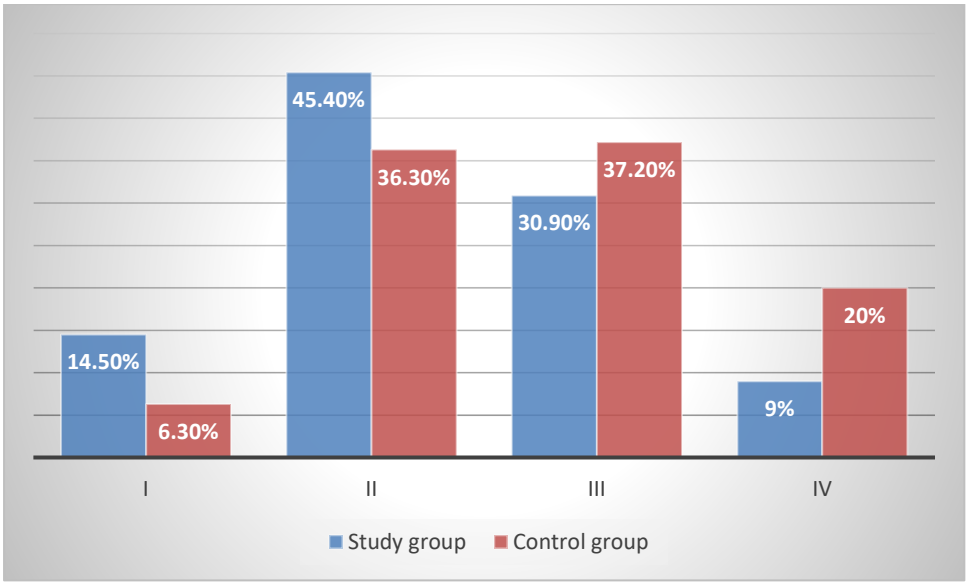


(*suggested significant p<0.05 ** suggested highly significant p<0.001)

In Graph 5 showed that all the parameters of Pulmonary Function Test were significantly decreased ($p < 0.0001$) in study group as compare to control group.

Graph -6: Gold Stage data of the COPD patients



Different stages of COPD stage I –IV were 14.5%, 45.4%, 30.9%, 9.0% respectively in study Group in Graph 6.

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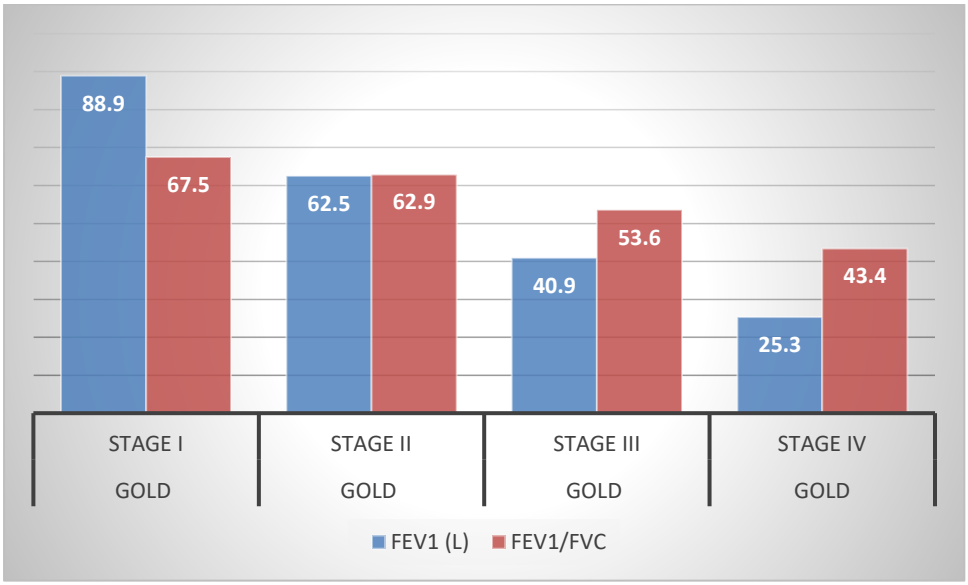
Graph -7: Gold Stage data among each COPD grade



According to the GOLD (Global Initiative for Chronic Obstructive Lung Disease) classification system for chronic obstructive pulmonary disease (COPD):
- **Stage I (mild COPD)**: FEV1 (Forced Expiratory Volume in 1 second) ≥ 80% predicted
- **Stage II (moderate COPD)**: 50% ≤ FEV1 < 80% predicted
- **Stage III (severe COPD)**: 30% ≤ FEV1 < 50% predicted
- **Stage IV (very severe COPD)**: FEV1 < 30% predicted or FEV1 < 50% predicted plus chronic respiratory failure

1. **Stage I (GOLD I)**:
   - FEV1 = 88.9% predicted
2. **Stage II (GOLD II)**:
   - FEV1 = 62.5% predicted
3. **Stage III (GOLD III)**:
   - FEV1 = 40.9% predicted
4. **Stage IV (GOLD IV)**:
   - FEV1 = 25.3% predicted

The FEV1/FVC (Forced Vital Capacity) ratio is also used in the assessment of COPD severity:
- **Stage I (GOLD I)**:
  - FEV1/FVC = 67.5%
- **Stage II (GOLD II)**:
  - FEV1/FVC = 62.9%
- **Stage III (GOLD III)**:
  - FEV1/FVC = 53.6%
- **Stage IV (GOLD IV)**:
  - FEV1/FVC = 43.4%

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These values suggest a progressive decline in lung function as COPD severity increases from Stage I to Stage IV. The FEV1 is a crucial indicator of how much air a person can forcibly exhale in one second after taking a deep breath. The lower the FEV1 percentage, the more severe the COPD is considered according to the GOLD classification.

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DISCUSSION

Although, smoking is considered the most important predisposing factor in development of emphysema; environmental exposures also play an important role. There have been several studies on work related respiratory symptoms and ventilator disorders among employees of cement industry. [9] The present study is done among the construction workers. In the present Study the Pulmonary Function tests FEV1, FVC, PEFR and MVV has shown significant decrement. Occupational and environmental exposure to hazardous particulate matter (PM) had lead to respiratory health care problems. [10]

Other Studies has shown that cement dust may enter into Systemic circulation and thereby reaching all the organs of body and different tissues including heart, liver, spleen, Bone, hair, skin and ultimately affecting their microstructures and physiological performance as it creates the breeding ground for vector. [11] Also while conducting such kind of studies little consideration has to be given to promising factors which affect the lung function such as age, height, weight, and smoking. [12] Therefore, the study was designed to investigate the effects of airborne dusts on the lung function of construction workers matched for age, height and weight. [13]

In the present study, FEV1, FVC, PEFR, MVV values showed highly significant reduction as compare to control groups. The significant decrease in these values is indicative of obstructive type of changes in lung functions. [14] Continuous exposure to dusty environment leads to inflammatory changes in small airways as well as in lung parenchyma leading to development of obstructive type of lung dysfunction. [15] These obstructive types of changes among study group can be correlated with the duration of exposure to dusty environment at the construction site, as majority of the subjects in study group were occupationally exposed to PMs for 5 to 10 years on an average. [16] Also, the prevalence of respiratory symptoms was more among the study group than the control group which can be explained on the same basis. [17]

CONCLUSION

We conclude from this study that workers exposed to wood dust have more respiratory symptoms than control subjects and that such exposure increases the risk of airflow obstruction. So, we recommend that workers should learn to use protective facemasks at sites and use other measures to reduce dust flow into the environment. It is important to take account not only of dust concentration, particle size, and exposure time, but also of a variety of background and individual factors (e.g., specific sort of wood, wood dust related biohazards, or disease history), since they may also contribute significantly to the decreased efficiency of lung function.

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