

Effect of occupational exposure to dust on pulmonary function tests in individuals working in saw mills in Raichur district

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Abstract

Introduction: In general, Exposure to dust at working places causes deterioration of pulmonary functions, increased prevalence of respiratory diseases, worsening of existing illnesses and also increased incidences of cancer and deaths. There are many saw mills situated in Raichur district of Karnataka and many workers are engaged in working at saw mills. They are exposed to saw dust during their working hours. So the present study was taken up to evaluate the effect of wood dust exposure on pulmonary functions of these individuals and also to know the additive effect of smoking on respiratory health of these individuals.

Aim: To estimate the effect of saw dust exposure on PFT of saw mill workers. To compare the effect of saw dust exposure on PFT of smokers and non-smokers among saw mill workers.

Materials and Methods: Data collection was effected by way of an interviewer-administered, questionnaire to determine years of exposure as from date of employment, site or position at workplace, use of safety gadgets such as dust masks and earplugs to prevent entry of airborne microorganisms and dust into the mouth, nose and ear which can cause infections, etc. All the male workers in saw mills of age between 20-50 years were included. Results were expressed as Mean \pm SD and Statistical comparison of measured variables between the 2 groups was carried out using unpaired-t-test and difference among mean values were calculated at a level of $P < 0.05$ and 95% confidence interval.

Results: A significant difference in FVC, FEV₁, FEV₁/FVC ratio between saw mill workers and control group was found. We have also found a marked decrease ($P < 0.001$) in FEV₁ and FEV₁/FVC ratio of smokers in comparison with non-smokers.

Conclusion: It is concluded from our study that exposure to saw dust causes inflammation which leads to decrease in lung compliance. Lesser compliance causes declined PFT values. A decrease in FVC in present study is an indication of restrictive lung disease conditions and decreased FEV₁/FVC ratio indication of Obstructive lung diseases.

Keywords: FVC, FEV₁, FEV₁/FVC ratio, Lung compliance, Obstructive lung diseases, PFT, Saw Mill, Smokers.

Introduction

In general, "Exposure to dust at working places causes deterioration of pulmonary functions, increased prevalence of respiratory diseases, worsening of existing illnesses and also increased incidences of cancer and deaths".¹⁻⁷ Human health may be significantly affected by various organic and inorganic chemical substances, toxins and microorganisms present in wood dust.⁸⁻¹⁰ It is also observed that throat irritation, oral cavity irritation, congestion in chest, dermatitis, urticaria, inflammation of alveoli, decreased pulmonary functions with reduced Forced Expiratory Volume (FEV₁) may be caused by these substances. These symptoms are observed when the dust exposure level exceeds higher than 5 mg/m³.^{3, 10-16} United States National Institute of Occupational Health and Safety (NIOSH) recommend that wood dust concentration should not exceed 1 mg/m³ in the working atmosphere for a 8-hour working period.¹⁷ The pulmonary function test is most important measure to assess lung functioning and efficiency. Measurement of dynamic lung functions is more important than that of static lung volumes. In respiratory diseases related to occupation, Spirometry plays a significant role in the diagnosis and prognosis of these diseases and is one of the most important diagnostic tools which describes the effect of restriction or obstruction on the lung function.¹⁸⁻¹⁹

Disabilities and work related disorders are the major complaints in saw mill worker population. The respirable dust (<10 μ m) present in the environment is the main problem encountered. Entry of fine dust into the respiratory system of humans evokes immune response against the foreign material increased morbidity and mortality from cardiorespiratory diseases are associated with exposure to ambient particulate air pollution.²⁰

Community based studies have demonstrated that occupational exposure to dust or gases cause increased relative risks for respiratory symptoms consistent with chronic obstructive pulmonary disease (COPD) as well as for excess annual declines in Forced Expiratory Volume in one second (FEV₁).²¹

A research study on sawmill workers concluded that due to saw dust exposure a significant reduction in FEV₁, expiratory flow rate and forced vital capacity in saw mill workers as compared to controls.^{22,23} Pulmonary obstruction, emphysema, pleural effusion, pneumothorax, pulmonary edema and poliomyelitis are being a pathophysiological aspects of a drop in the lung function parameters.²⁴ Similarly, the forced expiratory volume in first second reduced in obstructive lung diseases due to increased airway resistance during expiration and in restrictive lung diseases lung volumes are reduced due to decreased compliance of the lungs.²⁵ The decline in FEV₁ is a

convenient standard against which we can measure marked declines in subjects with the history of chronic obstructive pulmonary disease (COPD) or in subject exposed to environmental pollutants.²⁶

Many studies have also elaborated the effect of smoking on respiratory illness in association with occupational dust exposure. A study conducted by Laraqui et al²⁷ on carpenters proved that smoking was significantly associated with symptoms of respiratory illness. Another study conducted by Marcuccilli et al²⁸ noted that besides occupational exposure to wood, tobacco had an influence on the occurrence of cough and expectoration. All the above research results suggest the fact that more often lung function impairments is related to a synergistic effect between tobacco and wood dust and not a separate impact of only one.

There are many saw mills situated in Raichur district of Karnataka and many workers are engaged in working at saw mills. They are exposed to saw dust during their working hours. So the present study has been undertaken to evaluate the effect of wood dust exposure on pulmonary functions of these individuals and also to know the additive effect of smoking on respiratory health of these individuals.

Objectives

1. To estimate the effect of saw dust exposure on PFT of saw mill workers
2. To compare the effect of saw dust exposure on PFT of smokers and non smokers among saw mill workers

Materials and Methods

Duration of the Study: Four months (April to July-2016).

It is a Cross Sectional Study, the samples were obtained by Simple Random Sampling method. The study was conducted on saw mill workers at Raichur district in Karnataka. The Ethical Clearance Certificate was obtained by Institutional Ethical Clearance Committee and also written informed consent was obtained by all the volunteers.

Table 1: Anthropometric parameters of saw mill workers and control group

Parameters	Saw Mill Workers	Control Group
Height(cms)	166.75±4.13	167.3±3.92
Weight(kgs)	66.43±9.25	64.76±8.94
Age(years)	33.4±5.28	33.38±5.73

Note: cms- centimeters, kgs- kilograms.

Table 2: Comparison between Mean± SD of pulmonary function tests of saw mill workers and control group

Parameters	Mean± SD of Saw Mill Workers	Mean± SD of Control Group	P- Value
FVC (ltrs)	3.0±0.49	3.3±0.31	0.0002*
FEV ₁ (ltrs)	2.1±0.60	2.7±0.34	0.0001*
FEV ₁ /FVC ratio (%)	70±14.0	81±6.1	0.0001*

Note: FVC- Forced Vital Capacity, FEV- Forced Expiratory Volume, *- Significant, ^{NS}- Non significant.

Table 2, shows Mean± SD of saw mill workers and control group. There are significant differences (P<0.001) obtained in FVC, FEV₁, FEV₁/FVC ratio between Saw mill workers and Control groups.

A total of 60 individuals working in saw mills for more than 5 years were selected for the study.

Data collection were effected by way of questionnaire to determine exposure duration, site or position at workplace, usage of safety gadgets like dust masks and earplugs, etc., Information on general health, history of past diseases and habits such as smoking and alcohol consumption from last 1 year were obtained.

Inclusion Criteria: All the workers in saw mills of age between 20-50 years were included.

Exclusion Criteria: Individuals having cardiorespiratory diseases before entering into the occupation were excluded. Individuals aged below 20 years and above 50 years were excluded from the study. Female individuals were not included in the study due to unavailability.

ATS reference Values consider for obstructive and restrictive lung diseases.

Obstructive Lung Diseases

1. Mild: Predicted FEV₁ <100% and ≥70%
2. Moderate: Predicted FEV₁ <70% and ≥60%
3. Moderately severe: Predicted FEV₁ <60% and ≥50%
4. Severe: Predicted FEV₁ <50% and ≥34%

Restrictive Lung Diseases

A reduction in the VC without a reduction of the FEV₁/FVC ratio as a restriction of the volume excursion of the lung.

1. Mild: Predicted TLC < lower limit of normal but ≥70%
2. Moderate: Predicted TLC <70% and ≥60%
3. Moderately severe: Predicted TLC <60%

Statistical Analysis

Results will be expressed as Mean ± SD and Statistical comparison of measured variables between the 2 groups will be carried out using unpaired-t-test and difference among mean values will be calculated at a level of P<0.05 and 95% confidence interval.

Results

Table 3: Comparison between Mean± SD of pulmonary function tests of smokers and non-smokers among saw mill workers

Parameters	Mean± SD of Smokers (N=26)	Mean± SD of Non-Smokers (N=34)	P- Value
FVC (ltrs)	2.9±0.52	3.0±0.46	0.4332 ^{NS}
FEV ₁ (ltrs)	1.8±0.57	2.4±0.50	0.0001*
FEV ₁ /FVC ratio (%)	60±14	78±7.7	0.0001*

Note: FVC- Forced Vital Capacity, FEV- Forced Expiratory Volume, *- Significant, ^{NS}- Non significant.

Table 3 Depicts the Mean± SD of FVC, FEV₁, FEV₁/FVC ratio of smokers and non-smokers among saw mill workers. There was no significant difference (P>0.05) obtained in FVC between smokers and non-smokers,

significant differences obtained in FEV₁ and FEV₁/FVC ratio between smokers and non-smokers among saw mill workers.

Table 4: One-Way ANOVA of pulmonary function tests of smokers, non-smokers and control group

Parameters	Mean± SD of Control (N=60)	Mean± SD of Smokers (N=26)	Mean± SD of Non-Smokers (N=34)	P- Value
FVC (ltrs)	3.3±0.31	2.9±0.52	3.0±0.46	0.0001*
FEV ₁ (ltrs)	2.7±0.34	1.8±0.57	2.4±0.50	0.0001*
FEV ₁ /FVC ratio	81±6.1	60±14	78±7.7	0.0001*

Note: FVC- Forced Vital Capacity, FEV- Forced Expiratory Volume, *- Significant, ^{NS}- Non significant.

In table 4, One-Way ANOVA for PFTs showing the significant differences (P<0.001) obtained between smokers, non-smokers and control group.

Discussion

In our study we have found a significant difference in FVC, FEV₁, FEV₁/FVC ratio between saw mill workers and control group (Table 2). Similar study was carried out by few researchers, they found decline in FVC, and FEV₁ with prolonged exposure to saw dust at workplaces.²⁹

In the present study we have also found a marked decrease (P<0.001) in FEV₁ and FEV₁/FVC ratio of smokers in comparison with non-smokers (Table 3), which indicates the added adverse effect of smoking on respiratory functions of saw mill workers who are smokers. Our study is in agreement with the results obtained by Patrick A. Hessel et al, They proposed that the significant differences in lung function were seen most strongly in smokers among sawmill workers, it is possible that smoking and occupational exposures in the sawmill are interactive.³⁰ Entry of particulate matter into the airways and lungs lead to increased oxidant levels and inflammatory reactions. These inflammatory reactions lead to increased oxidative stress and inflammation, increased constriction of airways and decrease in elasticity of lung tissues. Resultantly, increased airway resistance and loss of lung compliance cause decrease in forced vital capacity and forced expiratory volume.

Conclusion

It is concluded from our study that chronic exposure to saw dust causes inflammation which leads to decrease in lung compliance. Lesser compliance causes declined PFT values. A decrease in FVC in present study is an indication of restrictive lung disease conditions and decreased

FEV₁/FVC ration indication of Obstructive lung diseases. By the present study it is also concluded that cigarette smoking is one of the major additive factor for lung abnormality in sawmill workers, it fastens the deterioration of lung tissues and elasticity of lungs. It is recommended that saw mill workers must use masks and glove at their work places and also they must undergo routine lung function testing.

Limitations

Female individuals were not included in the study, in the present study molecular level testing was not carried out to know the molecular basis of the decreased lung compliance.

Implications

This study indicates the health hazards of sawmill workers. Present study results can be taken as references for the further extended studies on mill workers. The results of present study implicate the effects of saw dust, cigarette smoke and interaction of saw dust particles with cigarette smoke particles, which can be prospectively studied at molecular levels.

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Conflict of Interest: None.

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