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STUDY OF PULMONARY FUNCTIONS OF SAWMILL WORKERS IN CENTRAL INDIA

Physiology

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ABSTRACT

Background: Prevalence of occupational lung diseases is significant in India & is particularly high in sawmill workers.
Objective: To study effects of saw-dust on the lung functions of sawmill workers in central India.
Methodology: Fifty sawmill workers and equal number of age-sex matched controls were enrolled. Pulmonary function test parameters of all the participants were recorded & compared.
Observations: Mean FVC of cases was 3.02±0.68 litres & of controls was 3.39±0.56 litres. Mean FEV1 of cases was 2.28±0.79 litres & of controls was 2.76±0.61 litres. Mean FEV1/FVC ratio of cases was 74.22±12.92% & of controls was 80.81±7.83. Mean PEFR of cases was 6.44±1.45 litres/second & of controls was 7.18±1.15 litres/second. Mean FEF 25-75 % of cases was 3.06±0.83 litres/second & of controls 3.53±0.71 litres/second. All the results were statistically significant ($p<0.05$).
Conclusion: Sawmill workers are more vulnerable to respiratory impairment due to saw dust exposure in the workplace environment.

KEYWORDS:

Pulmonary function, Lung function, sawmill worker

INTRODUCTION:

The pulmonary function tests are age old but time tested parameters for assessing respiratory health of a person. With increasing population, indiscriminate industrialization and increased automobile utilization as a mode of transport, the intensity of pollution is escalating day by day. All these factors have an effect on respiratory health of population.[1-3] Pulmonary function tests help us to study effects of smoke, dust, cotton particles, vegetable dust etc. on respiratory function.

The prevalence of occupational lung diseases varies from 15- 30% in various parts of India.[4] Reduction in lung function is reported in cotton mill workers, coal miners, grain and flour mill workers, workers exposed to tobacco, barley and talc & wood dusts, etc.[5-7] Wood dust (saw dust) is one variety of organic dust, exposure to which is known to cause substantial health impacts.[9-11] Saw-mill workers have been reported to show evidence of a variety of clinical manifestation including dry cough, shortness of breath, occupational asthma, wheezing, lung fibrosis, allergic alveolitis, impairment of lung function and chronic obstructive lung disease.[9-11] Spirometry plays a significant role in the diagnosis and prognosis of most of these diseases and describes the effects of restriction or obstruction on lung function.

The present study was designed to study effects of saw-dust on the lung functions of saw mill workers in central India.

METHODOLOGY:

Study type- Prevalence comparative study
Study setting- Department of Physiology, Govt. Medical College & Hospital, Nagpur
Study Population- Sawmill workers & non-sawmill workers ('controls') from Nagpur city
Sampling method- Simple random sampling
Study Sample- 100 participants (50 sawmill workers, 50 controls)
Study period-

Inclusion Criteria-
- Sawmill workers & age-sex matched healthy controls working in the limits of city of Nagpur
- Age- 19-50 years

Exclusion Criteria-
- Any known congenital or musculoskeletal defects.
- Any known endocrine disorders.
- Any known cardiopulmonary disorders.
- Any systemic disease which affects the lung functions
- Smokers
- Exposure in any industry other than wood industry.

After written informed consent, subjects included in the study were enrolled as per mentioned inclusion & exclusion criteria. The age and sex matched subjects of same socio-economic status who were not exposed to wood industries were enrolled as controls. All the participants both in the study and the control groups were subjected to detailed history taking and clinical examination prior to pulmonary function tests. Only healthy subjects were selected for the study.

Computerised Spirometer (RMS-Helios 401, Transducer No. 400-666) was used to measure respiratory function tests. The subjects were informed about the whole manoeuvre before performing pulmonary function test along with the importance and non-invasive nature of the tests. All PFT were carried out at a fixed time of the day to in order to minimize any diurnal variation. The apparatus was calibrated and operated within ambient temperature range of 25-30^0 Celsius.

All the subjects were made familiar with the instrument and the procedure for performing the test. The data of the subject as regards to name, age, height, weight, sex, date of performing the test, atmospheric temperature was fed to the computer prior to study. Under all aseptic precautions, the test was performed within the subject in sitting position with using a nose clips. The results were obtained in spirometer were Forced Vital Capacity (FVC), Forced Expiratory Volume In One Second (FEV1), Forced Expiratory Ratio (FEV1/FVC%), Peak Expiratory Flow Rate (PEFR), Forced Expiratory Flow between 25% and 75% (FEF 25-75%). The test was repeated 3 times after rest, of which the best readings were considered. The data was analysed using STATA (version 10.0) software.

The protocol of project was submitted to institutional ethics committee and the project was started after approval.

RESULTS:

The present study was carried out on 50 saw-mill workers and equal number of age-sex matched controls. Pulmonary function test parameters of all the participants were recorded & compared.

The participants were fairly evenly distributed across age groups in the selection range of 19-50 years. Mean age of controls found to be 33.92 ± 9.68 years, while that of cases found to be 33.14 ± 9.64. ($P > 0.05$). Mean height of controls found to be 168.08 ± 7.70 cm, while that of cases found to be 167.07 ± 8.03 cm ($p > 0.05$). Only 2 cases & 5 controls had height more than 180cms. Mean weight of controls found to be 62.37 ± 6.95 kg, while that of cases found to be 61.1 ± 7.50 kg ($p > 0.05$). None of the cases & only 1 control weighed >80kgs; while 2 cases & no controls weighed <50kgs. Mean BMI of controls found to

be 22.01 ± 0.97 kg/m^2 while that of cases found to be 21.81 ± 1.22 kg/m^2. The differences between the two groups were statistically insignificant for age, height, weight and BMI.

Table 1: Comparison of pulmonary test parameters between sawmill workers & controls.

Parameter*	Sawmill worker	Controls	P-value
FVC (L)	3.02 ± 0.68	3.39 ± 0.56	0.0041
FEV1 (L)	2.28 ± 0.79	2.76 ± 0.61	0.0012
FEV1/FVC (%)	74.22 ± 12.92	80.81 ± 7.83	0.0027
PEFR (L/S)	6.44 ± 1.45	7.18 ± 1.15	0.0059
FEF 25-75 % (L/S)	3.06 ± 0.83	3.53 ± 0.71	0.0033

(* FVC = Forced Vital Capacity, FEV1 = Forced Expiratory Volume in One Second, FEV1/FVC% = Forced Expiratory Ratio, PEFR = Peak Expiratory Flow Rate, FEF 25-75% = Forced Expiratory Flow between 25% and 75%).

Table 1 shows comparison of various pulmonary test parameters between sawmill workers & controls. The mean FVC of cases was 3.02 ± 0.68 litres, while that of controls was 3.39 ± 0.56 litres and the difference was statistically significant with p-value 0.0041. The mean FEV1 (forced expiratory volume in one second) of cases was 2.28 ± 0.79 litres, while that of controls was 2.76 ± 0.61 litres, the difference being statistically significant (p-value-0.0012). The mean FEV1/FVC ratio of cases was 74.22 ± 12.92 %, while that of controls was 80.81 ± 7.83. Difference between the two means was found statistically significant with p-value 0.0027. After comparing Peak Expiratory Flow Rate of cases with that of control as shown in above table, it is noted that the mean PEFR (Peak Expiratory Flow Rate) of cases was 6.44 ± 1.45 litres/second, while that of controls was 7.18 ± 1.15 litres/second. It was noted that mean values of control was higher as compared to the cases and the difference between the two means was found to be statistically significant with p-value 0.0059. The mean FEF 25-75 % of cases was 3.06 ± 0.83 litres/second, while that of controls 3.53 ± 0.71 litres/second (p-0.0033).

Table 2: Correlation of duration of Exposure with PFT parameters in sawmill workers

PFT parameters	r – value	p-value
FVC	-0.7114	<0.0001
FEV1	-0.6665	<0.0001
FEV1/FVC	-0.3918	0.0049
PEFR	-0.6075	0.0001
FEF25-75	-0.5555	<0.0001

Table 2 shows the correlation of duration of exposure with different pulmonary function test parameters. Forced Vital Capacity (FVC) shows negative correlation with that of duration of exposure (r = -0.7114) which is significant (p value<0.0001). On correlating Forced Expiratory Volume in one second (FEV1) with duration of exposure, it was found that as the duration of exposure goes on increasing FEV1 value goes on decreasing, as negative correlation exists between them (r = -0.6665) with p value of <0.0001, which is significant. Correlation of duration of exposure with FEV1/FVC ratio revealed that there is negative correlation between duration of exposure and FEV1/FVC ratio with r value = -0.3918, which is also significant. It also showed that negative correlation exists between Peak Expiratory Flow Rate (PEFR) and duration of exposure (r = -0.6075) with significant p-value of 0.0001. Forced Expiratory Flow between 25% and 75% (FEF25-75%) also had negative correlation with duration of exposure (r = -0.5555) with significant p value (<0.0001).

DISCUSSION:

Present study was carried out on 50 saw mill workers of Nagpur city and equal number of age and sex matched control group of same socio-economic status. During the study, it was observed that the sawmill workers' workplaces are located in the temporary shelters with poles supporting roof made up of old iron sheets, and at places of wooden material. Their walls were also made up of wooden boards. Stacks of wooden logs were lying all over the place. The standing position of these workers was found to be very close to wood log cutting blades. Osman E[12] measured average wood dust amount to which the workers were exposed in their working places, which was 2.04 ± 1.53 mg/m^3. In our study we have not measured saw dust exposure due to unavailability of specific equipment. But general assessment shows it to be quite high, with no exposure control mechanism e.g. exhaust ventilation in place.

Various factors which may greatly influence the pulmonary functions like age, sex, height, weight, BMI and socioeconomic status were considered. Attempt was made to minimise confounding by using matched controls, excluding smokers, workers with previous industrial exposure other than wood industries, and the workplace environment was approximately consistent for all the subjects.

The results of our study show significant difference in pulmonary function test parameters between the subjects of the study group exposed to sawdust and the control group and there is inverse relationship between different pulmonary function test parameters and duration of exposure in years.

Shamssain et al[10] observed pulmonary function in non-smoker sawmill workers and reported that the exposed group had significantly lower forced expiratory indices than the control group. Mean percent predicted values and mean observed values for FEV1, FEV1/FVC%, FEF 25-75% and FEFR were lower in the exposed group compared to controls. These results of our study are in agreement with observations of this study.

Mandryk et al[13] reported that a mean percentage cross-shift decrease in lung function parameters; FVC, FEV1, FEV1/FVC, FEF25 – 75% for wood workers compared with the controls. Fatusi et al[14] found that the sawmill workers had significant lower lung function indices (FVC, FEV1 and PEFR) compared to the control group. The mean observed values of pulmonary function test indices in cases and controls obtained by us are slightly on lower side than the mean values obtained by Fatusi et.al.

Meo S.A.[15] observed that there was a significant reduction in the mean values of Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV1), and Maximum Voluntary Ventilation (MVV) in wood workers relative to their matched controls. This impairment was increased with the duration of exposure to wood industries. In present study also, such observations are made by us, indicating that deterioration in pulmonary function occurs with increase in duration of exposure.

Rastogi et al[16] observed that there is increased prevalence of respiratory impairment in the saw mill workers and the abnormality pattern was of restrictive type, when compared with lung function studies of controls of same age, sex, body parameters and socio-economic group.

In contrast to our results Ahman et al[17] conducted pulmonary function tests on 40 wood working teachers and observed no relationship between change in FVC, FEV1 and FEV1/FVC and measured total dust exposure. The most probable reasons for no change in lung function parameters are that the wood working teachers were not professional laborers of the wood industries and were performing their duties on a limited lecture basis. Moreover their working environment was quite clean. V.U.Johard et al[18] studied the values of TLC, FEV1 & RV in wood trimmers & control while studying signs of alveolar inflammation in non-smoking Swedish wood trimmers. They did not find any significant difference in the values between control & wood trimmers; which might be due to intermittent discontinuation from exposure.More recently, Sakariya et al[19] reported the mean values of FVC (2.4±0.55) & FEV1 (2.29±0.47) to be significantly lower and mean value of FEV1/FVC (87.97±18.3) to be significantly higher in workers as compared to control group (p<0.05) and noted predisposition towards restrictive lung disease amongst the sawmill workers exposed to wood dust.

Kacha et al[20] found saw dust to be causing restrictive type and restrictive plus obstructive mix type of pulmonary function impairments. Inhalation of wood/saw dust was reportedly leading to reduction in pulmonary function and greater decline in pulmonary function was noted with greater duration of exposure.The exposure to wood dust can elicit pulmonary inflammation via different mechanisms and is accompanied by induction of several proinflammatory cytokines and chemokines has been shown by Juha maatta et al.[21] The pulmonary function impairment that may occurs after exposure to wood dust may be due to release of histamine in the bronchioles by mechanical irritation of the deposited dust in the pulmonary tract similar to the action of cotton, hemp, jute and flax

dusts.[19] Other possible causes of adverse effects of exposure to sawmill dust could be due to chemicals such as pesticides used in preserving wood.

In conclusion, this study demonstrates that the sawmill workers are more vulnerable to respiratory impairment due to wood dust (saw dust) exposure in the workplace environment. The impairment of pulmonary function parameter is associated with dose-effect response of years of exposure to wood dust, where the subject with longer duration of exposure is worst affected. Efforts are recommended to control the levels of dust to within safe occupational limits with a well-designed, efficient and properly used exhaust ventilation system, usage of personal protective equipment, good housekeeping and other measures to similar effect. Periodic medical examination of the workers is also strongly recommended.

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