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Original Research Article

Study of occupational health hazards in sawmill workers in central India

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ABSTRACT

Background: Occupational lung diseases are occurring at an increasingly significant level in India and the prevalence is particularly high in sawmill workers. The present study evaluated effects of sawdust on the lung functions of sawmill workers.
Methods: In this prevalence study, 50 sawmill workers and equal number of age-sex matched controls were enrolled. Pulmonary function test parameters of all the participants were recorded by spirometry. Relevant comparisons were drawn between the groups.
Results: Mean FVC of cases was 3.02±0.68 litres and of controls was 3.39±0.56 litres. Mean FEV1 of cases was 2.28±0.79 litres and of controls was 2.76±0.61 litres. Mean FEV1/FVC ratio of cases was 74.22±12.92% and of controls was 80.81±7.83. Mean PEFR of cases was 6.44±1.45 litres/second and of controls was 7.18±1.15 litres/second. Mean FEF 25-75 % of cases was 3.06±0.83 litres/second and of controls 3.53±0.71 litres/second. All the results were statistically significant ($p<0.05$).
Conclusions: Sawmill workers are more vulnerable to respiratory impairment due to saw-dust exposure in the workplace environment. Efforts are recommended to control the levels of dust to within safe occupational limits.

Keywords: Lung functions, Occupational health, Sawmill workers, Spirometry, Saw dust

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 and wood dusts, etc.[5-8] 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 exhibit 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 exposure on the lung functions of sawmill workers in central India.

METHODS

The present prevalence study was conducted at a tertiary care centre in central India between January and December 2018 (duration of one year). The study population consisted of Sawmill workers and non-sawmill workers (‘controls’) from Nagpur city who were selected by simple random sampling. A total of 100 participants (50 sawmill workers, 50 controls) were enrolled with following criteria in mind:

Inclusion criteria

- Age group of 19-50 years.
- Both genders.
- Minimum service of 2 years as sawmill workers.

Exclusion criteria

- Current smokers.
- Subjects with exposure in any industry other than wood industry.
- Any known congenital or musculoskeletal defect, endocrine disorder, cardiopulmonary disorder or any other disease which affects lung functions.
- Unwilling to consent for the study.

The controls were age and sex matched subjects of same socio-economic status who were not exposed to wood industries. 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 administer pulmonary function test (PFT). 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 PFTs 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 25-300 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 with the subject in sitting position with using 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.

Ethical approval was obtained from the Institutional Ethics Committee before starting the study. Informed written consents were obtained from each participant prior to start of the study. The data was analysed using STATA (version 10.0) software.

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 and compared.

The participants were fairly evenly distributed across age groups in the selected range of 19-50 years. Mean age of controls was 33.92±9.68 years, while that of cases was 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 and 5 controls had height more than 180cms.

Mean weight of controls was 62.37±6.95 kg, while that of cases was found to be 61.1±7.50 kg ($p > 0.05$). None of the cases and only 1 control weighed >80kgs; while 2 cases and no controls weighed <50kgs. Mean BMI of controls was 22.01±0.97 kg/m2 while that of cases was observed to be 21.81±1.22 kg/m^2. The differences between the two groups were statistically insignificant for age, height, weight and BMI.

(* 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%).

Comparison of various pulmonary test parameters between sawmill workers and controls were drawn. 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 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. The mean PEFR of cases was 6.44±1.45 litres/second, while that of controls was 7.18±1.15 litres/second and the difference between 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 1).

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

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

The correlation of duration of exposure with different pulmonary function test parameters was also undertaken. Forced Vital Capacity (FVC) showed negative correlation with that of duration of exposure ($r = -0.7114$) which is statistically 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) (Table 2).

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

DISCUSSION

Present study was carried out on 50 sawmill workers of an urban population of central India 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 et al measured average wood dust amount to which the workers were exposed in their working places, which was 2.04±1.53 mg/m^3.[11] 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 this 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, 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.[9] These results of our study are in agreement with observations of this study.

Mandryk et al, 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.[12] Fatusi et al, found that the sawmill workers had significant lower lung function indices (FVC, FEV1 and PEFR) compared to the control group.[13] 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.[13]

Meo et al, 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.[14] Rastogi et al observed that there is increased prevalence of respiratory impairment in the sawmill 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.[15]

In contrast to results Ahman et al, 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.[16] Johard et al, studied the values of TLC, FEV1 and RV in wood trimmers and 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 and wood trimmers; which might be due to intermittent discontinuation from exposure.[17]

More recently, Sakariya et al, reported the mean values of FVC (2.4±0.55) and 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.[18]

Kacha et al, 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.[19]

The exposure to wood dust can elicit pulmonary inflammation via different mechanisms and is accompanied by induction of several pro-inflammatory cytokines and chemokines has been shown by Maatta et al.[20] 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.[20] Other possible causes of adverse effects of exposure to sawmill dust could be due to chemicals such as pesticides used in preserving wood.

CONCLUSION

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 parameters 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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