Research Paper

Volume : 2 | Issue : 10 | October 2013 • ISSN No 2277 - 8179

Effect of Duration & Severity of Exposure on Peak Expiratory Flow Rate Among Workers Exposed to Wood Dust in Central India (Nagpur)

Physiology

KEYWORDS : Wood dust, Duration of exposure, PEFR, Central India

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ABSTRACT

Objective: Occupational and environmental lung diseases are the major work related illnesses. The objective of the study is to assess the effect of wood dust, duration and severity of the exposure on Peak Expiratory Flow Rate (PEFR) among saw mill workers in Nagpur city (Central India) and additionally, to minimize possible health risks for wood workers by providing them with information about wood dust related hazards.

Method: The study was conducted during Feb 2013-july 2013 in the clinical physiology laboratory, IGGMC, Nagpur. It was designed as a case-control cross-sectional study of spirometry in 30 non-smoking wood workers, aged 25-40 yrs, who worked without the benefit of wood dust control ventilation or respiratory protective devices. PEFR were obtained on computed spirometry software by performing

FVC manoeuvre, in sitting position with the application of nose clip, by using Physiopac (PP-4) Windows based computerized Polygraph machine.

Results: The present study results demonstrated that the PEFR values in the wood dust exposed workers was significantly reduced as compared with their matched controls, but the duration of exposure was not found to cause significant decrease in PEFR.

Conclusion: Based on the results of the present study, we conclude that the decrease in PEFR values is more related to the severity of exposure rather than duration of exposure.

INTRODUCTION

The prevalence of occupational lung diseases varies from 15-30% in various parts of India (1).). The lung function impairment is the most common occupational respiratory problem in industrial plants especially in the welding, cement and wood industrial sectors (4,5,6). The lung with its extensive surface area, high blood flow, and thin alveolar epithelium is an important site of exposure with substances in the environment (3). They are usually induced by extended exposure to irritating or toxic substances that may cause acute or chronic respiratory ailments; however, severe single exposures can also generate chronic lung diseases. Wood is one of the worldwide most important renewable resources and extends over approximately one-third of the earth's total landmass. Wood dust is produced when machines or tools are used to cut or shape wood materials. Industries in which large amount of wood dust is produced include sawmills, dimension mills, furniture industries, cabinet-making, and carpentry (6). Wood dusts are a complex mixture of various substances and Its composition varies considerably according to species of tree and consists mainly of cellulose, polyoses, and lignin, with a large and variable number of substances of lower relative molecular mass, which may significantly affect the properties of the wood. These include polar organic extractives (tannins,flavonoids, quinones and lignans), non-polar organic extractives (fattyacids, resin acids, waxes, alcohols, terpenes, sterols, steryl esters and glycerol), and water-soluble extractives (carbohydrates, alkaloids, proteins and inorganic material) (3). It also contains contaminants such as fungal spores and other microbials, wood preservatives, coatings, sealants and glues (e.g. formaldehyde, pentachlorophenol, glycols, copper naphthanate, etc.) This mixture makes it difficult to determine a specific irritant or allergen.

Particle size is another important factor. The smaller the dust particle the further it will travel into the lungs. Exposure to wood dust has long been associated with a variety of adverse health effects. These include irritation (most common), allergic reactions(sneezing, runny nose, Itchy eyes, urticaria) and various symptoms including dry cough, malaise, chronic bronchitis, shortness of breath, chest pain, conjunctivitis, rhinitis, dermatitis, occupational asthma, allergic alveolitis, headache (6).

In view of the available information, it is worthwhile to investigate the dose-response effects of wood dust on peak expiratory flow rate (PEFR) in wood workers, working in small scale wood industries without the benefit of self-protective measures and to compare the results with those observed in their matched controls.

Studies of respiratory morbidity and lung function assessment have been performed among workers from various occupations but there are very few studies among saw mill workers in India. There is no data regarding the respiratory status of the wood workers in Central India. The present study was undertaken in saw mill workers in Nagpur city situated in the Central India, region of Maharashtra. The two other aspects of this investigation, deserving to be stressed are that all the participants were male non-smokers, and that matched case controls were used in the study.

MATERIALS AND METHODS

The study was approved by the ethics committee of our institution. The present study was conducted in the pulmonary laboratory of the Department of Physiology, Indira Gandhi Govt. Medical College , Nagpur, during Feb 2013 – July 2013.

A case control cross sectional study of spirometry was designed. Over several days, the principal investigator visited the lakadganj area of the Nagpur city during this period, where maximum wood industries are situated, and interviewed approximately 100 wood mill workers. Teak was the most frequent type of wood used in these industries. .A detailed history of each worker was taken to determine whether they would be included in the study on the basis of the exclusion criteria. They were questioned about smoking cigarettes or other tobacco products, chewing tobaccos or betel nut products. After initial interviews, 30 apparently healthy male wood workers, mean age 30.3 ± 0.75 yrs (mean ± SEM; range 20-40 yrs) with mean duration of exposure 5.67 ± 0.72 (mean ± SEM; range 1-8 yrs), were included were included in the study group and the rest were excluded from the study.

The wood workers worked for at least 8–12 hrs/day for six days/week, without using any self-protective measures, whereas the extent of exposure to dust was significant. The control

group primarily included were mainly shopkeepers, salesmen and security guards. All the subjects were matched for age, height and weight. All participants answered the designed questionnaire through a face-to-face interview, and each subject gave informed consent. The control group selected in the similar way. About 100 persons were interviewed, out of which 30 matched healthy men, mean age 34.87 ± 0.68 yrs (mean ± SEM; range 20-40 yrs). The control group was mainly shopkeepers and salesmen. All subjects were matched for age height and weight.

Exclusion criteria

Diagnosed cases of bronchial asthma, chronic bronchitis, emphysema, tuberculosis, and subjects with gross clinical abnormality of vertebral column, thoracic cage, neuromuscular diseases, diagnosed cases of IHD, malignancy, drug addicts, cigarette smokers, tobacco chewers and alcoholics, Subjects who had past abdominal or chest surgeries were also excluded. Subjects exposed in any industry other than wood industry having occupation known to cause alteration in Pulmonary functions (cotton spinning mill workers, flour mill workers, Paint industries, Safaiwalas, Farmers, coal mine workers, Bakers, Welders, Petrol Pump workers, cement factory workers) were also excluded from the study.

METHODS

Respiratory Questionnaire

A questionnaire was used to assess respiratory symptoms (Cough, Sputum, Breathlessness, Wheezing, Chest tightness),occupational history(place of work, duration of work in years, daily hours of working, type of work, questions about using gloves, a mask, or ventilation during work and whether it reduced the intensity of work-related symptoms). The questions regarding respiratory and were asked at the end of the working day or weekend (weekend for workers in Nagpur area is Wednesday) for the wood workers and only once for the control group. The questions regarding respiratory and allergic symptoms were asked in reference to the previous 24 hours (e.g., ''Have you had a cough during the past 24 hours?''). Common risk factors such as smoking, atopy, family history of atopy, and allergic reactions were also asked about. They also stated whether they, for some reason, had quit working as a carpenter for a period of more than a year.

Spirometry

The test was carried out at a fixed time of the day (9:00–13:00) to minimize the diurnal variation. The precise technique of performing various lung function tests in the present study was based on the operation manual of the instrument with special reference to the official statement of the American Thoracic Society (ATS) of Standardization of Spirometry (8). Pulmonary functions in the wood workers and control subjects were measured with spirometry using Physiopac (PP-4) Windows based computerized Polygraph machine Medicaid systems, Chandigarh. The apparatus was operated within the ambient temperature range of 20–25°C. After taking a detailed history and anthropometric data, the subjects were informed about the whole manoeuvres. The test was performed on the subject in sitting erect position with using a nose clip. The subjects were encouraged to practice these manoeuvres before the test. The subjects were encouraged and supervised throughout the test performance. Pulmonary function tests were performed three times in each subject using an acceptable technique, after adequate rest. The results were available in the spirometer.

Statistical analysis

The data of PFT values and age were expressed as Mean ± SEM. The data for the PEFR values between the study group (wood workers) and the control group were tested using the unpaired *t*-test.

A level of statistical significance was established at a value of $p < 0.001$. (Table-1,Figure-1). The PEFR data were correlated against the duration of exposure to wood dust by using ANOVA test.

RESULTS

Table 1.Peak expiratory flow rate (PEFR) in the study and control group.

PEFR (L/sec)		P value
Study group	Control group	
n = 30	n = 30	
4.26 ± 1.18	9.62 ± 3.97	< 0.001***

***** Highly significant.**

Overall anthropometric data, age, height and weight did not significantly differ between the study and control groups. The PFER values in the wood dust-exposed workers were significantly lower than in controls,(Table-1, Figure-1).and as the duration of exposure to wood dust increases PEFR does not significantly decreases,(Table 2, Figure-2). In contrast the significant difference was noted in the workers exposed for more than 8 years (range 10–14 years) (4). Hence we conclude that decrease in PEFR values is more related to the severity of exposure rather than period of exposure.

Table 2: Correlation of PEFR with duration of exposure in yrs in study group.

Duration of exposure.	PEFR(L/s)	ANOVA
1-4	4.69 ± 1.41 n = 14	NS*
4-8	4.35 ± 0.86 n = 07	NS*
> 8	3.54 ± 0.61 n = 09	NS*

***F value = 3.01709, P value = 0.0656753**

Fig-1: PEFR in study and control group.

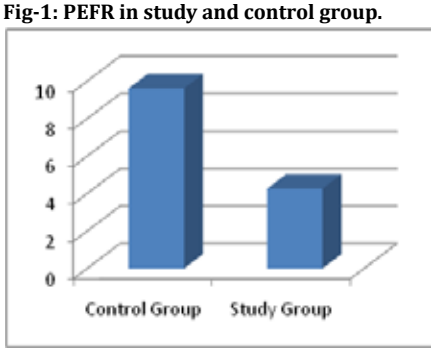
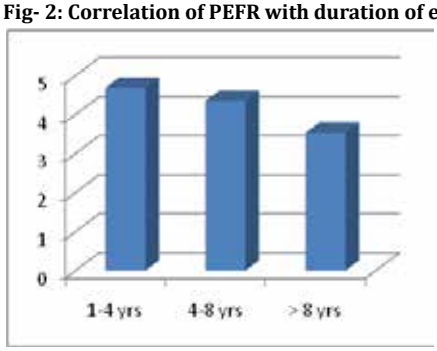


Fig- 2: Correlation of PEFR with duration of exposure



DISCUSSION

The present study shows the decreased PEFR values in non-smoking wood workers which is directly proportional to the severity of exposure, rather than duration of exposure. The other aspects of this study deserving to be stressed are that none of the worker used respiratory protective measures, and that the matched case controls were used in the study.

Meo S.A. (4) studied the effects of duration of exposure to wood dust on peak expiratory flow rate among workers in small scale wood industries. PEFR was significantly reduced as compared

to their matched control, and it is directly proportional to the duration of exposure.

Milanowski J, Gora A, Skorska C, Krysinska-Traczyk E, Mackiewicz B, Sitkowska J, et al.(6) studied Work-related symptoms among furniture factory workers in Lublin region (eastern Poland). Ann Agric Environ Med 2002; 9(1): 99–103. They reported lower FVC and FEV1 values in wood workers compare to controls. They also demonstrated significant pre-shift/post-shift decline in FVC, FEV1, FEV1/FVC, and PEFR among wood workers. They also showed significant reduction of PEFR in Furniture workers than in controls. However, in the present study we did not observe values based on the pre-shift and post-shit changes, but we found in wood workers the overall decline in the PEFR values.

DUDHMAL V.B.,SAYEDA AFROZ, JADHAV S.S. AND KARADKHEDKAR S. S.(9) studied Pulmonary function tests in 30 saw mill factory male workers in Nanded region of Maharashtra in the group of 18 to 25 yrs. They found no significant change in FVC, while FEV1 was significantly reduced. This shows that exposure to saw dust causes obstructive pulmonary impairment. PEFR was significantly reduced at 5% level of significance. This is probably due to hypertrophy of mucosal cells due to irritation by wood/saw dust , resulting in increase secretion of mucous & formation of mucosal plugs which causes obstruction to the exhaled air.

Bhat MR, Ramaswamy C. (10) studied A comparative study of lung functions in rice mill and saw mill workers.FVC was significantly reduced in saw mill workers compared to both the controls and rice mill workers. Both FEV1 and PEFR/min were significantly reduced in both mill workers compared to controls. FVC was reduced after five years of exposure only in saw mill workers. FEV1 was reduced within a year which was further reduced after five years in both mill workers. PEFR/min was highly reduced within a year remained so even after 5 years.

The present study confirms the findings of other authors and suggests that wood dust adversely affects the peak expiratory flow rate (PEFR).

This suggest that wooden dust has an effect on PEFR. This is probably due to hypertrophy of mucosal cells due to irritation by wood/saw dust, resulting in increased secretions of mucus and formation of mucosal plugs which causes obstruction to the exhaled air (7). The pattern of lung volumes in saw mill workers in our study are in agreement with earlier reports by Bhat MR (9).

In view of the pathphysiological aspects and the PEFR decrease, our results suggest that the wood dust adversely affects the lung function and this impairment is associated with the duration and severity of exposure to wood dust. The findings are of importance in that they demonstrate the need to reduce exposure and show the magnitude of the effect in a surviving population. Therefore, it is advisable that wood workers, their employers, and health officials work together to adopt technical preventive measures such as ventilated work areas and to use appropriate respiratory protective devices. Pre-employment and periodic medical surveillance tests in this occupational group are strongly recommended. These measures will help to identify susceptible workers so that they could take further preventive measures an appropriate medication.

CONCLUSION

The results of this study shows that the wood dust exposure have direct relationship with reduction in the PEFR values. It does not depend much on the duration of exposure, but it depends on the severity of exposure.

ACKNOWLEDGEMENTS

The study was approved by ethics committee and carried out under the supervision of Dept. of Physiology, Indira Gandhi Govt. Medical College, Nagpur.

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