# EFFECTS OF WOOD DUST ON RESPIRATORY FUNCTIONS IN SAW MILL WORKERS

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**Abstracts**: **Background & Objectives:** Occupational pulmonary diseases are more widespread and more disabling than any other group of occupational disease. The lung with its extensive surface area, high blood flow and thin alveolar epithelium is an important site of contact with substance in environment. The inhalation of dust over periods of time leads to proliferation and fibrotic changes in lungs. The workers working in industries suffer from various types of air way diseases like pneumoconiosis, farmer's lung, chronic bronchitis, pulmonary fibrosis and asthma. So the present study was undertaken to study the effects of wood dust on respiratory functions of exposed workers. **Methods:** Computerised spirometric parameters of saw mill workers were compared with their predicted values. We evaluated 50 male subjects in the age group of 18-50 years working in Saw Mill in different areas of Bhavnagar city. The present study was carried out by computerized software of pulmonary function test named "SPIROEXCEL". The various data were collected; compiled, statistically analyzed and valid conclusions were drawn. **Results**: The present study results showed the mean values of FVC, FEV1, $FEF_{25\%,}$ SVC, PEFR, FEF50% and MVV were significantly lower in Saw Mill workers as compared with their predicted value. The decrease in FVC and MVV indicates a restrictive impairments whereas decrease in FEV1, FEF25-75, PEFR indicates an obstructive impairment. **Interpretation & Conclusion:** Wood dust causes chronic bronchial irritation which is responsible for the restrictive type and restrictive plus obstructive mix type of pulmonary function impairment. The lung function indices of the saw mill workers decreased with their length of service. Inhalation of wood/saw dust is associated with a reduction in pulmonary function and also greater decline in pulmonary function was noted with greater duration of exposure.

**Key Words**: Occupational pulmonary diseases, Computerized Spirometric Parameters, Saw Mill Workers, wood/saw dust

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**Introduction:**

It is estimated that at least 2 million people are exposed to wood dusts every day [1,2] around the world. In general, wood dust exposure deteriorates pulmonary functions, increases the prevalence of respiratory diseases, exacerbates existing illnesses, increases cancer incidence and deaths [1–7]. International Agency for Research on Cancer (IARC) reports that wood dust causes cancer and included it in 1995 into Group 1 carcinogens[1]. Besides, wood contains many microorganisms (including fungi), toxins and chemical substances and they may significantly affect human health [1, 2, 8–10]. It is recognised that those agents may cause irritation of oral cavity and throat, tightness of the chest, irritant dermatitis, urticaria, alveolitis, deterioration of pulmonary functions, and a reduction of FEV1 (Forced expiratory volume in 1 second) [1,2,7,10–16]. Basic tools for evaluating the effect of exposure on respiratory system include pulmonary function tests [1,2]. Many studies on workers in furniture manufacturing sector evidenced that upper and lower respiratory system symptoms increased in people exposed to wood dust [3, 16–23]. Also, these symptoms are related to the exposure levels and seen frequently in cases of exposures higher than 5 $mg/m^3$ [3,17]. Woodworking industry has developed in Turkey; however, studies on exposures to wood dust are limited. The threshold value for hard wood dust exposure as specified in the regulation on 'Health and Safety Measures for Working with Carcinogenic and Mutagenic Materials', which was put into effect in 2003 in Turkey, is 5 $mg/m^3$ [24]. United States National Institute of Occupational Health and Safety (NIOSH) recommend that wood dust concentration should not exceed 1 $mg/m^3$in the working atmosphere for a 8-hour working period [25]. The threshold value in Turkey is higher than that specified by NIOSH and scientific studies on the effects of this higher threshold value are required. Saw Mill workers are exposed to wood dust at all stages of wood processing. For many years, wood dust was considered to be a nuisance dust that

irritated the nose, eyes, or throat, but did not cause permanent health problems. Numerous recent studies, however, have shown that exposure to wood dust can cause health problems. Wood is classified as either softwood or hardwood. Softwoods come from coniferous trees such as spruce, pine, and fir. Hardwoods come from deciduous trees such as oak, alder, and maple[7].

The pulmonary function test is one of important measures to assess respiratory efficiency. These tests are important for clinical diagnostic, prognostic value and research purpose too. Up till now plenty of work has been done to assess pulmonary function test in healthy as well as diseased condition like asthma, tuberculosis, ascites etc[8]. Measurement of dynamic lung functions is more important than that of static lung volumes [26]. Now it is well recognized that pulmonary function tests have been beneficial in the early recognition of pulmonary dysfunctions in patients considered to be normal on the basis of clinical and radiological examination and in the differential diagnosis of patients with a known pulmonary disease. A large number of workers are engaged in Saw mills in Gujarat, so it is necessary to evaluate health hazards in this group of workers. So the present work is performed to study the effect of wood dust on respiratory function of exposed workers of our locality.

**Material and Methods:**

After taking prior permission of institutional review board & ethical committee the present study was carried out at pulmonary function test lab, department of physiology, Govt. Medical College, Bhavnagar, Gujarat. 50 male subjects working in Saw Mill in different areas of Bhavnagar city were included in this study.

All the individuals from Saw Mill worker are subjected to history taking and clinical examination prior to spirometry.

Inclusion Criteria: (1) Sex - male (2) Age - 18 yrs to 50 yrs. (2) Subjects who have worked in Saw Mill more than 3 years. (3) No any past or present history of major chronic diseases like Tuberculosis, Diabetes mellitus, Hypertension and other major respiratory illness (4) No any history of smoking in past or present. (5) Subject must not be using any protective equipment at working place. (6) Subjects who are agree to give written informed consent.

The present study was carried out by us using computerized software of pulmonary function test named “SPIROEXCEL”. Spiro excel is an instrument designed for lung function screening. The core of the system is the “intelligent” flow meter that, connected through the USB Cable, turns any personal computer (laptop or desktop) in a complete pulmonary function tasting lab. Spiro-excel is designed in such a way that it is easy and simple to operate and give highly accurate results. With the help of Spiro excel it is easy to analyze data and it gives accurate result without manual calculation according to standardize testing protocol and predictions. The system is composed of turbine flow meter, the measurement and elaboration device (light weight and ergonomic), and the communication cable by the software pack. Spiro-excel is a device that uses electronic and mechanical precision components and must be used in the following ambient condition: Temperature maintained between 5˚C and 40 ˚C, relative humidity lower than 90%. Avoid using it in environment full of noxious smoke and excessive dust. Never set the instrument near any kind of heat and water source. All pulmonary function tests were carried out at a fixed time of the day to minimize the any diurnal variation[27].

Method: All the subjects were physically healthy on basis of clinical examination, without any symptoms of any acute respiratory illness. The experimental protocol was explained to all the subjects and written consent was obtained from them.

Anthropometrical measurements including age, height and weight were recorded. Further a preliminary clinical examination was carried out on the subjects to rule out any medical problems.

Spiro metric parameters using “spiroexcel”: All tests were recorded in sitting comfortable and relaxed position in chair on 11 A.M. Before lunch and with no any tight clothing which substantially restricts full chest and abdominal expansion. Subjects were explained and demonstrated about the procedure to be performed. They were allowed to do enough practice, as lung volume depends on subject making a maximal voluntary effort. Full

series of tests takes time of about four to five minutes. The testing procedures were quite simple, non-invasive and harmless from subject's point of view. Only three maneuvers required to collect all data which are forced vital capacity (FVC), slow vital capacity (SVC) and maximal voluntary ventilation (MVV).

For FVC maneuver, subjects nose was clipped and instructed to take maximum deep inspiration as much as possible and hold it, then mouth piece was kept firmly in the mouth between lips so as to avoid escape of any air, then asked the subject to blow out force fully and as fast and long as much possible in the mouth piece and by doing this value of FVC and its components were obtained. For MVV maneuver, the subject was asked to perform inspiration and expiration as fast and as deep as possible in the mouth piece for minimum of 15 seconds with nose was clipped. For SVC maneuver, the subject was asked to perform first three tidal respiration and one deep expiration and deep inspiration followed by other three tidal respirations in the mouth piece.

By doing above three maneuvers we obtained actual and predicted values of following parameters: Forced vital capacity ( FVC ) , Forced expiratory volume (FEV ) , FEV1 / FVC ratio, Forced expiratory flow 25–75 % ( FEF 25-75 ) and Maximal voluntary ventilation( MVV ) L/min , slow vital capacity SVC(L), Peak expiratory flow rate (PEFR) (L/S), FEF 25% (L/S), FEF 50%, FEF 75%.

Following acceptability criteria were used for good quality results: A sharp peak flow and an expiratory duration is greater than six seconds, Two or three acceptable maneuvers should be performed, The two highest FEV1 values from these acceptable maneuvers should be within 0.15 L of each other, Graph must be free from artifacts, There must have no cough, no leak, and no obstruction in mouthpiece and have good start.
Predicted values of all Spiro metric parameters for age and stature were provided by the manufacturer of the spiroexcel. Statistical analysis was done by "unpaired student t test" with the help of "Graph pad instate" statistical software.

**Result:**

**TABLE-1: Anthropological parameters of Saw Mill workers**

| Parameter | Saw Mill worker (Mean ± SD) |
|---|---|
| Age | 38.92 ± 9.66 |
| Weight | 67.42 ± 12.89 |
| Height | 168.09 ± 6.04 |
| BSA* | 1.75 ± 0.16 |

*BSA- Body Surface Area

**Figure-1: Age distribution in saw mill workers**

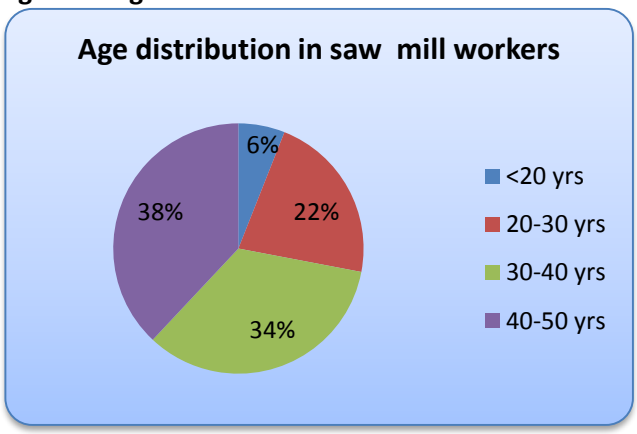


**TABLE-2: Computerized Spirometric parameters in Saw Mill worker**

| Parameters | Predicted | Test | P value |
|---|---|---|---|
| | Mean ± SD | Mean ± SD | |
| FVC | 4.31 ± 0.44 | 2.43 ± 0.55 | P < 0.001 |
| FEV1 | 3.59 ± 0.39 | 2.07 ± 0.55 | P < 0.001 |
| PEFR | 8.73 ± 0.59 | 4.67 ± 2.19 | P < 0.001 |
| FEF25-75 % | 4.24 ± 0.44 | 3.18 ± 1.28 | P < 0.001 |
| FEF25 % | 7.54 ± 0.45 | 4.28 ± 2.08 | P < 0.001 |
| FEF50 % | 4.78 ± 0.39 | 3.48 ± 1.60 | P < 0.001 |
| FEF75 % | 2.01 ± 0.31 | 2.14 ± 0.78 | P < 0.001 |
| FEV1/FVC | 80.15 ±1.97 | 85.24± 11.50 | P = 0.475 |
| SVC | 4.45 ± 0.47 | 2.57 ± 1.2 | P < 0.001 |
| MVV | 128.60± 11.31 | 38.40± 20.43 | P < 0.001 |

According to the data given in above table it is seen that the forced vital capacity of Saw Mill worker is very much compromised when compare to their predicted value. So, overall spirometric parameters in Saw Mill workers are reduce as compared to their predicted values.

**TABLE-3: Computerized Spirometric parameters in percentage of predicted value and test value of Saw Mill worker (Based on mean values)**

| Parameters | Predicted | Test | % of predicted |
|---|---|---|---|
| FVC | 4.31 | 2.43 | 56.38 % |
| FEV1 | 3.59 | 2.07 | 57.66 % |
| PEFR | 8.73 | 4.67 | 53.49 % |
| FEF25-75(L/S) | 4.24 | 3.18 | 75 % |
| FEF25%(L/S) | 7.54 | 4.28 | 56.76 % |
| FEF50%(L/S) | 4.78 | 3.48 | 72.81 % |
| FEF75%(L/S) | 2.01 | 2.14 | 106.46 % |
| FEV1/FVC (%) | 80.15 | 85.24 | 106.35 % |
| SVC(L) | 4.45 | 2.57 | 57.75 % |
| MVV (L/M) | 128.6 | 38.4 | 29.86 % |

**TABLE -4: Distribution of subjects according to vantilatory impairments of lung function**

| Vantilatory Impairments | Saw Mill Workers | | |
|---|---|---|---|
| | Pure Obstruction | Pure Restriction | Obstruction plus Restriction |
| | 0% | 74% | 26% |

**Discussion:** This study was designed to investigate the effects of wood dust on the lung function in Saw Mill workers. In our study significant difference was seen between observed and predicted value of Spirometric parameters in subjects of study group. The subject exposed to saw dust have decreased value of FVC, FEV1, FEF25-75, PEFR, FEF25%, FEF50%, SVC and MVV. The present study supports the findings of other researchers and suggests that wood dust adversely affects the pulmonary function parameters.

A study conducted by Carosse A et.al, showed a decrease in FEV1 in workers exposed to wood dust. The observations made in our study are also in agreement with these findings. Thus indicate that exposure to wood dust or broncho active substances related to wood causing lung function impairments[28]. In our study we also found the reduced observed value for Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV1), and Maximum Voluntary Ventilation (MVV) in wood workers relative to their predicted value. According to study of Noertjojo HK in 1996 Sawmill workers had significantly greater declines in FEV1 and FVC compared with office workers adjusted for age, smoking, and initial lung function[29].

The effect of chronic exposure to dust from local woods such as ebony, achi, and iroko on lung function of timber market workers in Calabar Nigeria, was studied by Okwari OO et. al[30]. Forced vital capacity (FVC), Forced Expiratory Volume in one second, (FEV1), Forced Expiratory Volume as a percentage of forced vital capacity (FEV1%), and Peak Expiratory Flow Rate (PEFR) were measured and the mean values of FVC, FEV1, FEV1% and PEFR of the timber workers were significantly lower ($P<0.01$) than in control subjects.

A study conducted by Dudhmal V.B. et. al,[31] on saw mill factory workers showed stastically significant decreased value of FEV1 and PEFR in saw mill workers.

A study conducted by Erdinc osman and kayihan pala[32] on wood workers in Turkey showed that the mean FEV1 and FVC values of woodworkers were significantly low as compared to control group.

A study conducted by Bhat MR and Ramaswamy C [33].in saw mill workers in Mangalore showed that FEV1, PEFR and FVC were significantly reduced in saw mill workers as compared to controls.

While discussing the pathophysiological aspects of a drop in the values of the aforesaid lung function parameters, FVC is decreased in pulmonary obstruction, emphysema, pleural effusion, pneumothorax, pulmonary edema and poliomyelitis[34]. Similarly, the FEV1 value is low in obstructive lung diseases and in reduced lung volume[35]. 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[36]. Whereas, PEFR provides an objective assessment of functional changes associated with environmental and occupational exposures and determines acute

or chronic disease processes[37]. In patients with severe COPD, PEFR is persistently low and represents collapsing of large airways[38]. In addition, MVV reflects the function of the entire ventilatory apparatus and depends upon the compliance of the thoracic wall and lungs, airway resistance and muscular force. MVV is profoundly reduced in patients with airway obstruction or emphysema [38].

In view of pathophysiological aspects and a drop in FVC, FEV1, FEF25-75, PEFR, FEF25%, FEF50%,, SVC and MVV parameters, our results suggest that wood dust adversely affects the lung function and causes restrictive pattern as well as mix restrictive plus obstructive patterns of lung function impairment. Because when a airways disease become more advanced, time segments of the spirogram such as the FEV1 will be reduced out of proportion to the reduction in FVC.

If we try to identify the subject according to ventilatory impairment, it shows that most of the subject from saw mill have restrictive type of lung function impairments which is about 74% and remaining 26 % of subject shows mix restrictive plus obstructive patterns [39] because the decrease in FVC and MVV indicates a restrictive impairment whereas decrease in FEV1, FEF25-75, PEFR indicates an obstructive impairment.

All those facts allow concluding that the problem of effects of saw dust is of importance in that it highlights the need to reduce exposure and shows the magnitude of the effect on the population at risk because the dust exposure can lead to lung function impairments. It is advisable therefore, that health risk should be reduced by the mutual collaboration between health officials, mill management and their workers in the area of implementation of protective measures, such as improvement of ventilation and use of individual protective devices.

**Conclusion:**

Wood dust causes chronic bronchial irritation which is responsible for the restrictive plus obstructive type of pulmonary impairment of lung functions. The lung function indices of the saw mill workers decreased with their length of service. So chronic inhalation of wood/saw dust is associated with a reduction in pulmonary function and also greater decline in pulmonary function with greater duration of exposure.

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