

## Original Research Article

# Pulmonary function analysis in carpenters: a study from Kerala

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## ABSTRACT

**Background:** There has been an increase in proportion of workers suffering from occupational diseases compared to past. Only limited studies have been conducted to evaluate the pulmonary functions of carpenters, exposed to wood dust. Hence the present study was undertaken to find out any functional impairment in carpenters due to their occupational environment.

**Methods:** Study was done in 300 subjects who were divided into two groups of 150 each. One group comprised carpenters with minimum 5 years exposure to wood dust. Other group comprised matching healthy subjects who served as controls. Pulmonary function parameters were recorded from all subjects. Parameters recorded were Slow Vital Capacity (SVC), Forced Vital Capacity (FVC), Forced Expiratory Volume in 1 second (FEV<sub>1</sub>), and Peak Expiratory flow Rate (PEFR). 'Knudson and Collagens' standard reference values for south Indians were used here for interpretation. Statistical analysis of the data of study subjects and the controls were done by using student's 't' test. The level of significance was fixed as 5%.

**Results:** A statistically significant reduction in SVC, FVC, FEV<sub>1</sub> and PEFR was seen in the study group compared to control group. FEV<sub>1</sub>/FVC was less than 80% of the predicted values in 8% of the study population. Seventeen percentage of the study population had less than 80% of predicted value of both FEV<sub>1</sub> and FVC with normal FEV<sub>1</sub>/FVC.

**Conclusions:** Lung functions of carpenters show statistically significant reduction compared to normal healthy adults. This could be due to their exposure to wood dust.

**Keywords:** Carpenters, PFT, Wood dust

## INTRODUCTION

Occupational diseases have become one of the major economic burdens of every country. According to International Labor Organization report 2013, more than 2.3 million people die of occupational diseases. Impairment of health due to exposure to wood dust is an important occupational hazard. It is estimated that at least 2 million people are exposed to wood dust every day around the world.<sup>1</sup>

Wood dust exposure deteriorates pulmonary function, increases the prevalence of respiratory diseases, increases cancer incidence and death.<sup>2</sup> Wood dust also causes allergic dermatitis and decreased mucociliary clearance leading to mucostasis. Out of these, effects on respiratory system are more common.<sup>3</sup> Wood contains microorganisms like fungi, toxins and chemical substances which may significantly affect human health.<sup>4</sup> Two types of woods are seen in nature, soft wood and hard wood. Chemical constituents of woods are cellulose,

polyoses, and lignin. Cellulose is the major component in both soft and hard woods. But proportion of polyoses and lignin differs.<sup>4</sup>

Carpentry is one important occupation in which there is considerable exposure to wood dust. Spirometry is one of the basic tools in evaluating the respiratory function.<sup>5</sup> Studies conducted worldwide have proven the impairment of pulmonary functions in wood workers.<sup>6,7</sup>

Even though several studies have been conducted in wood workers worldwide, not much have been published from India. One study from Nagpur, reported significant decrease in PEFR in wood workers.<sup>6</sup>

In Kerala, a South Indian state, almost 6 lakhs people are working as carpenters.<sup>8</sup> To the best of our knowledge no study has been done so far in this population. In view of a dearth of information on this issue from South India, it was necessary to conduct such a study.

## **METHODS**

This study was conducted under the auspices of the Department of physiology, Medical College Kottayam and with the help of Department of Pulmonary Medicine, Medical College, Kottayam. The study population was from Kottayam town, who were members of District Carpenters Association, Kottayam.

Study design was descriptive cross sectional. Carpenters were summoned by phone and letters, with the permission of the president and the secretary of the District Carpenters Association. Furniture industry is one of flourishing industry in this area and so many carpenters are working in this field.

Criteria for selection of study population were, male carpenters having more than 5yrs of exposure to wood dust. Those who had respiratory complaints before joining for work were excluded. Subjects having cardiac diseases and those on medications were also excluded.

One hundred and fifty carpenters were taken as subjects of the present study. Data were collected from 150 carpenters with a minimum period of 5 years exposure to wood dust and 150 healthy volunteers were included as controls for the study. Basic demographic data, history of exposure to wood dust, history of respiratory symptoms present and history of any other illnesses were collected using the help of proforma from all subjects. Proforma was prepared based on standard questionnaire published by British Medical Research Council.<sup>9</sup> Vital parameters were recorded. Blood pressure was recorded using manual sphygmomanometer. The anthropometric measurements including height and weight were recorded. Height recorded using stadiometer and weight using a floor weighing balance. Physical examination was done by an experienced pulmonologist. Guidelines were strictly followed in taking clinical data.<sup>10</sup> Pulmonary

function tests (spirometry) were done using a portable vitalograph (spirotrac, version 4.36). Spirometry performance and validation were done according to the guidelines published by American Thoracic Society<sup>11</sup>. The various indices of spirometry that were recorded and used for analysis were, Slow vital capital (SVC), Forced vital capital (FVC), Forced Expiratory volume in 1second (FEV1), FEV1/FVC, Peak Expiratory Flow Rate (PEFR) and Forced Expiratory Flow (FEF 25-75%).

## **Procedure**

All the subjects were given clear instructions prior to each test. Spirometry was done in the morning, in sitting position with neck slightly extended. A disposable mouth piece was used for each subject. After the insertion of mouth piece it was made sure that there were no air leaks around the mouthpiece. All maneuvers were performed in sitting position and at rest with the nose clip in place. The subjects were asked to loosen tight clothing, if any. Each worker was taught about the various maneuvers to be performed for about 5minutes. Demonstration was also given. Every subject was given ample time to understand carefully and then was allowed to do some practice blows. Sufficient rest was provided between the procedures.

## **Selection of reference values**

Parameters of lung function are affected by standing height, age, gender and race. 'Knudson and Collagens' standard reference values for south Indians are used as reference values here.

## **Statistical analysis**

Analysis of the data obtained from the study subjects and the controls was done by using Students' 't' test. The level of significance is fixed at 5%. Analysis done using SPSS software.

## **RESULTS**

### **Age distribution**

There is no significant difference between age distribution of study and control groups. Applying student's 't' test,  $t=1.3859$   $p$  value= $0.1682 > 0.05$  (Table 1). Application of F test ( $F=0.7059$ ,  $p$  value =  $0.9151 > 0.05$ ) also showed that there is no difference in the mean and variance of age of two groups.

### **Distribution of symptoms, and signs (crepitations/ rhonchi) in the study group**

Cough is the most common symptom, being present in 58% of study group, followed by breathlessness (47%) and rhinitis (44%). Forty-five percentage of study group had chest signs (Table 2). This shows the severity of impairment of lung function in the study group.

**Table 1: Mean and SD of age.**

	Study group	Control group	P- value
Mean age ±SD	50.07±12.52	47.03±12.35	0.1682

**Table 2: Symptoms/chest signs.**

Symptoms	Patients	% of total study group
Rhinitis	66	44
Cough	87	58
Breathlessness	71	47
Chest signs	68	45

When we consider duration of exposure, it has been found that all symptoms except rhinitis are highest in the group with maximum duration of exposure. Rhinitis more in the less exposed group (beginners). In this group (<10yrs) 50% had cough and breathlessness and all of them had rhinitis (Table 3).

**Table 3: Symptoms/sign Vs duration of exposure to wood dust.**

Symptoms	<10yrs	10-20yrs	21-30yrs	>30yrs
Rhinitis	7 (50%)	11 (38%)	16 (41%)	30 (46%)
Cough	7 (50%)	16 (54%)	19 (47%)	45 (68%)
Breathlessness	7 (50%)	14 (46%)	12 (29%)	38 (57%)
Chest signs	7 (50%)	14 (46%)	12 (29%)	36 (54%)

When data of carpenters with multiple symptoms were analysed, out of total 66 subjects in group IV, 21 (31.8%) had all 4 symptoms. Out of total 40 subjects in group III, 12 (30%) had all 4 symptoms. Out of total 30 subjects in group II, only 5 (16.6%) had all 4 symptoms. Out of total 14 subjects in group I, only 21 (14.2%) had all 4 symptoms (Table 4). This clearly shows that severity of symptoms increases with duration of exposure to wood dust.

**Table 4: Multiple symptoms/sign Vs duration.**

No. of symptoms	<10yrs	10-20yrs	21-30yrs	>30yrs	Total
0	5	7	21	12	45
1	0	5	2	12	19
2	2	8	5	12	27
3	5	5	0	9	19
4	2 (14.2%)	5 (16.6%)	12 (30%)	21 (31.8%)	40
Total	14	30	40	66	150

**Lung parameters**

FEV1 of the study group was significantly reduced when compared to that of control group. FVC was also reduced significantly. But FEV1/ FVC was not reduced.

**Table 5: Lung parameters in study and control groups.**

Parameter	Study group	Control group	P' value
SVC	84.5±11.13	88.87±9	0.0159*
FVC	87.12±10.86	92.51±8.16	0.0019*
FEV1	85.05±13.32	91.5±9.86	0.0024*
FEV1/FVC	97.77±10.32	98.5±6.44	0.6338
PEF	90.05±20.05	100.18±20.41	0.0054*
FEF 25-75%	61.1±22.05	71.15±20.32	0.0083*

\*Statistically significant

**Table 6: Percentage abnormality lung parameters Vs duration of exposure.**

Parameter	<10yrs	10-20yrs	21-30yrs	>30yrs
SVC	33	54	65	39
FVC	66.7	15	29	57
FEV1	66.7	69	29	57
FEV1/FVC	0	23	6	43
PEF	33.7	46	35	61
FEF25-75%	50	85	71	82

When we analyze lung parameters against duration of exposure, PEF and FEV1/FVC are impaired maximum in the group having maximum duration of exposure (Table 6 and 7).

**Table 7: Mean & SD of pulmonary parameters Vs duration of exposure.**

Parameter	<10yrs	10-20yrs	21-30yrs	>30yrs
SVC	76.11±8.45	81.01±7.37	85.66±11.52	87.48±11.97
FVC	78.9±7.86	84.65±8.45	88.97±10.42	88.99±12.01
FEV1	77.95±11.63	77.31±9.58	86.36±10.85	89.54±14.77
FEV1/FVC	98.53±8.97	91.51±10.27	97.11±7.9	101.00±10.97
PEF	86.33±15.83	82.53±21	88.03±17.18	96.04±21.36
FEF25-75%	71.80±22.31	58.58±21.86	67.96±19.59	55.67±22.71

## DISCUSSION

This study was done to observe the effects of wood dust on the pulmonary function of carpenters. Total number of study population were 150 and equal no of controls were added. All members in the study and control group were males. Majority of the study population were between the ages of 20 and 60. Since there was no significant statistical difference between the age distribution of study and control population, both groups were found to be matching.

Cough was the most common symptom (58%). Breathlessness (47%) and Rhinitis (44%) were also high. All these values are significantly higher than the general population. Breathlessness for 45% is markedly high, when compared to 10-15% in the general population<sup>11</sup>. Sixty percentage of study population had respiratory symptoms or abnormal chest signs. This strongly supports other studies.<sup>12,13</sup>

When we analyzed the clinical data based on duration of exposure, all the symptoms/signs were highest in the group having maximum duration of exposure. In this group (>30 yrs exposure) 68% had cough, 57% had dyspnea and 54% had chest signs.

If you take the number of subjects having more than one symptom/sign, which shows the severity of their physical abnormality, again the group having maximum exposure to wood dust has the highest number. Groups having exposure more than 30yrs and between 20 and 30 yrs had subjects with all the four symptoms/sign 31.8% and 30% respectively. This is markedly high when compared to 14.2% and 16.6% in 1<sup>st</sup> and 2<sup>nd</sup> groups. This supports similar study conducted by Oge OM, (Nigeria) in 2000.<sup>14</sup>

The lung parameters showed that there was statistically significant reduction in FVC and FEV<sub>1</sub>. This shows impairment of lung function due to exposure to wood dust. This is in agreement with previous studies like Boskabady M, Pramanik P.<sup>15,16</sup>

FEV<sub>1</sub>/FVC was not impaired significantly. This points to a restrictive type of abnormality as supported by the previous studies like Mahamood NM, Noertjojo HK and Schlunssen.<sup>17-19</sup> Significant reduction in PEFR in study group compared to the control group shows that there is an element of obstruction along with restrictive abnormality. FEF 25-75 shows small airway disease. In our study there was significant reduction FEF 25-75. This shows small airways were affected in wood dust exposure.

FEV<sub>1</sub>/FVC, the marker of obstructive disease is most affected in the group IV (>30 yrs exposure). Around 43% had FEV<sub>1</sub>/FVC abnormal. This clearly shows the relationship of lung function with duration of exposure. FEV<sub>1</sub>/FVC in group I give 100% normal. This might

mislead us to think that group 1 (<10 years) are having good lung function. Normal value of FEV<sub>1</sub>/ FVC in this group is due to very low values of FEV<sub>1</sub> and FVC. Both have been reduced markedly in group I. This can happen in severe obstruction. This shows only severity and acuteness of problem. FEF 25-75%, which is considered the function of small airways is markedly reduced in group IV (>30 yrs). In group I, it is better. Even though FEF 25-75% is highly variable very high percentage of less than 80% of predicted in group IV shows as duration of exposure increases small airways are more affected. These are early signs of further deterioration of lung function. FEV<sub>1</sub> markedly decreased in all groups. Almost 60% of population FEV<sub>1</sub> is abnormal. Only 21-30 group slightly better values 29%. This again shows clearly the element of obstruction in carpenters. PEFR an important parameter which reflects the level of obstruction is very much reduced in all groups.

All these are similar to results of previous studies.<sup>15-18</sup> Maximum abnormality (61%) is in group IV (>30 yrs). Minimum impairment in the group I (only 33.7%). This shows steady decline with duration of exposure.

## CONCLUSION

Pulmonary function tests using the spirometry were conducted among 150 carpenters of Kottayam town in 6month period. Symptoms/sign and The PFT variables recorded and data analyzed. A Statistically Significant reduction was seen in SVC, FVC, FEV<sub>1</sub>, PEF and FEF 25-75% compared to normal healthy adults. No significant reduction was seen in FEV<sub>1</sub>/FVC, pointing to the restrictive nature of dysfunction. Those exposed to wood dust for maximum duration were having maximum dysfunction which shows the effect of duration of exposure. Millions of people are involved in the wood industry and millions depend on them. Governments have to make and implement strict rules and regulations for the betterment of workers in this field to prevent excess exposure and pulmonary dysfunction.

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