ORIGINAL RESEARCH PAPER

Medical Science

OCCUPATIONAL EXPOSURE TO WOOD DUST AND ITS EFFECT ON PEAK EXPIRATORY FLOW RATE IN A SAMPLE OF CARPENTERS IN BAGHDAD CITY.

KEY WORDS: Occupational exposure, Wood dust, Peak expiratory flow rate, Carpenters, Baghdad.

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ABSTRACT

Background: Occupational lung diseases are important medical conditions due to increased exposure to various chemicals and dusts as in textile, cement, wood and marble industries. Carpenters are at high risk of developing occupational lung disease due to their continuous exposure to wood dust in their workplaces.
Objective: To evaluate the effect of wood dust on PEFR value of healthy, non-smoker carpenters.
Subjects and methods: A cross sectional study was conducted on 50 non-smoking carpenters, while 50 non-smoking persons working other than carpentry were selected as a control group. The data were collected from the 14th of June 2018 to the 14th of December 2018 including demographic parameters such: age, sex, smoking habits, height, weight, BMI and duration of exposure on PEFR in both cases and control subjects by using Mini Wright's peak flow meter. The statistical analysis was done by using Student's t-test. A p-value was considered statistically significant if < 0.05.
Results: The PEFR values in carpenters were lower than that of control subjects according to age, height, weight and BMI and these results were highly significant statistically.
Conclusion: The decrement in PEFR in carpenters was probably caused by continuous exposure to wood-dust in their workplaces causing an adverse effect on their respiratory health status so we suggest pre-employment medical checkup with periodic monitoring of respiratory health status and using respiratory protective devices as facemasks with good ventilated workplaces to decrease the harmful exposure to wood-dust.

INTRODUCTION

Occupational lung diseases are lung conditions that are related to work which caused by exposure to certain materials within the person's workplace such as textile industries, cement industries, wood industries, marble industries … etc. which lead to decrease in the lung health status of workers and affect their daily life activities [1-3].

Wood dust or sawdust is a waste product that is produced by woodworking operations as sawing, drilling, milling, routing, planning and sanding of wood. The composition of sawdust is small fine wood particles [4].

Industries that have a high risk of sawdust exposure include furniture manufacture, sawmills, secondary wood products manufacture (windows, doors, etc.), dimension mills, carpenters and cabinet makers. Wood workers can be exposed to different types of exposure during their work, i. e. hard or softwood dust, natural wood dust, pure wood dust or other containing paints, adhesives or other types of chemicals [5].

Carpentry is mostly a job for men worldwide in the United States of America (USA), 98.5% of carpenters are males and it was ranked as the fourth occupation dominated by males in 1999, 1.5 million positions were there in 2006 [6].

Occupational exposure of carpenters to wood-dust during their professional jobs can cause different types of respiratory and cardio-vascular illnesses [7].

Wood dust presents the most important occupational exposure problem in wood industries including carpentry and the inhalation of that dust can be associated with many upper and lower pulmonary signs and symptoms such as coughing, wheezing, phlegm production and breathlessness [8&9].

Sawdust acts as a sensitizing or irritant agent to skin causing dermatitis and urticaria, also sensitizing eyes and nasal mucosa causing conjunctivitis and rhinitis [10].

Few researchers found that wood-dust has a role in some respiratory diseases as occupational asthma, pneumonitis and chronic bronchitis [11].

Many researchers found that pulmonary function parameters were reduced in wood workers in comparison to general population. Pramanik and Chaudhury in 2013 did a research that revealed 58% of carpenters were complaining from occupational respiratory symptoms in which coughing and wheezing were the most observed symptoms [12].

Other studies were done to evaluate the lung function indices by pulmonary function tests that showed a significant reduction in lung volume, forced vital capacity (FVC), forced expiratory volume in one second (FEV1) and forced expiratory flow 25-75 %(FEF25-75%) [13-15].

According to cardiovascular system involvement, wood-dust exposure is a risk factor for hypertension in carpenters as it increases both systolic and diastolic blood pressure with no effect on pulse rate [16].

Exposure to wood-dust is associated with variety of hazardous health effect; it has a carcinogenic effect on human based on some studies showing an increased risk of nasopharyngeal, sinonasal and lung carcinomas [17-19].

Work-related exposure to wood-dust increase the morbidity and causing a decline in carpenters' health status, the

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decrement in PEFR with time in carpenters might be due to inflammatory changes in the respiratory airways by induction of several cytokines and chemokines that lead to increase airway resistance due to wood dust particles leading to airway remodeling and hypertrophy of mucosal cells resulting in increased mucus secretion and plug formation which may cause airway obstruction and lung problems [(20)]. In our country, there were a little attention to occupational lung diseases within the health sector and there was no information about work- related wood dust exposure and the effect on pulmonary health status.

So, it was important to do this research on effect of sawdust on peak expiratory flow rate (PEFR) to evaluate the lung health status of carpenters in Baghdad/Iraq to put a plan for future dust control in wood factories.

Aims of study:
To evaluate the effect of wood dust on PEFR value of healthy, non-smoker carpenters.

Subjects and methods
A cross sectional comparative study (Case – Control study) was conducted on 50 carpenters (study group) in their workplaces and 50 non carpenters (control group) whom were selected according to the criteria of inclusion and exclusion. The data were collected from the 14th of June 2018 to the 14th of December 2018. These data included demographic parameters as: age, sex, smoking habits, height, weight, BMI, duration of exposure to wood dust and PEFR which were recorded by using a questionnaire and all subjects were signed on a written informed consent for ethical issue. The inclusion criteria were healthy looking carpenters, males, non-smokers, i.e. nonsmokers who have never smoked a cigarette in their entire life at all or smoked fewer than 100 cigarettes in their life [(21&22)], their ages were between 16-50 years, work at least 8 hours per day for 6 days a week and not using any self-protection ways as face mask so there was a significant dust exposure. The control group included matched healthy, nonsmoker college students, shopkeepers and office workers. All subjects were matched according to age, height and weight.

The exclusion criteria were subjects who smoke cigarettes, cigar, narjil (hookah), and any diagnosed respiratory diseases by a physician as bronchial asthma, bronchiectasis, TB, malignancy, and any chronic severe illnesses. Musculoskeletal abnormality of thoracic cage or vertebral column also excluded from the study.

Peak expiratory flow rate (PEFR):
A Mini Wright's peak flow meter was used in the study to measure the PEFR. It is an instrument introduced in 1942 by Hadorn which is an accurate, portable and rugged instrument made as a plastic cylinder measured about (15*5 cm) and weighted about (70g), used for measuring PEFR in a simple, reproducible and can be easily affordable test to evaluate the lung function [(23)].

The procedure was simple, harmless and non-invasive to the subjects. It was explained and demonstrated by a teaching video about how to do the correct procedure using Mini Wright device for each subject.

The subjects were in standing position, taking a maximum breath and blow it forcefully and rapidly into the instrument with a close monitoring to be sure that there was a tight seal between the subject's lips and the device's mouth piece. The procedure was repeated thrice for each subject and the highest reading was taken in L/min for the analysis. The apparatus mouth piece was disinfected by medical alcohol 70% before and after each time used.

Height:
The subjects were stood with barefoot against a wall which was calibrated in centimeters by using a tape measure and their heights were recorded.

Weight:
The subjects were stood with barefoot and light clothes (trousers and T- shirt) on the center of a digital scale with a maximum of 150Kg and their weights were recorded.

Body mass index (BMI):
It was calculated by dividing the weight of the subject in Kg over their height in square meter (kg/m^2). According to BMI, all the subjects were classified as either underweight (<18.5), normal (18.5-24.9), overweight (25-29.9) or obese (≥30) [(24&25)].

Statistical analysis:
Statistical analysis of data was analyzed by using the Microsoft Excel and the Soft Package Scientific Statistics (SPSS, version 25.0) and tested for normal distribution.

Data variables were expressed as mean ± standard deviation (SD). All variables between different groups were tested by using Student's t-test. A p-value was considered as statistically significant if less than 0.05.

RESULTS
A total of 50 male non-smoker carpenters were interviewed in Baghdad in their work places and completing the questionnaire for the study. Also, a total of 50 male non-smoker workers other than carpentry were interviewed too and completing the questionnaire of the study, both groups were in age interval between 16-50 years.

There were no significant difference between the study and control groups according to overall anthropometric data, age, weight and height.

Comparison of PEFR was done in both study and control groups according to their age, height, weight, BMI and duration of exposure to wood dust in carpenters. Data was collected and analyzed statistically.

The PEFR values in carpenters were lower than that of control group.

Table (1) and figure (1) shows the mean and standard deviation of PEFR in study (carpenters) and control (non-carpenters) subjects.

The mean of PEFR in study group was significantly less than that of the control group.

There was a significant difference between the two groups statistically (p<0.01).

Table (1): The PEFR (Mean and SD) in study (carpenters) and control (non-carpenters) groups.

Subjects	PEFR range (L/min)	Mean ± SD of PEFR (L/min)	'p' value
Study (carpenters)	310-480	395.10±50.21	<0.01
Control (non-carpenters)	400-590	491.32±46.72	

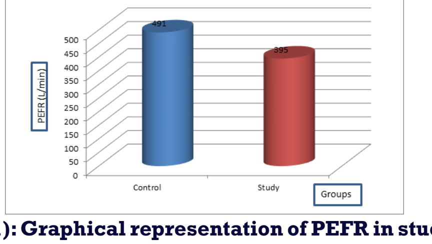

Figure (1): Graphical representation of PEFR in study and control groups.

Table (2) and Figure (2) shows the mean and standard deviation of PEFR in study and control groups according to their age which was divided into three age intervals.

Table (2): The PEFR (mean and standard deviation) in study and control groups according to their age.

Age (years)	Study		Control		'p' value
	No. of subjects	Mean ± SD of PEFR (L/min)	No. of subjects	Mean ± SD of PEFR (L/min)	
16-26	15	420.20±41.23	16	500.47±47.45	<0.01
27-38	19	378.09±45.22	15	489.38±45.13	<0.01
39-50	16	369.14±46.92	19	480.01±43.76	<0.01

The mean of PEFR in study subjects was less than the mean of PEFR in control subjects in all three age divisions and that difference was significant statistically (p<0.01).

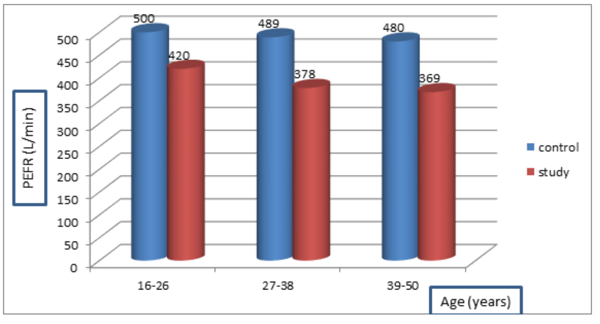

Figure (2): Graphical representation of PEFR in study and control groups in relation to their age.

Table (3) and figure (3) shows the mean and standard deviation of PEFR in study and control groups according to their height which was divided into three height intervals.

The mean of PEFR in study subjects was less than that of controls in each divisions of height intervals with a statistically significant difference (p<0.01).

Table (3): The PEFR (mean and standard deviation) in study and control groups according to their height.

Height (cm)	Study		Control		'p' value
	No. of subjects	Mean ± SD of PEFR (L/min)	No. of subjects	Mean ± SD of PEFR (L/min)	
≤160	12	380.45±48.65	18	480.11±45.21	<0.01
161-175	28	390.50±50.01	20	499.51±44.16	<0.01
≥176	10	428.11±45.22	12	508.02±52.17	<0.01

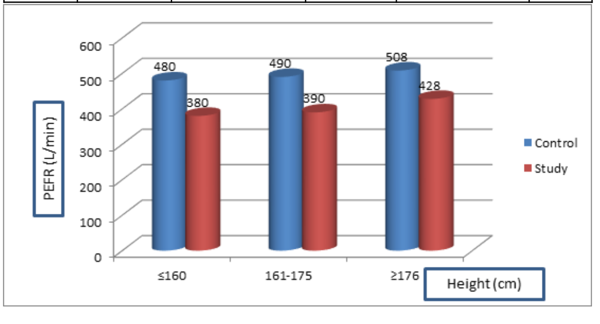

Figure (3): Graphical representation of PEFR in study and control groups in relation to their height.

Table (4) and figure (4) shows the mean and standard deviation of PEFR in study and control group according their weight which was divided into three weight intervals.

In study group, the mean of PEFR was less than that of control group in all of weight interval divisions. The difference was statistically of significance (p<0.01).

Table (4): The PEFR (mean and standard deviation) in study and control groups according to their weight.

Weight (Kg)	Study		Control		'p' value
	No. of subjects	Mean ± SD of PEFR (L/min)	No. of subjects	Mean ± SD of PEFR (L/min)	
≤55	15	387.91±45.02	10	485.21±46.23	<0.01
56-76	28	385.33±48.00	29	489.02±44.12	<0.01
≥77	7	430.48±50.12	11	510.02±45.77	<0.01

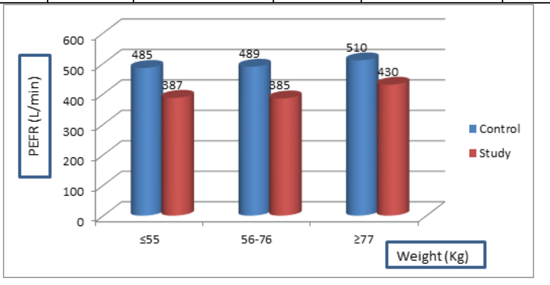

Figure (4): Graphical representation of PEFR in study and control groups in relation to their weight.

Table (5) and figure (5) shows the mean and standard deviation of PEFR in study and control groups according to their BMI which was divided into three groups also.

In study group, the mean of PEFR was less than that of controls in each sub-divisions of BMI and that difference was statistically significant (p<0.01).

Table (5): The PEFR (mean and standard deviation) in study and control groups according to their BMI.

BMI	Study		Control		'p' value
	No. of subjects	Mean ± SD of PEFR (L/min)	No. of subjects	Mean ± SD of PEFR (L/min)	
≤18.5	17	380.01±46.29	15	470.43±45.09	<0.01
18.5-24.9	27	386.32±50.04	26	491.05±43.10	<0.01
≥25	6	432.99±47.06	9	510.98±40.71	<0.01

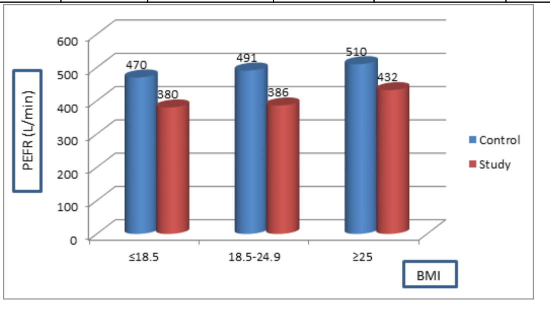

Figure (5): Graphical representation of PEFR in study and control groups in relation to their BMI.

Table (6) and figure (6) shows the mean and standard deviation of PEFR in the study subjects in relation to the duration of exposure to wood dust which was divided into four duration interval groups, the mean PEFR decreased as the duration of exposure to wood dust increase in the study subjects.

Table (6): The PEFR (mean and standard deviation) in study group according to the duration of exposure to wood dust.

Group No.	Duration of exposure (years)	Numbers of subjects	Range of PEFR (L/min)	Mean ± SD of PEFR (L/min)
1	1-4	14	350-480	420.91±38.07
2	5-10	20	335-480	390.76±45.39
3	11-15	10	310-440	366.05±43.21
4	>15	6	310-390	332.86±34.95

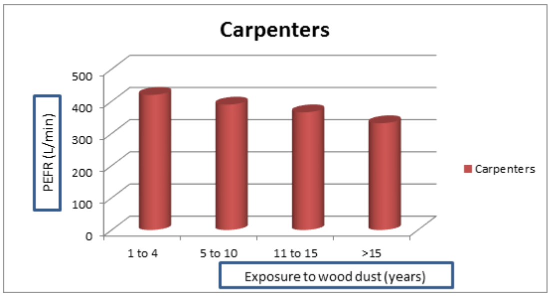

Figure (6): Graphical representation of PEFR in study group according to the duration of exposure to wood dust.

DISCUSSION

The present study was done to show the effect of occupational exposure to wood dust on respiratory health status of carpenters in Baghdad by using a simple peak flow meter and measuring the values of PEFR.

Our study revealed that the mean PEFR value in non-smoking carpenters was significantly less than that of controls in general (the mean PEFR value in carpenters was 395.10±50.21 L/min in compared to a value of 491.32±46.72 L/min in non-carpenters).

The values of PEFR in our study are in line with various studies done in different countries. In a study done in Ondo State, University of Science and Technology, Tobin et al. , 2016, reported that the mean PEFR in Nigerian sawmill workers (404.11±88.80 L/min) was lower than that of control group (457.40±84.45 L/min) [26].

Our finding was also in consistent with a study done by Tanko et al. , 2011, which revealed a significant difference in mean PEFR of carpenters and non-carpenters subjects (342.72±8.30 L/min , 400.31±7.40 L/min respectively) [16].

In another study, Usman et al., 2013, observed that there was a significant reduction in PEFR of wood dust exposed workers in comparison to matched controls [27].

Our results were also similar to the results of Ennin et al., 2015, who found a notable reduction in lung function including PEFR in wood workers relative to control subjects [28].

These findings were also supported by other studies on hardwood workers which were done by Ige and Onadeko, 2000, Bosan and Okpapi, 2004 and Okwari et al., 2005, showing a remarkable decrease in the PEFR in study group compared to control group (29-31). However, our results were higher than the results reported by Kherde et al., 2017, who found that the mean PEFR in sawmill workers was (386.4±87 L/min) which was lesser than that of controls (430.8±60 L/min) [32].

Melanowski et al., 1996, found a significant decline in PEFR values among woodworkers of furniture factory compared to control subjects. Our results also correlate with Milanowski et al. results [33].

Another Study was done in Patiala, India, Department of Physiology, Rajindera Medical College, Mohan et al., 2013, showed a remarkable difference in mean PEFR values between carpenters and control groups (393±52.14 L/min, 485.53±45.10 L/min respectively). Our results were in line with Mohan et al. results too [34].

Age: Our study showed that PEFR decreased with increasing age, as in age group of 16-26 years, the mean PEFR was 500.47±47.45 L/min in controls in compared to 420.20±41.23 L/min in carpenters. These values are decreasing as the age increased reaching a decrement of 480.01±43.76 L/min in controls compared to 369.14±46.92 L/min in carpenters when reaching 39-50 years of age (table 2). So that the PEFR in carpenters according to age was less than that of matched control subjects and this difference was significant statistically.

Ebomoyi and Iyawe, 2005, found that the mean PEFR for young adult males in Nigeria was 573.18±15.73 L/min decreasing to a value of 537.18±53.05 L/min in older males and that was statistically significant. Our values were lesser than that of Ebomoyi and Iyawe [35].

On the other hand, our results were higher than that reported by Mohan et al., 2013, who also found that the PEFR decreased as age increase. He reported that the mean PEFR in age group of 18-27 years was 495.36±45.42 L/min in controls, while in carpenters; it was 429.36±40.72 L/min. The results of PEFR were decreasing to a value of 475.93±42.67 L/min in controls and 367.83±47.93 L/min in carpenters at the age of 37-45 years [34].

Height: Our study showed that the PEFR increased with increasing in height, as the mean PEFR in height of ≤160 cm was 480.11±45.21 L/min in controls, while in carpenters, it was 380.45±48.65 L/min and these values increasing as height increased reaching to a value of 508.02±52.17 L/min in controls compared to a value of 428.11±45.22 L/min in carpenters at a height of ≥176 cm (table 3). So that the PEFR in carpenters according to height was less than that of matched control subjects and this difference was significant statistically.

Ebomoyi and Iyawe, 2005, found that the mean PEFR in height of ≤160 cm was 492.57±43.24 L/min rising to a value of 598.31±35.15 L/min in height of ≥176 cm. Our results were lesser than that of Ebomoyi and Iyawe [35].

Our results were supported by a study of Mohan et al., 2013, he reported that the mean PEFR in height group of <155 cm was 473.89±42.22 L/min in controls and 383.61±50.55 L/min in carpenters. The mean PEFR increased to a value of 500.57±51.16 L/min in controls and 436.67±48.02 L/min in carpenters in height of >169 cm [34].

Another study was consistent with our study showed that an increase in PEFR as height increased done by Elubute and Femipearse, 1971 [36].

Weight: Our study showed a positive relationship between PEFR and weight as the PEFR increased with increasing in weight in both study and control subjects. The value of mean PEFR in weight group of ≤55 kg was 485.21±46.23 L/min in controls compared to a value of 387.91±45.02 L/min in carpenters and increasing to a value of 510.02±45.77 L/min in controls compared to a value of 430.48±50.12 L/min in carpenters when weight increased to ≥ 77 kg (table 4). The PEFR in carpenters according to weight was less than that of matched control subjects and this difference was significant statistically.

Ebomoyi and Iawye, 2005, found that the mean PEFR was 540.77±68.83 L/min in weight group of ≤ 55 kg and the value of mean PEFR rises to 600.0±36.23 L/min as the weight increasing to >76 kg and that supports our study [35].

Our results were supported also by other studies from Mohan et al., 2013 and Elebute and Femipearse, 1971 [34&36].

BMI: Our study showed an increase in mean PEFR as BMI increased in both carpenters and controls. The mean PEFR was 470.43±45.09 L/min in controls in compared to 380.01±46.29 L/min in BMI ≤18.5. The PEFR value rose to 510.98±40.71 L/min in controls and to 432.99±47.06 L/min in carpenters when BMI ≥25 (table 5). The mean PEFR of study group was less than that of controls and that was significant statistically.

Our results were supported by Sherif et al., 1989 and Mohan et al., 2013 as both studies reported a positive correlation between PEFR and BMI [37&34].

Duration of exposure: Our study revealed that the mean PEFR in carpenters decreased with increasing duration of exposure to wood-dust. It was starting from 420.91±38.07 L/min after one year of exposure reaching to a decrement of 332.86±34.95 L/min in carpenters working for more than 15 years in carpentry.

Kherde et al., 2017, found that a negative correlation between PEFR and duration of exposure to wood dust as the mean PEFR was 447.6±78.6 L/min in sawmill workers in a duration of less than 5 years of exposure. This value decreased to 301.8±37.2 L/min in workers for more than 15 years of exposure. Our results correlate with the results observed by Kherde et al. [32].

In another study done by Meo S. A., 2004, on wood workers in Saudi Arabia, he found that exposure to wood dust for longer periods had significantly reduced the values of PEFR when compared to control group. He reported that workers for less than 4 years had a mean PEFR of 312.28±23.62 L/min. The value of mean PEFR was significantly reduced to 175.00±22.29 L/min after 8 years of exposure [38].

Ihekwaba et al., 2009, reported a significant relationship between dose and duration of wood dust exposure as the PEFR values in saw millers were decreased with increasing time of exposure compared to controls [39].

Dudhmal et al., 2006, took 30 sawmill workers and dividing them to 3 subgroups according to duration of exposure to saw dust (<2years, 2-4 years and 4-6 years of exposure) showing that the PEFR and all lung functions decreased as the duration of exposure increased [40].

Mohan et al., 2017, reported that the mean PEFR of carpenters decreased from 430.8±39.48 L/min after more than 1 year of exposure to 340.43±26.54 L/min after more than 11 years of exposure. Our results were in correlation with Mohan et al. results [41].

Other studies were done by Shamssain et al., 1992 and Usman et al., 2013, showing that the PEFR also decreased with increasing time and that was confirming the results of our study [41&27].

Limitation of the study:

1. Small sample size both study and control groups that could affect data obtaining and interpretation.
2. Environmental measures were not performed, so that the effect of the level and the type of exposure in these carpenters in their workplaces couldn't be documented.
3. As the study was cross-sectional, so we couldn't exclude the impact of healthy workers' effect on our data.

Strength of the study:

As smoking has a greater effect than wood-dust on lung health, so we exclude the effect of tobacco smoke on respiratory health and focusing on the occupational exposure to wood-dust only.

CONCLUSION:

From the present study, we find that the mean PEFR of carpenters group was less than that of non-carpenter workers group in general. It was lesser than that of controls in each subgroup of age, height, weight and BMI. Our results were highly significant statistically.

This decrement of PEFR in carpenters was due to continuous exposure to wood-dust in their workplaces that cause a negative effect on their respiratory health status.

Suggestion:

From this study, we suggest that pre-employment medical checkup with periodic surveillance tests for carpenters' respiratory health status are much recommended to detect any undesirable effect of wood-dust on respiratory system at an early stage and to treat affected persons promptly.

As most carpenters work in confined places, so we suggest also a good ventilated workplaces and using a respiratory protective devices as facemasks to decrease the dose of wood-dust exposure as possible.

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