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Original Article

Impact Of Occupational Exposure To Wood Dust On Pulmonary Health Of Carpenters In Small Scale Furniture Industries In West Bengal

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Abstract

Wood dust exposure deteriorates pulmonary functions, increases the prevalence of respiratory disease and exacerbates existing illness. This study was undertaken to estimate pulmonary function among carpenters exposed to wood dust at least last 5 years. Pulmonary function indices of carpenters will be compared with those of noncarpenters to evaluate the influence of such occupational exposure. A short questionnaires were administered face to face to the subject relating demographic data, smoking habit, protective equipment used status etc. Respiratory symptoms were retrospectively estimated in a sample of 167 carpenters in West Bengal, India using questionnaires on work related respiratory symptoms in the past years. Anthropometric measurement and pulmonary function test were performed on the subjects. Results were compared with age and smoking habit matched control population. In our investigation, we found that 58% of carpenters were suffering from work related respiratory symptoms. Coughing and wheezing were the most common symptoms. All respiratory symptoms were higher in smoker than nonsmoker carpenters. The result of pulmonary function test (PFT) indicates that there was a significant decrease in lungs volume viz. forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV1) while ratio of FEV1/FVC was normal. Pulmonary flow rate including peck expiratory flow rate (PEFR) and Maximal mid expiratory flow rate (FEV 25-75%) also reduced significantly.

Carpentry work was associated with a higher frequency of respiratory symptoms. PFT values were significantly lower among carpenters compared to noncarpenters. There is a relationship between pulmonary function indices and duration of working in furniture industry. Thus, carpenters are susceptible to occupational asthma.

Key words: wood dust, carpenter, asthma, spirometry.

Introduction

Industries have been established since the time of civilization. to meet the demand of humans. Some of the industries were found to exert unwanted effects on human health. Now-a-days occupational lung disease captures a remarkable place in respiratory medicine.

It is well established that at least two million people are exposed to wood dust every day around the world (1). In general wood dust exposure deteriorates pulmonary function and increases the prevalence of respiratory diseases (2). Many studies on workers in furniture manufacturing sector reported increased upper and lower respiratory system symptoms in people exposed to wood dust (3). The basic tool for evaluating effect of exposure on respiratory system is spirometry (1). Spirometry is a simple and useful test to identify and monitor respiratory impairment (4). There is a relationship between PEFR and duration of working as carpenters (5). Carpenters have been shown to be susceptible to develop asthma related to their work (6). Occupational asthma among Indonesian carpenters has been reported (7). There is no data regarding respiratory status of West Bengal carpenters. Therefore the aim of this study were to estimate occupational exposure to wood dust in the small scale furniture industry and to compare the pulmonary function of carpenters with those of noncarpenters and to evaluate the influence of such occupational exposure.

Materials and method

Study population

The present cross sectional study was conducted at Chinsurah, district Hooghly of West Bengal state. The study population included 167 male carpenters comprising of 119 smokers and 48 nonsmokers and 100 control healthy male comprising 60 smokers and 40 nonsmokers having age limit in between 25-55 years with very similar socio economic status. Written consent from the subjects involved in the study was obtained. Exclusion criteria for the subjects included presence of any self reported acute illness, lung diseases like chronic obstructive pulmonary disease, heart failure, malignant disease, chronic liver or kidney failure and diabetes mellitus. Before spirometry the procedure was explained and demonstrated to each subject.

Protocol

Survey was conducted in three phases: i). Interview of the subjects, ii). Anthropometric measurement and iii). pulmonary function test.

Interview: A short questionnaires were administered face to face to the subject relating age, sex, duration in occupation, working hour /week, protective equipment use status, tobacco related behaviors and respiratory symptoms.

Anthropometric measurement: Body weight was measured using bathroom scale accurate to 0.5kg. The scale was kept on a fate surface and adjusted with ‘0’ mark. Now the subject was requested to step on it in bare feet. Weights were taken in light cloth. Weight was recorded to the nearest 0.5kg.

Height was measured using anthropometric rod. Height of the subject was recorded without footwear and expressed to the nearest 0.1cm.

Body mass index (BMI) was calculated from the height and weight using following equation: BMI (kg / m2) = weight (kg) / height (m). Subjects having BMI from 18.5-25.0 were selected for pulmonary function tests.

Pulmonary function test: Spirometry was done using computerized spirometer (Medikro Spirostar USB Spirometer , Model: M929 , Finland) following the method of Pramanik, 2012 (8). The subject was asked to sit comfortably in a chair. The complete procedure was explained and demonstrated. All doubts if any were cleared. Subject was instructed to breathe in fully by deep inspiration with closed nostril. Three trials were given for each subject. Best of the three was recorded and analyzed. Following spirometric parameters were recorded:

Forced vital capacity (FVC): It is the volume of air that can be maximally forcefully exhaled.

Forced expiratory volume in 1^{st} second (FEV1): It is the volume of air that is forcefully exhaled in one second.

Ratio of FEV1/FVC: It is expressed as percentage of FEV1 to FVC.

Peak expiratory flow rate (PEFR): It is the maximum velocity with which air is forced out. It is expressed as liter/sec.

Forced expiratory flow between 25% and 75% (FEV25-75%): It is the flow rate (Liter/sec) over the middle of FVC.

Test values for the FVC, FEV1 and FEV1/FVC fell below the lower limit of the 95% confidence interval of the predicted value were classified as abnormal (9). A low spirometric FVC together with a normal or high FEV1/FVC ratio has been classified as a restrictive abnormality (10, 11). The fall in FEV1, PEFR and other flow rates indicate obstructive lung changes (12).

Statistical analysis

Correlation (Pearson’s correlation coefficient) between anthropometric parameters and PFT indices were calculated for smokers and nonsmoker control groups. Linear regression equation for PFT indices were drawn on the basis of two anthropometric parameters with higher correlation coefficient. Predictive value for PFT of carpenters was calculated on the basis of linear regression equation.

Data obtained from the study were given as mean $\pm$ SD. Correlation between duration of carpentry and percentage change in PFT were evaluated. The statistical significance was determined by student's t test. Two tailed p values were used throughout and p value less than 0.01 were judged as statistically significant.

Results

In the present study both control and experimental subjects were divided into two categories: smokers and nonsmokers. Age, sex and BMI matched with carpenters were selected from general population as control subjects. Table-1 shows the characteristic of control and experimental subjects.

Table-1: Characteristics of experimental (carpenters) and control (noncarpenters) ssubjects

Characteristics	Experimental (carpenter)	Control (noncarpenter)
No. of subject	167	100
Age(years)	25-55	25-55
BMI(kg/m2)	18.5-25	18.5-25
Smoking habit: Smokers	119	60
Nonsmokers	48	40
Duration in occupation: >10years	20(smokers) & 10(nonsmokers)	-------
10-20years	47(smokers) & 24(nonsmokers	------
<20years	52(smokers) & 14(nonsmokers	-------
Working hour /week	50.36 + 5.28	------
Use of personal protection	Nil	------

The frequency of respiratory complications of carpenters was retrospectively estimated with questionnaires on work related respiratory symptoms and represented in table 2. Cough, wheezing and stuffy nose were common complication of carpenters. Respiratory complications depend on duration of carpentry. Coughing is the most common complication of wood dust exposure.

Table-2: Respiratory complication of carpenters according to the working duration

Complication	Smoker carpenter (Duration in carpentry in years)			Nonsmoker carpenter (Duration in carpentry in years)		
	>10 (n=20)	10-20 (n=47)	<20 (n=52)	>10 (n=10)	10-20 (n=24)	<20 (n=14)
Coughing	2(10)	18(38%)	38(73%)	-	4(16.7%)	7(50%)
Wheezing	-	4(8.5%)	10(19.2%)	-	1(4.2%)	2(14.3%)
Stuffy nose	-	10(21.3%)	13(25%)	-	1(4.2%)	1(7%)

Higher correlation coefficient were noted between PFT indices and height and then for age in control subjects. Linear regression equations for FVC, FEV1, PEFR and FEF25-75% were evaluated and represented in table-3.

Table-3: Linear regression equations for PFT indices of smokers and nonsmokers control subjects

Smokers
FVC(L) = 0.0555 height(cm) - 0.0291 age(year) - 4.807
FEV1(L) = 0.0408 height(cm) – 0.0226 age(kg) – 2.956
PEFR(L/S)= 0.032height(cm) – 0.00894 age(kg) + 1.0129
FEF25-75%(L/S) + 0.0074 height(cm) – 0.0109 age(kg) + 3.177
Nonsmokers
FVC(L) = 0.0497 height(cm) - 0.0216 age(year) – 3.880
FEV1(L) = 0.0269 height(cm) – 0.0218 age(kg) – 0.5326
PEFR(L/S)= - 0.0104height(cm) – 0.0179 age(kg) + 9.0600
FEF25-75%(L/S) = - 0.0056 height(cm) – 0.0153 age(kg) + 5.700

Predicted value of pulmonary function indices of carpenters were estimated using linear regression equation. Now measured values were represented as percentage of predicted value (table-4).

Table-4 : Pulmonary function test indices of smokers and nonsmokers furniture workers in respect to percentage of respective control

Pulmonary function indices	Smoker carpenter (Duration in carpentry in years)			Nonsmoker carpenter (Duration in carpentry in years)		
	>10 (n=20)	10-20 (n=47)	<20 (n=52)	>10 (n=10)	10-20 (n=24)	<20 (n=14)
FVC	76.31 ± 12.51	74.00 ± 10.14	65.37 ± 12.25	79.10 ± 6.10	71.35 ± 11.11	68.08 ± 11.66
FEV1	81.41 ± 13.21	77.79 ± 13.90	72.33 ± 12.78	84.50 ± 6.27	75.21 ± 10.63	72.59 ± 8.98
PEFR	90.23 ± 10.43	71.17 ± 11.46	59.43 ± 18.53	90.60 ± 7.91	79.24 ± 15.45	63.76 ± 14.07
FEF25-75%	97.98 ± 9.44	60.73 ± 10.03	55.94 ± 12.50	92.62 ± 10.91	78.41 ± 16.14	67.64 ± 8.73

*value represent mean ± SD

Correlation between pulmonary function indices and duration of carpentry was represented in table-5. There is significant negative correlation between pulmonary function indices and year of exposure in carpentry both in smokers and nonsmokers. Correlation coefficient is more in smokers than nonsmokers carpenter. Maximum correlation coefficient was noted for FEF25-75% of smokers and PEFR of nonsmokers.

Table-5: Correlation between duration of carpentry and pulmonary function indices

PFT	Smoker carpenters		Nonsmokers carpenters	
	Correlation coefficient [r]	p-value	Correlation coefficient [r]	p-value
FVC	-0.570	<0.001	-0.277	<0.001

FEV1	-0.662	<0.001	-0.390	<0.001
PEFR	-0.490	<0.001	-0.575	<0.001
FEF 25-75%	-0.698	<0.001	-0.479	<0.001

Discussion

The result of the present study showed that there was a significant decrease in FVC and FEV1 among carpenters. FEV1/FVC ratio was normal. Results indicate restrictive type of pulmonary impairment (10, 11). These findings were supported by previous observations (13).

PEFR is convenient for monitoring air flow obstruction in patient with bronchial asthma (14). It is dependent on expiratory effort exerted during forceful expiration as well as upper airway obstruction (15). In our present study PEFR was decreased significantly in carpenters in duration dependent exposure. This result supports previous observations (5). Thus occupational exposure to wood dust affects upper airway.

FEF25-75% is recommended to identify small airway impairment (16). It is more sensitive than FEV1 to detect slight airway obstruction. It is considered as a measurement of small airway potency (17). In our study FEF25-75% was decreased in carpenters depending on duration of carpentry. This result suggests that small airways were affected by wood dust exposure. We also noted that ratio of FEV1/FVC was normal but FEF25-75% was decreased significantly in carpenters. In mild to moderate asthma FEV1/FVC ratio was normal but FEF25-75% was decreased (18). Thus result of our experiment suggested that occupational exposure to wood dust may be a cause of asthma. Respiratory complication also supports wood dust induce asthma.

FEF25-75% below 65% of predicted is considered as abnormal (19). Bronchial hyper reactivity (BHR) is a pathological characteristic of asthma. Low FEF25-75 %(< 65%) is a predicted factor of BHR (20). FEF25-75% was decreased below 65% in smokers and nonsmokers carpenters engaged in carpentry above 10years and 20 years respectively.

Conclusion

Thus, wood dust exposure harmfully affects lung function and this mutilation is associated with duration of exposure to wood dust. Occupational exposure to wood dust in carpentry for more than 10 years increases the risk of asthma. These findings exhibit the need to lessen wood dust exposure. In conclusion it is suggested that carpenters should adopt precautionary measures like suitable protective respiratory device during their woodwork.

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