FEV_1, FVC, FEV_1/FVVC AS PREDICTORS OF RHINITIS AMONG SAW MILL WORKERS IN NORTH CENTRAL NIGERIA

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ABSTRACT

BACKGROUND:
Rhinitis is one of the commonest occupational related respiratory disorders that is only restricted to the upper airway but can involve the lower respiratory tract with considerable airflow limitation, this study was conducted assess the ventilator function of persons exposed to saw dust with rhinitis symptoms

METHODS:
This is a cross sectional study carried out among 200 randomly selected saw mill workers and 200 healthy staff of Jos University Teaching Hospital staff in Jos metropolis from September to November 2008. Data on sociodemographic variables, symptoms of rhinitis, etc was obtained using a modified semi structured British medical research council questionnaire while respiratory function data was measured using a spirometry

RESULT:
A total of 400 responds comprising of 200 saw mill workers and 200 controls participated in this study. Based on diagnostic criteria. 43% of the subjects fit into diagnosis of rhinitis, 33% had asthma symptoms and 24 % did not fit into any category compared to none of < 5% of the control group. The ventilatory function based on FEV1, FVC, FEV1/FVC ratio and PEFR showed a significant decline when matched with controls and predicted value, suggesting an airflow limitation among the rhinitis group.

CONCLUSION:
Rhinitis associated with wood dust exposure is not restricted to airway but involves the entire respiratory tract with airflow limitation as one of its consequences.

KEYWORDS: Ventilatory function, Rhinitis, wood dust exposure.

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INTRODUCTION

Wood dust are known to cause respiratory disorders like rhinitis, asthma, skin irritations and adenocarcinoma of the nasopharynx. Studies globally are still in keeping with high prevalence of these wood dust related respiratory diseases.[1]

Lung function is the most objective and widely used procedure to assess the limitation to airflow during expiration, most common pattern of airflow limitations observed among those exposed to wood dust is obstructive pattern which is suggested by a decline in Forced Expiratory Volume in one second (FEV_1), Forced Vital Capacity (FVC) the ratios FEV_1/FVC and Peak Expiratory Flow Rate (PEFR).[2]

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Rhinitis is an inflammation of the nasal mucosa, it is a common disorder affecting up to 40% of the population. The most frequent pulmonary symptoms among the sawmill workers are running nose and sneezing (57.40%) and productive cough 34.30%, while the symptoms of dyspnea and wheezing occurs each in about 4.10% of population which is work and exposure dependent. Allergic rhinitis is the most common type of chronic rhinitis affecting 10 to 20% of the population. This occurs when the immune system overreact to particles in the air that is inhaled. The respiratory effects of wood dust exposure include nasal congestion, sneezing, nasal itching, rhinorrhea, facial pain and occasionally rise in body temperature, asthma-like condition, hypersensitivity pneumonitis and chronic bronchitis. Other common symptoms associated with wood dust exposure include skin and eye irritation, nasal dryness with obstruction and prolonged colds.[3,4]

Rhinitis use to be considered to be a disorder localized to only upper airways, but current evidence suggest

that it may represent a component of systemic airway disease involving the entire respiratory tract. There are a number of functional, physiological and immunological relationships between the upper and the lower airways. The submucosa of both upper and lower airways consist of collection of blood vessels, mucosal glands, supporting cells, nerve and inflammatory cells, studies have shown that allergen provocation of the upper airways leads to inflammatory process in both upper and lower airways, this is supported by the coexistence of rhinitis and asthma.[1,5]

In Allergic rhinitis, numerous inflammatory cells, including mast cells CD4 positive T cells, macrophage and eosinophils infiltrate nasal mucosa on exposure to an inciting allergen, most commonly airborne dust, mite fecal particles, cockroach residues, animal dander, moulds and pollens. The T-cell that infiltrate the nasal mucosa are predominantly T helper (Th_2) in nature which release cytokines like IL-3, IL-4, IL-5 and IL-13, this in turn stimulate humoral site of immunoglobulin production by plasma cell to produce more of IgE which triggers off the release of mediators of inflammation such as histamine and leukotrienes that are responsible for arteriolar dilatation, increase vascular permeability, pruritus, rhinorrhea, mucous secretion and smooth muscle contraction.[3,4] The mediators and cytokines released during the early phase of immune response to an inciting allergens, triggers a further cellular inflammatory response over the next 4 to 8 hours (late phase inflammatory response) which result in recurrent symptoms usually nasal congestion.[3,6]

Traditionally rhinitis has been categorized as seasonal which occurs during a specific season or perennial which occurs throughout the year. However not all patient may fit into this classification scheme, e.g. some allergic triggers such as wood dust, pollen may be work related or seasonal, in cooler climate but perennial in warmer climate and patient with multiple seasonal allergies may have symptoms throughout most of the year.[6] Therefore rhinitis is now classified according symptom duration as Intermittent or persistent and severity as mild, moderate or severe.[3,5] Rhinitis is considered intermittent when the total duration of the episode of inflammation is less than 6 weeks, and persistence when the symptoms continue throughout the year. Symptoms are classified as mild when patient are generally able to sleep normally and perform normal activities including work or school, mild symptoms are normally intermittent. Symptoms are normally categories as moderate/severe if they significantly affect sleep and activities of daily leaving and if they are considered bothersome, it is important to categories base on severity and duration of symptoms as this will guide the management approach.[3]

Rhinitis patient may have abnormal airway function as demonstrated by obstruction in small or large airways and increase bronchial reactivity to inhaled nonspecific provocative. The nonspecific Bronchial Hyper reactivity (BHR) is particularly important in patient with rhinitis because they are more prone to develop asthma. However the factors associated with BHR in rhinitis patient is yet to be substantiated. Non asthmatic rhinitis patient with BHR may have mild but significant changes in airways.[7]

The recognition of a relationship between respiratory disease and working environment is an integral part of labour laws in both developing and developed nations, this study aim at establishing a substantial link between sawdust, and allergic rhinitis

MATERIAL AND METHODS

Study area:
The study was conducted in Jos metropolis, Plateau State, Nigeria. The city has a population of about 900,000 residents based on the 2006 census[18]. Popularly called "J-town", it is the administrative capital of Plateau State. The city is located on the Jos plateau at an elevation of about 1,238 meters or 4,062 feet high above sea level. During British colonial rule, Jos was an important center for tin mining.

There are 4 saw milling factory in Jos metropolis, 2 located in Bukuru LGA and 2 in Jos North LGA

Study design and study population
The cross sectional study was carried out among saw mill workers (study group) and staff of Jos University Teaching Hospital (control group) in Jos metropolis, Nigeria. Saw mill workers who are exposed to saw dust, have been working in the saw mill industries continuously for at least 1 year, who are neither current nor past smokers and without previous history of chronic respiratory disorders were recruited. Those excluded were administrative staff in the sawmill industries whose exposure to saw dust is minimal. The control group include staff of University of Jos Teaching Hospital with the same criteria that obtains for the sawmill workers and who has never worked in a saw mill industry or have past exposure to saw dust were recruited.

In addition, all subject with documented evidence of chronic chest conditions, recent thoracic or abdominal surgery, chronic exposure to other dust apart from saw

dust like cement, flour, tin or kaolin were excluded from the study.

Data was collected for this study between September to November 2008

Sample Size Determination
Sample size was calculated using the formula for comparing two sub-sample assuming an equal number for both the study and control groups was used at 95% confidence interval and power of 80%. One hundred and ninety five (195) was obtained as the sample but this was rounded to two hundred (200) respondent were used per group in order to allow for non-response

Sampling Technique
Multistage sampling technique was used for this study. First stage, all saw mill factories were selected for the study. In each of the selected factory a list of all factory workers was obtained, this form the sampling frame. Twenty five respondent were randomly selected from the four saw mills given a total respondent of 200 using table of random numbers

Data collection/Instruments
Data was obtained using a pre-tested modified semi structured British Medical Research Council questionnaire on respiratory symptoms; peak respiratory flow was measured using spirometry; and a detailed physical examination, anthropometric measurement using a measuring tape was also performed.

After detailed demographics; participants were asked a detailed history of occupational exposure to saw dust and previous respiratory symptoms prior to employment. Physical examination was carried out, and anthropometric data was obtained. Weight (in kilograms) and standing height (in meter) was measured using a meter. Patients were asked to remove their shoes and heavy clothes like jackets for the measurement.

Spirometric values were expressed as percentages of predicted normal values for Nigerian men.79 PEFR= 4.29HT – 1.49 Age – 153.38 (HT = height in centimeters; Age in years). The FEV1 = 4.228 stature – 0.0232 Age – 3.248, FVC = 3.513 stature – 0.0251 Age – 1.301 (Stature = height in meters; age in years)

Based on this questionnaire, rhinitis is said to be diagnosed if the subject answers "yes" to at least two nasal symptoms (rhinorrhea, nasal itching, nasal congestion, or sneezing) at least 2 days a week. 76 Atopy state is diagnosed if the person has, currently or in the past, one or more of the following disorders according to the questionnaire atopic dermatitis, asthma, or perennial rhinitis.

A lung function assessment was carried out by means of a Wright's peak flow meter. Computerized spirometer (Vitalography - Alpha Spirometer 2008 model) was used to perform a lung function test according to the standard of American thoracic society.[77] The measuring maneuvers were carried out after full inhalation with maximum expiratory effort into the mouth piece of the instrument with no hesitation, cough or glottal closure during the procedure and without obstruction to the mouth piece. The methodology was consistent with the standards of occupational safety and health administration.[77]

All pulmonary function test was carried out at a fixed time of the day (9am – 2pm) to minimize any diurnal variations[77,78]

Spirometry was performed with subject standing relaxed with head in a horizontal Frankfort position and with only light clothing allowed, after an initial instruction session. Subjects were asked to perform forced expiratory maneuvers from total lung capacity to residual volume to obtain measurement of FCV and FEV_1, the best FEV_1, and the best FVC was taken from three technically satisfactory forced expiratory maneuvers where the best two recordings were within 5% of each other, for the FEV_1, FVC and PEFR, the highest value obtained after a few practice attempts was recorded for analysis.

The dust concentration at the mill was measured by subjective assessment of dustiness of the environment on a scale of 0-3 and mean dust concentration by dust sampler, this consist of a seven hole filter holder housing pre weighed poltytetrafluoroethene (PTFE) filters (1.2µmpore size, 25mm diameter, santorious instrument ltd, GB-Belmont, survey).

Sampling time ranged from six to eight hours covering a work shift; after sampling the filters are immediately re-weighed on a santorious R180D balance so that the total dust concentration is calculated, this was also confirmed by the subjective assessment of the dustiness of the environment. The high exposure area of milling and sanding has dust concentration ranging from 4.4-22.4mg/m^3.

Data Management
All statistical evaluation was done with Statistical Package for Social Science (SPSS) version 16.0 statistical software. The main measures and indicators used for analyzing the results were frequency distributions, sample means and percentages for the variables. Categorical variables such as socio-demographic

characteristics of respondents was expressed in proportions and these variables were compared between the study and controls using z-test and Chi-square (as the case may be). To standardized for any age and height difference between individuals in both study and control groups, observed lung function values (FEV_1, and FVC) was in addition expressed as percentage of predicted normal. This was done using age and height regression equations developed for Normal Nigerian men. Evaluation of pattern of lung function abnormality was based on the ventilatory ratio and American thoracic society statement on lung function testing Any observed value less than 80% of the predicted value was considered abnormal also any FEV_1/FVC value less than 70% was considered abnormal. Subjects whose ventilatory ratios (FEV_1/FVC) are less than 70% are categorized as having obstructive pattern of lung disease. Those whose vital capacity (VC) is reduced, as suggested by observed FVC value less than 80% of the predicted, and those whose ventilatory ratio are normal or raised (FEV_1/FVC %> 70%) are categorized as having a restrictive ventilatory defect. Statistical significance was set at P<0.005 for all values of the t – test distribution and X^2 test, student t test was used to compare group means

Ethical Consideration

Ethical clearance for the study was obtained from the ethical review committee of Jos University Teaching Hospital. Approval was gotten saw mill workers' union. All subject provided a signed informed consent

RESULTS

A total of 200 saw mill workers and 200 control subjects participated in the study. The mean age of the study and control subjects were 31.82 ± 15.21 years and 32.05 ±16.603 years respectively. The mean heights were 165.78 ± 6.96m for the saw mill workers and 166.26 ±7.020m for the staff of JUTH The mean weight of the study subjects was 62.64 ± 8.62kg and that of the control subjects was 67.64 ± 8.619kg,. The Age, height and weight were normally distributed. The demographic characteristics of the study and controls subjects are shown in table I.

Table 1 – Demographic Characteristics of the study population (mean ± SD)

	Study Subjects (n=200)	Study Control (n=200)	*P* value
Mean Age (yrs)	31.82 ± 15.21	32.05±16.603	0.8852
Height(m)	1.6578 ± 0.0696	1.6626±0.07020	0.4927
Weight (Kg)	62.64 ± 8.62	67.64±8.619	0.3995
Duration at work	7.22 ± 7.03	7.18 ± 7.07	0.8613

The mean (SD) duration of employment of the subjects was 7.22 ± 7.03 years, with a median of 5 years and a range of 0.5 to 33 years (table I).

The dust concentration at the mill was measured by subjective assessment of dustiness of environment on a scale of 0-3 and mean dust concentration by dust sampler, this consist of a seven hole filter holder housing pre weighed poltytetrafluoroethene (PTFE) filters (1.2µmpore size, 25mm diameter, santorious instrument ltd, GB-Belmont, survey).

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Age Distribution of subjects and control

Thirty eight percent (38%) of saw mill workers and 42% of the controls were below twenty five years of age. The modal age group for Study and control subjects was 25 to 34 years. Subjects and controls showed similar distribution across the different age groups, see table 2 below.

Table 2: Age distribution of subjects and control

Age groups (years)	Study Subjects *n* (%)	Study Controls *N* (%)	*P* value
<25	76 (38.0)	86 (42.0)	0.475
25-34	69 (34.5)	54 (27.0)	0.129
35-44	13 (6.5)	15 (7.5)	0.845
45-54	16 (8.0)	19 (9.5)	0.723
55-64	14 (7.0)	14 (7.0)	1.000
>65	12 (6.0)	12 (6.0)	1.000

PREVALENCE OF RHINITIS SYMPTOMS

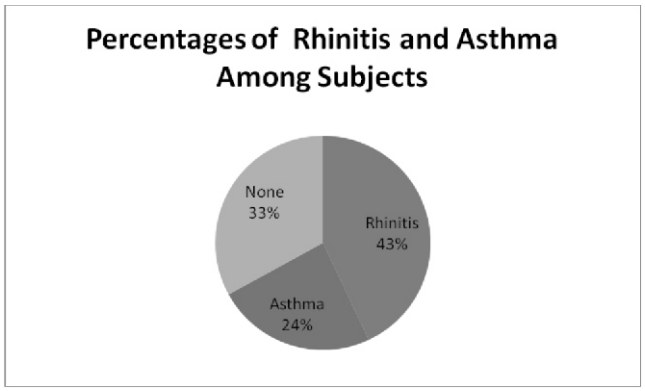
Table 3 – Frequency of respiratory symptoms among Subjects and Control

Symptoms	Subjects %	Control %	X^2	OR	95% CI	*P* value
Cough	51 (101)	2	72.24	50.50	76.0-98.5	0.000
Phlegm	76(149)	10	57.65	10.20	58.9-86.5	0.000
Chest tightness	80(160)	4	70.76	25.00	74.3-96.0	0.000
Breathlessness	30 (59)	1	71.26	101.69	72.0-99.0	0.000
Wheeze	24 (47)	4	58.39	25.53	57.3-92.4	0.000
Nasal Congestion	24(48)	15	31.91	6.67	29.3-65.6	0.000
Rhinorrhoea	25(50)	8	46.53	12.50	45.0-82.2	0.000
Sneeze	37(74)	12	43.1	8.33	43.1-77.2	0.000
Itching	25(50)	10	41.88	10.00	40.0-77.2	0.000

OR=odd ratio, CI= confidence interval.

Chest tightness was noticed to be much frequent among the subjects than control (80% v 0.5%%), this was followed by sputum production (75% v 0.5%), cough (50% v 1%), sneeze (40% v 2%), breathlessness (30% v 0 %), allergy (28% v 1.5%) and wheeze (22% v 0%). See Table 3.

Figure 1: Percentages of Rhinitis and Asthma among exposed subjects



.Table 3: Mean ventilatory indices for Subjects Exposed with Rhinitis and Subjects exposed without Rhinitis

	Exposed Subjects		
Lung function	With Rhinitis	Without Rhinitis	*P* value
FEV_1	2.79 ± 0.79	2.84 ± 0.49	0.840
FVC	3.45 ± 0.54	3.89 ± 0.51	0.000*
FEV_1/FVC	71.76 ± 15.69	82.1 ± 3.5	0.000*
PEFR	522.93 ± 110.81	552.0 ± 51.0	0.003*

The mean FEV_1 was 2.79 ± 0.79 L in the subjects and 2.84 ± 0.49 L in the controls (P=0.840). The mean FVC was 3.45 ± 0.54 L in subjects and 3.89 ± 0.51L in controls (P=<0.000). The mean ratio of FEV1/FVC in subjects was 71.76 ± 15.69 and the control was 82.1±3.5 (p=<0.000) .The mean PEFR was 522.93 ± 110.81 L/min in saw mill workers and 552.0± 51.0 L/min in the control group, (P=0.003). See table 3 above.

DISCUSSION

Exposure to wood dust and substances connected with wood processing has been associated with a variety of health hazards, both upper and lower respiratory tract disease have been noticed and described. Several publications are found in the literature on this topic but few studies were conducted from the savannah belt with peculiar climatic condition.

Both organic and inorganic wood dust has been associated with adverse effect on respiratory health and this has been recognized over centuries ago. The ventilatory effect and presence of Rhinitis symptoms associated with exposure to wood dust among saw mill workers was looked into in this study which has shown a significant decline in the ventilatory function among subjects when compared with the controls, similarly when the subjects were also matched with the predicted values for that age and height in that environment there was also a significant decline in the ventilatory indices of the subjects.

Rhinitis is characterized by sneezing, rhinorrhea, obstruction of the nasal passage, and pharyngeal itching following exposure to allergens or irritants.[10] Nasal hair and turbinates' serve as filters for particles and gases. The initial nasal mucosal response to deposition of particles and gases is vasodilatation with increased permeability, rhinorrhea and congestion.[10]

Numerous substances in the workplace, including wood dust causes allergic and upper air-way disease. Wood dust is alkaline and irritates the airways.

Allergic rhinitis, which occurs in atopic people, needs to be differentiated from occupational rhinitis. People with allergic rhinitis usually have a family history of atopy and a personal history of collateral allergy expressed as eczema, dermatitis, urticaria and / or asthma.

Occupational rhinitis is distinguished from perennial and seasonal rhinitis by an improvement in symptoms when the person is away from work.[11]

The larynx has the smallest cross-sectional area in the respiratory tract. Laryngitis presents as inflammation and edema of the vocal cords resulting from irritants and allergens or from the drainage of inflammatory mediators from the nasal passage.[12]

Ventilatory function as determine by spirometry is a non invasive way of measuring expiratory flow rates which takes only 10-15 minutes; it is cost effective with no attendant risk.

The forced expiratory volume in first second (FEV_1), is the most important Spirometric variable for assessment of airflow obstruction. It declines in direct and linear proportion with clinical worsening, it also determines the degree of obstruction as mild, moderate or severe. The measured FEV_1 is usually expressed as a percentage of the predicted for determination of normality.[13] As a rough guideline, the predicted FEV_1 for a 50 year old man of average height is 4.0 L and 3.0 L for a woman of the same age. There is usually a very gradual transition from normal lung function to mild airway obstruction. In order to improve sensitivity physiologist adopt FEV_1/FVC ratio as a more sensitive

index, which is usually expressed as a percentage, 70% being considered as the lower limit of normal for FEV_1/FVC ratio.[13]

In this study, the pulmonary function parameters were also significantly lower (p=0.000) in the sawmill workers that have fulfilled the criteria for Rhinitis than controls. There was a significant decline in the mean values for forced vital capacity (FVC) 3.89 ± 0.54L, peak expiratory flow rates (PEFR) 522.93±110.81L, and FEV_1/FVC ratio, 71.76 ± 15.69L among Rhinitis group compared to subjects without Rhinitis see table 3.

Similarly when the mean ventilatory indices was match with control and predicted value for the matched age, height and environment there was a significant decline in lung function among the Rhinitis group suggesting a more causal relationship between saw dust exposure and onset of rhinitis see table 4 & 5.

Non Asthmatic patient with rhinitis and bronchial hyperactivity (BHR) may have mild but significant changes in airways as suggested by the decline in the FEV_1, FVC, FEV_1/FVC and PEFR.[14]

This study showed a prevalence of rhinitis symptoms with decline in ventilatory function among subjects exposed to wood dust than controls. An across work shift symptoms was also noticed similarly rhinitis symptoms was noticed to be more in areas of high dust concentration suggesting a causal relationship between wood dust exposure and rhinitis. The crude prevalence of respiratory symptoms in the subjects was 93%. This finding is expected because of the high level of dust particles generated in saw mill industries, due to openness of such industries with non of the subjects studied using a face mask.

There were 43% of the subjects who met the criteria for Rhinitis based on the presence of symptoms of Rhinorrhea, sneezing, nasal itching and congestion. Similarly 24% of the subjects fit in the criteria for asthma based on the symptoms of wheeze, chest tightness, breathlessness, and cough with or without phlegm production. After excluding for Rhinitis and Asthma, 33% of the study subjects had no symptoms suggestive of Rhinitis or Asthma. See figure 2 above

The findings indicate that respiratory symptoms are common during the working hours among the sawmillers and 35% of the subjects studied suffered some degree of airway obstruction where as 5% showed restrictive defect.

The health effect of wood dust is due to chemicals in the wood or chemical substance in the wood created by bacteria, fungi or moulds. Coughing or sneezing is caused by dust itself, asthma may be due to sensitivities to chemicals found in the wood. Plicatic acid found in the red cedar is responsible for asthma reaction and allergen effect associated with the wood dust.[15]

The prevalence of occupational rhinitis in this study is higher than previous study done in Nigeria and abroad, suggesting a rise in the incidence of rhinitis associated with saw dust exposure. (Aguwa E et al 2007, Milanowski et ali 2002).[16,17]

A large number (94.9%) of the workers were aware of the potential hazards of exposure to saw dust while less than 20% wear protective mask.

This study has demonstrated that in addition to the symptoms of Sneezing, nasal congestion, rhinorrhea and intra nasal itching, a decline in ventilatory function following an obstructive pattern of airflow limitation may suggest a rhinitis in individuals exposed to wood dust.

In conclusion exposure to wood dust is associated with high prevalence of rhinitis and other respiratory symptoms with significantly lower FEV_1, FEV_1/FVC and PEFR than normal population. An obstructive pattern of lung disease was also shown to be more prevalent among the exposed subject with rhinitis.

Marked exposure to more than one species of wood and dust from wooden boards could trigger variable allergic response and exposure to different species of wood could make difficulty in analyzing the wood specie with more allergic effect.

RECOMMENDATIONS

This study has demonstrated that sawmill workers have higher prevalence of pulmonary symptoms with reduced PEF compared with non-exposed population. There is need for the reduction of the quantity of wood dust that wood workers are exposed to by ensuring a healthy working environment through modernization of the wood processing factories, furniture and timber shade, this will reduce the adverse effects they suffer due to high dust exposure, also use of personal protective devices should be made mandatory as part of the work place policy.

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