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Lung function status of workers exposed to wood dust in timber markets in Calabar, Nigeria

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Summary
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. Forced vital capacity (FVC), Forced Expiratory Volume in one second, (FEV_1), Forced Expiratory Volume as a percentage of forced vital capacity (FEV_1%), and Peak Expiratory Flow Rate (PEFR) were measured in 221 workers (aged 20-25 years) exposed to wood dust to assess their lung function and compared with 200 age- and sex- matched control subjects who were not exposed to any known air pollutant. The concentration of respirable dust was significantly higher in the test ($P<0.001$) than in control site. The mean values of FVC, FEV_1, FEV_1% and PEFR of the timber workers were significantly lower ($P<0.01$) than in control subjects. Respiratory symptoms such as cough, chest pain and nasal irritation had higher prevalence in the test group than in the control group. Non-respiratory symptoms (skin and eye irritation) were prevalent in the test group but not found in the control group. Workers exposed to wood dust had restrictive pattern of ventilatory function impairment. The lung function indices of the timber workers decreased with their length of service. Chronic exposure to wood dust impairs lung function.

Keywords: *FVC, FEV_1, FEV_1%, PEFR, lung function, wood dust.*

Résumé
L'effect de l'exposition chronique des scieurs aux polluants d'air des bois local telsque l'ébony, Uchi et Iroko sur les functions pulmonaires des scieurs du bois à calabar était étudié. La capacité vitale forcée(CVP), le volume expiratoire forcé en une minute(VEF1), le volume expiratoire forcé comme pourcentage de la capacité vitale forcéeVEF%) et le peak du taux d'expiration étaient mésurés chez 221 scieurs agés de 20-25 ans . La quantité de poussiére respiratoire était significativement plus élévés qu'aux controles. Les valeurs moyenne du CVF, VEF1 , VEF% et PTE étaient significativement réduitent ($P<0.001$) qu'aux groupe de controle. Les symptomes respiratoire telsque la toux , les douleurs de poitrine et nasale, irritation avaient une prevalence élevée aux scieurs qu'aux sujets controle. Les symptomes non-respiratoires étaient prévalent aux scieurs de planches et pas aux groupe de controle. Les travailleurs exposés aux polluants d'air du bois avaient une fréquence de function ventillatoire impaire. Les indices des functions pulmonaires chez ces scieurs de bois réduisaient avec la période d'exposition chronique à ces polluants d'air.

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Introduction

Some dusty occupations impair lung function and cause pneumoconiosis [1,2,3]. Unfortunately, our knowledge about what dusts and chemicals cause disease and how, is not precise [4]. Some wood dust exposure has been reported to impair lung function [5,6,7]. Unfortunately, the woods used were foreign to Nigeria. The biological effects of exposure to wood dust depend on its composition and the content of the microorganisms [8]. There are some studies on the effect of dust from our local woods on the lung function of workers actively engaged in the sawing and planning of wood [9,10]. However, there have been no comparative studies to show the effect of wood dust on the lung function of persons passively exposed to the dust like buyers and sellers of wood with those actively exposed to the dust like the sawyers and planers of wood.

The aim of this study therefore was to ascertain the lung function status of workers exposed to wood dust in timber markets in Calabar and compare it with that of the normal population. The lung function of persons considered actively engaged in the wood industry like the sawyers and planers was compared with those passively exposed to the dust like buyers and sellers of wood. The prevalence of respiratory and non-respiratory symptoms in the wood dust-exposed workers was also assessed and compared with control subjects.

Materials and methods

Subjects

Lung function indices were measured in 221 Nigerians aged 20 – 45 years who were engaged in mechanized wood sawing, planning and allied carpentry work as well as those engaged in selling woods in timber markets in Calabar for a minimum duration of one year. These subjects comprised the test group. Two hundred subjects who were not exposed to any

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known air pollutants served as control. They were sex-, height, body weight and age matched with the test group since these anthropometric parameters affect lung function. These were civil servants drawn from ministries and parastatals. They had no history of any pulmonary disease. Cigarette smokers were excluded from the study since cigarette smoking worsens lung function [9]. The procedure and aim of the study was explained to every subject and their consent obtained before proceeding.

Dust sampling

A gravimetric dust sampler made in the Department of Physics, University of Calabar, Nigeria was used for dust sampling in the timber market and control sites. This instrument measures the concentration of respirable dust as it maintains a constant supply of air at 2 litres per minute through its filter for 4 hours. The concentration of respirable dust was expressed in mg per cubic metre.

Test procedure

Lung function indices measured to assess lung function were as follows: forced vital capacity (FVC); forced expiratory volume in one second (FEV_1); forced expiratory volume in one second as a percentage of forced vital capacity (FEV_1%) and peak expiratory flow rate (PEFR). The vitalograph spirometer (Model TM Buckingham, England) was used for the measurement of FVC, FEV_1, while FEV_1% was computed from FEV_1 and FVC. A mini Wright peak flow meter was used to measure PEFR.

Subjects were called in groups and instructed on the procedure of all the tests. To help them understand the test procedures, demonstrations were performed and questions entertained. After the group instructions, subjects were called individually and a modified British Medical Council Respiratory Disease Questionnaire [10] was personally administered to them with the assistance of a physician who conducted the clinical examination. The questionnaire recorded their names, sex, age, type of job, smoking habit, duration of exposure and history of symptoms (respiratory and non respiratory). Height without shoes and weight with light clothing were measured and recorded.

Comparisons

Respirable dust levels were measured and compared in the test and control sites. Comparison between the lung function indices: (PEFR, FVC, FEV_1 and FEV_1%) and anthropometric parameters (age, height and weight) of dust exposed and control subjects was also done. The dust-exposed subjects were also divided into 2 groups namely; those in direct contact and those not in direct contact with the wood dust. Those considered to be in direct contact with the wood dust were the sawyers and planers. Those considered not to be in direct contact with the wood dust were the sellers and carriers of wood. The prevalence of respiratory and other non respiratory symptoms in the test and control subjects were also compared. The relationship between the lung function indices and the duration of service of exposed workers (test group) was also determined.

Statistical analysis

The unpaired student's t-test was employed for comparison of lung function indices, respirable dust levels, in the test and control subjects. All data were presented as means ± standard error of the mean (SEM). Chi square test was used to compare percentages as in prevalence of symptoms. P values of less than 0.05 were considered as significant.

Results

Dust sampling

The mean concentration of respirable dust in the test site was 31.75± 3.4mg/m^3 and was significantly higher (P<0.001) than in control site which was 2.8± 0.1mg/m^3.

Table 1: Lung function indices and anthropopmetric parameters of workers exposed to wood dust and their control.

Ventilatory/ anthropometric parameters	Test n=221±SEM	Control n=200±SEM	P-value
PEFR (L/min)	385.50±11.00	586.70±10.90	0.01
FVC (L)	3.20± 0.10	3.90± 0.40	0.01
FEV1(L)	2.60± 0.10	3.20± 0.10	0.01
FEV1%	76.53± 2.60	82.80± 1.60	0.01
Height (cm)	167.00± 1.10	167.30± 1.20	>0.05
Weight (kg)	63.30± 1.40	64.40± 1.40	>0.05
Age (yr)	38.70± 1.30	38.90± 1.90	>0.05

Table 1 compares the lung function indices and anthropometric parameters of workers exposed to wood dust and their control subjects. PEFR, FVC, FEV_1 and FEV_1% were significantly lower ($P<0.001$) in test group than in control group. There were however, no significant differences between the anthropometric parameters of test and control groups. Table 2 compares the pulmonary function indices, anthropometric parameters and duration of service of subjects considered to be in direct contact with the wood dust, namely; sawyers and planers and those not in direct contact, namely; sellers and carriers of wood. There were no significant differences between pulmonary function indices, anthropometric parameters and duration of service of the two groups in the markets (Table 2).

Table 3 shows the prevalence in percentages of some respiratory and non respiratory symptoms in both test and control subjects. Respiratory symptoms such as cough (non productive and productive), chest pain and nasal irritation had significantly higher prevalence ($P<0.01$) among the test subjects than in control. Other non respiratory symptoms such as skin and eye irritation had higher incidence among test subjects than their control ($P<0.01$).

Table 2: Pulmonary function indices, anthropometric parameters and duration of service of two groups of workers, sawyers/planers and sellers/carriers in the timber markets.

Ventilatory/ anthropometric parameters	Sawyers/ Planners n=221±SEM	Sellers/ Carriers n=200±SEM	P-value
PEFR (L/min)	322.40±6.30	342.40±6.80	>0.05
FVC (L)	3.20±0.20	3.25±0.10	>0.05
FEV1 (L)	2.30±0.10	2.50±0.12	>0.05
FEV1 (%)	71.90±4.80	74.00±8.60	>0.05
Height (cm)	167.60±1.10	166.90±1.60	>0.05
Weight (kg)	62.80±2.20	64.10±1.90	>0.05
Age (yr)	31.00±1.90	30.50±1.80	>0.05
Duration of service (Yrs)	6.20±1.40	7.40±0.10	>0.05

Table 3: Prevalence of respiratory and non respiratory symptoms among subjects in test and control sites.

Symptoms	Test n=221 N(%)	Control n=200 N(%)	P-value
Respiratory			
Cough-mild dry	80 (36.2%)	5 (2.3%)	0.01
Cough-moderate dry	32 (14.5%)	2 (0.1%)	0.01
Cough-productive	25 (11.3%)	0 (0%)	0.01
Chest pain	24 (10.9%)	0 (0%)	0.01
Nasal irritation	60 (27.2%)	0 (0%)	0.01
Non-respiratory			
Skin irritation	20 (7.1%)	0 (0%)	0.01
Eye irritation	50 (22.6%)	0 (0%)	0.01

of service versus FEV_1% (P<0.05). Height and body weight of the timber workers correlated positively (P<0.01) with all the lung function indices except FEV_1%.

Discussion

The results obtained in this study have shown a significant impairment of lung function of workers exposed to wood dust in two timber markets in Calabar, Nigeria. The mean values of FVC, FEV_1, FEV_1% and PEFR were significantly lower in the test group than in their control which shows impaired lung function. However, the mean value of FEV_1% of the test subjects was about 77% which is within normal range. This signified that the test subjects had generally a restrictive lung defect [13]. This is in consonance with dust related studies [9,14]. Although, it was not possible to determine all the factors that may be responsible for lung function impairment in the wood dust exposed workers, dust sampling in both test and control environments suggests that chronic exposure to wood dust may be a causative factor. The respirable dust level in the vicinity of the timber market was very high when compared with the control environment.

The building and furniture woods in the timber market comprise ebony, mahogany, achi, achi-gum, obeche and *iroko* which are tropical trees. Chemical analyses of these tropical trees have not yet been documented. However, analysis of other woods such as pine, oak, redwood, plywood, particle board, corupixa, have been shown to contain microorganisms, moulds, genotoxic, carcinogenic compounds and chemicals such as urea-formaldehyde, and silica [15-20].

The biological effects of wood dust depend on its composition [18]. Damage to lung tissue will impair lung function. Several investigators have shown the effects of wood dust on pulmonary function. Most investigators also report significant decline in FVC, FEV_1 and PEFR in sawmill and furniture workers [5,6,7,9,10]. It is conceivable that our local woods may contain some confounding factors other than dust that caused the decline in lung function. Formaldehyde has been shown to impair the lung function of exposed subjects [21]. Unfortunately, we could not estimate the chemical composition of wood dust in the environment owing to technical problems.

Table 4: Relationship between lung function indices, anthropometric parameters and duration of exposure of timber workers and control.

Parameter	FVC		FEV1		FEV1%		PEFR	
Age (yrs)	-0.135		-0.226	0.05	-0.256	0.05	-0.220	0.05
Height (cm)	0.513	0.001	0.470	0.001	0.009	>0.05	0.395	0.001
Weight (kg)	0.364	0.001	0.304	0.01	-0.025	>0.05	0.374	0.001
Duration (yrs)	-9.011	>0.05	-0.107		-0.249	0.05	-0.156	

Table 4 shows the relationship between lung function indices (FVC, FEV_1, FEV_1% and PEFR) and anthropometric parameters including duration of service of the timber workers. The negative coefficient of correlation indicates a general decline of lung function values with increasing age and duration of service and vice versa. The decline was statistically significant for age versus FEV_1 (P<0.05), FEV_1% (P<0.05) and PEFR (P<0.05); and duration

There were also no significant differences in both anthropometric and lung function indices between the two groups of timber market workers, namely; those whose job was considered as directly exposing them to the dust (sawyers and planers) and those whose jobs were considered as not directly exposing them to the dust (sellers and carriers). This shows that the two groups were equally affected by the causative factor, probably the wood dust generated from the sawing of timber in the markets. So, chronic buying and selling of wood may also impair lung function.

Correlation tests showed that whilst lung function of the timber workers significantly increased with height and body weight, it decreased with greater length of service and age. In an attempt to disentangle the overlapping influence of age and length of service on lung function of the timber workers, a multivariate analysis showed that age was independently related to FEV_1 and PEFR whereas there was no significant relationship between length of service and FEV_1 and PEFR. Other investigators have also reported that lung function declines with age and duration of service [6,16] and with age [22]. So, with time, the lung function of the dust exposed workers will worsen and could be fatal.

The major presenting respiratory symptoms were cough, chest pain and nasal irritation among the exposed timber workers. These symptoms were significantly higher in the test group than control. It is likely that inhaled dust particles irritate nasal passages and the trachea, thereby provoking cough. Other non-respiratory symptoms like skin and eye irritations also had higher prevalence in the timber market workers than normal subjects. The skin and eyes of the wood-dust workers were probably allergic to dust particles thereby causing skin and eye irritation.

Conclusion

In conclusion, chronic exposure to wood dust from our local timber (ebony, mahogany, achi, achi-gum, obeche and *Chlorophora excelsa* [iroko]) may impair lung function and cause some respiratory and non respiratory symptoms. Chronic passive exposure to wood dust like selling and buying of wood may also impair lung function. There is therefore need to introduce precautionary measures such as wearing face masks and use of vacuum dust extractors to minimize inhalation of dust in the environment. There is also the need to carry out periodic lung function test with a view to redeploying those adversely affected to less hazardous areas or jobs.

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