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Respiratory symptoms and peak expiratory flow among sawmill workers in South Western Nigeria

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ABSTRACT

Aim: The aim of the study is to assess the respiratory symptoms and peak expiratory flow (PEF) of sawmill workers. **Methods:** The comparative cross-sectional analytical study was carried out among 50 randomly selected sawmill workers in Osun State from March to May 2013. Age and sex matched controls consisting of 50 local government workers were also used. The respondents all had their PEF measured and also underwent modified British Medical Research Council questionnaire on respiratory symptoms. Data were analyzed using Statistical Package for Social Sciences version 16 and level of significance was set at $P < 0.05$. **Results:** The most prevalent respiratory symptoms among the study group were cough (60%) and sneezing (54%). The prevalence of respiratory symptoms such as cough (60%), phlegm production (46%), and sneezing (54%) were significantly higher among sawmill workers than the control ($P < 0.05$). The mean PEF rate was also significantly ($P < 0.001$) lower among sawmill workers (341.8 ± 77.13) than the control (479.8 ± 58.24). The PEF rate was found to significantly decrease with an increase in length of exposure to wood dust ($P = 0.003$, $r = -0.291$). **Conclusion:** Our study showed higher prevalence of pulmonary symptoms with reduced PEF from wood dust exposure among sawmill workers compared with a non-exposed population, measures should therefore be put in place for air control and reduce exposure of sawmillers to wood dust.

KEY WORDS: Peak expiratory flow, respiratory symptoms, sawmill workers, wood dust

INTRODUCTION

Sawmilling is one of the oldest wood processing industries in Nigeria and over 90% of them are small-sized [1]. The nature of the work done by workers in sawmills and the types of equipments and materials they handle is associated with many hazards, which lead to health problems. One of the major health problems of sawmill workers is respiratory problems, which usually result from breathing in noxious or toxic chemicals like wood dust [2]. The use of ageing equipments, poor maintenance of the local exhaust ventilation systems, and leakage of dust from the joints of the central exhaust ventilation system into the working environment are other factors that enhance high dust exposures at sawmills [3].

The respiratory health effects associated with wood dust come not only from the wood dust alone; biological organisms such as endotoxins, Gram-negative bacteria (of the genus Rahnella), allergenic fungi and mold, which grow on the wood as well as chemicals such as formaldehyde, copper naphthanate, and pentachlorophenol used in the processing of some woods are also implicated [4,5]. Processing plywood and fiber board may cause

exposure to formaldehyde, [6] and asthmatic symptoms among woodworkers exposed to formaldehyde alone or in combination with wood dust have been documented [7].

Sawmill workers are exposed to high level of wood dust, which can significantly lower their lung function; hence, they are more likely to wheeze or run out of breath [2,8]. Previous comparative study among sawmill workers and other workers (control) showed the sawmill workers to have significantly high prevalence of regular cough, regular phlegm, regular runny nose and nasal secretion, frequent headaches and irritation of the eyes compared to the control [3]. Most adverse effects caused by microorganism associated with wood dust have immunological background and the best known effects are those caused by molds, which may abundantly develop in suitable conditions on stored wood as a secondary wood infection. The inhalation of large amounts of spores and mycelia fragment of fungi may cause in exposed workers strong antibody response and respiratory disorders or organic dust toxic syndrome [9]. The lung is one of the most important organ involved in occupational health [10]. The respiratory tract is vulnerable to organic and inorganic dusts generated from various industries [11] and inhalation is by far the commonest route of the entrance to the body of occupational agents [10]. Jeroen Douwes in his study found out the higher prevalence of asthma in sawmill workers exposed to high levels of dust [12].

The prevalence of nasal symptoms, which is 49%, cough of 43%, and phlegm production of 15% was found to be very high in workers exposed to wood dust in Umtata, Transkei a small independent homeland in Southern Africa on the Indian Ocean [13]. Mean peak expiratory flow (PEF) of sawmill workers was reported to be significantly lower than that of control subjects, [14] and other pulmonary function parameters have also been shown to be significantly lower in sawmill workers than controls [15]. Respiratory symptoms such as cough, phlegm production, dyspnea, wheezing, and runny nose have been found to be more common among sawmill workers, worldwide [3,11,14,16].

Ugheoke *et al*. have reported in their study carried out in Benin that the prevalence of cough, sputum production, breathlessness, and wheeze among sawmill workers were 35.1%, 51.8%, 8.3%, and 3.1%, respectively, compared to control with prevalence of 8.6%, 1.6%, 0%, and 0%, respectively [11]. Significant correlations have also been found between reduction in lung function (PEF) and wood exposures among sawmill workers [17].

In Nigeria, Lagos, Ekiti, Osun, Cross River, Ondo, Oyo, Imo, Edo, Delta, and Ogun States together account for over 90% of the saw milling activities [18]. This indicates that guaranteed log supply is a major factor in the location of sawmills in the country, thus making Osun State to have lots of sawmills. It follows that a large number of the workforce is engaged in the sawmill industries in Osun State; assessing the pulmonary functions of these group of workers is therefore important.

The aim of this study was to evaluate the respiratory symptoms and the PEF in sawmill workers in Osun State, South-West Nigeria.

MATERIALS AND METHODS

Study Area

The study was carried out in Osun State, South-West Nigeria. It has three senatorial districts namely Osun central, Osun west, and Osun east each comprising of 10 local governments (LGs) (thus making 30 LGs) and one area office, located in Osun east senatorial district [12]. There are 106 registered sawmill industries in Osun State and the average number of workers per industry is 9-11.

There are various departments with different job descriptions in sawmills. When the tree logs are transported from the forest, the log loaders (usually called laborers) transport the logs to the big milling machine (band saw); after the logs are cut into wide planks by the machine operators, the planks may be cut to smaller planks by another small machine (circular machine) or stacked directly, the laborers are also responsible for stacking these planks. There is also usually an administrative staff that serves as the supervisor/manager of the sawmill industries. The laborers and machine operators are all exposed to wood dust throughout the work period, but the manager/supervisors' exposure is minimal as they spend more time in the offices.

Study Design and Study Population

The comparative cross-sectional analytical study was carried out among sawmillers (study group) and LG workers (control group). Sawmill workers who are exposed to wood dust (laborers and machine operators), have been working in sawmill industries continuously for at least 1 year, who is neither a current nor past smoker and who does not have chronic respiratory problem (s) prior to working in the sawmill industry were recruited. Those excluded were administrative workers (managers/supervisors) in sawmills whose exposure to wood dust is minimal. In Osun State LG Service Commission, administrative (office) workers who has the same criteria that obtains for sawmill workers and who has never worked in a sawmill industry or have a past history of exposure to wood dust were recruited as controls.

Data collection and analysis were from March to May 2013.

Sample Size Determination

Sample size was calculated using the formula for comparing two sub-samples assuming an equal number for both study and control groups was used at 95% level of confidence and power of 90%. Forty six was obtained, but 50 respondents were used per group in order to give room for non-response.

Sampling Technique

Multistage sampling technique was used [Figure 1]:

Stage 1: Seven LGs were randomly selected from the existing 30 LGs using the balloting technique

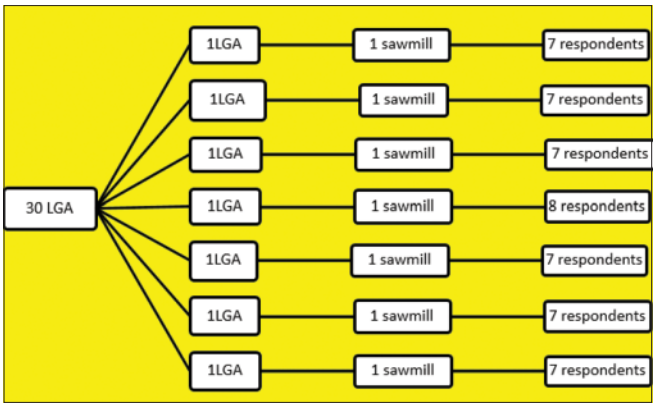

Figure 1: Multi-stage sampling technique process used to select respondents

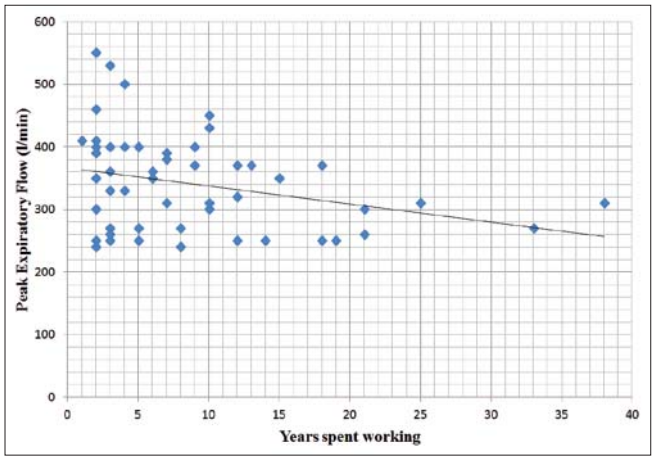

Figure 2: Relationship between peak expiratory flow and years spent working in sawmill. $r = -0.291$, $P = 0.003$

Stage 2: From each of the selected LG, one sawmill workshop was randomly selected using the balloting technique to make seven sawmills.

Stage 3: From each of the selected sawmill, the total number of members of staff was obtained from the superintendent/manager and seven respondents were randomly chosen (and eight in one sawmill to make 50) using the table of random numbers.

The administrative (office) members of staff of the LG were purposively selected by matching them with the selected sawmill workers in terms of some socio-demographic characteristics which influence lung function such as sex, age, and height (frequency matching).

Instruments

Pre-tested semi-structured questionnaires with modified British Medical Research Council questionnaire on respiratory symptoms, [20] peak flow meter, and tape measure were used as instruments in this study.

Peak expiratory flow of respondents was measured with a mini-Wright's peak flow meter. The PEF measurement was obtained in the upright sitting position and the highest of three readings per respondent was taken.

In addition to measurement of the PEF, the respiratory rates of respondents were also counted, and the transverse diameter and anterior–posterior (AP) diameter of their chest walls were measured using a tape measure and recorded in centimeters. The transverse diameter was measured from one mid-axillary line to the other using the nipples as a landmark; while the AP diameter was measured from the sternum to the vertebral xyphoid process also using the nipple as landmark. AP to transverse diameter ratio > 1 signifies barrel shaped chest, which may be seen in obstructive respiratory problems.

Data Management

Data were analyzed using Statistical Package for Social Sciences (SPSS) version 16 (Chicago II, USA). 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 and prevalence of respiratory problems of respondents were expressed in proportions and these variables were compared between the study and controls using *z*-test and Chi-square (as the case may be). Whenever the expected cell frequencies were <5, Fischer's exact test or likelihood ratio Chi-square was used for comparisons of the proportions. Continuous variables that were normal in distribution such as age, height, PEF values, respiratory rates and AP to transverse diameter ratio of chest walls of respondents were expressed as means (±standard deviation). The arithmetic means of the study and control groups were compared using the *t*-test. Association between values of PEF and length of exposure to wood dust was estimated with Pearson correlation. Statistical significance was set at $P < 0.05$ for all values of the test statistic.

Ethical Consideration

Ethical clearance for the study was obtained from the Ladoke Akintola University of Technology Teaching Hospital, Osogbo Ethical Review Committee. Permission was also taken from the Osun State chapter of sawmill workers association and the Osun State LG Service Commission before carrying out the study. Verbal consent was obtained from each respondent after explaining the objectives of the study to them. Arrangements were put in place for referral of respondents with debilitating respiratory impairment (such as severe dyspnea at rest) to a hospital; however, none of the respondents had such symptoms.

All information gathered was kept confidential.

RESULTS

Fifty male sawmill workers and 50 control subjects (LG workers) were included in the present study. The mean age was 34.53 ± 11.01 years for sawmill workers and 34.14 ± 9.98 years for LG workers. The mean heights were 1.68 ± 0.06 m for sawmill workers and 1.68 ± 0.07 m for LG workers. Among participants

of age of 20-39 years, there were 33 (66%) and 32 (64%) of sawmill workers and control LG workers, respectively. The level of education between the sawmill workers and control group, significantly differed ($P < 0.001$). Table 1 shows that 27 (54%) and 6 (12%) of sawmill workers had secondary and technical/diploma school, respectively. At the same time, 10 (20%) of the LG workers had secondary school certificate and 12 (24%) had technical/diploma certificates, respectively. Only 1 (2%) of sawmill workers had first degree, but 22 (44%) of the LG workers had first degree [Table 1].

Table 2 shows the occupational history of both groups of respondents. There was a significant difference between the number of years spent on the job for the study and control groups ($P < 0.014$). Thirty-two (64%) sawmill workers had spent <10 years on the job unlike the LG workers in whom this proportion was 20 (40%). The number of LG workers (16 [32%]) that had spent 20 years and above on their jobs were more than those of the sawmill workers (5 [10%]). The mean number of years worked in sawmill was 8.54 ± 7.77, while that of the LG workers was 13.30 ± 8.57. There was also significant difference ($P < 0.001$) between the hours both groups of respondents spent working as the majority (48 [96%]) of sawmill workers worked for > 8 h/day while none of the LG workers worked for >8 h/day.

All the LG workers had formal training for their jobs, but only 17 (34%) of the sawmill workers had formal training for their own jobs, a difference that is statistically significant ($P < 0.001$). Twenty-five (50%) sawmill workers held previous jobs before becoming sawmill workers and 5 (10%) were still engaged in part time jobs, but for the LG workers, 4 (8%) held previous jobs while none had a part time jobs.

Table 1: Socio-demographic characteristics of sawmill workers and local government workers

Variables	Sawmill workers (n=50), frequency (%)	LG workers (n=50), frequency (%)	χ^2	df	P value*
Religion					
Christianity	22 (44)	17 (34)	1.051	1	0.305
Islam	28 (56)	33 (66)			
Height (m)**	1.678	1.682	−0.463	1	0.644
Age (years)**	34.53	34.14	0.262	1	0.793
Age group (years)					
<20	1 (2)	1 (2)	3.958	4	0.410
20-39	33 (66)	32 (64)			
≥40	16 (32)	17 (34)			
Marital status					
Single	15 (30)	16 (32)	1.419	2	0.492
Married	34 (68)	34 (68)			
Separated	1 (2)	0 (0)			
Educational level					
None/incomplete primary	2 (4)	2 (4)	34.540	4	<0.001
Primary	14 (28)	4 (8)			
Secondary	27 (54)	10 (20)			
Technical/diploma	6 (12)	12 (24)			
First degree	1 (2)	22 (44)			

*P<0.05 are statistically significant. **Mean values with t statistic. LG: Local government; df: Degree of freedom

Prevalence of some respiratory symptoms among the study group (sawmill workers) and control group (LG workers) were compared. More sawmill workers significantly had cough ($P = 0.024$, 60%) and phlegm production ($P = 0.021$, 46%) than the LG workers where 20% had a cough and 10% had phlegm production. Prevalence of sneezing was also found to be significantly ($P = 0.037$) higher among sawmill workers (54%) than the control (18%). None of the LG workers reported having wheeze, chest pain, chest tightness, and shortness of breath, while 8%, 22%, 8%, and 2% of sawmill workers had wheeze, chest pain, chest tightness, and shortness of breath, respectively. None of both groups of respondents had dyspnea [Table 3].

Table 4 shows comparisons of some respiratory functions of the study and control group. More sawmill workers (76%) significantly ($P < 0.001$) had their PEF value to be < 400 l/min

Table 2: Occupational history of respondents

Variables	Sawmill workers (n=50), frequency (%)	LG workers (n=50), frequency (%)	χ^2	df	P value*
Years spent on job					
<10	32 (64)	20 (40)	8.568	2	0.014
10-19	13 (26)	14 (28)			
≥20	5 (10)	16 (32)			
Mean years spent on job**	8.54	13.30	16.916	1	<0.001
Hours worked per day					
7-8	2 (4)	50 (50)	121.675	2	<0.001
9-10	30 (60)	0 (0)			
11-12	18 (36)	0 (0)			
Formally trained for job					
Yes	17 (34)	50 (100)	62.732	1	<0.001
No	33 (66)	0 (0)			
Held a previous job					
Yes	25 (50)	4 (8)	21.418	1	<0.001
No	25 (50)	46 (92)			
Has a part time job					
Yes	5 (10)	0 (0)	3.849	1	0.05
Butchering∞	1 (20)	0 (0)			
Petty trading∞	3 (60)	0 (0)			
Electronic repairer∞	1 (20)	0 (0)			
No	45 (90)	50 (100)			

*P<0.05 are statistically significant. **Mean value with t statistic. ∞n=5. LG: Local government; df: Degree of freedom

Table 3: Comparing respiratory symptoms of sawmill workers and local government workers

Variable	Sawmill workers (n=50), frequency (%)	LG workers (n=50), frequency (%)	z	P value*
Cough	30 (60.0)	10 (20.0)	2.25	0.024
Phlegm production	23 (46.0)	5 (10.0)	2.31	0.021
Have wheeze	4 (8.0)	0 (0.0)	0.71	0.475
Chest pain	11 (22.0)	0 (0.0)	1.97	0.048
Chest tightness	4 (8.0)	0 (0.0)	0.71	0.475
Shortness of breath	1 (2.0)	0 (0.0)	0.00	1.000
Dyspnea	0 (0.0)	0 (0.0)	-	-
Sneezing	27 (54.0)	9 (18.0)	2.08	0.037

*P<0.05 are statistically significant. LG: Local government

Table 4: Respiratory functions of sawmill workers and local government workers

Variables	Sawmill workers (n=50), frequency (%)	LG workers (n=50), frequency (%)	χ^2	df	P value*
Peak expiratory flow (l/min)					
<400	38 (76.0)	4 (8.0)	47.455	1	<0.001
≥400	12 (24.0)	46 (92.0)			
Peak expiratory flow (l/min)**	341.8	479.8	14.279	1	<0.001
Respiratory rate (breaths/min)					
12-20	33 (66.0)	48 (96.0)	14.620	1	<0.001
>20	17 (34.0)	2 (4.0)			
Anterior-posterior to transverse diameter ratio of chest					
≤1	25 (50.0)	37 (74.0)	6.112	1	0.013
>1	25 (50.0)	13 (26.0)			

*P<0.05 are statistically significant. **Mean values with t statistic. LG: Local government; df: Degree of freedom

compared with the control (8%). There was also statistically significant ($P < 0.001$) difference in the mean values of the PEF (341.80 ± 77.13 for sawmill workers and 479.80 ± 58.24 for LG workers). More sawmill workers had significantly higher respiratory rates than control subjects (>20 breaths/min) (34% vs. 4% [$P < 0.001$]). AP to transverse diameter of the chest wall ratio > 1 was also significantly different among the two groups (50% for sawmill workers and 26% for control) ($P = 0.013$).

Significant negative relationship ($P = 0.003$, $r = -0.291$) was found between the PEF of sawmill workers and the number of years they had spent on the job [Figure 1].

DISCUSSION

Sawmill workers are usually in the active age group because of the demands of the job [11,21,22]. Most workers are also usually males; [23] respondents in this study were all males, with about 60% of them in the active age group. The level of education of respondents showed half of the sawmill workers had secondary school education, similar to findings in another Nigerian[24] as well as Malaysian studies [25]. In contrast, almost half of the LG workers were first degree holders, this is not surprising as many of the controls recruited for the study were administrative workers in the LG that are usually first degree graduates.

Chronic exposure to wood dust impairs lung function, [11,14,16] and the length of this exposure determines the extent of the respiratory problems [16]. More than a third of the respondents in our study had been working in the sawmill industry for 10 years or more. Mean years of exposure to wood dust in our study is similar to the mean years of exposure to wood dust in a previous study where some workers that were exposed for that length of time were already having asthmatic symptoms [26]. Over 90% of the sawmill workers worked for >8 h/day; those who spend > 8 h/day have been said to experience more stress that can increase the risk of injury at workplace [8]. Surveys indicated that a large proportion of machine operators had long-term health problems that are connected to their longer hours at work [8,27].

Only one-third of sawmill workers had formal training for the job. Lack/inadequate training for sawmill workers have been reported in previous studies [23-25]. and its implication of not properly equipping workers with the information needed for injury prevention [24].

Several studies have reported that health effects of wood dust were associated with allergic respiratory symptoms, [28-30] and studies have compared these symptoms with controls who are not exposed to wood dust [3,11,14,15,30]. Results of our study showed that respiratory symptoms in sawmill workers were significantly higher than in the control group, which is in accordance with previously published studies [3,11,14,15,30]. Cough and sneezing/running nose were parts of the most prevalent symptoms among respondents. Ige and Onadeko also reported cough and running nose as the most prevalent pulmonary symptoms in their study [14]. Half of the sawmillers in our study had a cough and sneezing while only about one-fifth of the controls had them. Fatusi and Erhabor have reported cough as one of the most prevalent pulmonary symptoms too [15]. Other prevalent pulmonary symptoms reported in past studies were sputum/phlegm production, [11,15] and chest pain [15]. Almost half of the respondents in this study had phlegm production and almost a quarter had chest pain, about one-tenth had wheeze and one person had shortness of breath. A 10th of the controls (LG workers) had phlegm production and none had wheeze or shortness of breath. Another finding in this study comparable to the previous studies [11,15] is that the prevalence of more disabling symptoms such as dyspnea was absent while shortness of breath and wheeze were low compared to the likes of cough, phlegm production and sneezing/running nose. This is not surprising as subjects in studies like this represent a survival population. Subjects with more disabling symptoms might have changed jobs [11].

The effects of wood dust on respiratory functions of sawmill workers was further evaluated by measuring the PEF, respiratory rate and AP to transverse diameter ratio of chest of the sawmill workers was compared with the controls. Most healthy people will have PEF values more than 400 l/min [31] respiratory rate of between 12 and 20 breaths/min [31,32] and AP to transverse diameter of chest ratio of <1 [31]. Results of our study showed that about three-quarter of the sawmill workers had PEF <400 l/min, this outcome however occurred in about one-tenth of the control. About 33% of sawmill workers had respiratory rate of >20 breaths/min and half of them had AP to transverse diameter ratio of chest of >1 (corresponding numbers for the control were 4% and a quarter, respectively). Low PEF, high respiratory rates and AP to transverse diameter ratio of chest of >1, which is seen in a barrel-shaped chest, are often indications of chronic obstructive pulmonary symptoms [31,32]. The mean PEF of respondents was also lower than the control in spite of no differences in their mean ages and heights, similar to the Ugheoke *et al*.'s study in Benin [11]. This study further looked at how much influence exposure to wood dust has on PEF, and it was

realized that PEF decreases as exposure increases. In accordance with our result, previous studies also reported that decrease in lung function was associated with the time spent working in wood industry [16]. A healthy workforce is very important for increased productivity at work; hence, the productivity of workers with reduced lung functions will not be optimal.

CONCLUSION

Our results showed that sawmill workers have higher prevalence of pulmonary symptoms with reduced PEF compared with non-exposed population. Thus, the level of wood dust should be regularly monitored in wood related industry. Furthermore, control measures regarding the monitoring of aerosol quality in sawmill industries should be implemented. The health status of workers should be monitored in order to prevent respiratory diseases in wood industries.

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