EFFECT OF ENVIRONMENTAL DUST POLLUTION ON LUNG FUNCTION OF ADULT MALE EXPOSED TO SAWDUST

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ABSTRACT

Environmental and occupational dusts have been implicated to be potential risk factors for the development of pulmonary disease.This study aimed at assessing the effect of environmental pollutant such as sawdust on Lung functions and oxygen saturation of Saw millers in Benin City, Nigeria. The study participants consist of 240 apparently healthy male subjects, made up of 180 subjects (experimental group) and 60 subjects (control group). The experimental groups were broken down into three groups of sixty subjects each. Group A: Those who have worked from 1-5 years, Group B: 6-10 years and Group C: 11-15 years in the Sawmill. Analysis carried out includes measurement of Particulate matter of dust and investigation of Lung function parameters which include Forced expiratory volume in one second (FEV_1), forced vital capacity (FVC), FEV_1/FVC and Peak expiratory flow rate (PEFR), of all the human Subjects using a digital spirometer (Spirolab iv Italy), for both flow and volume parameters. Pulse oximeter was used to measure the level of oxygen saturation in blood. Statistical analysis was done using Graph pad prism, Version 5.0. The results were expressed as mean ± SEM and P<0.05 was considered significant. The distribution of respiratory symptoms among the experimental group include, running nose (catarrh): 50%, Cough: 20%, sneezing: 5%, Chest tightness: 5%, chest pain: 10% and sore throat: 10%. Experimental site: Particulate matter ($PM_{2.5}$) =2.290mg/m^3 ±0.003, $PM_{(10)}$ = 2.185mg/m^3 ±0.04, Control site: (Pure water factory) $PM_{2.5}$ = 0.013mg/m^3 ±0.0004, $PM_{(10)}$= 0.145mg/m^3 ±0.012; Comparatively, PEFR control (3.25±0.2L/min) against experimental (1.68±0.09L/min), FEV_1 control (4.01±0.2L) and experimental (2.32±0.1L), FVC control (3.82±0.04L) and experimental (2.32 ±0.1L). Overall oxygen saturation was 97.45±0.48% and 84.00±0.93% for test and control subjects respectively. The presence of respiratory symptoms viz a viz a compromise in the pulmonary function are clear indications that sawdust is a potential risk factor for the development of chronic respiratory diseases.

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INTRODUCTION

Environmental pollution has become a global issue in the last few years as a result of the several activities of human causing the release of substances that are toxic into the atmospheric environment, these toxic substances ranging from dust, fumes, gases, heat, noise etc, which emanate from work places. The toxic substances, however, differ in reactions, composition of chemicals, emissions, effects on human health and persistency in the environment (Kampa and Castanas, 2008). The major link between workplace pollution and environmental pollution is that the source of pollutants is the same. The significance of this lies in the fact that, even in the presence of good ventilation, general contamination of the environment can occur quickly, which becomes worse, especially when done in a confined space (Alakija *et al.,* 1990), thus constituting occupational hazard.

Occupational hazard, as defined by the occupational health and safety Act 2015 is a condition resulting from exposure in a work place to physical, chemical or biological agents such that the normal physiological mechanisms are affected and the health of the worker impaired. These substances have been shown to affect human health negatively (Pope and Dockery, 2005; Azad and Kitada, 1998; Pat-Mbano and Nkwocha, 2012). In the year 2002, World Health Organization, documented that over 2.9 billion workers across the Globe are exposed to hazardous risks at their work places, and this account for 775,000 recorded death cases (WHO report, 2004). Although the concentration and persistence of environmental pollution vary from place to place, dust arising from many industrial processes such as sawmills, cement factories, poultries etc. has been shown to be a leading cause of occupational hazard in third world countries due to the particulates released into the atmosphere (Akeredolu, 1989; Begum *et al*., 2004; Cachier *et al.*, 2005; Farombi, 2008).

Wood dust is released into the atmosphere during processes of wood sawing, sanding, planning, routing etc. (Parkes, 1994) and is common with carpenters, sawmillers and furniture making companies. A lot of wastes which include, wood off-cuts, sawdust, plain shavings, wood backs, wood rejects among others are produced in sawmills (Dosunmu and Ajayi, 2002). The total number of wood work industries in Nigeria accounts 93.32% (Fawupe, 2003; American Conference of Governmental Industrial Hygienists, 2008; Lennox *et al.,* 2010). It is documented that at least 2 million people are exposed to the noxious effect of wood dust occupationally (IARC, 1995). Dust generated in sawmill easily exceed the safety occupational exposure limit of the United States National Institute of Occupational Health and Safety threshold safety limit level of 5mg/m^3 over an 8hour work period (European Commission, 1999; TjoeNij *et al.*, 2003). Anavberokhai (2008) reported an association between continual exposure to wood dust, nasal cancer and asthma. Wood dust comprises of suspended particulate matters. These Particulate matters are the deadliest form of air pollutants due to their ability to infiltrate deep into the lung and blood stream. Based on aerodynamic diameter, particulate matters are characterized into inhalable particles (PM between 2.5µm and 10µm), and respirable particles (PM less than 2.5µm) (Brauer *et al.*, 2002).

Pulmonary function test provide objective, scientific measures of lung function. It is useful because it used to examine environmental effects, drug exposure, evaluate surgery risks, assess and examine heart and lungs diseases, examination of employer's performance for insurance sake, it also used for assessment of some physical routine and fitness check. Some respiratory disorders such as chronic obstructive pulmonary disease can be ruled out and other overlooked lungs diseases can be identified with pulmonary function test (Crapo, 1994). Spirometry is the method to measure lungs volumes and capacities. The simple instrument used for basic testing and screening of pulmonary function is called spirometer. The modified spirometer is called respirometer. Nowadays plethysmograph is also used to measure lungs volumes and capacities. The forced vital capacity (FVC) is the most important measurement of spirometry. FVC is the volume delivered for the duration of expiration made as vigorously and wholly as possible starting from full inspiration, and the forced expiratory volume in one second (FEV_1), which is the volume delivered in the first second of an FVC manoeuvre. The vital capacity done with forced expiratory effort maximally in liters at saturated water vapors of ambient pressure and body temperature is also FVC. More than a few epidemiological studies have shown a sturdy link between elevated levels of particulate matters and increase morbidity and mortality of respiratory diseases among humans (Pérez-Rios *et al.,* 2010; Lin and Lee, 2004; Namdeo and Bell, 2005). Increase exposure to inhalable particulate matters, is associated with an enhance rate in the incidence of lung cancer by 22% and 36% on exposure to respirable matters (Raaschou-Nielsen *et al*., 2013).

Result from previous studies showed a reduction in the lung function parameters, such as Forced Vital Capacity (FVC), Forced Expiratory Volume in 1 second (FEV_1), the ratio of FEV_1/FVC and Peak Expiratory Flow Rate (PEFR), of sawmllers when compared with the control (Chan-Yeung *et al*., 1984; Fatusi and Erhabor, 1996; Douwes *et al.*, 2001; Ugheoke *et al.*, 2006; Jacobsen *et al.*, 2008; Anupriya and Afroz, 2014).

Halpin *et al*. (1994) and Mahmood *et al*. (2016) also reported the prevalence of several respiratory symptoms among sawmillers. According to Sosman *et al.* (1969), respiratory ailment, resulting from continuous exposure to wood dusts may be owed to allergic response to unknown toxic or mechanical irritant materials. Chronic cough, coryza, breathlessness and wheeze are signs of respiratory infection and they are common among wood workers with areas of high degree exposure with low ventilation (Bosan and Okpapi, 2004). Asthma, chronic obstructive lung disorder (COLD), and allergic alveolitis also known as hypersensitivity pneumonitis are also caused by wood dust occupational exposure (Terho *et al.*, 1980; Carosso *et al.,* 1987). Wood workers as reported in study done by a South Australian (Pisaniello *et al*., 1991) have occurrence of regular blocked nose is 51%, sneezing 41%, regular runny nose and excess nasal secretion 45% and eye irritation 35% (Shamssain, 1992). The study also recorded that the woodworkers with higher degree of exposure were more likely to report symptoms than those with least exposure. In contrast to the previous South Australian study, the South African study reported that the prevalence of cough and nasal symptoms increased with increase in the number of years of employment. A Canadian study reported high prevalence of cough (38%), sputum (30%), wheeze (18%), rhinitis (32%) and eye irritation (20%) among woodworkers compared with the controls (Holness *et al*., 1985).

Recently, there has been an increasing interest on the elemental composition of total suspended particulate matters in ambient air. Several epidemiological studies carried out showed the presence of trace elemental in the ambient air of these industrial areas, which usually affect human health (Akeredolu, 1989; Okuo and Ndiokwere, 2005). Some of these trace metals have been implicated in the reduction of lung functions (Ukpebor *et al.*, 2007; Zeleke *et al*., 2010; Baccarelli *et al.,* 2014). Several researchers have attempted to explain the causes of reduction in lung functions. Osagbemi *et al*. (2010) published that respiratory changes observed among sawmillers could be due to quantity of wood dust in the workers vicinity, while Douwes *et al*. (2000) and Dutkiewicz *et al*. (2001) attributed it to be the effect of endotoxins of microorganisms such as bacteria, fungi and mould growing on the surface of the wood, others implicated chemicals such as formaldehyde, copper naphthenate formaldehyde, etc, (Huff, 2001) involved in wood procession. Hence, this study aimed to investigate the effect of sawdust on saw millers in Benin City using selected toxic metals as indicator of lung functions, measurement of particulate dust concentration in sawmills as an index of degree of exposure.

MATERIALS AND METHOD

Area of Study

This study was done in Benin City, Edo state, south-south Nigeria. They included sawmills from randomly selected work areas within Ugbowo, Isihor, Idunmwowina, Iguosa, Oluku, Ovbiogie, Ekiadolor communities and its environs.

Size of Sample

Calculation of the sample size (N) was done using prevalence from previous studies done on ventilatory dysfunction among sawmill workers which was 4.0% in Benin City, Edo State (Tobin *et al*., 2016). The sample size for this study was obtained using the formula described by Daniel (1999).

$$N = \frac{Z^2 P (1 - P)}{D^2}$$

N = required sample size

Z = confidence level at 95% (standard value of 1.96)

P = estimated prevalence of ventilatory dysfunction due to saw dust inhalation (4.0%)

D = margin of error at 5% (standard value = 0.05)

$N = \underline{1.96^2 \text{ X } 0.04(1-0.04)}$

$$\frac{3.8416 \text{ X } 0.04(0.96)}{0.0025}$$

0.05^2

N = 59 minimum sample size.

Study Population

This consist of 240 (two hundred and forty) apparently healthy male Subjects, This was classified into groups, experimental and control groups. They were within the age bracket of 20-40 years with a work duration of 6-8 hours daily, 6 days in a week and a work experience of between 1 -15years.

The experimental group was further broken down into three groups of sixty subjects each, based on duration of exposure. Group A, B and C.

Group A: Those who have worked from one to five years.

Group B: Those who have worked from six to ten years.

Group C: Those who have worked from eleven to fifteen years.

Group D: CONTROL GROUP (Unexposed), were compared with the experimental group matched with age, sex, height and weight.

Informed consent was taken from each subject after detail explanation of the research procedure. Self-administered well-structured questionnaire was given to obtain information about workers demographic data, life style, medical history and occupational history.

The research was carried out between the hours of 8am-5pm each day, during the period of the study.

Anthropometric measurements: which include age, sex, weight, height, BMI and chest circumference were taken and Data properly documented. Ethical clearance was obtained from the Ethics and Collaboration committee of College of Medical Sciences, University of Benin.

Measurements

Height: Using a meter rule and calculated in meters (m).

Weight: Measured in kilogram (kg) with a calibrated weight scale.

Body Mass Index (BMI) calculated by weight /height^2 and recorded in kg/m^2.

Chest Circumference: Measured in centimeters with a tape rule.

Age: Recorded in years.

Exclusion Criteria

They include subjects with known cardiorespiratory diseases, metabolic disorders, thoracic/abdominal surgeries, hypersensitivity and drug therapy. Also subjects with histories of smoking and tobacco usage.

Sample Collection from Human Subjects

5ml of blood sample was collected aseptically from the antecubital fossa of each subject, and the 5ml was dispensed into sterile plain container for the analysis of toxic metals (lead, cadmium and chromium).

Measurement of Lung Function

Measurement of Lung function parameters was with the aid of a computerized spirometer (Spirolab 1Vitaly). This include: FVC, FEV_1, FEV_1/FVC and PEFR measured using a digital spirometer, for both flow and volume parameters.

Before commencement of the experiment each day, subjects were educated on procedure of research, the use of the spirometer and the research objectives. Lung function test were measured with the aid of a digital spirometer supplied with a detachable mouth piece customize for each subjects. The procedure involved making the subjects sits uprightly and comfortably. The spirometer was switched on, with the mouth piece positioned within the mouth, the lips sealed properly around it, and the nostrils closed with the aid of a nose clip, they were instructed to take a deep breath and expire maximally. Three manoeuvres were made and the highest of them all taken and recorded appropriately as displayed on the screen. Parameters recorded include, Force Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV_I) and Peak Expiratory Flow Rate (PEFR).

Measurement of Oxygen Saturation: Using Pulse Oximetry.

Pulse oximeter was used to measure the level of oxygen saturation in blood. Before commencement of the procedure, the subjects were educated on the use and purpose of the device. They were asked to sit comfortably and remove anything such as wrist watches, artificial nails, rings and bangles this is to avoid anything that can absorb light that may interfere with the result. The thumb was inserted into the oximeter. The device was switched on for one minute and results (pulse rate and oxygen saturation) were displayed on the colored screen, which was subsequently recorded appropriately.

Quantification of Dust

This was carried out from randomly selected work place using the calibrated dust collection apparatus known as Casella micro product monitor. The particulate matter was collected using Casella Cel-712 Micro dust Pro Real-time Dust Monitor with polyurethane foam (PUF) and a glass fiber filter (GFF).

Sample Collection

The fine particulate matter (PM2.5) was collected using Casella Cel-712 Micro-dust Pro Real-time Dust Monitor with polyurethane foam (PUF) and a glass fiber filter (GFF). The sampler was placed at heights of 1.5 m above ground level and within the human breathing zone. The glass fiber filter (GFF) was used to collect the fine particulate matter. The sampler was connected to a pump with a flow rate of 2 L/min for a sampling period of 8 hours/day. A size selective polyurethane foam (PUF) fixed in the sampler probe served as a collecting medium and a glass fiber filter also fitted in the probe collected PM2.5 screened through the PUF as described by Gaita *et al.* (2014). Meteorological parameters such as humidity and temperature were simultaneously measured using thermo-hygrometer during the period of sampling. At the end of each sampling day, samples were carefully wrapped in a polyethene bag and kept in a plastic container to avoid contamination prior to measurement.

Statistical Analysis

Data were entered into the Microsoft excel spread sheet (version 10) prior to descriptive analysis. The data were represented as mean ± SEM. The data were analyzed using the paired sample students't-test and Duncan's multiple range analyses of variance, ANOVA ($p<0.05$) and correlation analyses were done using the Pearson's correlation ($p=0.05$), Graph pad prism, Version 5.0.

RESULTS

Result of Questionnaire Obtained from Sawmillers

Result of Questionnaire: The distribution of respiratory symptoms present at one time or the other in the test group.

Running nose (catarrh):50%

Cough: 20%

Blocked nose: 5%

Chest tightness: 5%

Parameters Of Dust Extracted From Sawmill, Over An Eight (8) Hour Work Period:

Particulate Matter (PM)2.5 Average Value=2.296mg/m^3

PM10 Average Value=2.168mg/m^3

Control Site; (Pure Water Factory):

PM2.5 Average Value=0.012mg/m^3

PM10 Average Value=0.153mg/m^3

Values of Particulate Matter (PM) Of Dust Extracted from Experimental and Control Site

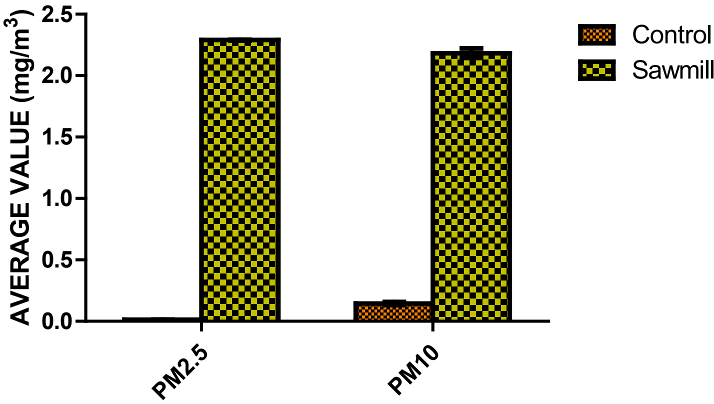

Figure 1: Value of Particulate Matter of Dust from Control and Experimental Sites.

The result is presented as Mean ±SEM. This result shows that there is significant increase ($p<0.05$) in $PM_{2.5}$ and PM_{10} of experimental site compared with control.

LUNG FUNCTION PARAMETERS OF TEST GROUPS EXPOSED TO SAWDUST WITH VARIATIONS IN YEARS OF EXPOSURE COMPARED WITH CONTROL.

*P<0.05 indicates significant difference at the different durations compared with control

$^{\alpha}$P<0.05 indicates significant difference at 6-10yrs and 11-15yrs compared with 1-5yrs respectively.

$^{\delta}$P<0.05 indicates significant difference at 11-15yrs compared with 6-10yrs.

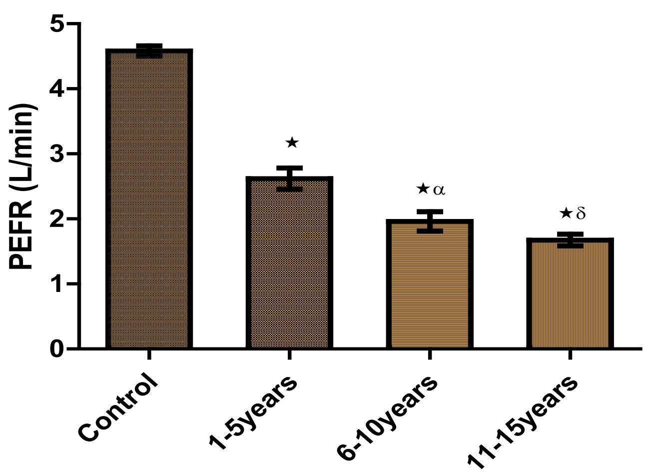

Figure 2: Peak Expiratory Flow Rate (PEFR) of Sawmillers with Variations in Years of Exposure, compared with Control.

The result is presented as Mean ±SEM, P<0.05 is considered significant. It shows significant decrease (p<0.05) in the PEFR of all test group when compared to control. Significant decreases were also observed when those in the group of 6-10 years and 11-15 years of exposure were compared with those in 1-5 years of exposure.

*P<0.05 indicates significant difference at the different durations compared with control
$^{\alpha}$P<0.05 indicates significant difference at 6-10yrs and 11-15yrs compared with 1-5yrs respectively.
$^{\delta}$P<0.05 indicates significant difference at 11-15yrs compared with 6-10yrs.

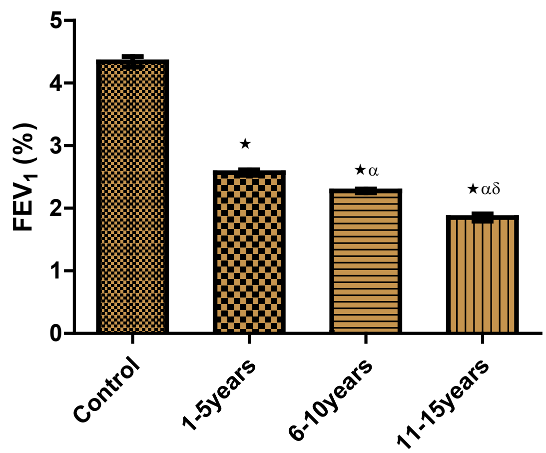

Figure 3: Forced Expiratory Volume in One Second (FEV_1) of Sawmillers with Variations in Years of Exposure, compared with Control.

The result is presented as Mean ±SEM, P<0.05 is considered significant. FEV_1 was significantly decreased (p<0.05) in all the subjects when compared with control. Significant decreases were also observed among the groups i.e. between 1-5years and 6-10years and between 6-10years and 11-15years.

*P<0.05 indicates significant difference at the different durations compared with control.
$^{\alpha}$P<0.05 indicates significant difference at 6-10yrs and 11-15yrs compared with 1-5yrs respectively.
$^{\delta}$P<0.05 indicates significant difference at 11-15yrs compared with 6-10yrs.

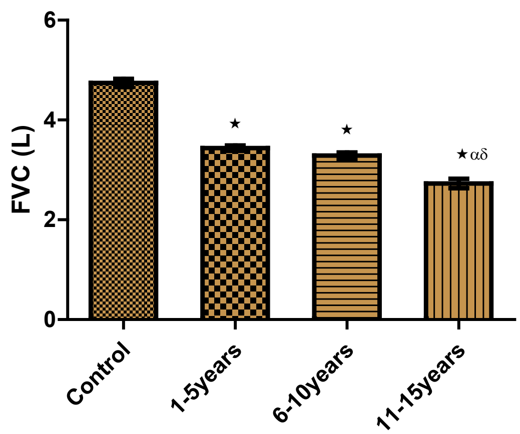

Figure 4: Forced Vital Capacity (FVC) Of Sawmillers with Variations in Years of Exposure, compared with Control.

The result is presented as Mean ±SEM, P<0.05 is considered significant. Significant decrease (P<0.05) in the FVC was observed in all the test groups when compared with control. Significant decrease was also observed when those in the group of 6-10 years were compared with 11-15 years of exposure. There was however no significant decrease between 1-5 years and 6-10 years of exposure.

*P<0.05 indicates significant difference at the different durations compared with control
$^{\alpha}$P<0.05 indicates significant difference at 6-10yrs and 11-15yrs compared with 1-5yrs respectively.
$^{\delta}$P<0.05 indicates significant difference at 11-15yrs compared with 6-10yrs.

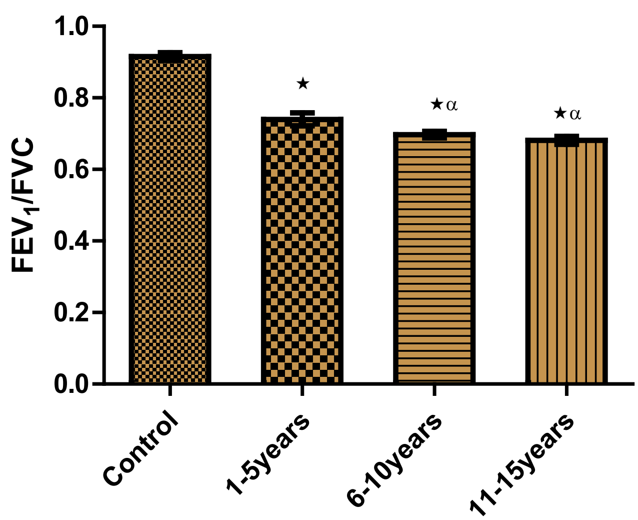

Figure 5: Ratio of Forced Expiratory Volume in One Second to Forced Vital Capacity (FEV_1/FVC), of Sawmillers with Variations in Years of Exposure, compared with Control.

The result is presented as Mean ±SEM, $P<0.05$ is considered significant. FEV_1/FVC ratio was significantly decreased ($P<0.05$) in all subjects when compared with control. Significant decrease was also observed when 6-10 and 11-16 years exposure was compared with control.

Effect of Sawdust on the Pulse Oximeter of Sawmillers Exposed to Sawdust with Variation to Years of Exposure compared with Control.

*$P<0.05$ indicates significant difference at the different durations compared with control
$^{\alpha}P<0.05$ indicates significant difference at 6-10yrs and 11-15yrs compared with 1-5yrs respectively.
$^{\delta}P<0.05$ indicates significant difference at 11-15yrs compared with 6-10yrs.

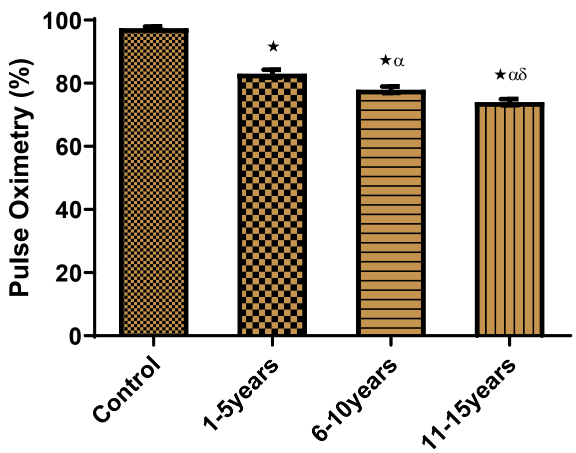

Figure 6: Pulse Oximeter of Sawmillers with Variations in Years of Exposure, compared with Control.

This result shows significant decrease ($p<0.05$) in pulse oximeter of all subjects when compared to control. This decrease was however significant between groups, but was still within physiological range.

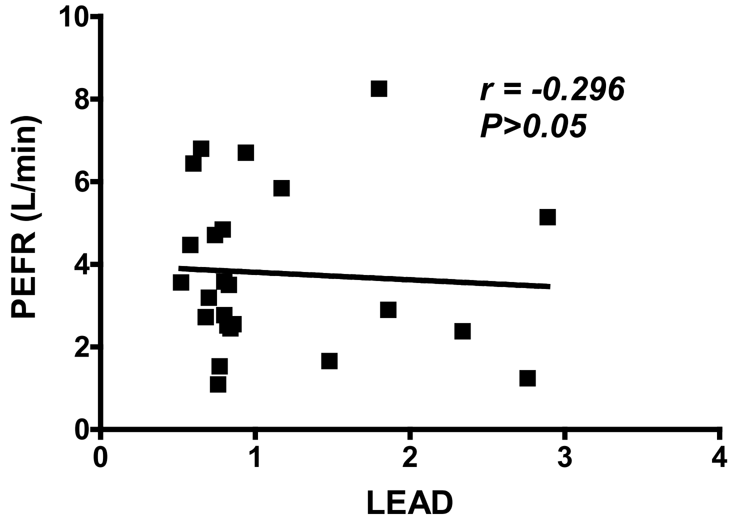

Figure 7: Shows the scattered graph of PEFR and Lead.

There was no significantly correlation between PEFR and Lead, (P>0.05).

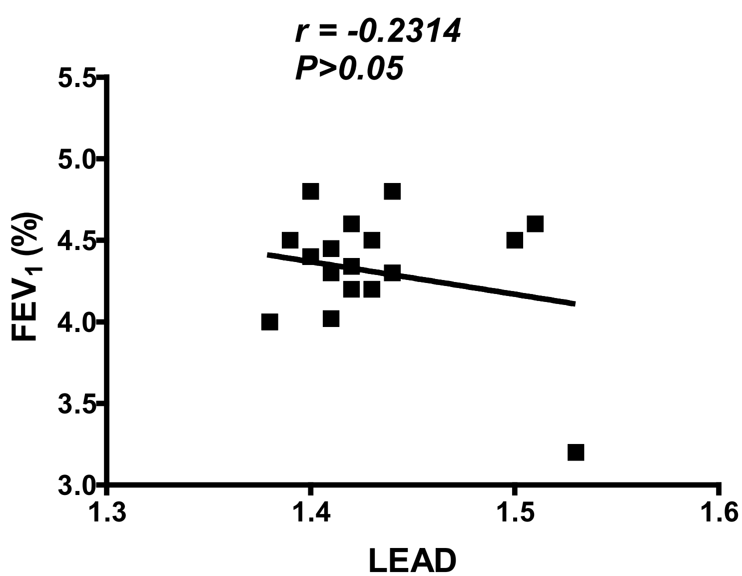

Figure 8: Shows the scattered graph of FEV_1 and Lead.

There was no significantly correlation between FEV_1 and lead, (P>0.05).

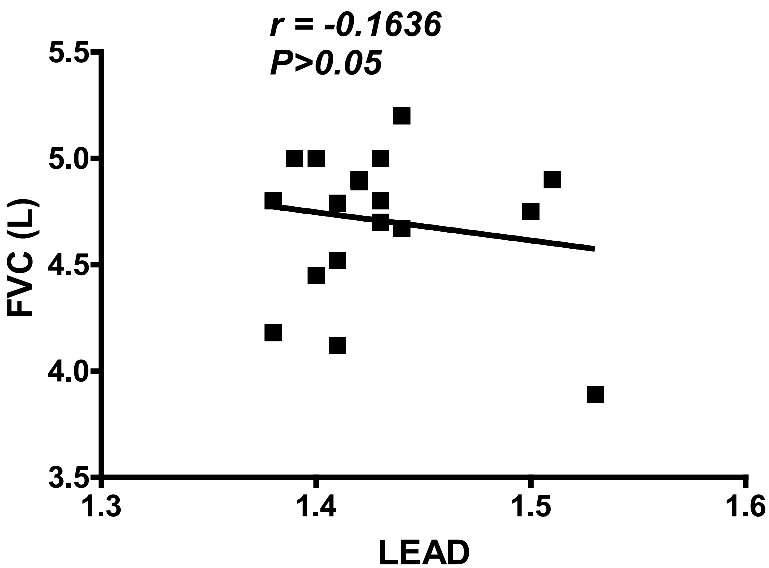

Figure 9: Shows the scattered graph of FVC and Lead.

There was no significantly correlation between FVC and lead, (P>0.05).

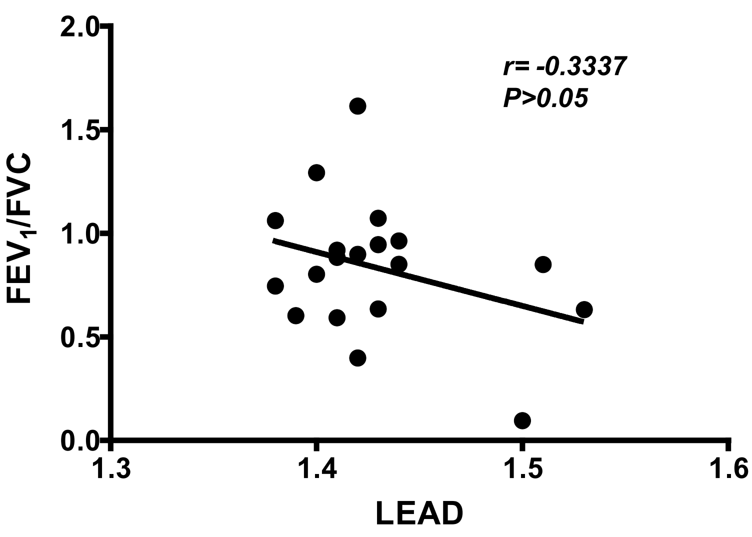

Figure 10: Shows the scattered graph of FEV_I/FVC and Lead.

There was no significantly correlation between FEV_I/FVC and lead, (P>0.05).

Table 1: Showing the correlation matrix of the heavy metals, lung function parameters and pulse oximeter

	PEFR	FEV1	FVC	Pulse oximetry
Lead	r = -0.2958, P > 0.05	r = -0.1374, P > 0.05	r = -0.2330, P > 0.05	r = 0.201796, P > 0.05
Cadmium	r = -0.1598, P > 0.05	r = -0.0462, P > 0.05	r = 0.3561, P > 0.05	r = -0.1467, P > 0.05
Chromium	r = -0.1956, P > 0.05	r = -0.1367, P > 0.05	r = -0.1697, P > 0.05	r = 0.0296, P > 0.05

The result shows negative correlation between heavy metals and lung function parameters, however not statistically significant.

DISCUSSION

The major challenge to human health is environmental dust pollution, being a leading cause of respiratory diseases (Iyawe and Ebomoyi, 2005). The result from questionnaire conducted among the study population shows high occurrence of respiratory symptoms, which is a possible implication of dust exposure in developing respiratory diseases. This observation is in consonant with previous work from other comparative studies (Bhatti *et al*., 2011; Ediagbonyi *et al*., 2016). The prevalent symptoms which include, catarrh, cough, blocked nose etc., observed in this study is an indication of prevalence of upper respiratory tract infections. These infections could be linked to the body response to lodged dust particles within the respiratory tract. This observation was further confirmed by result obtained from dust sampling of the study and control site. The concentration of dust particles, (Inhalable and Respirable particles), in the study site was significantly higher than that of the control site. This value far outweighs the recommended 1mg/m^3 safety limit documented by the European Union scientific committee on occupational exposure limit and American conference of Governmental industrial hygienist threshold limit value committee. Similar observation was also documented by Rosenberg *et al.* (2002), Siew *et al.* (2012). This increase could be attributed to absence of dust control device within the Sawmill. Furthermore the preferential significant increase in respirable particles ($PM_{2.5}$) compared with the inhalable particles (PM_{10}), could be attributed to the size and weight of the particulate matter. The heavier PM_{10} settles faster to the ground than the lighter $PM_{2.5}$, and as such are not fully captured by the gravimetric air sampler, which measures air borne dust. $PM_{2.5}$ has been implicated as the deadliest form of particulate matter (Chung *et al*., 2000) being able to travel faster and deeper into the respiratory tract. They excite inflammatory reactions which result in manifestations of symptoms that may resolve over time with eventual remodeling of the respiratory tract.

Result from spirometric investigation of lung function parameters shows that there was significant decrease in lung function parameters (FEV_1, FVC, PEFR, and FEV_1/FVC) of all the test subjects, when compared with control as seen in Fig. (2-5) this observation is consistent with the work done by Rosenberg *et al*. (2002) and Mahmood *et al.* (2016).

Measurement of FEV_1/FVC ratio reveals a decreased ratio which is indicative of an obstructive defect (Fig. 5). This observation is in line with the work done by Swanny *et al*. (2008) and Pallegrino *et al*. (2006). However, Mahmood *et al*. (2016), Ediagbonya *et al*. (2016) reported no change. This defect could be as a result of inflammatory response to the inhaled dust which results in increase secretion of mucus that hardens and narrows airways.

This study also showed progressive decline in lung function in relation to increase duration of exposure. Similar observation was also seen by Ennin *et al.* (2015), Okwari *et al*. (2006) and Meo (2006). This is however in contrast to the views of Malmberg *et al.* (1996), Milanowski *et al*., (2002), Bosan and Okpapi, (2004). Osman and Pala (2009) also reported significant increase in FEV_1 and FVC in subjects with less than 10 years exposure. These observable decreases in lung function cannot be attributed to age as lung function decreases from the age of forty and above (Jain and Gupta, 1967). The age group used for this study was between 18-40 years. Thus the decline in lung function could be due to persistent irritation of the respiratory tract by the sawdust particles, which result in defensive proliferation and hypertrophy of the mucosal cells, resulting in increased production of mucus, which could form plugs and narrows the tract. However the decline in lung functions in the test subjects cannot be attributed to the dust particles alone, as $PM_{2.5}$ in dust has been documented to absorb, combine and transport heavy metals, bacteria, viruses and other toxic substances, which are potential carcinogens (Tucker, 2000; Alexis *et al*., 2006; Dergham *et al*., 2012). Hence other investigation was carried out to assess their effect on lung function.

Result from investigation of the pulse oximetry (Fig. 6) of the subjects shows significant decrease ($p<0.05$) in the oxygen tension of blood of the experimental group compare with control. Similar observation was documented by Penney *et al*. (1974). However there are paucity of literatures on the effect of saw dust on oxygen carrying capacity of blood, but the observable reduction in oxygen tension of the blood of the test subjects may be due to the obstructive lung defect, as a result of inflammatory reaction stimulated by the particulate matter and oxidative tissue damage caused by the heavy metals bio accumulation.

CONCLUSION

The presence of respiratory symptoms viz a viz a compromise in the pulmonary function are clear indications that sawdust is a potential risk factor for the development of chronic respiratory diseases.

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