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Evaluation of Respiratory Symptoms and Lung Function in Apparently Healthy Wood Dust Exposed Workers in Port Harcourt, Nigeria

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Abstract Background: The burden of non-communicable respiratory diseases is rising globally, with environmental and occupational pollutants playing a significant role. It is known that workers exposed to wood dust are at risk of respiratory disease and lung function impairment. The objective of this study was to determine the pattern of respiratory symptoms and lung function parameters in sawmill woodworkers in Port Harcourt, Nigeria. Methods: A cross-sectional comparative descriptive study of sawmill workers from 3 sites in Port Harcourt, selected by multistage and stratified sampling compared to controls in non-risk occupations was done. Demographic and anthropometric parameters were assessed in addition to respiratory symptoms evaluation and spirometry testing of study subjects. Subjects with a history of smoking, asthma, pneumonia and already established respiratory diseases were excluded from the study. Data were analyzed with SPSS version 23. Results: Respiratory symptoms were significantly more prevalent in the 105 sawmill workers compared to 60 controls, with a significant risk and odds ratio. The most prevalent symptoms in subjects were Catarrh 45.7%, Chest Pain 39.0%, Cough 31.4%, Breathlessness 28.6%, Wheezing 25.7%, Sputum Production 23.8% and Fast Breathing 22.9%. The FEV1 (L) and FEF25-75% (L) were significantly lower in sawmill workers compared to controls with values of 2.70±0.77 vs 3.11±0.44, p=0.000 and 4.18±0.87 vs. 5.87±1.34, p=0.000 respectively. Conclusion: Respiratory symptoms and reduction in FEV1 are common among sawmill workers in Port Harcourt Nigeria. In an environment with significant environmental air pollution from soot, it is important for woodworkers at risk of occupational lung disease in Port Harcourt, to improve personal protective device use while regulatory authorities implement preventive occupational health.

Keywords: *wood dust, respiratory disease, lung function, Nigeria*

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1. Introduction

The burden of non-communicable respiratory disease is revealed to be on the rise globally. [1] This evidenced by the global burden of disease report 2018 [1], which shows a prevalence and incidence in thousands of 544899·2 and 62161·4 respectively for chronic respiratory disease. The time trend analysis for two time periods 1990-2007 and 2007 to 2017 also shows an increase in prevalence with values of 21.9% rise for 1990 to 2007 and 22·8% for 2007 to 2017. The same trend is observed for pneumoconiosis with a 27·0% rise for the period 2007 to 2017 [1]. The burden of chronic non communicable respiratory diseases significantly contributes to mortality especially in sub Saharan Africa as shown in the age-standardised death rates from chronic obstructive pulmonary disease (COPD) which is highest in low-income regions of the world, particularly South Asia and sub-Saharan Africa [2]. In addition the increasing contribution of Global and National indoor and outdoor air pollution from environmental and occupational exposure to respiratory disease burden is also acknowledged [2]. Diseases related to dust in environmental and occupational settings are also documented as significant contributors to the burden of non-communicable respiratory disease in Nigeria as shown by Akanbi et al [3], with cross sectional studies on exposure to dust from wood [4,5], coal and stone [6] and cement [7] among occupationally exposed Nigerians showing significant outcomes.

Wood dust exposure is a known contributor to the burden of respiratory disease and lung function limitation, with a spectrum of presentation ranging from upper and lower respiratory tract diseases, allergic and non-allergic lower lung diseases including asthma and chronic bronchitis; in addition to impairment in lung function and malignancies of the nasal cavities. [8]

The degree of indoor and outdoor air pollution with obvious soot in Nigeria’s Niger delta and Port Harcourt specifically and its consequent impact on health has been a source of concern [9],[10]. Therefore the impact of occupational dust exposure on the existing burden of air pollution is expected to increase the risk of respiratory disease in occupationally exposed workers in Port Harcourt.

It is known that workers exposed to wood dust are at risks of respiratory disease and lung function impairment [8]. The risk is estimated to be higher in a country like Nigeria, where it has previously been established that a limited number of wood and sawmill workers utilize respiratory protection in addition to poor methods of dust control and occupational health regulation for this category of workers [11].

In view of the poor regulation of occupational dust exposure and continuous risk to wood workers in Port Harcourt, studies which evaluate the impact of wood dust on respiratory health in Port Harcourt are therefore significant and relevant. The importance of such evaluation is strengthened by the current poor occupational regulation, low risk awareness [11] and significant burden of outdoor air pollution [9,10]. The objective of this study was to determine the pattern of respiratory symptoms and lung function parameters in sawmill wood workers in Port Harcourt, Nigeria.

2. Methodology

2.1. Study Design

A cross sectional comparative study of sawmill workers from 4 sites in Port Harcourt, selected by multistage and stratified sampling compared to controls in non-risk occupations was done.

2.2. Study Setting and Study Population

The study was carried out in two council areas of Port Harcourt and Obio-Akpor located in the greater Port Harcourt territory of Rivers state Nigeria.

The study subjects comprised of 105 sawmill workers who had been consistently engaged in the occupation for over one (1) year compared to a control group of 60 clerical, healthcare workers and students of the University of Port Harcourt who were matched for sex and age.

The sawmills which are small scale mills with low level of technology and industrialisation generate wood dust from the processing of a combination of hard and soft wood to planks. The mills also lack environmental protective designs to limit exposure to dust.

Subjects and controls with a history of cigarette smoking, asthma, pneumonia and already established respiratory diseases were excluded from the study.

2.3. Study Tools, Methods and Ethics

The British medical research council (MRC) respiratory symptoms questionnaire [12] was adopted for use in the evaluation of respiratory symptoms. The demographic and anthropometric parameters of age, height (metres), weight (kilograms), chest circumference (centimetres) were measured in accordance with standards for anthropometric measurement [13].

Lung function was assessed using Schiller Spirovit SP1 20/30 RN253018. Spirometry was performed with subjects seated and relaxed with belt loosened. The testing procedure was explained prior to each test with a mock demonstration and tests to ensure subjects understood the test procedure. The test for each subject was repeated 3 times and best of the results taken. Antibacterial filters and disposable mouth pieces and turbines were used for each subject to limit infection risk. The predictive values were based on African origin in accordance with the ERS/Knduson standards with spirometry patterns categorized into obstructive and restrictive. Forced Vital Capacity (FVC) in litres (L), Forced Expiratory Volume 1 (FEV1) in litres (L), FEV1/FVC measured in percentage (%), and Forced Expiratory Flow (FEF) 25-75% in litres (L) and Peak Expiratory Flow (PEF) in litres (L) were measured.

Ethical approval for the study was obtained from the ethical committee of the University of Port Harcourt Teaching Hospital, Port Harcourt with informed consent obtained from study participants.

2.4. Data Analysis

Data was analysed using the statistical package software SPSS 23 for windows. Discrete data and continuous variables were presented as percentages with mean ± standard deviation and confidence intervals respectively. Comparisons of means were done using the ANOVA and independent t test. Proportions were compared using Z test and Chi-square test as appropriate. Pearson correlations were done to evaluate associations between variables. P value ≤0.05 was considered as significant.

3. Results

3.1. Demographic and Anthropometric Indices in Study Population

One hundred and five saw mill workers (105) and 60 controls were studied. The demographic and anthropometric indices of the study population are displayed in Table 1. The mean age in the study subjects was 30.30±9.69 years compared to 29.56±8.64 in the controls (p=.625).

3.2. Prevalence of Respiratory Symptoms

The pattern and prevalence of respiratory symptoms in the study population is as shown in Table 2. The most prevalent respiratory symptoms in the study population were Catarrh (29.67%), Chest pain (26.06%), Cough (20.61%), Sputum Production (15.15%),) Breathlessness (18.18%), wheezing (16.36%) and Fast Breathing (14.55%). The symptoms were significantly more prevalent among sawmill workers compared to controls with higher odds risk ratio (See Table 2).

Table 1. Showing demographic and anthropometric indices of study population

Variable	Study Group	N	Mean±SD	Confidence Interval 95% (Equal variances assumed)		P value (Sig.2-tailed)
Age (years)	subjects	105	30.30±9.69	2.555	2.688	.625
	controls	60	29.56±8.64			
Height (cm)	subjects	105	167.41±7.34	-5.949	-1.756	.000
	controls	60	171.27±4.74			
Weight (Kg)	subjects	105	70.19±12.27	-10.447	-2.206	.003
	controls	60	76.52±13.92			
Chest Circumference (cm)	subjects	105	39.23±4.00	-1.657	0.818	.504
	controls	60	39.65±3.62			
BMI (Kg/m^2)	subjects	105	24.95±3.35	-2.222	0.211	.105
	controls	60	25.95±4.39			
Duration On The Job (years)	subjects	105	8.65±7.34	0.732	0.871	.643

Table 2. Comparison of Respiratory Symptom Prevalence between subjects and controls

Symptom	Overall (165) N (%)	Subjects (105) N (%)	Controls (60) N (%)	Significance, P value, OR
		Yes	Yes	p=0.000, OR = 49.69
Catarrh	49(29.67)	48 (45.7)	1 (1.7)	p=0.000, OR = 27.04
Cough	34(20.61)	33 (31.4)	1 (1.7)	p=0.000, OR = 49.69
Sputum Production	25(15.15)	25 (23.8)	0 (0.0)	p=0.000, OR = 17.48
Fast Breathing	24(14.545)	24 (22.9)	1 (1.7)	p=0.000, OR = XX
Chest Pain	43(26.06)	41 (39.0)	2 (3.3)	p=0.000, OR = 18.38
Breathlessness	30(18.18)	30 (28.6)	0 (0.0)	p=0.000, OR = XX
Wheezing	27(16.36)	27 (25.7)	0 (0.0)	p=0.000, OR = XX
XX = High Odds		OR = Odds Ratio		

Table 3. Comparison of lung function parameters between subjects and controls

Variable	Study Group	N	Mean ± SD	P value	Confidence Interval 95%	
FVC Measured (L)	subjects	105	3.43±0.46	0.885	-1.677	1.942
	controls	60	3.56±0.08			
FEV1 Measured (L)	subjects	105	2.70±0.77	0.000	-0.619	-0.186
	controls	60	3.11±0.44			
FEV1/FVC Measured (%)	subjects	105	90.70±6.37	0.282	-1.598	5.457
	controls	60	92.63±12.62			
FEF25-75 Measured (L)	subjects	105	4.18±0.87	0.000	-1.259	-.1.559
	controls	60	5.87±1.34			
PEF Measured (L)	subjects	105	7.38±1.27	0.757	-1.456	1.998
	controls	60	7.65±1.58			

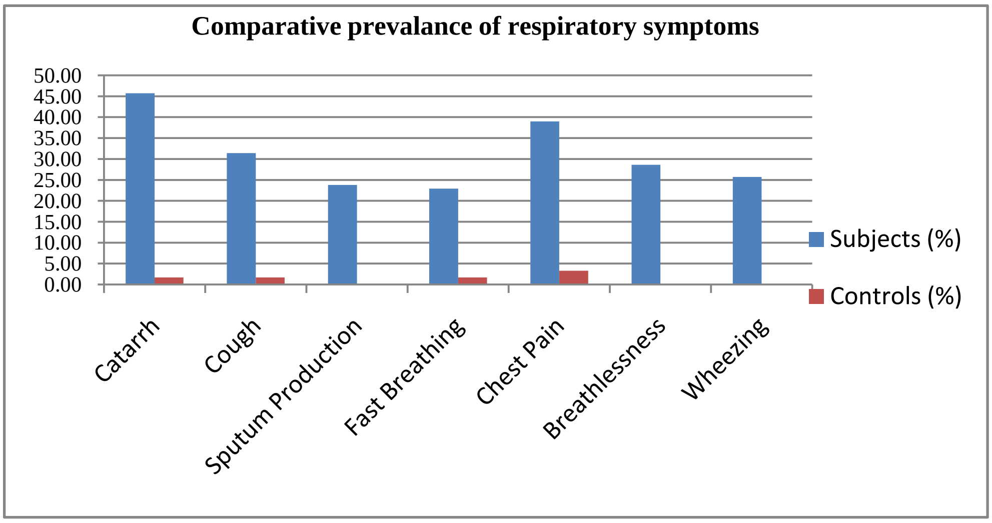

Figure 1. Comparative prevalence of respiratory symptoms in sawmill workers and controls

3.3. Lung Function Parameters

The comparison of lung function parameters between subjects and controls is as shown in Table 3. The FEV1 (L) and the FEF25-75 (L) were significantly lower in sawmill workers compared to controls with values of 2.70±0.77 vs. 3.11±0.44, p=0.000 and 4.18±0.87 vs. 5.87±1.34, p=0.000 respectively.

3.4. Significant Correlations with Lung Function

Chest Circumference (CC) cm was negatively and significantly correlated with FEV1/FVC% and FEF25-75% with r = -.279, p = .001 and r = -.237, p = .004 respectively while BMI (Kg/m^2) was negatively and significantly correlated with FEV1/FVC% and FEF25-75% with r = -.171 p = .037 and r = -.225, p = .004, respectively.

4. Discussion

Respiratory symptoms and lung function impairment has been shown to be linked to wood dust exposure, resulting in a varied pattern of symptoms and lung function impairment [8]. This study which compared aged matched non-smoking males occupationally exposed to wood dust and office worker controls found a significantly higher prevalence of the key respiratory symptoms in the sawmill workers with significant odds risk ratio.

The most prevalent respiratory symptoms in the study population were Catarrh (29.67%), Chest pain (26.06%), Cough (20.61%), Sputum Production (15.15%), Breathlessness (18.18%), wheezing (16.36%) and Fast Breathing (14.55%).

The findings of the study are consistent with that of various cross sectional studies within and outside Nigeria among wood workers.

Ige and Onadeko [5] also reported running nose and sneezing (57.40%) and productive cough (34.30%) as the most prevalent symptoms though with higher frequency than recorded in this study while dyspnoea and wheezing occurred in (4.10%) of the subjects far below the frequency of this index study.

A similar trend of respiratory symptoms were also reported by Tobin et al [14] in a study among sawmill workers in Benin, South Nigeria with Phlegm production and Cough occurring in 50.2% vs. 4.8% and 46.7% vs. 7.9% of subjects and controls respectively. Other prominent symptoms were breathlessness, wheezing, chest tightness and chest pain in 7.5% vs. 1.3%, 6.0% vs. 2.6%, 10.1% vs. 0.0%, 5.7% vs. 0.9% of subjects compared to controls respectively. Tobin et al [14] report higher prevalence of cough and sputum production and lower prevalence of wheezing and breathlessness when compared to this study.

Osuchukwu et al [15] in study from Calabar, Nigeria analysing occupational exposure to wood dust reported that 44.8% had upper respiratory tract symptom of sneezing. While 19.2% had cough comparable to 20.61% reported in this study. The proportion of subjects with wheezing and shortness of breath was 2.2% and 6.4% respectively and lower than 16.36% and 14.55% reported in this study.

The outcomes of other related cross sectional studies from other countries also show a similar pattern of respiratory symptoms as seen in this study. Neghab et al [16] from a study of bioaerosol and wood dust inhalation impact on respiratory symptoms and lung function in Iran reported significant differences and odd ratio in subjects compared to controls. Wheezing occurred in 37% of subjects compared to 11% of controls, with the prevalence of wheezing above the 16.36% reported in this study. Other prevalent symptoms were chest tightness, cough, phlegm production and dyspnoea.

Another study in Alberta, Canada by Hessel et al [17] reported a cough prevalence of 19.1% and wheezing attacks at 16.0% with rates comparable to the findings of this study. Bislimovska et al [17] in study from Macedonia also reported significantly higher prevalence of respiratory symptoms in wood dust workers compared to controls with 43.2% of subjects having respiratory symptoms compared to 24.3% of controls. Cough (29.7%) was the most prevalent symptom followed by phlegm (16.2%), chest tightness (13.5%), dyspnoea (10.8%) and wheezing (8.1%). The prevalence of cough and phlegm production are comparable with the values reported in the index study while the prevalence of dyspnoea and wheezing are lower than the values reported in this study. A study in Australia of asthmatic and non-asthmatics wood workers by Mandryk et al [19] reported higher prevalence of respiratory symptoms in wood exposed workers compared to controls with cough, phlegm production, breathlessness, features of chronic bronchitis and wheezing, chest tightness and catarrh as the more prevalent symptoms with rates comparable to the outcome of this study.

The outcome review of this and other studies though with varied prevalence shows a consistency in the patterns of symptoms. The symptom spectrum includes upper and lower airway disease manifestations, features of respiratory infections, bronchitis and asthma or allergic alveolitis in wood dust exposed workers. This spectrum of symptoms is comparable to established patterns documented in earlier reviews on the respiratory manifestations of wood dust exposure [8,20,21]. The varying symptom rates in this study and the comparator studies may be explained by factors such as the kind of wood exposure. It is known that effects from soft or hard wood, mixed wood, wet or dry wood and the presence of bio-aerosols produce varying symptoms [8,16,17,18,21,22]. Other confounding factors like the presence of smokers and asthmatics in the study population may also account for the differences. However the rates of wheezing and breathlessness were higher in this study than most of the comparator studies in this review.

The limitation in lung function parameters in workers exposed to wood dust has also been previously established [4,5,16,18]. The key findings of this study was a significantly lower FEV1 (L) in sawmill workers compared to controls with values of 2.70±0.77 vs. 3.11±0.44, p=0.000; and significantly lower FEF25-75% (L) with values of 4.18±0.87 vs. 5.87±1.34, p=0.000 respectively. Though FVC (L), FEV1/FVC (%), PEF (L) were lower in wood workers the differences were not statistically significant.

The comparison of this study with others show consistent outcomes with report of significant reduction in FEV1(L) also reported by Okwari et al [4] and Ige and Onadeko [5] from assessment of sawmill workers in Calabar and Ibadan, Nigeria respectively.

Tobin et al [14] documented an FEV1 (L) of 3.07 ± 0.51 in sawmill workers compared to 3.30 ± 0.53 in controls compared to 2.70±0.77 vs. 3.11±0.44 in subjects and controls respectively reported in this study. The values of reported FVC (L) and FEV1/FVC (%) of 3.60 ± 0.70 vs. 3.79 ± 0.69 and 77.64 ± 4.32 vs. 79.48 ± 6.26 respectively were also significantly different. The values of FVC (L) are comparable to the 3.43±0.46 vs. 3.56±0.08 reported in this study while the FEV1/FVC(%) are far lower than the 90.70±6.37 VS 92.63±12.62 reported in this study in spite of the insignificant differences.

The outcome of two other studies from Kaduna and Ibadan, Nigeria by Tanko et al [23] and Omole et al [24] also show comparable trends with this study outcome. In an evaluation of cardiopulmonary indices in wood workers and a control group, Tanko et al [23] reported lower predicted FEV1% and FEV1 (L) of 79.24±1.75 vs. 67.29±2.18 and 2.29±0.08 vs. 1.59±0.09 respectively in wood workers compared to the control group. The FEV1 (L) values are lower than that reported in this study in spite of the lower mean age of study participants of 23.90±0.36 vs. 24.60±0.61 compared to 30.30±9.69 vs. 29.56±8.64 reported for the index study. The FVC (L) values of 2.88±0.08 vs. 2.33±0.0 were significantly different in the overall subjects and controls groups in contrast to our findings which did not show significant difference though the FVC (L) values were higher 3.43±0.46 vs. 3.56±0.08. These findings may indicate more severe impairment of respiratory function in the participants of this study in comparison to the index study. Omole et al [24] reported significantly lower FEV1 (L) of 2.47±0.43 vs. 3.10±0.55 and FVC (L) of 2.73±0.53 vs. 3.14±0.37 in sawmill workers compared to controls. The FEV1 (L) values are approximate to the FEV1 (L) of 2.70±0.77 vs. 3.11±0.44 reported in this study while the FVC (L) values are lower than the 3.43±0.46 vs. 3.56±0.08 in this index study.

Related cross sectional studies outside Nigeria also show similar pattern as exemplified in the study by Neghab et al [16] in Iran who reported significant differences in predicted FVC%, predicted FEV1% and PEF% of 86.97±16.92 vs. 94.10±11.35, p = 0.03, 86.31±14.37 vs. 94.55±13.68 p =0.01, and 76.46±15.98 VS 85.76±20.76 P=0.03 respectively.

Correspondingly, Mahmood et al [25] from a study in Sulaimani city, Iraq also reported significantly lower values of FVC (L), FEV1(L), and PEF(L/s) 8.9 ± 0.5 vs. 7.3 ± 0.91, 8.9 ± 0.6 vs. 7.4 ± 0.8, 8.7 ± 0.6 vs. 7.1 ± 1.0 respectively, while the PEF values of 1.008 ± 0.03 vs 1.033 ± 0.09 did not show significant difference and was lower in the control group. Though the trend of results showed lower FEV1(L) in study subjects the values differed widely from that of the index study. These differences may be explained by the small sample size of only 24 subjects and 17 controls in addition to racial and anthropometric variations.

Eenin et al [26] in study of 104 sawmill workers and 104 controls in a market cluster of sawmills in Accra, Ghana, also reported significantly lower FEV1(L) of 2.58 ± 0.07 vs. 2.90 ± 0.06 which did not vary widely from the values of 2.70±0.77 vs. 3.11±0.44 in this index study. In a comparable way the FVC (L) values of 3.46 ± 0.08 vs. 3.63 ± 0.07 reported by Eenin et al [26] though lower in controls was not statistically significant.

Additional studies in Canada [17], Macedonia [18] and New Zealand [21] also corroborate the findings of this study documenting adverse impact of lung function parameters from wood dust exposure. Hessel et al [17] in a Canadian study comparing 94 sawmill vs. 165 oilfield workers with smokers inclusive reported significant differences in the overall FEV1(L) and FEV1/FVC% values of 4.133 vs. 4.211 and 77 vs. 80.7 respectively, while comparison of the FVC(L) values of 5.333 vs. 5.208 were insignificant.

Bislimovska et al [18] also found significant differences in percentage predicted FEV1% and FEV1/FVC% values of 82.6±10.2 vs. 86.4 ±9.4 and 0.75±0.05 vs. 0.78 ±0.03 in sawmill workers and controls respectively while the difference in percentage predicted FVC% values of 92.3±11.7 vs. 94.2±14.1 were insignificant.

An assessment of subjects with atopy from exposure to pine wood by Douwes et al [21] in New Zealand reported significant differences in the baseline FEV1 (L) of 3.59± 0.87 vs. 3.24± 0.91 and PEF (L) of 1 8.75±2.28 vs 7.56±2.04 in exposed subjects with or without asthma compared to controls; while the FVC (L) values of 4.61 ±1.04 vs. 4.49±1.12 was not significant corresponding to the pattern in this study.

The outcome of this study and the comparator reviews across Nigeria, Africa, Europe, North America, Australia and the Middle East show a consistency in the conclusion that exposure to wood dust has adverse effects on lung function with a tendency to predominance of obstructive patterns as shown in the constancy of significantly lower FEV1(L), PEF(L) and FEV1/FVC(%) reductions and less significant changes in FVC(L). The differences observed from the reviewed studies may be explained by study population differences which include age, racial and anthropometric variations, inclusion of smokers and subjects with existing lung diseases and sample size limitations.

Conclusion: This study established that respiratory symptoms are more prevalent in wood workers compared to controls. The pattern and spectrum of symptoms includes upper and lower airway disease manifestations, features of respiratory infections, bronchitis and asthma or atopy in wood dust exposed workers. The study also established that lung function parameters are more impaired in wood workers compared to controls, with impairment in FEV1 as a most consistent feature. Consequently it is recommended that more attention is given to the respiratory health of workers exposed to wood dust in Port Harcourt and Nigeria; especially in view of existing poor air quality and soot in Port Harcourt, Nigeria [9,10]. This can be achieved through education and awareness programs for wood workers on the risk to health from wood dust exposure. Emphasis on improved personal respiratory protection in the course of work should also be promoted and enforced. It is expected that improved occupational health regulation for this industry and category of workers will focus on environmental modification through modernisation of industrial processes in the course of wood processing to improve reduction of dust exposure. Longitudinal studies are recommended to evaluate the long term impact of wood exposure in Nigeria.

Acknowledgements

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