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Research Article

EFFECTS OF WOOD DUSTS ON THE ELECTRICAL ACTIVITY OF THE HEART OF TIMBER WORKERS IN NIGERIA POPULATION

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A B S T R A C T

Background: Associations between high level of occupational dust and cardiovascular diseases have been known for more than half a century.
Objective: The objective of the study was to determine the effects of wood dusts on the electrical activity of the hearts of timber workers in Abakaliki metropolis.
Methods: 200 subjects participated in this study. 100 timber workers (test group) and 100 civil servants (control group). A questionnaire was issued to the participants to obtain some vital medical and workplace information. Signed consents forms were obtained from the participants. An electrocardiogram machine was used to examine the electrical activities of their hearts. A handheld laser dust measuring device called air sampler PCE-PCO 1 was used to analyze the quantity, quality and sizes of particulate matters present in the research area.
Data were presented as Mean ±SEM, analyzed using a 2-way ANOVA, and a multiple comparison test using Tukey's Post Hoc Test. Level of significance was set at 95% confidence interval. All statistical analyses were carried out using Graph Pad prism 7 software.
Results: Participants were within the age of 25 to 50 years. Timber workers were exposed to particulate matter 0.5, 1.0 and 2.5 µm.The result showed significant increase in the P-wave duration (P = WS 0.0001, WSL 0.0001, WL 0.0008), QTc interval (P = WS 0.0100, WSL 0.024, WL 0.041) and T axis (P = WS 0.0328, WSL 0.0419, WL 0.0126) of timber workers when compared with the control. Furthermore, significant decrease was observed in the T-wave duration (P = WS 0.0091, WSL 0.0014, WL 0.0043) and P axis (P = WS 0.0002, WSL 0.0001, WL 0.0017) of timber workers when compared with the control. Also, among timber workers, wood sawyers recorded higher QT intervals when compared with other timber workers. No significant difference was recorded in the QRS duration, QT interval, QRS axis, RV_5 and SV1 amplitudes of timber workers when compared with the control.
Conclusion: Timber workers are exposed to high concentration of wood dusts that negatively influence the electrical activities of their hearts. Therefore, need to be encouraged to adopt respiratory health safety strategies like use of face mask, practice of active cycle of breathing techniques and also be educated on the wood dusts hazards by the public health workers.

INTRODUCTION

Associations between high level of occupational dust and cardiovascular diseases have been known for more than half a century (Brook *et al.*)[1]. Dust are small dry, solid particles projected into the air by natural forces such as wind, volcanic eruption and by mechanical or man-made processes such as crushing, grinding, milling, drilling, demolition, shoveling, conveying, screening, bagging and sweeping (IUPAC)[2]. Dusts, when in high concentration could harm animals, humans and vegetation (Rich *et al.*)[3]. There are four major types of dust found in work environment namely: mineral dust, organic and vegetable dust, metallic dust, and chemical dust. Examples of organic and vegetable dust are flour, cotton, pollens and wood dusts. Wood dust

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generated by the processing of wood, is composed of cellulose, polyoses and lignin compounds (Pedro *et al.*)[4]. A variety of biologically active low molecular weight compounds may also be present depending on the species of the tree. These compounds includes; alcohols, glycerols, sterols, terpenes, tannins, flavonoids, quinines, lignans, alkaloids (Pedro *et al.*)[4]. Dust particles are usually in the size range from about 1 to 100µm in diameter, and they settle slowly under the influence of gravity. They are generally called particulate matters. Particulate matters are classified by size of the particles into ultrafine PM< (0.1µm), coarse (Pm 1.0-2.5 µm), fine (PM > 2.5µm) and PM ≤10µm (Brook *et al.*)[1]. These particles are composed of solid and liquid components that originate from vehicle exhaust, road dust, forest fire, wind-blown soil and wood dusts. Particle size, surface area and chemical composition determine the health risk posed by particulate matters. Particulate and gaseous pollutants coexist in the air and may induce adverse health effects, whereas compelling data implicate particulate matters as a major perpetrator of various types of cardiovascular diseases, particulate matters rarely exists by itself within the ambient environment because gaseous and semi volatile compounds are constantly changing and interacting (Schwartz & Morris)[5]. Many of these vapor-phase compounds attach to the surface of particulate matters and/or by themselves form secondary aerosol particles (Schwarz & Dockery) [6]. These particles are composed of solid and liquid compounds depositing in the alveoli and entering the pulmonary circulation and presumably into the systemic circulation (Peters *et al.*)[7].The potential mechanisms by which pollutants may cause cardiovascular diseases include alterations in autonomic function, increase repolarization abnormalities, local and systemic inflammation, increase reactive oxygen species, coagulation and myocardial ischemia (Brook *et al.*)[1].

Cardiovascular diseases that may be cause by air pollution include cardiac arrhythmias, myocardial ischemia, hypertension, myocardial infarction, atherosclerosis etc. Many studies have been carried out to determine the effects of occupational dust on the electrical activities of the heart among the exposed workers. Ljungman *et al*[8] and Zareba *et al*[9] revealed that exposure to particulate matters can lead to a significant increase in the PR, QT and QTc interval of the exposed individuals. (Peters *et al.*)[7] revealed that exposure to air pollution can lead to an increase in ventricular arrhythmias. The dangers of air pollution with respect to cardiac arrhythmias have been well documented. However, no study has investigated the effects of wood dusts on the electrical activities of the hearts of timber workers in Abakaliki metropolis where majority of people are engaged in wood work to earn a living. Hence the need for this study to bridge the gap in knowledge about the effects of wood dust on the electrical activities of the hearts of timber workers in Abakaliki metropolis.

METHODS

This was a cross sectional study. The study was conducted in 2019 on the timber workers and non-timber workers. There was three different groups of timber workers in Abakaliki metropolis namely; wood sawyers, wood loaders and wood sellers. The electrical activity of their hearts were also compared among the different groups of timber workers. One hundred timber workers (test group) and one hundred non-timber workers (control group) were purposively sampled. Timber workers within the age of 25 to 50 years, have been in the job for at least minimum of three years and are not engaged in other air pollutant Jobs participated in this study. Timber workers that have been previously diagnosed of any cardiovascular diseases, pregnant workers and those taking drugs that can directly or indirectly affect the cardiovascular system were excluded from this study.Cohen[10] sample size formula was used to estimate sample size in this study.Study area was timber industry where there are many timber workers exposed to wood dust. Materials used in this study were; ECG machine (BPL – model: 6208) and its graph paper, an examination couch, a lubricating electrostatic k-y jelly, a methylated spirit and a cotton wool. A handheld laser dust measuring device called air sampler PCE-PCO 1 was used to analyze the quantity, quality and sizes of particulate matters present in the research area.

Participants were made comfortable, the aims of the procedure was explained, a signed consent obtained and a questionnaire to determine participants age, sex, years in the job, exclusion and inclusion criteria obtained. Questionnaire was developed by the authors and it was interviewers – administered.

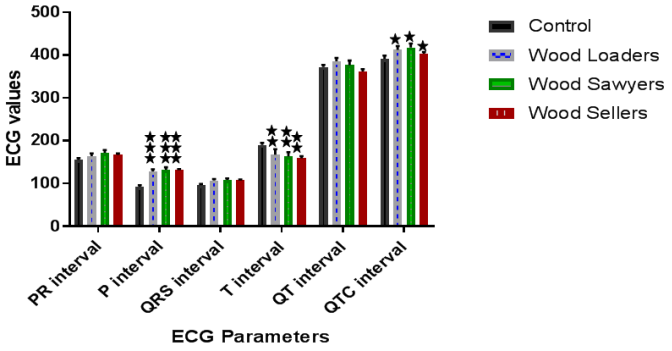
The procedure for ECG recording was performed according to the society for cardiological science and technology (SCST) approved clinical guidelines for recording a standard 12-lead electrocardiogram The electrocardiogram machine recorded the cardiac waves namely p-wave, QRS complex and T-waves. Also the variables that were calculated included the amplitudes, axis and intervals. The totality of this waves and variables determined the electrical activity of the heart weather normal (normal sinus) or abnormal (arrhythmias) and the medical implications.

Ethical approval: Obtained from the Ebonyi State University Ethical Committee and the Ministry of Health Ethical Committee with reference number Ref: EBSU/TET fund /IBR/2015/26.

Data Analysis

Data were presented as Mean ±SEM, analyzed using a 2-way ANOVA, and a multiple comparison test using Tukey's Post Hoc Test. Level of significance was set at 95%confidence interval. All statistical analyses were carried out using Graph Pad prism 7software.

RESULTS



Key*: indicate significant.

Figure 1 Comparison of ECG Intervals and Durations between Timber Workers and Control.
Values were expressed as Mean±SEM for timber workers and control.

The result showed a significant increase in the P-wave duration of timber workers (wood sawyers P=0.0001, sellers P=0.0001 and loaders P=0.0008) when compared with the control. A significant decrease was observed in the T-wave duration of wood sawyers (P= 0.0091), wood sellers (P=0.001) and wood loaders (P = 0.004) when compared with the control. Also, a significant increase was recorded in the QTc- intervals of wood sawyers (P=0.0100), wood sellers (P = 0.024) and wood loaders (P = 0.041) when compared with the control. However, no statistical difference was observed in the PR-intervals, QRS-duration, and QT- intervals of timber workers when compared with the control.

Table 1 Comparison of ECG Intervals and Durations among Timber Workers

	PR-interval	P-duration	QRS-duration	T-duration	QT-interval	QTc-interval
Timber workers	**Mean±SEM**	**Mean±SEM**	**Mean±SEM**	**Mean±SEM**	**Mean±SEM**	**Mean±SEM**
WL	164.1±6.6	128.6±4.8	107.5±3.10	167.841±12.2	375.5±8.2	412.3±8.70
WS	171. 7±6.9	132.13±5.8	108.73±3.4	163.53±10.03	386.5±10.9	417.5±9.64
P-value	**0.7882**	**0.9835**	**0.9992**	**0.9710**	**0.0407***	**0.9490**
WL	164.1±6.6	128.6±4.8	107.5±3.10	167.841±12.2	375.5±8.2	412.3±8.70
WSL	167.7±3.5	132.2±1.8	108.2±1.44	159.1±4.8	361.7±5.7	403.2±4.1
P-value	**0.9859**	**0.9757**	**0.9998**	**0.7433**	**0.2273**	**0.7176**
WS	171. 7±6.9	132.13±5.8	108.73±3.4	163.53±10.03	386.5±10.9	417.5±9.64
WSL	167.7±3.5	132.2±1.8	108.2±1.44	159.1±4.8	361.7±5.7	403.2±4.1
P-value	**0.9340**	**0.9999**	**0.9999**	**0.9408**	**0.0308***	**0.2498**

Key: *indicate significant.
SEM = standard error of mean.
WS = wood sawyers
WSL = wood sellers
WL = wood loaders

Values were expressed as Mean±SEM for timber workers.
The result showed a significant increase in the QT- intervals of wood sawyers when compared with wood sellers and wood loaders. No statistical difference was observed in the PR-intervals, P-wave duration, QRS- duration, T-wave duration, and QTc- intervals among other groups of timber workers.

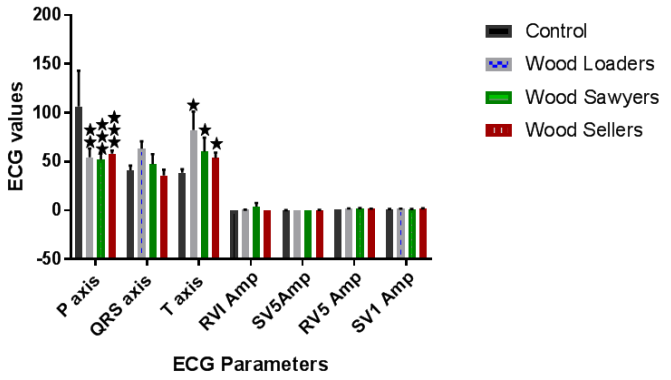


Figure 2 Comparison of ECG Axis and Amplitudes between Timber workers and Control.

Key: * indicate significant.
Values are expressed as Mean±SEM for timber workers and control.

The result showed a significant decrease in the P-axis of wood loaders (P= 0.0017), sawyers (P= 0.0002) and sellers (P=0.0001) when compared with the control. A significant increase was observed in the T- axis of wood loaders (P= 0.0126), wood sawyers (P = 0.0328) and wood sellers (P = 0.0419) when compared with the control. However, no statistical difference was observed in the QRS- axis, RV1, SV5, RV5 and SV1 amplitudes of timber workers when compared with the control.

Table 2 Comparison of ECG Axis and Amplitudes among Timber workers:

	P-axis	QRS-axis	T-axis	RV5amp	SV1amp
Timber workers	Mean±SEM	Mean±SEM	Mean±SEM	Mean±SEM	Mean±SEM
WL	54.5±8.7	63.14±7.5	82.2±19.1	1.9±0.2	1.6±0.2
WS	52±6.4	47.4±10.1	60±14.6	2.2±0.2	1.23±0.113
P-value	**0.9983**	**0.7236**	**0.4564**	**0.9999**	**0.9999**
WL	54.5±8.7	63.14±7.5	82.2±19.1	1.9±0.2	1.6±0.2
WSL	57.97±3.3	35.7±6.05	53.6±5.6	1.6±0.1	1.74±0.4
P-value	**0.9940**	**0.1705**	**0.1431**	**0.9999**	**0.9999**
WS	52±6.4	47.4±10.1	60±14.6	2.2±0.2	1.23±0.113
WSL	57.97±3.3	35.7±6.05	53.6±5.6	1.6±0.1	1.74±0.4
P-value	**0.9598**	**0.7626**	**0.9503**	**0.9999**	**0.9999**

SEM = standard error of mean.
WS = wood sawyers
WSL = wood sellers
WL = wood loaders

Table 2 shows the Mean±SEM for timber workers (wood sawyers, loaders and sellers).

The result showed no significant difference in the P- axis, QRS- axis, T- axis, RV5 and SV1 amplitudes among all the groups of timber workers.

DISCUSSION

This study detected a significant increase in P wave and a significant decrease in T wave durations of timber workers when compared with the control. These indicate that timber workers may be prone to atrial and ventricular arrhythmias. This finding is in line with the study done by (Ljungman *et al.*)[8] who revealed that a 10 µg/m^3 rise in particulate matters ($PM_{2.5}$) was significantly associated with increase P-wave duration, and therefore, concluded that $PM_{2.5}$ adversely affects atrial fibrillation/flutter predictors, PR-interval, p-wave duration and P-wave complexity. This result also agrees with the findings of (Peters *et al.*)[7] who investigated the relationship between air pollution and ventricular arrhythmias in 100 participants and revealed an increase in ventricular arrhythmias.

No significant difference was observed in the PR- interval, QRS-duration and QT intervals of timber workers when compared with the control. The lack of difference discovered here may be due to their genetic susceptibility. These findings contradict the results of (Ljungman *et al.*)[8] and (Zareba *et al.*)[9] who revealed that exposure to particulate matters can lead to a significant increase in the PR and QT interval of the exposed individuals.

Furthermore, the result showed a significant decrease in the P-axis of timber workers when compared with the control. This finding suggests that timber workers may be prone to left bundle branch block which is an indication for left axis deviation.

A significant increase was observed in the T- axis of timber workers when compared with the control. This may be because wood work is a form of resistance exercises and resistance exercises have been shown to cause ventricular muscle enlargement which in turn can result in axis deviation. This suggests that wood workers may be at a risk of developing right axis deviation. Unfortunately, there is no sufficient studies to support this finding. The findings from this study also showed no statistical difference in the QRS-axis, RV1, SV5, RV5 and SV1 amplitudes of timber workers when compared with the control. The lack of statistical difference may be attributed to their demographic characteristics.

In comparison of ECG parameters among timber workers, the result showed a significant increase in the QT – intervals of wood sawyers when compared with other timber workers. This is an indication that greater exposure to wood dust may cause greater damage to the heart.

Limitation

Inability to measure lifestyles variables of the participants.

Recommendations

1. The work exposure limits for wood dusts must not exceed eight hours per day.
2. Dust extraction must be provided at working machines to capture and remove dust before it can spread.
3. Dampers should be fitted in every wood work factory to prevent spread of dusts.
4. Education of timber workers by the public health workers on the danger of exposure to wood dusts through health out reach.
5. A suitable face mask should be worn by every timber worker to prevent wood dust inhalation and subsequent absorption into the circulation.

CONCLUSION

Timber workers have abnormal P and T wave durations, P and T axis than non-timber workers thus have compromised electrical activities of their hearts. Also, prolonged QT-interval recorded by the wood sawyers when compared with other groups of timber workers is an indication that greater exposure to wood dust may cause greater damage to the heart. Timber workers need to be encouraged to adopt health safety strategies and also, be educated on wood dusts hazards.

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