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Assessment of the liver biochemical status of carpenters occupationally exposed to wood dust in Enugu metropolis South-East Nigeria.

[§,1]Obianyido Ozioma Ebere, [2]Obianyido Hector Okechukwu, [1]Okwuosa Chukwugozie Nwachukwu

[1]Department of Medical Laboratory Sciences, Faculty of Health Sciences and Technology, University of Nigeria, Enugu Campus, Enugu, Nigeria.
[2]Department of Medical Biochemistry, Faculty of Basic Medical Sciences, University of Nigeria Enugu Campus Enugu, Nigeria.

Corresponding author: Obianyido Ozioma Ebere. Email/Phone number ozioma.obianyido@unn.edu.ng/+234 8034734347

Abstract

Liver disease has a global distribution and ranks as the twelfth leading cause of mortality. This cross-sectional study carried out between June and November 2021 aimed to assess the liver biochemical status of carpenters occupationally exposed to wood dust in Enugu metropolis South-east Nigeria. The Ethical Committee of the University of Nigeria Teaching Hospital in Enugu gave its approval. A total of one hundred and twenty-four (124) participants; sixty-two (62) carpenters (exposed) and sixty-two (62) age and sex-matched (males) control (unexposed) were recruited for this study. Study participants were chosen by simple random sampling. Spectrophotometric method was used to test participants' blood samples for liver enzymes alanine transaminase (ALT), aspartate transaminase (AST) and alkaline phosphatase (ALP). A statistically significant increase ($p<0.05$) was observed in the liver biochemical enzymes of the carpenters (exposed) in comparison to the controls (unexposed). The carpenters do not use any form of personal protective equipment (90.32%) or have a good knowledge of any occupational risk (83.87%) they are exposed to. A statistically significant positive correlation ($p<0.05$) was observed between ALT, AST and ALP enzyme activity and the duration of exposure to wood dust (in years) of the exposed. This study suggests that occupational exposure to wood dust may cause metabolic changes in the Liver. Constant use of personal protective equipment when at work, personal hygiene and regular health check is recommended.

Key words: Occupational exposure, Wood dust, Alanine transaminase, Aspartate transaminase, Alkaline phosphatase

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INTRODUCTION

Wood is one of the world's most significant sources of revenue, and its extensive usage makes it one of the most prevalent occupational exposures (Basinas *et al.*, 2023). Wood dust is a complex combination of cellulose, lignin, polar, non-polar, and water-soluble chemicals produced during wood processing (Cao *et al.*, 2022; Villalba *et al.*, 2022). Carpentry involves working with wood, and as a consequence of their activity, a lot of wood dust is produced. The procedure entails manually sanding, drilling, and cutting wood for constructing furniture (Moshen *et al.*, 2021). Installing filters or local aeration on the machines often reduces dust (Cao *et al*., 2022).

Notwithstanding this effort, some of the wood dust would always slip out of the filters, exposing the employees (Tobin *et al.*, 2016). The private sector operates most of the carpentry business in Nigeria (Agu *et al.*, 2016). They do not have the resources to adequately implement engineering control systems, dust monitoring, raise employee understanding of occupational hazards or provide them with safety equipment (Agu *et al.*, 2016). Due to these inadequacies, carpenters are exposed to high quantities of wood dust due to antiquated methods and machinery. Wood is preserved using chemicals such as pentachlorophenol and creosote (Komorowicz *et al.*, 2023). Acute exposure to these chemicals could result in lung inflammation, hepatic cell death, kidney damage, and neurological damage (Omrane *et al.*, 2018). Deposition of wood dust on the skin or in the lungs may be harmful both locally and systemically (Nsowu-Anyanwu *et al.*, 2023). Researchers observed that exposure to wood dust may impair renal function, biliary system function, and tissue blood flow (Mohammadyan *et al.*, 2020). Sarah et al., (2016), observed that carpenters occupationally exposed to wood dust had their blood ALP and total protein levels elevated while their albumin levels were decreased.

Liver disease has a global distribution (Ye *et al.*, 2022). The liver disease ranks as the twelfth leading cause of mortality; however, liver fatalities may be underreported. Affected individuals are frequently asymptomatic for an extended period, making collecting accurate incidence and prevalence information on the general population difficult. Premature mortality from liver failure, cirrhosis, and hepatocellular carcinoma are only a few examples of the devastating effects of liver disorders on public health globally (Ghazal *et al.*, 2022).

A lot of work have been published on the effects of wood dust exposure on oxidative damage (Nsonwu-Anyanwu *et al*., 2023), liver biochemical parameters (Holy *et al*., 2018), kidney function, respiratory function(Bosan *et al*.,2004;Okwari *et al*.,2005;Tobin *et al.,* 2016), cardiopulmonary function(Tanko *et al*., 2011;Wali *et al*., 2020) of individuals occupationally exposed to wood dust in south-south and northern Nigeria, nevertheless, there is paucity of data on liver biochemical status of carpenters in Enugu metropolis, south-eastern Nigeria. This present study aims to assess the liver biochemical status of carpenters occupationally exposed to wood dust in Enugu metropolis South- east Nigeria. The findings of this study will serve as a baseline data to define the strategies that will be employed to minimize occupational hazards associated with wood dust exposure.

MATERIALS AND METHODS

Study design

The study employed a cross-sectional survey design to assess the liver biochemical status of carpenters occupationally exposed to wood dust in Enugu metropolis, Southeast Nigeria. The study was conducted between June and November of 2021 in Enugu metropolis, located in Southeast Nigeria. Residents of Enugu State are employed in numerous fields, including government, commerce, the arts, and agriculture.

Study population

Carpenters (exposed) and non-carpenters (unexposed) who live and work within the Enugu metropolis and in addition, fulfilled the inclusion criteria were recruited for the study. Beechwood (*gmelina arborea*), African mahogany (*khaya ivorensis*), cotton tree (*ceiba petra*), and Achi (*brachystegia eurycoma*) are the most prevalent types of wood used by carpenters. Combinations of cinnamomum camphora, paraffin oil, neo-pynamin, cypermethrin, and 2, 2-dichlorovinyl dimethyl phosphate are utilised as preservatives for wood. Carpenters apply wood preservatives by sprinkling or painting using bare hands. Moreover, it was observed that the majority of carpenters do not use any form of personal protective equipment while at work.

Inclusion criteria

Adult (over 18 years old) full-time carpenters with at least five years of exposure to wood dust were included in the study,

Exclusion criteria

Subjects who tested positive for Hepatitis A, B, C, or HIV on screening and those who smoked cigarettes or sniffed tobacco were excluded from participating in the study. Subjects who have a history of hypertension, liver disease, diabetes, heart disease, or any other systemic disease were also excluded.

Sample size determination

The sample size was determined using the formula of (Niang *et al.*, 2022), and the prevalence of liver disease in Southeast Nigeria was 7.9 % (Nwokediuko *et al.,* 2013).

Sample size $n = \frac{A^2 B (1-B)}{C^2}$

A= statistics for the level of 95% confidence interval (1.96)
B= % prevalence of renal disease in southeast Nigeria.
C= Preferred precision; in this case, 0.05
Sample size, n=

$$\frac{3.842 \times 0.079 \times 0.921}{0.0025}$$

$$= 111.8$$

Approximately; 112
An extra 10% was added for attrition
Approximately, 124
Sixty-two (62) carpenters and sixty-two (62) age and sex-matched control subject unexposed to wood dust were recruited, giving a total of one hundred and twenty-four (124) participants for the study.

Sampling technique

The study participants were selected by simple random sampling. Every fifth consenting individual that fulfilled the inclusion criteria was selected.

Ethical consideration

The Ethical Committee of the University of Nigeria Teaching Hospital in Enugu reviewed and approved the study (NHREC/05/01/2008B-FWA00002458-1RB00002323). All study procedures adhered to the principles enumerated in the 1964 Declaration of Helsinki. Participants' privacy was protected.

Questionnaire administration

After obtaining informed consent, a pre-tested, semi-structured questionnaire was used to collect the subject's demographic, medical, and social history.

Blood sample collection

The epidermis at the antecubital fossa was extensively cleansed with methylated spirit. Five millilitres of venous blood were obtained via venipuncture and placed in a plain bottle. The samples were taken to the laboratory for centrifugation at 1500 rpm for 10 minutes. Clear serum was placed in an aliquot bottle and kept in a -20^0C freezer until analysis. All samples were analyzed seven (7) days after blood sample collection.

Determination of alanine transaminase (ALT), aspartate transaminase (AST) and alanine phosphatase (ALP) in participants' blood samples.

Serum aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were measured using the colorimetric technique outlined by Reitman and Franke (Rifai, 2017). The colorimetric procedure developed by Belfield and Goldberg was used to measure serum alkaline phosphatase (Rifai, 2017).

Statistical analysis

The statistical analysis software, GraphPad Prism version 7 (Graph pad Software Inc., USA), was used to analyse the data from this study. Univariate variables were expressed as frequency (percentage) and mean ± standard deviation. A chi-square test was used to compare the differences in socio-demographic characteristics of the participants. Student's t-test was conducted to compare bivariate variables such as the enzymatic activity of ALT, AST and ALP between the study participants. One-way ANOVA was used to compare the multivariate variables, the mean difference in the enzymatic activity of ALT, AST, and ALP at different years of work (1-10 years, 11-20 years, 21-30 years and 31 years and above). In addition, Pearson correlation was used to assess relationships between the measured parameters ;(work duration and ALT, AST and ALP). A p-value of <0.05 was used to determine statistical significance.

RESULT

Table 1 presents the demographic parameters of the study participants. A hundred and twenty-four (124) males (100%), comprising sixty-two (62) carpenters exposed to wood dust and sixty-two non-carpenters unexposed to wood dust, completed this study. No statistically significant difference (p>0.05) was observed in the mean age of the study participants. This study observed 36.92±10.03 as the Mean ± SD age of the carpenters (exposed), while for the controls (unexposed), 38.10±10.00 (p=0.580). Although the majority (88.7%, 55/62) of the carpenters had some form of formal education, others (11.3%, 7/62) had no formal education (p<0.001). This study observed a statistically significant increase in the level of education of the unexposed compared to the exposed.

Table 1: Demographic characteristics of the study participants

	Exposed			Unexposed			
Parameters	LCI	UCI	Mean± SD	LCI	UCI	Mean SD	p-value
Age(years)	33.26	41.64	36.92±10.03	34.02	43.38	38.70±10.00	0.580
ALT(IU/L)	10.36	11.95	11.16±2.06	8.70	10.41	9.57±1.83	0.008
AST(IU/L)	11.05	15.40	13.22±4.37	9.37	12.07	10.92±2.72	0.047
ALP(IU/L)	40.10	47.88	43.94±7.91	35.22	40.54	37.88±5.17	0.012

Table 2. Knowledge and attitude of the adverse effects occupational exposure to wood dust among carpenters in Enugu metropolis

	Yes	**%**	**No**	**%**
Do you think your job has adverse effects?	10	16.13	52	83.87
Do you use any PPE?	6	9.35	56	90.32

Table 2 presents the knowledge and attitude of the adverse effects of occupational exposure to wood dust among carpenters in Enugu metropolis. This study observed, the majority of the carpenters 83.87% (52/62) do not think their job has any effect on their health while 90.32% (56/62) do not use any form of PPE.

Table 3: Comparison of the mean Age and liver biochemical parameters of the study participant

	N	**(%)**	**N**	**(%)**	**p-value**
	Exposed		Unexposed		
Male sex	62	100	62	100	
Age (years)					0.658
<20	2	3.2	4	6.4	
21-30	18	29.1	22	35.5	
31-40	22	35.4	20	32.3	
41-50	20	32.3	16	25.8	
Total	62	100	62	100	
Educational status					<0.001
No formal education	7	11.3	0	0	
Primary education	20	32.3	4	6.5	
Secondary education	30	48.4	40	64.4	
Tertiary education	5	8	18	29.1	
Total	62	100	62	100	

Table 3 presents the liver biochemical parameters of the study participants. This study observed a statistically significant increase (p=0.008) in the Mean ± SD of ALT enzymatic activity of the exposed (11.16±2.06) IU/L in comparison to the unexposed (9.57±1.83) IU/L. There was a statistically significant increase (p=0.047) in the Mean ± SD of the AST enzymatic activity of the exposed (13.22±4.37) IU/L compared to the unexposed (10.92±2.72) IU/L. In addition, this study observed a statistically significant increase (p=0.012) in the Mean±SD of the ALP enzymatic activity of the exposed (43.94±7.91) IU/L in comparison to the unexposed (37.88±5.17) IU/L.

Table 4: Comparison of the liver biochemical parameters of the exposed subjects according to duration of exposure.

Exposure(years)	1-10	11-20	21-30	>31	P-value
Parameters					
ALT(IU/L)	8.69±0.70[a,b]	11.13±1.44[a,c]	12.02±0.81[b,d]	14.20±0.34[c,d]	<0.001
AST(IU/L)	11.43±2.51[e,f,h]	13.80±2.95[g,h]	15.10±0.25[e,g]	16.00±1.03[f]	<0.001
ALP(IU/L)	38.43±1.13[i,l]	39.33±3.88[j,k,l]	37.50±1.60[j]	44.00±6.16[i,k]	0.012

a= p<0.001, b=p<0.001, c= p<0.001, d= p<0.001, e= p<0.001, f= p<0.003, g= p<0.001
h= p<0.001, i= p<0.002, j= p<0.001, k= p<0.001, l= p<0.05

Table 4 presents the liver biochemical parameters of the exposed participants in comparison to their duration of work in years. The enzymatic activity of ALT was observed to significantly increase (p<0.001) as the duration of exposure increased from 1-10 years, (8.69±0.70) IU/L, 11-20 years (11.13±1.44) IU/L, 21-30 years (12.02±0.81) IU/L and 31years and above, (14.20±0.34) IU/L. A statistically significant increase (p= <0.001) was observed as the duration of exposure increased from 1-10 years to 11-20 years. A statistically significant increase was observed (p= <0.001) as the duration of exposure increased to 1-10 years and 21-30 years. This study observed no statistically significant increase (p=0.267) as the duration of exposure increased from 11-20 years to 21-30 years. A statistically significant increase (p <0.001) was observed as the duration of exposure increased from 11-20 years to 31 years and above. A statistically significant increase (p <0.001) was observed, as the duration of exposure increased from 21-30 years to 31 years and above. The enzymatic activity of AST was observed to increase significantly (p<0.001) as the duration of exposure of the exposed study participants increased. 1-10 years, (11.43 ±2.51) IU/L, 11-20 years (13.80±2.95) IU/L, 21-30 years (15.10±0.25) IU/L and 31years and above, (16.00±1.03) IU/L. This study observed a statistically significant increase (p=0.006) as the duration of exposure increased from 1-10 years to 21-30 years. A statistically significant increase (p=0.003) was observed as the duration of exposure increased from 1-10 years to 31 years and above. A statistically significant increase (p<0.001) as the duration of exposure increased from 11-20 years to 21-30 years. A statistically significant increase (p=0.006) was observed as the duration of exposure increased from 11-20 years to 31 years and above (p <0.001). However, there was a statistically significant increase (p>0.05) as the duration of exposure increased from 1-10 years to 11-20 years. There was no statistically significant increase (p>0.05) as the duration of exposure increased from 21-30 years to 31 years and above. The enzymatic activity of ALP significantly increased (p=0.012) as the duration of exposure increased from 1-10 years, (38.43±1.13) IU/L, 11-20 years (39.33±3.88) IU/L, 21-30 years (37.50±1.60) IU/L and 31years and above, (44.00±6.16) IU/L. A statistically significant increase (p=0.005) as the duration of exposure increased from 1-10 years to 21-30 years. A statistically significant increase (p=0.002) as the duration of exposure increased from 1-10 years to 31 years and above. A statistically significant decrease (p<0.001) as the duration of exposure increased from 11-20 years to 21-30 years. A statistically significant increase (p <0.001) as the duration of exposure increased from 11-20 years to 31 years and above. A statistically significant increase (p=0.05) as the duration of exposure increased from 1-10 years to 11-20 years. This study observed no statistically significant increase (p>0.05) as the duration of exposure increased from 21-30 years to 31 years and above. Figure 1 presents the correlation between ALT and the exposed participants' exposure duration. There was a statistically significant positive correlation (r=0.575, 0.003) between ALT activity and time of exposure. Figure 2 presents the correlation between AST activity and the exposed participants' exposure duration. There was a positive statistically significant correlation (r=0.579, p=0.002) between AST activity and time of exposure. Figure 3 presents the correlation between ALP activity and the exposed participants' exposure duration. There was a positive statistically significant correlation (r=0.421, p=0.004) between ALP activity and time of exposure

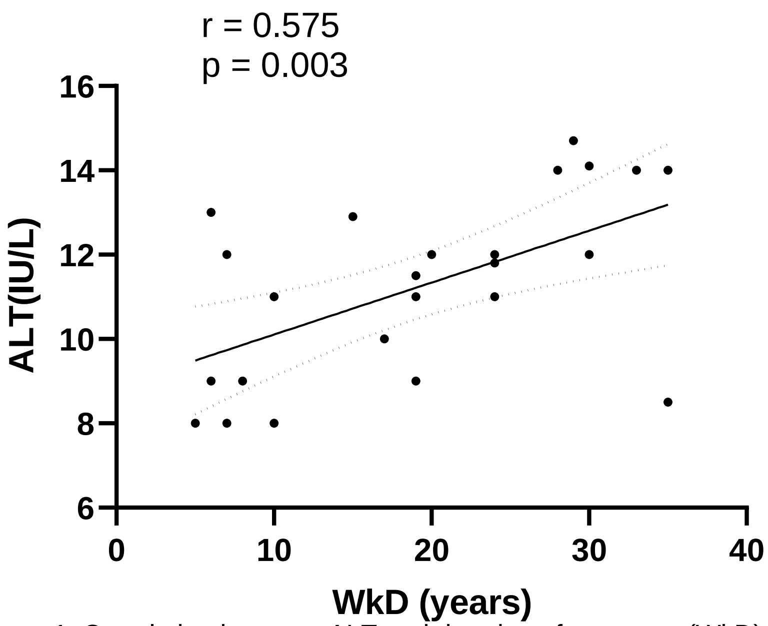

Figure 1: Correlation between ALT and duration of exposure (WkD) of the exposed participants. There was a statistically significant positive correlation(r=0.575, 0.003) between ALT activity and duration of exposure.

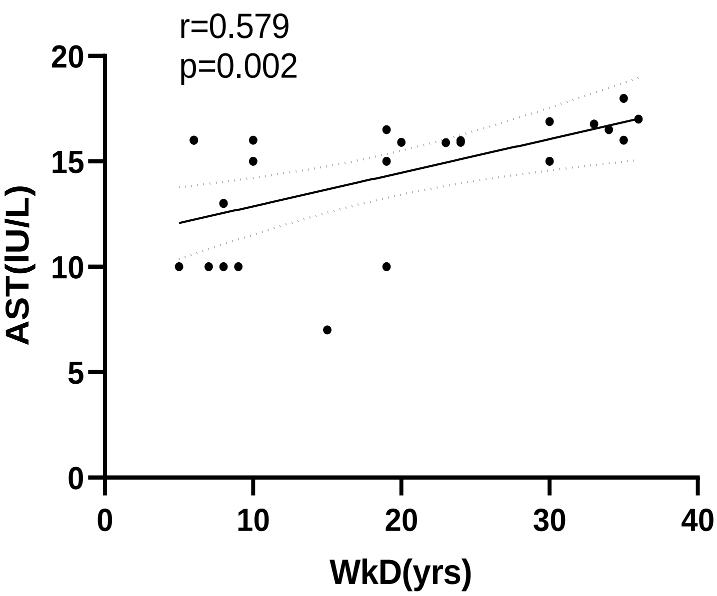

Figure 2: Correlation between AST activity and duration of exposure (WkD) of the exposed participants. There was a positive statistically significant correlation (r=0.579, p=0.002) between AST activity and duration of exposure.

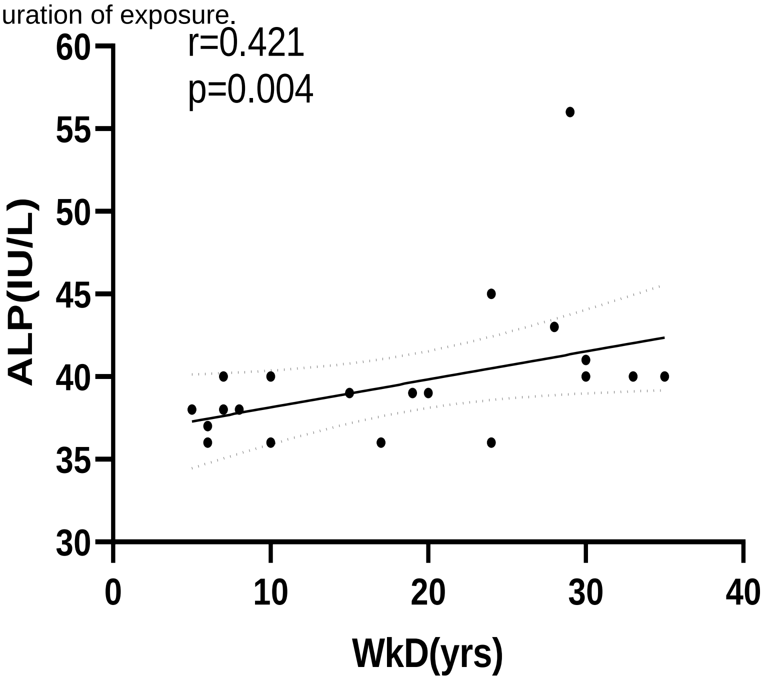

Figure 3: Correlation between ALP activity and duration of exposure (WkD) of the exposed participants. There was a positive statistically significant correlation (r=0.421, p=0.004) between ALP activity and duration of exposure.

DISCUSSION

This study assessed the liver biochemical parameters of carpenters occupationally exposed to wood dust in Enugu metropolis, Southeast Nigeria. The study observed a statistically significant decrease in the level of education of the exposed participants compared to the non-exposed participants. Socioeconomic status is one of the most critical determinants associated with medical outcomes. Most carpenters are unaware of any adverse effect of occupational exposure to wood dust and its associated chemical preservative. Even though they complained of occasional body pains, they regarded it as "one of the things that come with being a man". The researcher also observed that the carpenters do not use any personal protective equipment while at work, even though their job involves spraying hazardous chemicals.

The liver biochemical parameters, ALT, AST and ALP of the exposed participants from this study were observed to increase significantly compared to the unexposed. These findings agree with the observation in an African survey by Ibama *et al.* (2018) in Port Harcourt, Nigeria. Although Ibama *et al*. (2018) in their study included smokers and alcohol drinkers, this present study excluded those as confounding variables that may increase liver enzyme activity. The present study is interested in the effect of occupational exposure to wood dust only, excluding other lifestyle modifications. The result of this current study shows that occupational exposure to wood dust may present an adverse effect on the liver. Increased activity of the liver biochemical enzymes in spite exclusion of other confounding variables, as observed in this study is evident to this fact. Serum enzyme levels are regarded as markers of an individual's overall well-being, particularly in cases of damage to hepatocytes and associated stress (Kathkah *et al.*, 2022). Carpenters in the Enugu metropolis preserve wood with a combination of *Cinnamomum camphora*, paraffin oil, neo-pynamin, cypermethrin and 2, 2-dichlorovinyl dimethyl phosphate compound. These chemical preservatives are detrimental to health (Bhattacharya *et al*., 2002). Awotusin *et al.* (2021), in his study, found substantial dose-dependent elevations in alanine transaminase (ALT) and aspartate transaminase (AST) levels in the livers of dichlorovinyl dimethyl phosphate exposed rats.

Any harmful substance that enters the body, such as dichlorovinyl dimethyl phosphate, undergoes biochemical alteration in the liver and is detoxified by being metabolized. Overburdening the detoxification pathways causes a buildup of toxins in the body, resulting in more significant amounts of free radicals, an excess of which can harm liver cells (Molomo *et al.*, 2020). Carpenters in the Enugu metropolis spray preservatives and manually polish sprays on the wood with their bare hands. Inhalation of the chemical and wood dust mixed with chemicals while sanding the wood may have been a reason for an increased liver enzyme.

This study observed an elevation of the liver enzymes as the duration of work in years increased, 1-10 years, 11-20 years, 21-30 years and 31 years and above, respectively. This finding agrees with the observation of Awotosin *et al*. (2021) in his study on rats. However, this study's findings disagree with the analysis of Ibama. According to increased years of exposure, the elevation of liver enzymes could be due to increased hepatocyte cell membrane permeability and consequential enzyme leakage into the bloodstream as an insult to the liver cells grows over time.

A positive correlation between the duration of wood dust exposure in years and all assayed liver biochemical enzymes (ALT, AST and ALP) as observed in this study can attest to this.

CONCLUSION

Occupational exposure to wood dust may bring about adverse effects on the liver. Carpenters are advised to always put on personal protective equipment such as eyeglasses, face masks and an overall cloth dedicated to work. Regular health checks and a healthy lifestyle are also recommended. In terms of limitations, language barrier was part our problem. Some of the carpenters do not understand both the central Ibo language and English. They are more comfortable with their mother tongue. This may affect some of the answers they supplied to the questionnaire, even though we got someone to interpret the questions. Most of the carpenters also do not know their exact year of birth. Nevertheless, they know when they started the wood work.

Conflict of interest

The authors have no conflict of interest to declare.

Author contributions

OOE, OHO and OCN conceived and designed the experiment. OOE and OCN did the laboratory work. OHO performed the statistical analysis. OOE, OHO and OCN wrote the manuscript. All authors read and approved the final draft.

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