



**ASSESSING LEAD AND CADMIUM EXPOSURES AND EVALUATING LIVER AND KIDNEY FUNCTIONS IN SAWMILL WORKERS: A PRELIMINARY STUDY**

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**ABSTRACT**

Sawmill workers are exposed to sawdust daily, which has been reported to contain heavy metals. The latter are not biodegradable, thus becoming a potential threat to the environment and to man. They have been associated with diverse health challenges including liver and kidney damage. This study aimed to determine the levels of these heavy metals in sawmill workers and to conduct a biochemical assessment of the functional states of their liver and kidneys. The study involved fifty sawmill workers and fifty apparently healthy controls from Lagos state. Ten (10) ml blood sample was collected from each of the participants and 5ml each was dispensed into two different lithium heparin bottles. One plasma portion was used for the heavy metal analysis by atomic absorption spectrophotometry and the other for liver and kidney function tests using automated techniques. Results showed significant ( $P < 0.05$ ) increases in the plasma levels of cadmium and urea, while that of conjugated bilirubin was reduced in the exposed than that of the control. Plasma levels of lead and other analytes remain unchanged. Our study showed that sawmill workers are at the risk of subtle increase in cadmium level and that the liver and the kidney functions of the sawmill workers were observed to be intact.

**Keywords:** Cadmium, Kidney, Lead, Liver, Sawdust

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**INTRODUCTION**

The socioeconomic benefits of the sawmill industry have been well-documented by Olawuni and Peter [1], their studies highlight the significant role that sawmill activities play in the development of the ancient city of Ile Ife in Nigeria. Sawdust, a waste product generated from sawmill operations such as sawing, milling, planing, drilling, and crushing [2], is released into the environment during wood processing. This process transforms wood into materials suitable for furniture and construction, enhancing strength, durability, usability, and functionality. However, the release of sawdust into the environment exposes sawmill workers and neighbouring communities to potential occupational hazards through inhalation, dermal contact, and accidental ingestion. The environment also suffers from the impact of sawmill operations [2].

Study have shown the presence of heavy metals in sawdust, with the soil where the wood originated from, being the likely source of contamination [3]. These heavy metals pose environmental and human health threats. Additionally,

chemicals used in wood preservation among woodworkers are another potential source of heavy metal contamination [4]. Sawdust's absorbent properties make it useful in removing heavy metals from wastewater; this further explains the likely reason for the presence of these metals in sawdust [5]. This was corroborated by Nwajei and Iwegbue [6] who observed elevated levels of cadmium, lead, barium, chromium, arsenic, and mercury in sawdust particles collected around sawmills in Sapele, Delta State, Nigeria, and its environs. These levels exceeded the permissible occupational exposure limits. Some of these heavy metals have been linked to diverse health challenges, including organ damage [7, 8, 9]. For instance, arsenic, lead, mercury, cadmium, and chromium can cause structural damage to the liver through lipid peroxidation. The biochemical mechanism of this toxicity involves protein binding, impairing their activity and causing damage [7]. Recently, there were reported cases of abortion associated with exposure to some heavy metals [10]. Exposure to sawdust has also been linked to respiratory disorders, allergic reactions, dermatitis, and cancers,

among other diseases [7]. Increases in serum urea, creatinine, total cholesterol, and low-density lipoprotein levels, along with reductions in albumin, triglycerides, and liver enzyme activities were observed in albino rats exposed to wood dust extracts [11]. In another biochemical research work, elevated plasma alkaline phosphatase activity and total protein levels were detected in carpenters exposed to wood dust [12]. Investigations into the states of the liver and kidneys—two vital organs—are rarely conducted among sawmill workers. This study aimed to determine the levels of these heavy metals in sawmill workers and to conduct a biochemical assessment of the functional states of their liver and kidneys.

## MATERIALS AND METHODS

### Study area

This study was conducted at the “Oko-baba” sawmill in the Yaba Local Government Area and the “Akinogun” sawmill in the Alimosho Local Government Area.

### Study design and population

This was a cross-sectional study employing a purposive sampling method. A total of 100 apparently healthy participants, 50 sawmill workers and 50 control subjects were enrolled.

### Inclusion criteria

The study included participants who worked in sawmills for six to ten hours daily, four to six days per week and had a minimum of five years of experience in the sawmill industry. Controls were sex and age-matched individuals with no work history related to woodwork or sawmill activities, recruited from the University of Lagos and the Alimosho Local Government Area.

### Ethical consideration and informed consent

Ethical approval was obtained from the Health Research and Ethics Committee of Olabisi Onabanjo University Teaching Hospital, Sagamu, Ogun State. After being thoroughly briefed about the study's objectives and procedures, all participants gave their consent. Participants were assured of confidentiality, voluntariness, and the protection of their rights. The investigation was conducted without any financial burden on the volunteers.

### Data collection

Data on demographic, occupational, and lifestyle characteristics, and health history knowledge, were

collected using a semi-structured interviewer-administered questionnaire.

### Blood collection

Blood samples were obtained by venepuncture from the antecubital veins using sterile disposable needles and syringes. Ten (10) millilitres of blood were collected and dispensed into two (2) lithium heparin bottles for heavy metal determination and liver and kidney tests. The blood samples were centrifuged at 3000 rpm for five minutes, after which the plasma was meticulously separated and transferred into pyrogen-free plain bottles. These samples were stored at -20°C to maintain their integrity for biochemical analyses [13]

### Biochemical analyses of parameters

Using standard methods, liver function analytes, including Alkaline Phosphatase (ALP), Aspartate Aminotransferase (AST), Alanine Aminotransferase (ALT), Total Protein, Albumin, Total Bilirubin, and Conjugated Bilirubin, along with kidney function analytes, Urea and Creatinine, were measured in plasma samples using the Cobas Auto-Analyser (Cobas C111, Roche Diagnostics) at the Clinical Chemistry Laboratory of the University of Lagos Medical Centre.

### Determination of lead and cadmium

Plasma lead and cadmium levels were measured using an acetylene flame atomic absorption spectrophotometer (FAAS) at the research laboratory of the University of Lagos. Deproteinization was performed by adding 3.0 ml of 2M HCl to 1.0 ml of plasma in a test tube [13]. The resulting supernatant was aspirated into the Flame Atomic Absorption Spectrophotometer after adjusting the wavelength to 216.9 nm for lead and 228.8 nm for cadmium [13]. Concentrations were displayed electronically, and results were expressed in µg/l.

### Statistical analysis

Data entry was performed using Microsoft Excel 2007. Statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS) version 23, including Chi-square tests to compare categorical variables across subject and control groups and non-parametric independent Sample, Mann Whitney U's tests to compare medians of parameters across the groups. Results were presented as median ± Interquartile range (IQR), with a significance level of  $P < 0.05$  considered statistically significant.

**RESULTS**

**Table 1:** Socio-demographic and lifestyle characteristics of control and subject participants

Variables		Controls (n=50)	Subjects (n=50)	P-value
Age (years), n (%)	≤ 50	29 (58.0)	31 (62.0)	0.838
	≥ 51	21 (42.0)	19 (38.0)	
Sex, n (%)	Male	34 (68.0)	42 (84.0)	0.100
	Female	16 (32.0)	8 (16.0)	
Marital Status, n (%)	Married	40 (80.0)	43 (86.0)	0.595
	Single	10 (20.0)	7 (14.0)	
History of Smoking, n (%)	Yes	4 (8.0)	3 (6.0)	1.000
	No	46 (92.0)	47 (94.0)	
History of Alcohol, n (%)	Yes	24 (48.0)	21 (42.0)	0.688
	No	26 (52.0)	29 (58.0)	
History of Liver or Kidney disease n (%)	No	50 (100.0)	50 (100.0)	

**Table 2:** Cadmium and lead in subject and control participants

Heavy Metals	Controls Median (Q <sub>3</sub> - Q <sub>1</sub> )	Subjects Median (Q <sub>3</sub> - Q <sub>1</sub> )	Z-test (Mann-Whitney U)	P-value
Lead (ng/ml)	0.30 (0.9 - 0.3)	0.50 (0.8 - 0.1)	-0.546	0.585
Cadmium (ng/ml)	0.79 (1.3 - 0.1)	1.16 (2.4 - 0.5)	-2.052	0.040*

Q<sub>3</sub>: 3<sup>rd</sup> quartile; Q<sub>1</sub>: 1<sup>st</sup> quartile; \*: significance

The difference in the Lead level between the test participants and the control was not statistically significant (P=0.585), while Cadmium level was statistically higher in the exposed than the unexposed (P=0.040).

**Table 3:** Comparison of biochemical parameters of liver function between the subject and control participants

Biochemical Parameters	Controls Median (Q <sub>3</sub> - Q <sub>1</sub> )	Subjects Median (Q <sub>3</sub> - Q <sub>1</sub> )	Z-test (Mann-Whitney U)	P-value
ALT (U/L)	20.90 (24.0 - 13.5)	14.45 (20.6 - 12.9)	-1.686	0.092
AST (U/L)	28.20 (35.2 - 22.7)	26.45 (34.8 - 22.7)	-0.634	0.526
ALP (U/L)	55.50 (71 - 44)	60.21 (70.5 - 51.4)	1.255	0.210
BILT (µmol/L)	7.70 (11.1 - 4.5)	6.80 (9.2 - 3.5)	-0.603	0.546
BILD (µmol/L)	4.60 (5.4 - 3.0)	3.35 (4.8 - 2.2)	-1.976	0.048*
T.P. (g/L)	74.35 (77.1 - 69.6)	70.30 (74.2 - 66.1)	-2.092	0.036*
Albumin (g/L)	41.39 (45.00 - 38.03)	41.47 (44.71 - 39.25)	0.210	0.833

Q<sub>3</sub>: 3<sup>rd</sup> quartile; Q<sub>1</sub>: 1<sup>st</sup> quartile; \*: significance

The difference in Bilirubin (BILD) and Total Protein (T.P) levels between sawmill workers and control participants were significantly different (P = 0.048) and (P = 0.036) respectively. The levels being lower in the

exposed than the control in both analytes. There were no statistically significant differences in ALT, AST, ALP, BILT, and albumin levels between the sawmill workers and control participants.

**Table 4:** Comparison of biochemical parameters of kidney function between sawmill workers and control participants

Biochemical Parameters	Controls Median (Q <sub>3</sub> -Q <sub>1</sub> )	Subjects Median (Q <sub>3</sub> -Q <sub>1</sub> )	Z-test (Mann-Whitney U)	P-value
Urea (Mmol/L)	3.52 (4.45 - 2.92)	4.50 (5.30 - 3.97)	3.623	0.000*
Creatinine (Mmol/L)	93.10 (102.8 - 80.25)	91.14 (109.0 - 76.5)	0.496	0.620
Urea: Creatinine	0.04 (0.049 - 0.030)	0.05 (0.061 - 0.042)	3.075	0.002*

Q<sub>3</sub>: 3<sup>rd</sup> quartile; Q<sub>1</sub>: 1<sup>st</sup> quartile; \*: significance

The difference in urea levels between the two groups was statistically significant (P = 0.000), that of the test participants was higher than the control. The levels of creatinine were similar. However, the urea: creatinine ratio was significantly higher in the test participants compared with the control (P = 0.002).

**DISCUSSION**

This study aimed to determine the levels of heavy metals and to conduct a biochemical assessment of the functional states of the liver and kidney of sawmill workers in Lagos, Nigeria. Fifty sawmill workers with a minimum of five years of exposure and fifty sex and age-matched individuals with no work history related to woodwork or sawmill activities were recruited as controls for this study.

Results showed that sawmill workers had a significantly higher level of cadmium than the control but this was not the same with lead whose level remained unchanged. Only direct bilirubin and total protein were altered significantly among the liver function parameters, being lower in the sawmill workers than the exposed. Urea and creatinine were the kidney function parameters estimated in this study and a significant increase in urea was observed but not creatinine. Furthermore, the ratio of urea to creatinine was found to be raised. It was observed that all these analytes were found to be within the reference ranges used in this environment also that the mean blood cadmium levels in both the sawmill and the control workers were within the WHO permissible level for cadmium (0.03- 0.12 µg/dL) [21].

The findings indicate that sawmill workers are at subtle risk of exposure to higher level of the heavy

metal, cadmium, than those who are not involved with this occupation. This is not unexpected as Khan [15] reported that cadmium has the capacity to adsorb to sawdust due to its complexation capacity. Contact of these workers with sawdust has been reported to occur through routes such as inhalation, dermal and accidental ingestion [22]. Previous studies also reported the presence of heavy metals such as Cadmium, Chromium, Lead, Zinc, Iron, and Copper in sawdust [3] and woodworkers [4, 23].

Contrary to our study, Nwajei and Iwegbue, reported that the levels of some of these metals were above the permissible limits, though they were measured in sawdust particles and not blood samples as compared to our study. The primary source of cadmium in sawmill has been reported to be the soil from which the plants generating the sawdust originated, as it has been observed that plants can uptake cadmium through their roots [16]. The scope of this study did not include monitoring of cadmium levels in the soil of the plank origin or in the sawmill environment. Adverse effects of cadmium are one of the global health challenges affecting many organs including the liver and kidney [14, 21, 24].

We evaluated the health status of both the liver and the kidney by determining if there was hepatocellular damage and by assessing liver functions such as synthesis and excretion. our study showed that the binding, transport and synthesizing functions of the liver appeared intact, as there was no significant alteration in plasma albumin levels. This contrasts with the study of Ashade and Igbokwe [17] who observed decreased albumin levels in rats exposed to wood dust extracts. Quantum of exposure and different experimental models might be the reason for this observed difference. Our observation of a significantly

reduced level of total protein could be explained by a decrease in other plasma proteins, particularly that of globulin, which can point to likely risk of impairment in liver function (manifesting in reduction in synthesis of other plasma proteins within the liver) or from increased renal excretion of protein. The latter may be a pointer to renal dysfunction. Biomarkers of renal dysfunction include urea and creatinine. Increase levels of creatinine, a product of muscle mass and kidney filtration efficiency indicates glomerular damage, same with urea, though that of urea is not specific as it is affected by other factors such as diet and hydration. Our study did not show kidney impairment, as the level of creatinine was not significantly altered, though that of the urea was raised. This further shows that the synthetic ability of the liver remained intact for the synthesis of urea occurs in the liver. Earlier studies by Ibama *et al.* [14] also reported higher serum levels of urea in individuals exposed to sawdust compared to controls. Ashade and Igbokwe [17] also recorded elevated urea levels in rats exposed to wood dust extracts. Contrary to the observation on creatinine from our study, they observed raised levels, which was pointing to kidney dysfunction. The significant “urea: creatinine” observed in this study further confirmed that extra-renal event rather than renal.

In this study, we also observed that the excretory function of the liver was intact, as demonstrated by the unaltered bilirubin levels in plasma. Also, no record of hepatocellular damage was seen in the sawmill workers.

## CONCLUSION AND RECOMMENDATION

Our study has demonstrated a significant increase in the level of cadmium compared with the control and this level was both within the permissible and the reference ranges. The liver and the kidney functions of the sawmill workers were observed to be intact. This result imply that sawmill workers are at a higher risk of increased level of cadmium which may predispose them to diverse health challenges. Our study has contributed to the growing body of research on occupational exposures and health status among sawmill workers. However, it is limited in sample size, methodology and scope. Further studies should focus on multicentred and multivariate approach. Monitoring the cadmium level of the sawmill environment will confirm the source of the exposure. Future research could explore the relationship between cadmium exposure and the liver and kidney functions.

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## CONFLICTS OF INTEREST

No competing conflicts of interest to declare

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