Evaluation of some biochemical parameters inprintersoccupationally exposed to Large-format printing machines in Port Harcourt, Nigeria.

ABSTRACT

Ensuring occupational health and safety is crucial across diverse industries, and the printing sector is no exemption. Workers operating large format printing presses are exposed to printing inks and materials containing potentially hazardous chemicals and solvents. This case-control study aimed to assess hepatic and renal function indices in individuals operating large-format printing machines within Port Harcourt metropolis, Rivers State, Nigeria. The study involved recruiting a total of 120 subjects, both males and females, aged between 18 and 40 years. Among them, 60 subjects constantly exposed to large-format printing machines constituted the test group, while the remaining 60, without exposure to such machines, served as the negative control. From each subject's antecubital fossa, 5 milliliters (5 ml) of venous blood were collected, processed, and the serum obtained was used for analyzing aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP), sodium, potassium, urea, and creatinine using spectrophotometric and ion selective electrode methods. In the statistical analysis, SPSS version 24 was employed, with a significance level set at $p<0.05$. The results indicated significantly higher serum mean levels of AST 6.00±3.00U/l; ALT 7.70±3.69U/l, ALP 11.10 ±4.50iU/l, sodium 135.30±13.90 mmol/l, and urea 4.38±2.63 mmol/lrespectively in the test subjects compared to the control subjects 5.00±2.00 U/l; 6.22±2.45 U/l.; 9.50±3.40iU/l; 125.2±19.40 mmol/l and 3.45±0. 94 mmol/l respectively. Conversely, no significant difference was observed in the mean levels of potassium 3.3±0.50mmol/land creatinine 50.0±50 µmol/lbetween the test and control subjects 3.4±0.30 mmol/l and 53.0±50µmol/l respectively. Furthermore, gender-based comparisons within the test group revealed a significant increase in the mean levels of AST 7.12 ± 20mmol/l versus 5.40 ± 4.0mmol/land sodium142.1±10.0mmol/l in female subjects compared to male subjects 132.4±14.5mmol/l. These findings suggest that the exposure to large-format printing machines and their accessories may adversely affect liver and kidney function. The authors recommend the consistent use of personal protective equipment, such as nose masks as well as ensuring well-ventilated working environments, and regular medical checkups for individuals working with large-format printing machines.

Keywords:*printing industry, large-format printing machines, hazardous chemicals, solvents, hepatic function, renal function*

1.0 INTRODUCTION

The utmost importance of occupational health and safety extends to various industries, including the printing sector. Many ancient civilizations independently pioneered the creation of inks for writing and drawing (Siva *et al*., 2021). Archaeological findings and written records provide insights into the recipes and production techniques of these inks; for example, lampblack, a soot byproduct, was a common ingredient of ink. In ancient Egypt, ink was used for writing and drawing on papyrus as early as 26th century BC, incorporating various pigments and ions (Christiansen, 2020). Chinese inks, dating back four millennia, utilized plant, animal, and mineral sources, with inksticks incorporating materials like pine tree resin and specific glues (Benkhaya *et al*., 2020). India ink, originating in China, involved a method using hide glue, carbon black, and pigments (Ren *et al*., 2018).

The printing industry, acknowledged as a potential risk for both workers and those in its vicinity, has been a longstanding concern, as noted by Pongboonkhumlarp and Jinsart (2022). The adoption of new technologies is resulting in the phasing out of traditional printing systems, thereby diminishing specific acknowledged risk factors like inorganic lead (Ilychova and Zaridze, 2012; Sancini *et al*., 2010), potentially elevating the associated risks. Therefore, workers in the printing industry face exposure to a variety of chemicals, with printing inks being a central element in their work environment (Suparna and Jaiswal, 2021).

The components of printing ink, including pigments, binders, solvents, and additives, vary depending on the specific printing process and formulation.Additionally, this printing ink mixture contains organic solvents, heavy metals, and volatile organic compounds (VOCs)(Pekarovicova and Husovska, 2016), which are known to cause deleterious effects on humans, as reported by Brauner *et al*. (2020); Gazwi *et al*., 2020; and Xu *et al*. (2022).Regrettably, employees in the printing sector often face exposure to these chemicals primarily through breathing in fumes and coming into contact with their skin, potentially leading to the development of certain health conditions over time. The flex material on which the printing is made which dominate the outdoor advertising is also a made up of chemicals which may be a potential risk to health and safety of the operators.

This study aims to investigate the potential impact of exposure to printing inks on the liver and kidneys of individualsworking with large-format printing machines. The liver, which is crucial for metabolizing and detoxifying substances (Liu *et al*., 2017; Liu and Mabury, 2021), including those in printing inks, is likely the primary organ affected by toxic substances. Monitoring serum levels of liver enzymes, such as aminotransferases and alkaline phosphatase, can serve as indicators of liver health, with elevated levels suggesting damage(Malaguarnera *et al*., 2012).

Moreover, substances, including those present in printing inks, that are absorbed into the systemic circulation are distributed to various organs, including the kidneys, which have a crucial role in excretion; however, the kidneys could be vulnerable to the toxic effects of substances found in printing inks (Varshney, 2020). Consequently, examining renal indices in serum levels would offer valuable information about thecondition of the kidneys.

2.0 MATERIALS AND METHODS

2.1 Experimental Design

This is an observational study with a case-control design conducted in Port-Harcourt, Rivers State, Nigeria. The study involved a total of 120 participants aged 18-60 years. Among them, 60 individuals worked with large-format printing machines (test subjects) located at Education bus stop, Mile 1 axes of Port-Harcourt, while the remaining 60 participants did not work with printing machines (control subjects). The subjects were informed about the study, and oral consent was obtained from those interested. A well-structured questionnaire was employed to collect pertinent information from each participant. The study took place from April 2023 to November 2023, and ethical approval was secured from the Rivers State Ministry of Health, Port Harcourt, Nigeria and all experiments were conducted in line with the provisions of Helsinki with regards to experiments involving humans.

2.2 Blood Sample Collection

From each subject's antecubital fossa, 5 milliliters (5 ml) of venous blood were collected and transferred into plain bottles. The serum specimen was acquired by centrifuging the whole blood at 3500 rpm for 5 minutes, after which it was transferred to another set of plain containers. These containers were then stored in the refrigerator's freezing compartment at a temperature of $-4^{o}C$ until the time of analysis. The serum was subsequently used to determine the levels of AST, ALT, ALP, sodium, potassium, creatinine, and urea.

2.3 Sample Analysis

Enzymatic methods were employed to analyze the serum levels of AST, ALT, ALPand urea using kits obtained from Spectrum, Egypt. Jaffe's method was used for the analysis of serum creatinine with kits from Spectrum, while ion selective electrodefrom STEPLABS technical services Ltd was used to analyze the serum levels of potassium and sodium.

2.4 Statistical Analysis

The results obtained from the analysis were presented as mean ± standard deviation and subjected to analysis using the Statistical Package for the Social Sciences (SPSS) version 24. Mean and standard values for different parameters were compared using one-way ANOVA and Turkey tests. Statistical significance was considered when the results had a confidence interval of 95%, with a significance level of $p \geq 0.05$.

3.0 RESULTS

3.1 Demographic Characteristics of the test Population

Table 1 provides information on the demographic characteristics of the test population. The age distribution indicates that 13.3% of participants were below 20 years old, 53.3% were in the 20-25 age group, 20.0% were aged 26-30, and an additional 13.3% were 31 years old or older. Additionally, the gender distribution shows that 70.0% of participants were male, and 30.0% were female.

Table 1: Demographics Characteristics of the Test Population(n=60)

		N	**%**
Age	Less than 20	8	13.3
	20-25	32	53.3
	26-30	12	20.0
	31&above	8	13.3
Gender	Male	42	70.0
	Female	18	30.0

KEY: *N = number of subjects*

3.2 Comparison between the Biochemical Parameters of Test and Control Subjects

Details of this are shown in Table 2 below. It reveals that the mean levels of AST, ALT, ALP, sodium, and urea were significantly higher ($p<0.05$) in the test subjects as opposed to the control subjects. In contrast, there was no significant difference ($p>0.05$) observed when the mean levels of creatinine and potassium between the test and control subjects were compared.

Table 2:Mean Levels of the Biochemical Parameters of Test and Control Subjects

	ALT (IU/L)	AST (IU/L)	ALP (IU/L)	Na (mmol/L)	Urea (mmol/L)	K (mmol/L)	Creatinine (µmol/L)
Test	7.70±3.69	6.00±3.00	11.10 ±4.50	135.30±13.90	4.38±2.63	3.3±0.50	50.0±50
Control	6.22±2.45	5.00±2.00	9.50±3.40	125.2±19.40	3.45±0. 94	3.4±0.30	53.0±50
p-value	0.05	0.01	0.02	0.001	0.012	0.47	0.72
t-value	1.95	2.54	2.23	3.30	2.57	-7.32	-0.36
Inference	S	S	S	S	S	NS	NS

KEY:*NS= Non-significant, S=Significant, ALT= Alanine aminotransferase, AST= Aspartate aminotransferase, ALP= Alkaline phosphate, Na = Sodium, K = Potassium*

3.3 Comparison between the Biochemical Parameters of male and female test Subjects

Details of this are shown in Table 3 below. It reveals that the mean levels of AST and sodium were significantly higher ($p<0.05$) in the female subjects as opposed to the male subjects. In contrast, there was no significant difference ($p>0.05$) observed when the mean levels of ALT, ALP, urea, potassium, and creatinine between the test and control subjects were compared.

Table 3: Comparison between the Biochemical Parameters ofMale and Female Individuals working with Large-Format Printing Press

	ALT (IU/L)	AST (IU/L)	ALP (IU/L)	Na (mmol/L)	Urea (mmol/L)	K (mmol/)	Creatinine (µmol/L)

Male	8.14± 4.24	5 ± 2	11.2 ±4.7	132.4±14.5	4.45±2.66	3.3±0.6	50±5
Female	6.67 ± 1.53	7± 4	10.9 ±4.3	142.1±10.0	4.22±2.65	3.5±0.3	51±5
p-value	0.14	0.03	0.58	0.005	0.91	0.22	0.48
t-value	1.9	-1.83	-0.56	2.98	0.83	1.23	0.72
Inference	NS	S	NS	S	NS	NS	NS

KEY:*NS= Non-significant, S=Significant, ALT= Alanine aminotransferase, AST= Aspartate aminotransferase, ALP= Alkaline phosphate, Na = Sodium, K = Potassium*

4.0 DISCUSSION

The aim of this study was to assess certain hepatic enzymes (AST, ALT, and ALP) and renal indices (creatinine, urea, potassium, and sodium) in individuals employed to work with large-format printing machines. The findings indicated that the majority of study participants fell within the age range of 20-25 years, with the next largest group being individuals aged 26-30. On the contrary, individuals below 20 years of age and those above 31 years had comparable numbers, and constituted the smallest groups within the study.

The study reveals significantly higher levels ($p<0.05$) of AST, ALT, and ALP in the test group compared to the control group, suggesting potential hepatocyte damage. The increased release of these liver enzymes into the bloodstream may be linked to the metabolism of substances found in the inhaled printing inks. These findings align with the research of Sancini *et al*. (2014), which similarly observed a significant rise in specific liver enzymes (ALT and AST) among individuals exposed to printing ink when compared to a control group.Nevertheless, when it comes to alkaline phosphatase (ALP), there is a discrepancy in the findings compared to Sancini *et al*. (2014). Their study did not observe a significant elevation in ALP concentration in comparison to control subjects. This disparity in results may stem from differences in the methods of exposure to printing ink among the subjects in the two studies.The difference in results could also be attributed to the timing of sample collection. Sancini *et al*. (2014) gathered samples in the morning before workers had eaten or commenced work. In contrast, our study collected samples during active work hours and after the workers had eaten. This divergence in sampling times may elucidate the observed rise in ALP concentration, as food intake has been recognized to temporarily elevate ALP levels, as highlighted by Matsushita and Komoda (2011).

The study also disclosed a significant rise in sodium concentration, whereas there was no significant increase in potassium, aligning with the observations made by Okpogba *et al*. (2020). Okpogba *et al*. found a substantial difference in sodium levels among individuals occupationally exposed to lead, a primary constituent of printing ink. The elevated sodium levels could potentially be attributed to excessive water loss, indicating dehydration among factory workers.Additionally, the study highlighted a significant increase in urea concentration, which is consistent with the findings of Okpogba *et al*. (2020). However, there was no significant difference in creatinine concentration, which agrees with the findings from a similar study conducted by Egoro *et al*. (2021) on workers exposed to volatile organic solvents.

Among the hepatic enzymes, only AST levels exhibited a significant increase in female subjects as opposed to male subjects. This increase could be associated with factors not related to the liver, such as injury from other organs like muscles, the heart, kidneys, or hemolysis. Similarly, the sodium levels in female subjects were notably higher compared to those in male subjects. The heightened sodium levels might be indicative of potential sodium retention in the female subjects as men are known to have higher sodium excretion than females.

5.2 CONCLUSION

The findings from this study indicate alterations in the levels of various biochemical parameters, evidenced by a significant increase in the concentration of hepatic enzymes, although levels are within the normal range in the locality tested. This suggests a potential adverse impact on liver and kidney function from the chemicals present in large-format printing materials.As a result, individuals working with such materials should consistently prioritize the use of personal protective equipment, such as a nose mask, ensure that the working environment maintains adequate ventilation, and undergo regular medical checkups.

Authors contributions

Author DOO designed the project and did the final editing, IO wrote the first draft, OR did the laboratory analysis and data acquisition, while EI and AB did the statistical analysis. Author HW and NB did the review of the manuscript.All the authors read and approved the final version of the manuscript

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