Assessment Of Liver And Renal Functions Among Workers In Municipal Waste Evacuation, Paint Production And Sawmill Companies In Port Harcourt, Nigeria

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***Abstract*—Factory workers are exposed to various types of occupational hazards. This study aimed at assessing some hepatic and renal function parameters among workers in municipal waste evacuation, paint and sawmills in Port Harcourt, Nigeria. A total of 100 male subjects aged 18 to 60 years, 25 each working in: municipal waste evacuation, Paint production, sawmill, and 25 control subjects, wer involved. Their weight and height were measured and BMI calculated. Data about their socio demographic, occupational history and use of personal protective equipment was obtained. Venous blood (4ml) was collected from each subject and used to estimate some markers of liver and kidney function as well as serum electrolytes. Results show significant ($p< 0.05$) increase in AST, AST/ALT ratio, significant ($p< 0.05$) decrease in ALT, K^+ ($P = 0.001$), Ca^{2+} ($P<0.05$) and random blood sugar ($P= 0.01$) respectively among municipal waste evacuation workers, when compared to the control group. Also, there was a significant ($p< 0.05$) decrease in ALT and random blood sugar ($P=0.01$) among paint production workers, when compared to the control. In addition, there were significant increase in serum levels of Na^+ ($P= 0.009$) and urea ($P = 0.001$); with significant decrease in serum Cl^- ($P= 0.043$), Ca^{2+} ($P<0.05$) and random blood sugar ($P=0.010$) respectively among sawmill workers, when compared to the control group. The effects were dependent on the duration of work exposure. In conclusion, prolonged work-place exposure to municipal solid waste, paint and sawmill environment altered hepatic and renal function parameters, and may therefore be at risk of renal and hepatic dysfunction.**

Keywords—Municipal wastes; Paint workers; Sawmill workers; biochemical parameters; Renal function, Work place hazard.

INTRODUCTION

Depending on the type of work, factory workers are exposed to chemical, ergonomic, physical and biological hazards with attendant health consequences[1]. Presently, various organic solvents such as toluene, xylene, carbon tetrachloride, ethyl benzene [2] and heavy metals like mercury, Arsenic, platinum, chromium, lead and cadmium have been identified as some occupational toxicants [3].

Port Harcourt, one of the rapidly developing cities in the Niger delta region, South-South of Nigeria [4] is faced with the challenge of increased generation of solid waste [5], which is projected at about 210,934; 304,477 and 352,853 tonnes per annum in 1982, 1990 and 2000 respectively; with an estimated solid waste generation rate of 1.25 kilogram per person per day [6]. Report revealed that municipal waste contain appreciable amount of certain hazardous heavy metals like Chromium (Cr), Lead (Pb), Nickel (Ni), Cadmium (Cd), Copper (Cu) and Mercury (Hg) [7], all of which are hazardous to the health of humans.

Paint workers are vulnerable to chemicals used in the production of paint, although the level and pattern of exposure differs [8]. Solvents and other chemicals in paint have been reported to affect many organ and systems in humans, such as haematopoisis, liver, central nervous system, kidney, and reproductive system [9, 10, 11]. Few studies had suggested that organic solvent exposure might prompt glomerulonephrit is while other studies did not find any danger [12, 13].

Sawmill is a factory where machine is used to cut wood into different dimensions and forms such as planks and boards [14, 15]. The working environments in sawmills are hazardous due to the generation of harmful wastes products like; wood off cuts, saw dusts, backs of wood, plain shavings and wood discards [16]. Ref [17] reported that sawmill workers are vulnerable to health hazards due to inadequate usage of personal protective equipment. Dust from wood is made up of diversity of polar organic compounds such as lignans, quinones, tannins, flavonoids and nonpolar organic compounds such as, alcohols, sterols, resin acids, waxes, glycerols, fatty acids, terpenes and steryl esters as well as water-soluble compounds like, alkaloids, proteins, carbohydrates and inorganic material [18]. Human exposure to chemicals at the workplaces has risen intensely due to an alarming increase in industrial and

technological applications [19]. A large amount of these toxic chemicals have been reported to accumulate in the kidneys and liver which play crucial role in the detoxification and excretion of these chemicals [20]. Hence, this study aims to Assess the liver and renal functions among workers in municipal waste evacuation, paint production and sawmill companies in Port Harcourt, Nigeria.

MATERIALS AND METHOD

Study Design and setting: This is a cross sectional analytical study involving workers in municipal waste management companies, sawmill industries, and paint industries in Port Harcourt, south-south, Nigeria.

Selection of subjects: A total of 100 apparently healthy adult male industry workers were randomly selected, comprising of 75 test subjects (25 municipal waste evacuation workers, 25 paint factory workers and 25 sawmill workers); while 25 served as control group. Subjects included for this study were all of similar socio-economic status and biometric distribution. Only subjects who fulfilled the inclusion criteria were involved in the study. They include:

i. Those that voluntarily granted informed consent.
ii. Exposed subjects that have worked for a minimum of 6 months in the enlisted occupations.
iii. Control group subjects must not be working or living near industries that generate or utilise toxic and hazardous chemicals.
iv. Apparently healthy subjects without any medical history of liver, kidney or chronic diseases.

Data Collection: Structured questionnaire was issued to respondents who willingly filled and returned the questionnaires. Their heights (m) and weights (kg) were measured as described by [21], and the body mass index (BMI) for each subject was calculated using the following formula: BMI= weight (Kg) / square of the height (m^2).

Collection and analyses of Samples: From each subject, five millilitres (5ml) of venous blood was aseptically withdrawn through venepuncture using a needle and syringe [22]. 4ml of the blood was dispensed into sample bottle which contains lithium heparin anticoagulant. The Samples were centrifuged at 3000 rpm for 10 minutes, then serum was aspirated into clean plain sample bottles, and preserved in a freezer (-15^0C). A Computerized biochemical auto-analyzer, the Mindray System (Mindray BS series analyzers/ Mindray Reagent, Model Bs: 800M, China) was used to determine the levels of liver enzymes (AST, ALT and ALP), electrolytes (Na^+, K^+, Ca^{2+}, Cl^- and HCO_3^-), urea, uric acid and creatinine, at the Chemical Pathology Department, University of Port Harcourt Teaching Hospital, Port Harcourt, Nigeria.

Ethical Considerations: Ethical approval was sought and gotten from the ethical committee, University of Port Harcourt with reference number UPH/R&D/REC/04. Consent form was freely issued to all the participants involved in this study. Ethical approval was given by the Rivers state waste management agency, Port Harcourt, various sawmill and paint companies used for the study, and also from the Ethics and Research Committee of the University of Port Harcourt.

Statistical Analysis: The data obtained were subjected to statistical analysis using SPSS version 20.0. Statistical comparisons of measured variables between the test groups and control were carried out using students' T-test or one way analysis of variance (ANOVA) with Dunett post Hoc test for multiple comparisons. Values of $P<0.05$ were considered statistically significant. Results were presented in tables as Mean ± SEM, and as percentages.

RESULTS

From the result (table 1) of the anthropometric characteristics of the subjects in the population studied, there was no significant ($P>0.05$) difference in the age, weight, height and BMI of the three test groups when compared to the control.

The serum levels of liver enzyme (AST) (table 2) shows a statistically significant ($P \leq 0.05$) increase among Municipal waste evacuation workers and a non significant ($P>0.05$) increase among sawmill and paint industry workers, when compared to the control. There were significant ($P \leq 0.05$) decrease in the ALT levels of both municipal waste evacuation workers and paint industry workers while a non significant ($P>0.05$) increase among sawmill workers was observed when compared to the control. Also, non significant ($P>0.05$) decreases in the level of ALP were observed among Municipal waste evacuation workers and paint industry workers while a non significant ($P>0.05$) increase was observed among sawmill workers, when compared to the control. There was a highly significant ($p = 0.001$) increase in the AST/ALT ratio among Municipal waste evacuation workers and a non significant ($P>0.05$) increase among sawmill and paint industry workers, when compared to the control.

The serum levels of electrolyte (table 3) shows a highly significant ($P= 0.001$) decrease in the level of K^+ among municipal waste evacuation workers and a non significant ($P>0.05$) decrease among sawmill and paint industry workers respectively, when compared to the control. Significant ($P\leq0.05$) decreases in the level of Ca^{2+} were observed for both municipal waste evacuation workers and sawmill industry workers respectively but a non significant ($P>0.05$) increase was observed among paint industry workers, when compared to the control. There was a highly significant ($P = 0.009$) increase in the level of Na^+ among sawmill workers and a non significant ($P>0.05$) increase among paint industry workers, while a non significant ($P>0.05$) decrease was observed among Municipal waste evacuation workers, when compared to the control. The serum level of Cl^- shows a significant ($P\leq0.05$) decrease among sawmill workers

and a non significant (P>0.05) decrease was observed among Municipal waste evacuation workers and paint industry workers respectively when compared to the control. Also, non significant (P>0.05) decreases in the level of HCO_3^- were observed among each of the three test groups when compared to the control.

The serum levels of Uric acid, urea, creatinine and random blood sugar of the various test subjects and the control group were shown in (table 4). There were no significant (P>0.05) increases in the level of uric acid among each of the test groups, when compared to the control. There was a highly significant (P = 0.001) increase in the level of urea among Sawmill industry workers and non significant (P>0.05) increases were observed among municipal solid waste and paint workers respectively, when comparison to the control. Result also shows highly significant (P= 0.010) decreases in the random blood sugar level for both paint industry workers and sawmill industry workers, while a significant (P= 0.018) decrease among municipal solid waste workers was observed, when compared to the control. Percentage usage of personal protective equipments (PPE) (table 5) from the retrieved questionnaire shows that about fifty two per cent, thirty two per cent and eighty eight per cent of workers in municipal waste evacuation, Paint industry and sawmill companies respectively do not use personal protective equipment (PPE) at all.

Table 1: Anthropometric characteristics of the population studied

Group (occupation)	(n)	Age (Years)	Weight (Kg)	Height (m)	BMI (Kg/m^2)
Control	25	30.40 ± 5.85	74.28 ± 9.86	2.00 ± 0.00	25.28 ± 3.36
Municipal waste workers	25	30.28 ± 8.03	71.12 ± 11.81	2.00 ± 0.00	24.84 ± 3.20
Paint industry workers	25	29.96 ± 8.04	77.13 ± 16.25	2.00 ± 0.00	26.29 ± 4.05
Sawmill workers	25	31.00 ± 8.67	76.52 ± 13.26	2.00 ± 0.00	27.28 ± 4.08

[1]Values are expressed as mean ± SD

Table 2: Mean serum level of liver enzymes among the various groups studied

Group (occupation)	LIVER ENZYMES			
	AST (U/L)	ALT (U/L)	ALP (U/L)	AST/ALT
Control	35.88 ± 1.47	27.00 ± 1.96	63.20 ± 3.69	1.40 ± 0.12
Municipal Waste workers	40.24 ± 2.58*	20.96 ± 2.78*	59.88 ± 3.96	2.44 ± 0.25**
Sawmill Workers	37.44 ± 2.40	27.48 ± 31.05	66.24 ± 3.82	1.72 ± 0.11
Paint industry workers	37.83 ± 2.42	22.58 ± 2.27*	62.92 ± 3.24	1.87 ± 0.09

Values are expressed as mean ± SE (n=25) per group statistically significant differences (P ≤0.05) and (P ≤0.01) compared to control group are indicated by * and ** respectively.

Table 3: Mean serum level of electrolytes among the various groups studied

Group (occupation)	SERUM ELECTROLYTES				
	Na^+ (mmol/l)	Cl^- (mmol/l)	K^+ (mmol/l)	Ca^{2+} (mmol/l)	HCO_3^- (mmol/l)
Control	136.56 ± 0.59	103.80 ± 0.49	4.00 ± 0.06	2.28 ± 0.11	23.56 ± 0.33
Municipal waste workers	134.60 ± 1.17	100.64 ± 1.24	3.56 ± 0.12**	2.00 ± 0.00*	23.00 ± 0.78
Sawmill workers	140.76 ±1.17**	97.32 ± 1.71*	4.00±0.00	2.00 ± 0.00*	22.80 ± 0.36
Paint workers	138.13 ± 0.49	101.71 ± 2.62	3.96 ± 0.04	2.58 ± 0.10	22.58 ± 0.59

Values are expressed as mean ± SEM [2] (n=25) per group [3] statistically significant differences (P ≤0.05) and (P ≤0.01) compared to control group are indicated by * and ** respectively.

Table 4: Mean serum level of uric acid, urea, creatinine and random blood sugar among workers in the various groups studied

Groups	Uric Acid (mmol/l)	Urea (mmol/l)	Creatinine (µmol/l)	Random blood sugar (mmol/l)
Control	340.76 ± 11.98	3.36 ± 0.19	96.36 ± 3.02	5.88 ± 0.68
Municipal waste workers	359.96 ± 13.58	3.92 ± 0.17	87.64 ± 2.48	4.32 ± 0.14*
Sawmill industry worker	378.16 ± 17.25	4.52 ± 0.15**	87.40 ± 2.94	3.60 ± 0.14**
Paint Industry workers	355.75 ± 7.26	3.88 ± 0.22	90.49 ± 1.40	4.21 ± 0.16**

[1]Values expressed as mean ± SEM; [2] (n=25) per group [3] statistically significant differences (P ≤0.05) and (P ≤0.01) compared to control group are indicated by * and ** respectively.

Table 5: Percentage usage of personal protective Equipment (PPE) according to occupation

Group (occupation)	Percentage (%)Usage of PPE			
	Always	Sometimes	Not at all	Total (%)
Municipal waste workers	8	40	52	100
Paint industry workers	24	44	32	100
Sawmill industry workers	0	12	88	100

DISCUSSION

Findings from this study (table 2) shows statistically significant (P ≤ 0.05) increase in AST level among Municipal waste evacuation workers; significant (P ≤ 0.05) decrease in ALT levels in both municipal waste evacuation workers and paint industry workers; highly significant (p = 0.001) increase in the AST/ALT ratio among Municipal waste evacuation workers, when compared to the control. The serum electrolytes level (table 3) shows a highly significant (P= 0.001) decrease in Potassium ion (K^+) level among municipal waste evacuation workers; Significant (P≤0.05) decrease in calcium ion (Ca^{2+}) level in both municipal waste evacuation workers and sawmill

industry workers respectively; highly significant (P = 0.009) increase in sodium ion (Na^+) level among sawmill workers; significant (P≤0.05) decrease in the serum level of chlorine ion (Cl^-) among sawmill workers, when compared to the control. Findings from this study (table 4) also shows a highly significant (P = 0.001) increase in the level of urea among Sawmill industry workers; highly significant (P= 0.010) decreases in random blood sugar level among paint production workers and sawmill company workers, while a significant (P= 0.018) decrease in random blood sugar level was observed among municipal solid waste workers, when compared to the control.

Occupational workers such as municipal waste evacuation, paint production and sawmill factory workers examined in this study are exposed to various kinds of toxic chemicals (heavy metals and organic solvent) in course of their work. Report from several studies have revealed that municipal solid waste contain appreciable amount of heavy metals like Chromium (Cr), Lead (Pb), Nickel (Ni), Cadmium (Cd), Copper (Cu) and Mercury (Hg) [7, 23], which may be hazardous to the health of municipal evacuation workers. Paint industry workers are exposed to certain toxic chemicals in course of their job, such as: Solvents, binder, pigments and additives [24]. Pigments used in the production of paint include: cadmium, lead, chromium, aluminum, antimony and titanium (IV) oxide. Solvents used in paint production include: glycol ethers, xylene, alcohols, esters, toluene, methylene chloride, trichloroethylene, perchloroethylene, carbon tetrachloride, Formaldehyde, ethyl benzene, and methyl ethyl ketone etc. [8]. Heavy metals and solvents in paint have been reported to affect many organs and systems in humans, such as haematopoisis, liver, central nervous system, kidney, and reproductive system [9, 10, 11]. Sawmill factory workers are exposed to wood dust which contains polar organic compounds, nonpolar organic compounds, steryl esters as well as water-soluble compounds [18] and wood preservative which contains some toxic heavy metals like (chromium, copper and arsenic) and organic solvents [25].

The route of entry of these toxic chemicals into the body systems includes; accidental ingestion, through the skin and inhalation [26]. Due to the unique position the liver occupy in the circulatory system as the principal organ for metabolic bio-activation, this organ is mainly targeted and often injured by toxic chemicals [27 2].The kidney also plays vital role in excreting unwanted substances and the reabsorbing certain required substances back into the blood [28]. Toxic metals have been reported to accumulate along various portions in the nephron, causing changes in the function and morphology of the nephron [29]. Many occupational activities may lead to abnormalities in liver and kidney function. Recent studies performed in vivo and in vitro have indicated that oxidative stress, apoptosis, and necrosis are common phenomena in the course of liver toxicity and nephrotoxicity elicited by these heavy metals [2, 30].

Result (table 2) shows statistically significant (P ≤ 0.05) increase in AST level among Municipal waste evacuation workers and significant (P ≤ 0.05) decrease in the ALT levels in both municipal waste evacuation and paint production workers, when compared to the control. The serum liver enzyme (AST and ALT) levels measured among these occupational workers were significantly altered in Municipal waste evacuation and paint factory workers.The significant (P ≤ 0.05) increase in AST observed Municipal waste evacuation workers is in agreement with the findings of [31, 32, 33]. The significant (P ≤ 0.05) decrease in ALT observed in Municipal waste evacuation and paint production workers is in accordance with the finding of [34] but contrary to the report of [35] and [33]. The possible reason for this finding was reported by [36. 37]. A trend towards hepatocellular damage in the municipal solid waste, paint and sawmill exposed workers appears to be indicated. The possible reason for these alterations may be due to inadequate use of personal protective equipment and prolong exposure of occupational workers to toxic chemicals such as heavy metals and organic solvent. For instance, cadmium which is a constituent of municipal solid

waste has been recognized as one of the most toxic environmental and industrial pollutants. Chronic cadmium exposure has been reported to cause damage to numerous organs and systems [38] in the human body, thus accumulating irreversibly, particularly in the liver and kidneys [39]. Cadmium is a potent generator of reactive oxygen species, involved in the occurrence of DNA damage and the reduction of cellular antioxidants levels [40].

AST is an enzyme present in both cytoplasmic and mitochondrial compartments of the cell. AST catalyses the reductive transfer of an amino group from aspartate to α-ketoglutarate resulting in the formation of glutamate and oxaloacetate. AST leaks out into the serum during hepatocellular injury or necrosis (Amacher, 2002). Alanine aminotransferase (ALT) is mainly found in the liver with trace amount in heart and skeletal muscles. It is present in the mitochondria and cytoplasm where it is implicated in the metabolism of protein. It leaks out of damaged tissues in hepatocellular necrosis [42]. The highly significant (p = 0.001) AST/ALT ratio observed among municipal solid waste workers, when compared to the control is an indication that occupational workers exposed to toxic chemicals are at risk of hepatocellular injury because when AST/ALT ratio rises above one, liver fibrosis can be suspected, indicating that all is not normal [43]. Due to prolong exposure of occupational workers to toxic chemicals without adequate personal protective equipment, clinical features associated with liver disease such as: fatigue, appetite loss, arthralgia, hypertransaminasemia, hypergamma glutamyl transferase (GT) and splenomegaly [2] may manifest over time.

Result (table 3) shows a highly significant (P= 0.001) decrease in the level of potassium ion (K^+) among municipal waste evacuation workers; significant (P≤0.05) decreases in the level of calcium ion (Ca^{2+}) in both municipal waste evacuation workers and sawmill industry workers respectively; highly significant (P = 0.009) increase in the level of sodium ion (Na^+) among sawmill workers; significant (P≤0.05) decrease in chlorine ion (Cl^-) level among sawmill workers, when compared to the control. There were marked alterations in the electrolytes level among municipal waste evacuation, paint production and sawmill factory workers.

The significant decrease in the levels of (K^+) and (Ca^{2+}) observed are in accordance with the findings of [3] and [44], that reported the toxic effect of heavy metals such as cadmium (Cd) and lead (Pb) on the serum concentration level of K^+ and Ca^{2+} respectively. Occupational toxicants (Heavy metals) such as cadmium (Cd) and lead (Pb) have been implicated in the alteration of serum electrolyte level. The possible physiological mechanism responsible for the significant decrease in potassium ion as described by [3] involves the blocking effect of toxic heavy metals like cadmium on ion channels such as the renal outer medullary K^+ channel (ROMK) in the terminal segments of the nephron. However, cadmium has been reported to inhibit the reabsorption of Potassium ion, thus facilitating K^+ excretion. Also, experiment in mammalian cells has implicated the role of voltage-dependent Ca channels (VDCC) in the membrane permeation of two toxic metals, lead (Pb) and cadmium (Cd). These metal ions have been reported to antagonize Ca^{2+} influx through voltage-dependent and receptor-operated Ca channels [44].

Result (table 3 and 4) shows Significant (P= 0.009) increase in the serum level of sodium ion (Na^+); significant (P<0.05) decrease in the serum level of chlorine ion (Cl^-) and highly significant (P = 0.001) increase in urea level among sawmill company workers when compared to the control, This finding may be due to renal toxicity caused by heavy metals present in wood preservatives. Wood preservatives or pesticides have been reported to contain some heavy metals such as chromium, copper and arsenic (CCA) [45]. Accumulating evidence suggest that CCA-induced renal toxicity could be caused by chromium and arsenic. For instance, chromium nephrotoxicity has been revealed to cause altered proximal tubule function, decreased glomerular filtration, and distal segment dysfunction in rats [46], which could be responsible for the alteration in the levels of sodium ion, chlorine ion and urea observed among sawmill company workers, When compared to the control.

Result (table 4) shows a highly significant (P= 0.010) decreases in the random blood sugar levels for both paint production and sawmill company workers, while a significant (P= 0.018) decrease among municipal solid waste workers was observed, when compared to the control. This result is in agreement to the finding of [3]. Firstly, heavy metal interaction with sodium/glucose co-transporter have been implicated as the possible reason for the decrease in random blood sugar level observed among these occupational workers. For instance, cadmium has been reported to inhibit the Na/glucose co-transporters in the proximal tubule of the kidney thereby increasing renal excretion of glucose [3] and a concomitant decrease in the serum glucose level.

Secondly, wood cellulose and lignin which are prominent constituents of sawmill industry may have played a role as well resulting to the highly significant (P= 0.010) decrease in random blood sugar level observed among sawmill company workers. Wood dust is known to contain mainly cellulose (approximately 40–50%), polyoses, a large and variable number of substances of lower relative molecular mass [47].These chemical constituents have been reported by [48] to possess the ability to potentiate insulin secretion and potency. This action causes a decrease in glycaemia which is consistent with the findings of the present study. This finding is also in agreement with the report of [49]. The trend in this finding could be related to the fact that a greater number of sawmill workers studied (88 out of 100) reported not to adhere to the use of personal protective equipment (PPEs), which may have led to increased inhalation of wood dust, and hence

increased systemic concentration of wood cellulose and lignin. It is important to note that this finding on wood dust maybe clinically beneficial to patient with type II Diabetes mellitus, while x - raying its deleterious adverse effects especially on pulmonary functions. Hence, inadequately protected occupational workers are at risk of hypoglycaemia due the interaction between toxic Chemicals and the nephrons of the kidney. The physiological implication and the devastating effect of hypoglycaemia observed among all the various occupational workers studied, calls for great concern because the human brain almost depends completely on the oxidation of glucose for the production of energy, in order to meet up with its enormous metabolic requirements but unfortunately the brain can neither synthesize nor store glucose, as it relies on the constant supply from the cerebral circulation to provide its primary energy source. However, these occupational workers may encounter energy failure in the cerebral neurons with time, which may manifest by the onset of neuroglycopaenic symptoms such as poor concentration, drowsiness and reduced coordination. Further reduction in blood glucose level may lead to cognitive impairment, confusion, seizure, coma and permanent neurological deficit [50].

CONCLUSION

Significantly altered enzymatic biomarkers of liver and serum level of biochemical parameters of kidney damage observed in the Nigerian municipal waste evacuation, sawmill and Paint company workers studied may be associated with long-term occupational exposure to known renal and hepatotoxic heavy metals and organic solvent present in municipal solid waste, wood preservatives and paint. A trend towards hepatocellular damage in the municipal waste evacuation, paint and sawmill exposed company workers appears to be indicated. Also the alteration in serum level of renal biochemical parameters observed among municipal waste evacuation, sawmill and paint production workers is an indication that these workers are at risk of renal damage. Monitoring the status of liver enzymes and serum level of biochemical parameters of kidney damage would be very useful in evaluating the risk exposure of these occupational workers. As a preventive measure, municipal waste evacuation, paint production and sawmill company workers are advised to use personal protective equipment frequently to prevent possible hepatorenal damage. The result from this study would be useful in the formulation and implementation of policies in order to tackle the overwhelming challenges of poor occupational practices and its associated adverse health consequences, mainly in developing countries. In conclusion, this review revealed that Municipal waste evacuation workers, Sawmill and paint company workers exposed to toxic chemicals are at risk of developing kidney and liver damage, which may eventually affect the functions of these organs in humans. These findings will be of immense benefit to clinicians, regulatory agencies, industries and also occupational workers exposed to toxic chemicals.

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