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Journal of Clinical Toxicology

Research Article

Biochemical Assessment of the Hepatic and Hematological Functions of Printing Workers

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ABSTRACT

Background: In the printing industry, volatile organic compounds main sources are the uses of organic solvents, fountain solutions and cleaning agents. Biological monitoring of exposure to toxic chemicals in the workplace is a fundamental tool to evaluate human health risks and to improve occupational safety.

Aims and objectives: To investigate the effects of occupational exposure to organic solvents on some hepatic and hematological parameters among printing workers.

Materials and methods: This study was conducted in local printing company with two groups; the control group included (26) male healthy volunteer donors and the second is the workers group included (26) male volunteer workers, who have been exposed to chemicals for long time (10 years). Statistical analysis was employed.

Results: Hemoglobin and the red blood cell count of workers group were significantly lower than control group while, liver transaminases and lactate dehydrogenase enzymes were found significantly higher among printing workers as compare to the control group.

Conclusions: This study observed that the printing workers developed biochemical alterations in hematological and the hepatic enzymes with time. However, regular follow-ups are required and further studies to get better insights into the results.

Keywords: Liver enzymes; Hematological parameters; Organic solvents; Printing workers; Occupational exposure

INTRODUCTION

The origins of printing can be traced back several centuries [1,2]. Printing operations use materials that may adversely affect air, water, and land [3-5]. The most important chemical hazards associated with the printing industry come from: pre-press chemicals; printing inks; fountain solutions; cleansing solvents; and adhesives and glues [6-10].

Printing industry, within various printing techniques, is abundant with a specific source and processes that commonly emit high levels of Volatile Organic Compounds (VOCs), such as carbonyls, alcohols, alkanes, alkenes, esters, aromatics, ethers, and amides. Although necessary and required as components of inks, alcohol, cleaners, solvents, emulsions, thinners, retardants and de-emulsifiers, the increased emissions of VOCs and their resulting impact on the air quality are now considered as a major environmental concern. [3,4,9,11].

All types of organic solvents are lipophilic volatile liquids at room temperature [12-14]. Adverse health effects related to exposure to organic solvents through inhalation and skin contact in the workplace. Exposure of solvent vapours affects not only the lungs but the whole circulatory system and hence the whole body. Solvents accumulate principally in lipid and fat-rich cells in the nervous system, brain, bone marrow, liver, and body fat. Long-term health effects may be damage to internal organs such as liver, kidneys and lungs, etc. after absorption into the body [15-19].

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Received: August 18, 2021; **Accepted:** September 01, 2021; **Published:** September 08, 2021

Citation: Ahmed ST, Baghdadi HH, EI Demerdash FM (2021) Biochemical Assessment of the Hepatic and Hematological Functions of Printing Workers. J Clin Toxicol. S19:003.

MATERIALS AND METHODS

Prior to participation in this study, all volunteers were advised about the procedure and signed the informed consent. The participants were told about the aim of the study, and they were informed that the data would be used for scientific purposes only. They were also given the right to refuse or participate in the study.

The experimental design of this study contains two groups randomly selected at a local printing company at Alexandria city, Egypt: the first one is the control group included (26) male healthy volunteer donors of different age, sex, socio-economic level who were working in the other divisions of the same factory were classified into the control group and the second is the workers group included (26) male volunteer workers were also, who have been exposed to chemicals for long time (10 years).

Sample collection

Five milliliters venous blood samples were collected and aliquot were anticoagulant with (Ethylene Diamine Tetra acetic Acid) (EDTA). Plasma was obtained by centrifugation of the samples at 3000 rpm for 10 minutes.

Statistical analyses: All measurements were triplicate performed in independent experiments for all treatments. The results were expressed as mean ± Standard Error (SE). Statistical analyses were made with one-way Analysis of Variance (ANOVA), when differences were found, multiple comparisons by Tukey's post-hoc test using the SPSS version 21. The criterion for statistical significance was $p<0.05$.

RESULTS

The mean values and standard error of Hemoglobin (Hb), the Red Blood Cell Count (RBCs) of workers group were significantly lower than control group,13.51 ± 0.34/cm vs. 14.82 ± 0.59/cm and 4.73 ± 0.33 g/dl vs. 5.19 ± 0.40 g/dl ($p<0.05$); respectively as represented in Figure 1.

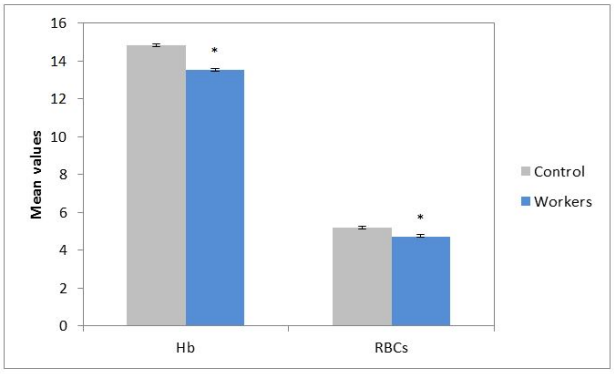

Figure 1: Hemoglobin (Hb) and Red Blood Cell count (RBCs) in control group (26) and workers group (26). Data are expressed as mean ± SE. Significant lower than control ($P<0.05$).

Workers showed increased alanine aminotransferase (ALT), Aspartate aminotransferase (AST) and Lactate de-Hydrogenase (LDH) levels when compared to the control as summarized in Figure 2 and Table 1, however, the values were within the normal range.

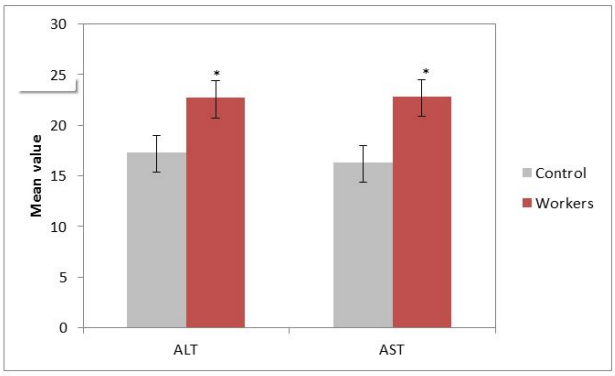

Figure 2: Alanine aminotransferase (ALT) and Aspartate aminotransferase (AST) in control group (26) and workers group (26). Data are expressed as mean ± SE. Significant higher than control ($P<0.05$).

DISCUSSION

Human are environmentally and occupationally exposed to hazardous agents which can affect biological systems and cause many types of diseases in various organs such as heart, liver, kidney, lung, nervous system, and skin [11,20].

Biological monitoring of toxic chemicals exposure in the workplace is a fundamental tool to evaluate human health risks and to improve occupational safety [21]. Workers in printing industries may be exposed to potentially hazardous levels of solvents, inks, adhesives, organic and inorganic pigments, polycyclic aromatic hydrocarbons, acrylates, lead, paper dust, and noise [11,19,22]. Dealing with exposure to a mixture of chemicals, risk assessment has to consider possible synergetic or additive effects in workers' health [10].

Organic Solvents (OSs) have various effects on human health [23]. Exposure to organic solvents can occur by inhalation or absorption through the skin, but inhalation is usually the main route of entry. It may occur despite the use of protective clothing, because solvents may penetrate certain types of gloves or cloth. Solvent mixtures are frequently used. Therefore, effects may also be caused by combined exposures [24].

VOCs exposure has been known to result in immunologic, respiratory, carcinogenic, reproductive, neurologic, and cardiovascular effects [16,19,25,26].

Solvents are a large group of chemicals which are used industrially in the production of paints, glues, coatings, degreasing agents, dyes, polymers, pharmaceuticals and printing inks. They have three characteristics in common, namely they are volatile liquids at normal temperature, evaporate and become incorporated into environmental air as volatile organic compounds [10,11].

Organic Solvents (OSs) are known to be hematotoxic, they are known to have a deleterious effect on bone marrow. Therefore, the clinical manifestations of these organic solvents range widely from anemia to leukemia [27].

Analyzing changes in haematological parameters that can be assessed used as a functional state of many tissues. Our findings are in agreement with [23,28,29] where low level of blood hemoglobin and RBCs in exposed workers when compared with control values, while in contrast with other studies of [30-32] didn't show any significant difference between workers and control.

The liver function tests will help to detect the abnormalities and the extent of liver damage [9]. Clinical assessments of enzyme activities in blood are important guide in diagnosis of diseases and serial estimations help in assessing prognosis [33].

Transamination is one of the processes involved in protein metabolism which catalyzed transfer of a particular group from one substrate to another, is a key physiological process in all forms of life [33,34]. The activities of transaminases enzymes (ALT and AST) are widely used to assess the liver function and detect hepatic disorders [35,36]. Elevated plasma transaminase concentrations are indicative of hepatocyte damage and good indicator of the type of cell damage [37].

Solvents may damage liver cells and liver transaminases may be used to monitor liver damage. Liver disease cannot be confirmed with a blood chemistry test, but clinically, ALT is most commonly used as a biomarker of liver damage. Unlike membrane-bound enzyme, cytosolic enzyme does not leak into blood. Healthy plasma membranes should be impermeable to macromolecules such as enzymes. It is generally accepted that increased cytosolic enzyme in the blood occurs secondary to cell membrane damage or cell necrosis [15].

Through analyzing the hepatic transaminase, the observed elevation in our results are in consistency with the previous findings of [15,18,21,28,38-40] but our results were not in agreement with those of [29,30,32,41-43] who reported that the liver function tests in their studies did not show any exposure-related abnormality, while decreased ALT and AST activities were reported in [44].

Increased activities of ALT and AST released into circulation due to hepatocytes damage induced by oxidative stress which induced by organic solvent. This elevation of enzymes correlates with the number of damaged cells [15,31,34,36,45,46]. Therefore, increased AST and ALT are biomarkers of hepatic injury rather than hepatic dysfunction.

Lactate De-Hydrogenase (LDH) that catalyses the reversible conversion of pyruvic acid and lactic acid, has wide spread activity in numerous body tissue, could be raised in acute myocardial infarction, liver disorders, carcinomatosis, leukemia's, renal tubular necrosis, pulmonary infarction, renal necrosis, muscle diseases[33,35,47].

Results indicated in Table 1 [48] that observed increased in LDH activities in the exposed group may have been because of the hepatocellular necrosis leading to leakage of the enzyme into the blood stream.

Functional and organic damage caused by organic solvents can be referred to inflammation, dysfunction of cytochrome P450, mitochondrial dysfunction, and oxidative stress and in consequence result in increasing oxidative stress. Under the permissible limit exposure to organic solvent could cause induced liver injury referred to oxidative stress. Thus, the oxidative damage caused by free radicals is thought to be a basic mechanism underlying hepatotoxicity by organic solvents, causing the release of liver enzymes in the circulation [15,46].

Parameter	Control N (26)	Workers N (26)	P value
LDH	293.08 ± 10.04	327.46 ± 13.83*	P<0.05

Note: Data presented as mean ± SE, Significant higher than control (P<0.05).

Table 1: Distribution of mean value of Lactate Dehydrogenase (LDH) in control and worker groups.

CONCLUSION

Among chronic exposure to organic solvents; periodic medical examination and laboratory investigations are mandatory to find out early hazardous health effects.

Our findings point to the use of screening tests assessing hematological and hepatic biochemical function in printing industry workers.

printing workers during their routine work should use protective devices since workers are constantly exposed to organic solvents and because of adverse effects it may cause on their health without knowing when it may happen, it is important they do period medical check-up.

ACKNOWLEDGMENTS

This study was a part of Postgraduate Ph.D. of the first author Ahmed under the supervision of Prof. (Dr.) Baghdadi and Prof. (Dr.) El-Demerdash.

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