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Research Article

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Contribution to Study of Paint Solvents' Toxicity Among Building Workers

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ABSTRACT

The purpose of this report is to investigate the effect of exposure to paint solvents on building workers in the El Tarf area. The work was subdivided into 2 parts: an epidemiological study: through using a questionnaire, the distribution of workers, age, duration of exposure, associated diseases before, during and after exposure were found out, and an experimental study: evaluating the variations of blood biochemical and cellular parameters in experimental compared to control group. The results show that this survey was reliable in order to distinguish the prevalence of workers in their professional environment, whose average age of exposed workers is between 30 and 40 years who practice the profession from 5 to 10 years. The rate of healthy workers before exposure is higher than that during or after exposure. The dominant pathologies in workers exposed to solvents are cardiovascular diseases, nervous disorders, kidney problems and diabetes. On the other hand, several metabolic and cellular perturbations were observed in the exposed workers compared to the controls, which testifies the hepatotoxic and hematotoxic effects.

Key words: *Solvent, Exposure, Prevalence, Health, Employees.*

INTRODUCTION

Recent years have been marked by pollution warnings due to many products commonly used at homes such as paints, varnishes and admixtures. These are usually loaded with volatile organic compounds (VOCs). Not only these substances are not very friendly to the environment since they contribute to the formation of tropospheric ozone "summer smog phenomenon", but they can also be dangerous for health causing notably respiratory problems [1].

The oldest traces of painting date back to about 15,000 BC, and have been discovered in France, Spain (Altamira) and South Africa. The paintings of the time were composed of a mixture of animal fats and mineral pigments. In the same way, ancient egyptians, greeks and romans frequently painted their boats, statues and buildings to decorate them [2]. The demand for paint was growing exponentially. While some synthetic pigments have already been developed during this period, the basic components of these coatings remain of natural origin.

Synthetic paints are composed of ingredients from petrochemicals and heavy chemistry. They contain toxic products that are released during and after their implementation. These emanations permeate the tissues and carpets of the habitat and remain in the air for several months [3].

In particular, the hepatotoxicity of certain solvents has been suspected since the end of the 19th century. Indeed, the liver is the target organ of many xenobiotics, such as drugs or industrial toxic, because of its role as purifier of the body. One of the most studied hepatotoxic is probably carbon tetrachloride. A review of the literature by Brautbar and Williams in 1986 [4] highlighted this toxicity, which can lead to cirrhosis and even liver cancer. Subsequent studies have attempted to demonstrate the toxic potential of organic solvent mixtures by their action on hepatic enzyme systems [5, 6]. It is reported that due to being difficult, apart from experimental studies, to individualize a particular solvent; professional exposures to solvents are often multiple and inseparable. The toxic mechanisms are numerous and some still unknown. This is the case of enzymatic induction via the activation of other cytochromes P450 [7].

MATERIALS AND METHODS

Our work is divided into two parts:
Epidemiological study: establishment of a survey of a population of workers in paint companies (solvent based on ethylene glycol derivatives category), using a questionnaire.
Experimental study: the impact of organic solvents of paints on the health of workers in the workplace (variation of blood biochemical and cellular parameters).

1. Epidemiological study (general distribution of the workers' population)

This work concerns a random epidemiological study of 50 workers from different age groups in the occupational sector exposed to solvent.

An individual, voluntary and anonymous questionnaire mainly concerning their distribution based on the following variability criteria: age, duration of exposure, associated diseases before, during and after exposure was used.

2. Experimental study

Our work involved 30 people divided into 15 control and 15 employees who have been exposed to paint solvents in their professional environment for 13 years (have no chronic disease before starting work, and non-smokers). The average age in our study population is between 25 and 68 years, these people participated in carrying out this experiment voluntarily.
We studied the variation of blood biochemical and cellular parameters that indicate the good functioning of the organism.

2.1. Blood biochemical parameters (metabolism products)

Blood collected in heparin tubes is used for counting blood cells: red blood cells, hemoglobin, hematocrit, and neutrophils. Another fraction of the blood is centrifuged; the plasma obtained is used to determine the biochemical parameters: glucose, cholesterol (HDL / LDL), transaminase enzymes (ASAT: Aspartate aminotransferase; ALAT: Alanine aminotransférase) and proteins.

2.2. Cellular parameters

It consists of studying the blood formula count with regard to four parameters of red blood cells, hematocrit, hemoglobin, and neutrophils. The quantitative and qualitative analysis of figured elements of blood, is done with an "Automat" which automatically measures the number of blood cells.

RESULTS AND DISCUSSION

1. Distribution of workers by age

Among the 60% of the workers' population (exposed in the painting field), we have established the age distribution, of which 30% of workers are aged between 30 and 40 years old, followed by the class of age of 20-30 years and 40-50 years with a rate of 20%. Workers aged 50-60 up to 70 represent the minority (Table 1).

Table 1. Distribution of workers by age

Age (years)	20-30	30-40	40-50	50-60	60-70
Rate (%)	20	30	20	16,67	13,33

2. Distribution of workers according to duration of exposure

The majority of workers have practiced the profession for a period of 5-10 years and 10-15 years. The duration of exposure decreases gradually after 15 years of work (Table 2).

Table 2. Distribution of workers by duration of exposure

Duration of exposure (years)	5-10	10-15	15-20	20-25	25-30	30-35

Rate (%)	36,67	33,33	10	6,67	3,33	10

3. Distribution of workers by disease rate before exposure

The results show that 73% of workers are healthy, while 26.67% declared that they have some pathologies, 67% suffer from diabetes and 10% from cardiovascular diseases (Table 3).

Table 3. Distribution of workers by pathology before exposure

Diseases	Healthy	Diabetics	Cardiovascular
Rate (%)	73,33	16,67	10

4. Distribution of workers according to pathologies during and after exposure

The rate of healthy workers is lower than that before exposure (13% vs 73%). The most prevalent pathologies among workers during or after exposure to paint solvents are cardiovascular disease with a rate of 17.78%, followed by nervous disorders (15.56%) compared to healthy people.

A high rate of diabetes and kidney problems (11.11%) and the presence of some cases of respiratory disorders, visual disturbances, conceptional delays, liver diseases, psychopathologies and hematological diseases were identified (Table 4).

Table 4. Distribution of workers by pathology during and after exposure

diseases	Healthy	Diabetics	Cardio-vascular	Kidney disorders	Lever desorders	Nervous disoders	Respiratory desorders
Rate (%)	13,3	11,11	17,78	11,11	4,44	15,56	8,89
	Visual disorders	Design delay	Psychological disorders		Hematologic disorders		Herniated disc
Rate (%)	6,68	4,44	2,22		2,22		2,22

5. Variations in blood biochemical parameters

The results show that there is a slight increase in glucose and an increase in bad cholesterol (LDL) with a decrease in good cholesterol (HDL) in workers exposed compared to controls, as well as an increase in total protein levels in exposed individuals relative to their value in controls. Increased values of both liver transaminase enzymes (ASAT and ALT) in exposed workers compared to controls (Table 5).

Table 5. Variations in blood biochemical parameters

Groups	**Control**	**Exposed workers**
Glucose g/l (X ± SD)	1,01 ± 0,10	1,81 ± 0,02
LDL g/l (X ± SD)	1,31 ± 0,01	2,63 ± 0,11
HDL g/l (X ± SD)	0,48 ± 0,02	0,16 ± 0,03
Proteins g/l (X ± SD)	73,53 ± 2,56	112,02 ± 4,07
ASAT UI/l (X ± SD)	28,18 ± 1,92	38,02 ± 2,39
ALAT UI/l (X ± SD)	26,72 ± 1,39	49,14 ± 2,68

6. Variations in blood cellular parameters

We recorded a decrease in all cellular parameters: number of red blood cells and neutrophils; hemoglobin (Hb), as well as hematocrit (Table 6).

Table 6. Variations in blood cellular parameters

Groups	Red blood cells (10^6/mm^3) (X±SD)	Hemoglobin (g/100ml) (X±SD)	Hematocrit (%) (X ± SD)	Neutrophils (%) (X ± SD)
Control	6,6 ± 0,12	15,70 ± 1,02	50,39 ± 3,13	68,69 ± 2,02
Exposed workers	3,9± 0,02	10,13 ± 1,72	38,13 ± 2,18	43,86 ± 2,92

According to the majority of studies at the international level, the human activities, whether industrial, chemical, agricultural or even domestic, are responsible for environmental degradation (global warming, climate change and ecosystem disturbances, depletion of the ozone layer, soil pollution and water, air, etc.). These "environmental threats" constitute a major risk of toxicity to human health (appearance and / or recrudescence of various pathologies: cancerous diseases, infectious diseases, congenital malformations, cardiovascular and respiratory pathologies, decreased quality of life and well-being, etc.) [8].

In our study, we are interested in the effects of exposure to paint solvents on the health of workers in building companies.

Solvent exposure is very common in work and home environments. The toxic effects common to all these compounds are centered on the cutaneo-mucous and neuropsychic disorders both acute and chronic. In addition, some solvents cause specific signs: neuropathy, hematologic toxicity, liver toxicity, birth defects, and reproductive toxicity. [9].

According to our results, paint solvents affect the proper functioning of workers' organism in their professional sector by altering the liver, kidneys and blood.

The effect on liver function is manifested in 2 planes: metabolic and structural. All metabolic products (glucose, cholesterol, protein) are disturbed in workers, as well as liver enzymes (ASAT and ALT), whose increase is indicative of a cellular lesion in the liver, heart, muscles and kidneys.

Tomei et al. in 1999 [10], report "an unexposed exposed study'' concerning cobblers, the footwear sector being heavily user of solvent mixtures. They are 33 craftsmen exposed to the same solvent mixture through a glue used in the work; the control group consisting of 61 people. A clinical examination and a liver function study (ALAT, ASAT, alkaline phosphatase, GGT, total and conjugated bilirubin) were performed. ALT and ASAT, GGT and conjugated bilirubin are significantly higher in exposed individuals.

The number of subjects with AST and ALT values above normal was significantly higher in exposed. All these disturbances are due to the alteration of liver functions by the solvent metabolites (based on glycol ethers which has an aldehyde function) which can inhibit oxydative phosphorylation, glucose metabolism (glycolysis and cycle Krebs, lead producers of ATP), protein synthesis, DNA replication and ribosomal RNA [11].

Repeated exposure to solvents produces functional and histological changes in the liver. They are always benign (modulation of enzymatic activities, swelling of hepatocytes, and increase in liver weight) and would rather reflect an adaptive metabolic response than a toxic effect on the liver [12].

The toxic effects of solvents have been confirmed in several studies at international level. On the other hand, studies have shown the effects of solvents on hepatic metabolism in experimental animals 13].

In humans, exposure to high dose of a solvent can lead to acute intoxication. Regular exposure, even at low doses, to one or more solvents can lead to more or less long-term often irreversible damage to the target organs. Some effects are common to most solvents, while others are specific to certain substances. All organic solvents are, to varying degrees, irritating to the skin and mucous membranes, the skin is by no means a barrier for solvents, most of which pass through to reach other sensitive organs [14].

Inhalation of solvent vapors may cause irritation of the upper airways (mouth, nose, pharynx, larynx) as well as ebiotic-narcotic manifestations (feeling of drunkenness, dizziness, headache, nausea). In case of massive exposure, disorders of the consciousness can appear (anesthesia, drowsiness, even coma).

Chlorinated and fluorinated solvents can disrupt the heart rate. The resulting arrhythmias may appear within 48 hours after the massive exposure. This effect remains remarkable in a professional environment [15].

Solvents have deleterious effects on several organs, including the skin, lungs, central and peripheral nervous systems, kidneys and liver. They can also cause birth defects in children, following regular occupational exposure from one of the parents. Solvents are at the origin of occupational diseases such as dermatitis, polyneuritis (n-hexane), leukemia (benzene), chronic toxic encephalopathy, psycho-organic syndrome (compensated in some European countries), hepatopathy (carbon tetrachloride) and tubulopathy (ethylene glycol).

Regarding the assessment of hematological toxicity, we observed a decrease in hemoglobin, hematocrit, red blood cells and neutrophils. This toxicity has been extensively studied in animal models: hemolysis, a lymphocyte deletion responsible for immunosuppression and toxicity to myeloid progenitors in the bone marrow.

The majority of solvents are responsible for some cases of haematological disorders in the form of neutropenia, which is characterized by an abnormally low level in the blood of a type of white blood cell, neutrophil granulocytes [16].

Studies in laboratory animals have shown that ethylene glycol derivatives, mainly those with a short alkyl chain (EGME), are responsible for hypocellularity (a decrease in blood lines), a decrease in progenitors in particular granulocyte and erythrocyte. These effects are responsible for leukopenia with neutropenia, and anemia [13].

Overall long-term effects will affect physiological systems (nervous, reproductive, endocrine, immune ...) but also more specifically they will affect organs (liver, kidneys, and bone marrow).

Not only immunotoxic effects (allergy ...), and organotoxicities (liver, kidneys, bone marrow, bladder ...), but also endocrine disorders, reproductive and especially neuronal degeneration, cardio-vascular disorders and cancers can appear. Several solvents, in the long term, can cause such pathologies.

Further analysis of these findings reinforces concerns where we found that the majority of these workers are young men around the age of 30-40 years, and the rate of healthy workers before exposure is greater than the one recorded after the exhibition. This leads us to say that the diseases observed among workers after entry to the profession (whose exposure period is generally between 5 and 10 years) are due to the effect of solvents on all functions. These results are in agreement with [17].

Conclusion

Chemicals, used in addition to our basic products, have significantly improved our quality of life. They eliminate insects for example fluidify the paintings, isolate the houses or even preserve the food.

However, these products can be toxic and therefore dangerous for health. The effects of toxic products on the body are varied and depend on the dose received and the synergistic exposure to different substances. They can range from simple respiratory discomfort to much more serious diseases such as cancer. But diseases due to chronic exposure remain little recognized. Toxic effects are often difficult to diagnose. The whole problem, for the general public as well as for the authorities, is to determine to what degree a product is defined as toxic and what risk we are willing to accept in order to benefit from the utility of these substances. To limit the toxic effects of current products, we must reduce the use of chemicals and control their use. Today, the best way to protect yourself from these products is to replace them and change your habits, but to do so, you should inform the public of the dangers they may incur and the dangers that toxic products may have on environment. However, the cost of healthy products should also be reduced and non-toxic products should be produced.

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