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Toxic chemical risk in the workplace : case of an oil and soap manufacturing company in the city of Bobo-Dioulasso, Burkina Faso

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Abstract

Risks associated with chemicals and waste management in industry remain a major concern. In developing countries, the health impact of chemical exposure remains real and poses a public health problem. This study aimed to assess the risks to which workers at an oil and soap production unit in the city of Bobo-Dioulasso (Burkina Faso) were exposed. This was a cross-sectional study conducted from April 15, 2011, to July 15, 2011. Data was collected using a multi-part questionnaire and direct observation of work situations. The study population consisted of 30 male workers. Our results showed that 10% of workers received vocational training before starting work. Dust, hexane, caustic soda, and sulfuric acid were listed as chemicals to which workers were exposed and which posed a risk of poisoning. Also, 47% of the population had shown at least one sign of toxicity following exposure to a chemical used in industry. The protective measures designed to minimize the toxic risk to workers were not suited to the working conditions. Activities carried out in the oil and soap industry exposed workers to numerous toxic risk factors. Training workers and installing protective equipment are measures that must be taken to ensure worker safety.

Keywords : *chemical risk, work environment, toxicity.*

Résumé

Risques liés aux produits chimiques toxiques sur le lieu de travail : cas d'une entreprise de fabrication d'huile et de savon dans la ville de Bobo-Dioulasso, Burkina Faso

Les risques liés à la gestion des produits chimiques et des déchets dans l'industrie restent une préoccupation majeure. Dans les pays en développement, l'impact sur la santé de l'exposition aux produits chimiques reste une réalité et pose un problème de santé publique. Cette étude visait à évaluer les risques auxquels étaient exposés les travailleurs d'une usine de production d'huile et de savon située dans la ville de Bobo-Dioulasso (Burkina Faso). Il s'agissait d'une étude transversale menée du 15 avril 2011 au 15 juillet 2011. Les données ont été recueillies à l'aide d'un questionnaire en plusieurs parties et par l'observation directe des situations de travail. La population étudiée était composée de 30 travailleurs de sexe masculin. Nos résultats ont montré que 10 % des travailleurs avaient suivi une formation professionnelle avant de commencer à travailler. La poussière, l'hexane, la soude caustique et l'acide sulfurique figuraient parmi les produits chimiques auxquels les travailleurs étaient exposés et qui présentaient un risque d'intoxication. De plus, 47 % de la population étudiée avait présenté au moins un signe de toxicité à la suite d'une exposition à un produit chimique utilisé dans l'industrie. Les mesures de protection destinées à minimiser le risque toxique pour les travailleurs n'étaient pas adaptées aux conditions de travail. Les activités menées dans l'industrie de l'huile et du savon exposaient les travailleurs à de nombreux facteurs de risque toxique. La formation des travailleurs et la mise en place d'équipements de protection sont des mesures qui doivent être prises pour garantir la sécurité des travailleurs.

Mots-clés : *risque chimique, environnement de travail, toxicité.*

1. Introduction

The chemical industry is one of the largest sectors contributing to the global economy. In developing countries, this industry faces challenges that jeopardize the health of the workers employed in it [1]. In fact, workers in the chemical industry are the most exposed to chemicals. And mortality linked to chemical exposure is on the rise. In 2012, it was 1.3 million, then in 2016 it was 1.6 million, and in 2019, it was 2 million people [2]. In addition to exposure risks, there are risks associated with the management of waste produced by industries. In Burkina Faso, industrial workers have little coverage in terms of occupational safety [3]. According to a study conducted in 1995, the annual waste production of the city of Ouagadougou was estimated at 200,000 tons [4]. Industrial waste poses a threat to human health and the environment. This waste contains toxic substances (corrosive, caustic, explosive, radioactive, carcinogenic, and teratogenic) that can seriously harm workers' health. Indeed, industrial waste is often poorly treated or not treated at all before being disposed of, leading to environmental degradation [5] and the degradation of receiving water bodies. This deterioration of water bodies is conducive to the proliferation of waterborne pathogens and toxin-producing cyanobacteria [6 - 8]. This makes exposure to waste one of the most pressing health and environmental issues. The prevention and reduction of work-related health problems caused by hazardous agents is mainly achieved by mitigating exposure to these toxic agents in the workplace [9]. Several preventive measures have been adopted. However, the implementation of these recommendations is still not being respected by industries in developing countries. The cotton industry in Burkina Faso employs several million people, from agricultural production to the finished product. Based in Bobo Dioulasso, workers at the cotton processing plant are exposed to risks associated with chemical substances as well as waste management. These risks have been real since the industry was created, in terms of exposure to chemicals. The aim of this study, conducted in 2011, was to highlight the realities faced by workers in this industry and to provide guidance on solutions to minimize workers' exposure to risk.

2. Methodology

The study was conducted at an oil and soap manufacturing company located in the industrial zone of Bobo-Dioulasso in western Burkina Faso. This was a cross-sectional study. The study took place from April 15, 2011, to July 15, 2011. The study population consisted of the working personnel of the production company and the effluent pretreatment plant. Information was gathered through questioning supported by three survey forms. Two were intended for workers, one to assess workers' knowledge of toxic risks and the other to assess waste management. A final form was used to collect data on compliance with protection rules. The variables analyzed in the study included: type of production and type of activities for the production cycle; sociodemographic characteristics (age, gender, level of education, professional qualifications, length of service); chemicals used; workers' knowledge, attitudes, and practices regarding chemical risks; data on the work environment and waste management. Data analysis was performed using Microsoft Excel version 2015. The workers gave their consent to participate in the study. In addition, they were informed of the confidentiality of their comments. Finally, the collection forms were anonymous and only included identification numbers.

3. Results

A total of 30 workers participated in the study by answering the various questions on the data collection form.

3-1. Sociodemographic characteristics

The 30 workers surveyed, all male, are broken down as shown in ***Figure 1***. The largest age group is 51-55 years old.

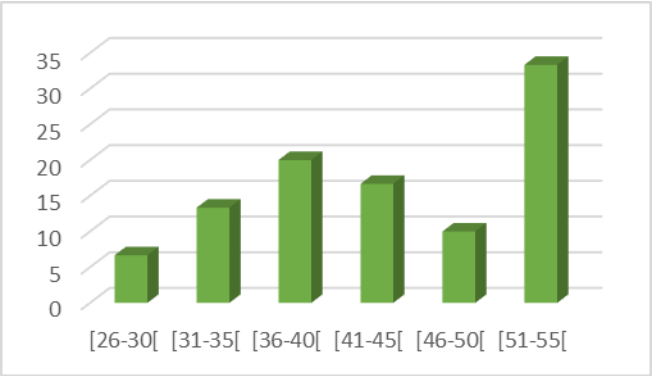

Figure 1 : *Distribution of workers by age (n=30)*

Of the 30 workers surveyed, 26 had attended school. These 26 workers had different levels of education ***(Figure 2)***.

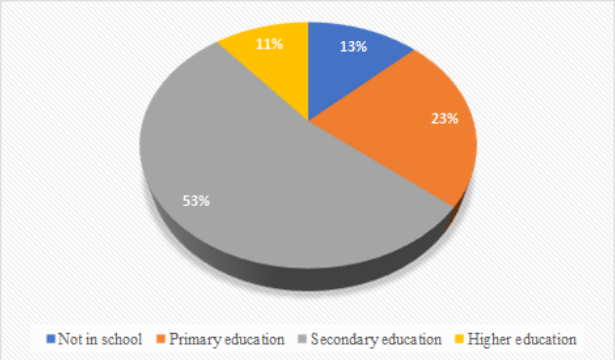

Figure 2 : *Distribution of workers by level of education (n = 30)*

Few workers received vocational training (10%) before starting work. Twenty-three of the workers surveyed had more than 10 years of service in their workshop. The workers worked 8 hours straight per day and 48 hours per week.

3-2. Workers' working environment

Table 1 below lists the various solvents used on a daily basis by workers. The toxicological data relating to these chemicals were reviewed in a literature review [10] in order to establish the link between the hazards to which personnel are exposed.

Table 1 : *Toxicological data on solvents used in industry*

Chemicals	Toxicity
Hexane	Neuronal toxicity, Dermal toxicity, Respiratory toxicity, Vision disorders
Caustic soda	Gastric toxicity, Caustic lesions of the digestive tract, Esophageal cancer, Respiratory toxicity, Renal toxicity, Metabolic alkalosis, Tissue necrosis, Gastrointestinal bleeding Eye damage
Phosphoric acid	Eye damage Respiratory toxicity Digestive tract ulceration Digestive bleeding Digestive tract stenosis
Sulfuric acid	Caustic skin lesions Eye damage Tissue necrosis Respiratory toxicity
Aluminum sulfate	Neuronal toxicity Renal toxicity Skin lesions Irritation of mucous membranes (nose, lungs, throat) Eye irritation

The survey revealed that 86.67% of workers were exposed to toxic risk factors in the workplace. The risk factors to which workers are exposed and which could give rise to toxic hazards are listed in *Table II* below, grouped according to workshop.

Table 2 : *Distribution of chemical and fire risk factors and the products involved*

Workers' workshops	Chemical risk factors			Fire hazard	Chemicals
	Corrosive liquid	Gas	Dust		
Cleaning and shelling workshop		X	X		Dust from husking Smell of delinted seed
Expanding workshop		X			Smell of the delinted seed
Extraction workshop		X		X	Hexane vapor
Neutralization workshop	X	X		X	Hexane vapor Caustic soda
Refining workshop	X		X		Caustic soda Bleaching earth (adsorbent earth)
Pelletizing workshop			X		Dust emanating from cotton flour
Soap-making workshop	X				Caustic soda
Effluent treatment workshop	X				Caustic soda Sulfuric acid Aluminum sulfate

3-3. Knowledge, attitudes, and practices regarding toxic chemical risks

Our study has shown that 60% of workers found industrial waste to be harmful, while the rest were unaware of its harmful effects. Collective and individual protective equipment depended on the workshop and was mostly limited to a protective mask + protective clothing (long-sleeved shirts + pants) + safety shoes. Among the study population, 47% showed signs of toxicity related to exposure to the chemical. ***Table 3*** below describes the equipment used by workers in each workshop and the health impacts associated with inadequate protection.

Table 3 : *Health impacts related to inadequate protection*

Workshops	Collective protection	Personal Protection	Equipment	Health impact
Cleaning and shelling workshop		X	Protective mask Clothing (long-sleeved shirts + pants) Safety shoes	Cough Breathing difficulties
Expanding workshop		X	Protective mask Clothing (long-sleeved shirts + pants) Safety shoes	Breathing difficulties
Extraction workshop		X	Clothing (long-sleeved shirts + pants) Safety shoes	Abscess of segment VI on hepatomegaly Memory lapses Functional colopathy Fainting Sexual disorders
Neutralization workshop		X	Clothing (long-sleeved shirts + pants) Safety shoes	Mild eye disorders Decreased vision (soda) Liver problems (soda)
Refining workshop		X	Clothing (long-sleeved shirts + pants) Safety shoes	Caustic injuries (soda) Minor eye damage (soda) Breathing difficulties (adsorbent earth)
Packaging workshop		X	Mask (face covering) Clothing (long-sleeved shirts + pants) Gloves Safety shoes	
Bottling workshop		X	White coat	
Pelletizing workshop		X	Clothing (long-sleeved shirts + pants) Safety shoes	
Soap-making workshop		X	Mask (face covering) Clothing (long-sleeved shirts + pants) Gloves Safety shoes	Eye irritation (soda) Skin problems (soda) Respiratory problems (soda) Decreased sensitivity to soda
Effluent treatment workshop		X	Clothing (long-sleeved shirts + pants) Safety shoes	Dermal stinging (Sulfuric acid)
Control laboratory	X	X	Hexane vapor extractor Lab coat	

4. Discussion

The presence of toxic chemicals in the workplace poses a danger to employees. Indeed, exposure to these substances can pose risks to their health [11]. However, preventing risks to workers' health remains a challenge. The objective of this study was to assess the toxic risks of industrial chemicals and waste to which workers at the company serving as the study setting are exposed. Analysis of demographic data shows a male study population. This could be explained by the various activities carried out within the company. These activities require physical strength and would therefore be more suited to men. However, this population of workers is aging. In fact, 33.33% of this population is in the extreme age group of 51 to 55 years old. The same observation holds true today. Faye et *al.,* 2023 obtained a similar result [12]. While the resilience and skills of these seniors may explain these results, it is important to note that this age group is vulnerable to chemicals and toxic waste in industrial environments. Aging organisms undergo several physiological and biochemical changes that affect chemical metabolism and the body's response [13, 14]. The results reveal that (10%) had received professional training before starting work. In accordance with general prevention rules, workers should receive training on the precautions to be taken to ensure their own protection and that of others. Workers should also be aware of instructions regarding hygiene measures and the use of protective equipment [15]. While knowledge of the manufacturing techniques used to produce various industrial products is well established, training workers in the use of toxic products and waste management remains a challenge. In addition, the lack of training on the dangers and risks to which workers are exposed remains one of the reasons why some workers do not use protective equipment. The lack of training would also lead to a lack of awareness of the risks involved in exposure to toxic chemicals. Lack of resources was one of the reasons for the lack of training. But the toxicological risks to which workers were exposed required a collective awareness.

4-1. Workers' working environment

An inventory of the products used within the company has identified certain chemicals whose use requires precautions. Hexane, one of the solvents used within the company, is a highly flammable vapor liquid. Hexane can be fatal when exposed orally or through inhalation. According to Chin-Chang Huang et al., 2008, [16] chronic exposure to low doses of n-hexane among industrial workers can cause axonal loss with sensory impairment. Industrial workers were also exposed to phosphoric acid without adequate protective measures. Inhalation of phosphoric acid may cause pulmonary edema [17].

4-2. Risk factors encountered by workers

The survey revealed that 86.67% of workers were exposed to toxic risk factors in the workplace. Chemical risks were predominant. The chemicals used were in gaseous, liquid, or solid form. The workers most exposed were those in the extraction, neutralization, refining, soap-making, and effluent treatment workshops. These workers carried out the activities assigned to their workshop using hexane, strong acids, and strong bases. Among the other toxic risk factors cited by workers, dust was mentioned in the cleaning and shelling workshop. Industries are a source of particulate matter, exposure to which can cause toxic effects. These particulate matter consists of products used in industries [18]. Workers are therefore right to cite dust as a toxic risk factor, since it generally contains products used in industry.

4-3. Knowledge, attitudes, and practices regarding toxic chemical hazards

Workers recognized the existence of toxic chemical hazards in industry. However, none of the workers were able to define toxic chemical hazards and industrial waste due to a lack of training and the low level of education among the workers. However, industrial waste may contain hazardous materials. Indeed, industrial waste may contain hazardous materials, such as toxic chemicals [19]. The impact of this waste could be revealed by biological analyses that establish causal links. In light of these risks, the protective measures in place to ensure worker safety are inadequate. Individual and collective protective measures are not being followed. In fact, in extraction and neutralization workshops where hexane is used as a chemical, the protective masks used were not suitable. The same observation was made in refining workshops with the use of caustic soda. Only the laboratory was equipped with a hexane vapor extractor. There was a lack of collective protection in workshops using hexane or other toxic chemicals. No isolation rooms or local ventilation systems had been implemented. Other measures are planned when the elimination of toxic gas or vapor is not technically feasible, in order to minimize the level of exposure as much as possible [20]. In the cleaning and husking workshop, the dust produced by husking is toxic to workers [21]. In addition to improving personal protective equipment, it would have been necessary to install general ventilation or local exhaust ventilation. According to European directives, employers must take all available measures to reduce the use of carcinogens [20]. Hexane, one of the most widely used solvents in industry, is classified as CMR (Carcinogenic, Mutagenic, or Toxic to Reproduction) [22]. Its use should therefore be replaced, or workers should be provided with collective protection to help minimize the risk of exposure to chemicals. Although no serious toxic effects were observed in workers, significant signs were reported. Among workers in the cleaning and shelling workshop, personal protective equipment was unable to prevent the onset of signs of toxicity, particularly breathing difficulties. Indeed, dust has an impact on the respiratory system [23]. The protective masks were not suitable, exposing workers to dust. Neurological disorders (memory loss and loss of consciousness) have been reported in the extraction workshop, as a result of a lack of collective protection and also a lack of appropriate personal protection. Workers are therefore exposed to hexane. One of the toxic effects caused by hexane is neurological [24]. In this workshop, some workers report sexual dysfunction that could be due to hexane inhalation. Studies by Kazuo Aoki et *al.*, and P Nylén et al. have demonstrated the toxic effects of hexane through its metabolite 2,5-hexanedione on reproductive health in adult male rats. These studies show that 2,5-hexanedione seriously impairs reproductive health [25, 26]. Further on, in the soap factory workshop, workers reported signs of eye toxicity. A case study and review conducted by Daniel J. L. Bunker et al. demonstrated the involvement of soda in causing eye burns, specifically to the cornea, requiring rapid treatment and sometimes surgery [27]. The workers in this workshop are not equipped with protective eyewear or other eye protection devices to prevent eye burns or irritation. In addition to the signs of ocular toxicity reported in the soap factory, dermatoses have been reported by workers. Soda is believed to be the alkaline agent responsible for this sign. Studies by [28 - 30] have demonstrated the involvement of soda in the onset of atypical dermatitis. Even though the workers in this workshop wear long-sleeved overalls and pants, it should be noted that this clothing does not prevent toxic symptoms from occurring. We also note the absence of pre-employment medical examinations, which is contrary to standards.

5. Conclusion

The objective of this study is to assess the risks to which workers at a cotton processing plant in Burkina Faso might be exposed. Workers operating in the various workshops of the factory are exposed to toxic risks from pollutants and chemicals such as dust, hexane, caustic soda, and sulfuric acid. Most of the workers had already been exposed to toxic risk factors. Collective protective measures were not in place and individual measures were not adapted to the existing toxic risk. It had been agreed by those responsible for the facility to carry out actions to prevent and protect workers from these risk factors, based on WHO recommendations. With the country's growth and the drive to minimize toxic risks, it would be interesting to reassess the situation ten years later in order to highlight progress and refocus efforts to reduce the impact of chemicals.

Conflicts of Interest

No conflict of interest

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