

Original Research

Ergonomics of Workstations and Analysis of the Risks and Diseases Associated with Occupational Poisoning

Moêz Smiri^{1, 2*}

¹Department of Biology, College of Science and Arts – Sajir, Shaqra University, Saudi Arabia

²ISSTE, University of Carthage, Tunisia

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Abstract

Measuring the level of poisoning exposure, study and control of the causes of different occupational diseases is very important in the workplace. Treatment of musculoskeletal disorders and allergies is a prerequisite for developing a health conservation program in the workplace. These measurements are carried out using different methods, including information provided by the occupational doctor or nurse in statistics and periodic records or through a survey. Occupational health records provide statistics on occupational diseases and accidents at work in relation to age, seniority, and the number of medical consultations. Herein, professionals and accidents diseases, and their main causes were assessed. More than 63% of the company's employees aged 20-35 were exposed to musculoskeletal disorders (MSDs), and 22% of employees exposed to significant levels of alcohol emissions. The most widespread disease in the different work sectors was allergic rhinitis, which had a frequency of 34% for workers performing the gluing activity. The MSDs represented by gestures and postures had high statistics (35% at the scratching post). The sheathing activity has the highest number of employees. Accordingly, it is considered the "red zone" of the company and requires exceptional surveillance.

Keywords: occupational poisoning, carcinogenic alcoholic products, asthma and allergic diseases

Introduction

Occupational toxicology is the study of chemical hazards in the workplace. Furthermore, toxicology studies enable occupational hazards to be assessed and controlled. The guidelines recommended by these studies limit occupational exposure to toxic substances.

Information about professional activity is of key importance in estimating the prevalence of certain risks. Through the safety data sheet, manufacturers, importers, or vendors provide employers with the information necessary to prevent poisoning chemical risks [1]. The assessment and control of risks associated with the performance of activities are fundamental to the success of the Health and Safety Environment Management System (HSE) [2].

*e-mail: almoez@su.edu.sa

The prevention of occupational diseases must be at the heart of everyone's concerns. At the outset of the assessment process, managers should identify the ongoing and planned activities for which they are responsible. It should be important for managers to determine whether these activities are likely to create significant risks to people, company assets, and the environment. The main steps in risk identification and assessment include: (1) Identifying activities and the level of risk, (2) Ensuring compliance with applicable legislation and standards, (3) Treatment of risks and their impact on the environment, (4) Reducing risks and their impact on the environment, and (5) Developing contingency plans. The head of the HSE unit must ensure that all legal requirements as well as laws and standards applicable to the company's activities are identified for each activity. Table 1 contains a non-exhaustive list of occupational risks. The company under study is a manufacturer of automotive safety equipment (steering wheels, knobs, bellows, airbags, and seat belts). This company has established a policy that defines and documents the company's commitment to the health and safety of individuals. The identification of possible risks, their assessment, and effective controls will minimize any adverse consequences and reduce risks to a low level. The implemented process is monitored and reviewed periodically to evaluate the performance of the system and identify areas requiring improvement. For employees involved in the company's daily activities, the requirements of the relevant safety systems must be provided to them and the necessary training should be offered. Employees are recruited on the basis that they are able and willing to perform the tasks entrusted to them. The tasks and responsibilities of each job within the company are also defined and documented. Documents are reviewed annually and are an element of the personnel evaluation system that allows for the delivery of the necessary training. The company's goal is to understand the interactions between employees, their skills, the feasibility of the components of the approved occupational system, the ability of workers to carry out the required work and to ensure employee welfare and the general efficiency of its employment systems.

The present study was designed to test the following hypotheses (1) Occupational diseases and accidents

are closely related to the age group exposed to risk (2) it decreases in the category of workers with seniority, (3) it can be avoided by following an appropriate distribution of workers, (4) and it can be avoided by providing a healthy work environment.

Materials and Methods

Knowledge, Attitudes, and Practices

A CAP survey is based on a questionnaire that is conducted on a specific population. Here, the survey was randomly assigned for 100 employees out of 2,200 working in one of the three sectors in the company (SWTF, Packaging; SWT1, gaiters, gear knobs and leather parts; SWT4, Packaging) (Table 2). In this CAP study, the following parameters were assessed: (1) general characteristics (age, gender, habits and history), (2) length of service, (3) level of exposure to odors, (4) knowledge of employees of the risks involved in carrying out assigned tasks at work stations various, and (5) preventative practices. The objectives of the CAP survey were to: (1) determine the target population's knowledge of the risks of exposure to alcohol, (2) assess the target population's attitude towards the work environment, (3) provide information on the main sources of information and education used in knowledge of the work environment, and (4) learn the importance of collecting data on the relative frequency of certain behaviors associated with the risk of exposure to chemical hazards in the work environment. To assess the degree of exposure to volatile organic gases and vapors, a sample of the vapors released on the badges attached to the collars of the operator gowns, as close as possible to their respiratory tracts, was retrieved for individual sampling to assess the concentration of pollutants in the workplace.

The 5 Sheathing Positions in the Company

Description of the Cladding Process: The cladding activity represents the main function of the company. In this process, a steering wheel passes through the following stages: (1) Scraping: once the foam is formed, the sheathing activity is initiated via scraping. This operation is done in a standing position and

Table 1. Identification of the occupational risks.

Risks	Dangers	Exhibition situations
Electrical risk	Electrocution death	Use of a power tool, Intervention in an electrical cabinet
Traffic	Multiple lesions	Commuting to and from work Movement (corridors; stairs),
Chemical risk	Chemical burns, intoxication	Phytosanitary treatments, maintenance of premises
Fire	Burns, intoxication	Handling of flammable chemicals
Musculoskeletal Disorders TMS	Dorsalgia, lumbago, Sciatica	Carrying heavy loads - Insufficient breaks (overload)

Table 2. Demographic characteristics of employees in the workplace.

Year	2021	
	N	%
Gender		
Male	1366	62.10
Female	834	37.90
Total	2200	100.00
Nationality		
Tunisian	2130	96.83
Non- Tunisian	70	3.17
Total	2200	100.00
Type of exposure		
Musculoskeletal disorders	1386	63
Alcohol emissions	484	22
Other	330	15
Total	2200	100.00
Age groups		
20-35 years	1108	50.35
36-45 years	778	35.38
> 45 years	314	14.27
Total	2200	100.00

requires physical effort. At this station, each of the two scrapers rubs a wheel with the 'scraper' by using repetitive muscular movements to smooth the wheel, which is then directly passed to the gluing station; (2) Sheathing-flying gluing: the gluing stage is carried out in an upright position, with one operator applying water-based glue to the steering wheel and another applying glue to the sheath by using a water-based glue burette and a brush. The sheath and the steering wheel will be left to dry for 45 min to ensure the remaining steps are performed properly; (3) Application of the sheath: the glue is heated with the heater at a temperature of 300°C; (4) Thread passage stations: the workers pass the threads through the leather sheaths to merge it with the steering wheel (sitting position and repetitive movements) in several forms, according to the customer's request; and (5) Finishing and Final Control: the finished flywheels will be passed to the screwing station where the electrical components would be applied by the leading operator.

Analysis of the Risks Related to Different Activities

Each trade contains risks that are aggravated by the harshness of the work and failure to deal with these

risks. Such avoidances result in an increase in both human and material costs. The sheathing activity is mainly associated with the following risks: (1) chemical risks related to the use of the adhesive (fire, explosion, ignition risks, etc.) and (2) injuries risk represented by musculoskeletal disorders (MSDs). The company mainly uses glue as a chemical product. To identify the degree of exposure risk, the following parameters must be studied: (1) the used quantity of the glue: this company can be classified in the fifth class of "very important" as the product is considered to be a regular work material; (2) frequency of use: this is considered to be continuous (every day throughout the year); (3) potential exposure class: this is defined through the risk phrases; and (4) priority class: this is defined according to the hazard class and the potential exposure class. Among the risks causing MSDs, handling, repetitive movements, awkward postures, vibrations, and movement are at the forefront. In addition, indirect risks, such as psychosocial factors, the layout of the premises, humidity, cold temperatures, working hours (either very early or in the evening), and work organization, can result in MSDs. In this company, exposure to chemical or biological risks and risks of falling are also potential causes of MSDs. In terms of work organization, employees often participate in other work activities outside of the company's operating hours.

Statistical analyses was conducted. Data are the mean of three replicates (\pm SE). Each replicate was carried out with 100 employees. Differences in the variables were tested using parametric one-way ANOVA tests. Different letters indicate significant differences ($P < 0.05$).

Results

Evaluation of Occupational Poisoning Risks and Diseases

The company has a total of 2,200 employees. The data in the CAP survey were retrieved from 100 employees. Three age groups were considered and distributed according to Fig. 1a). The average age of our sample population was 32 years old. Almost an equal number of employees belonged to the 20-35 and 36-45 age groups. Most of the employees were recognized to be trained staff, with 85% of employees in the 20-35 age group, 80% in the 36-45 age group, and 56% in the >45 age group being trained (Fig. 1b). The percentage of employees exposed to higher levels of alcoholic odors was higher in the younger age groups than the oldest group (80% for the 20-35 age group, 72% for the 36-45 age group, and 61% for the >45 age group; Fig. 1c). Further, the percentage of employees exposed to higher levels of MSDs was found to increase with age (approximately 38% for the 20-35 age group, 49% for the 36-45 age group, and 61% for the >45 age group; Fig. 1d).

When the attitude of employees toward consulting doctors was assessed, 30% of employees were not found to have regular consultations with the doctor, while 70% visited the doctor on a daily basis (Fig. 2a). Employees directly exposed to alcoholic gas visited the occupational physician periodically to ensure their health was regularly monitored. Although 79% of these employees are directly exposed, only 21% make occasional visits when exposed (Fig. 2b). The results presented in Fig. 2c) show that 19% of employees with high exposure to MSDs rarely made medical visits.

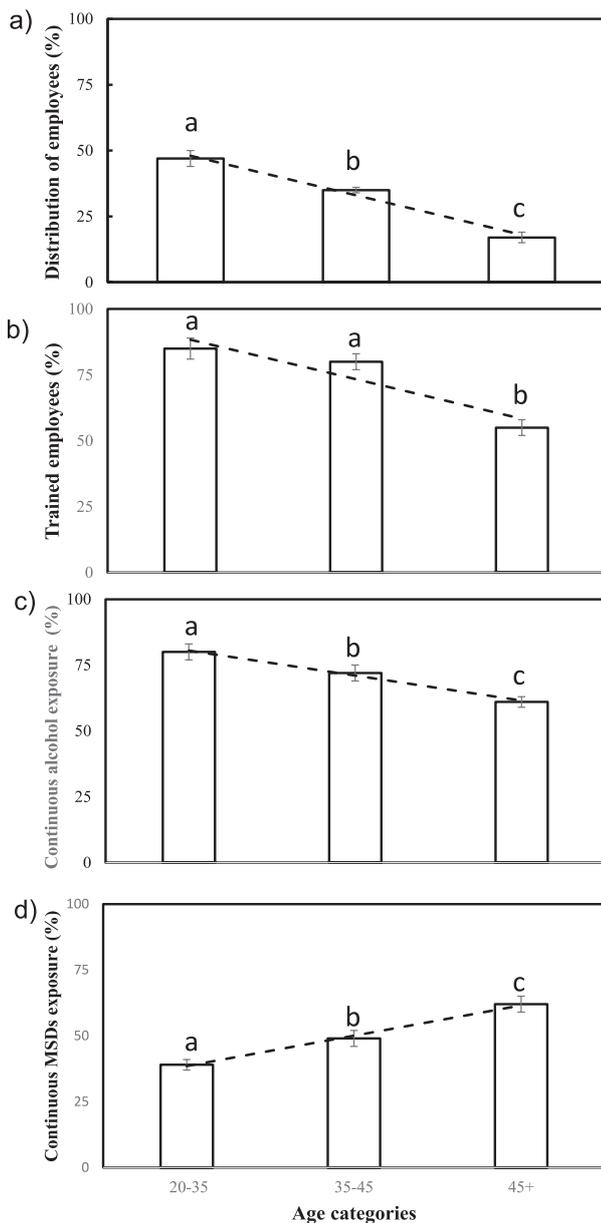


Fig. 1. Evaluation of risks and occupational diseases. a) Distribution of employees by age group (%), b) Trained employees rate (%), c) Distribution of employee exposure by age group (%), and d) Distribution of MSDs exposure of employees by age group (%). Data are the mean of three replicates (\pm SE). Each replicate was carried out with 100 employees. Different letters indicate significant differences ($P < 0.05$).

Most employees (80%) perceive that alcohol has a major impact on their health (Fig. 3a). However, for each age group, some employees did not comply with the recommendations regarding the wearing of personal protective equipment (PPE) (Fig. 3b). In fact, 44% of employees over 45 years old rarely or never used PPE. However, most employees aged 20 to 35 years old always or often (81%) used PPE. The results presented in Fig. 3c) show that 22% of employees who rarely or never use PPE were exposed to intense levels of alcoholic gases.

Proposal and Implementation of Indicators for Monitoring Performance in Ergonomic Terms

The frequency of work accidents recorded over three months was identified to be higher in the SWTF level (8

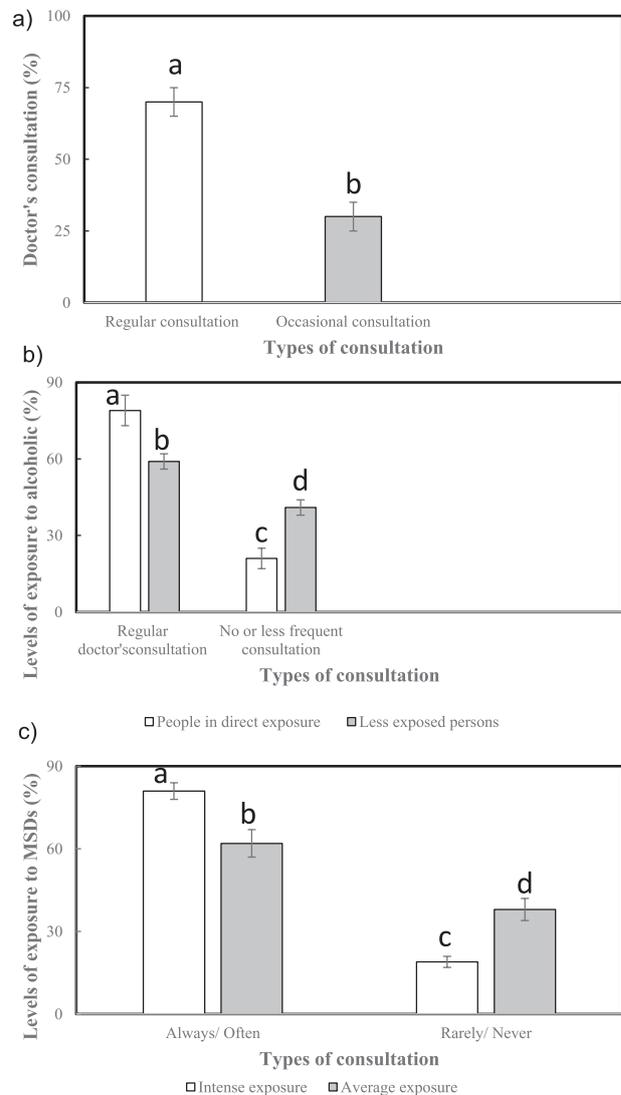


Fig. 2. Employee attitudes: Consultation with doctors. a) Distribution of employees by doctor's consultation, b) Attitude and level of exposure to alcoholic odours and c) Attitude and level of exposure to MSDs. Data are the mean of three replicates (\pm SE). Each replicate was carried out with 100 employees. Different letters indicate significant differences ($P < 0.05$).

people per month in May) than other sectors, as well as in the sheathing process than the cutting process (Fig. 4). The results of these analyses demonstrate that the jobs most associated with occupational risks are successive gluing, sheathing, followed by scraping, which causes a lower frequency of illnesses (Fig. 5). Fig. 6 shows that the most widespread disease in the different work sectors was allergic rhinitis, which had a frequency of 34% in workers performing the gluing activity. The statistics of occupational illnesses and work accidents recorded at the studied company show that MSDs and allergy are the major problems that require preventive ergonomic studies to limit their undesirable effects on staff and productivity (Fig. 7).

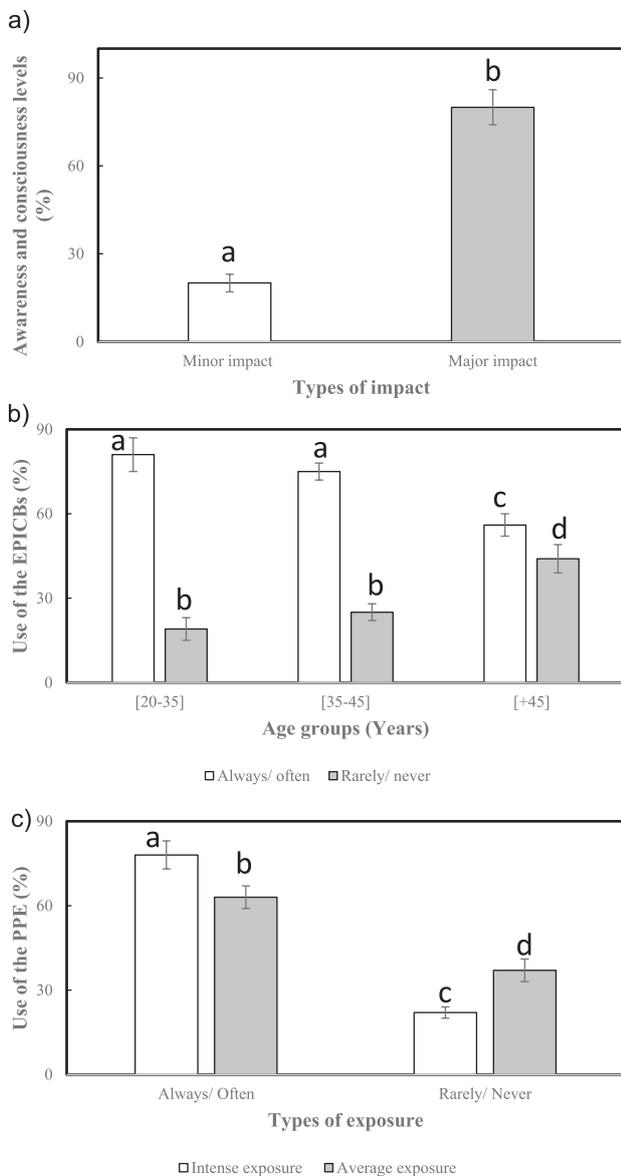


Fig. 3. Employees' knowledge of the effects of alcoholic gases. a) Awareness and consciousness levels, b) Distribution of use of the EPICBs by age group and c) Use of PPE by level of exposure to alcoholic gases. Data are the mean of three replicates (\pm SE). Each replicate was carried out with 100 employees. Different letters indicate significant differences ($P < 0.05$).

Compared to older workers, young workers aged 15-24 are more often victims of employment injuries [3, 4]. Among young people, the injuries compensated by the "Quebec Workplace Health and Safety Commission" (CSST) are mainly related to work accidents, such as traumatic muscle injuries and wounds or contusions. Data from the "Quebec Institute of Statistics" (ISQ) for 2004 revealed that half a million young people aged 15 to 24 work in Quebec. However, there is less concern about MSDs among this population of workers, as these conditions are generally not reported at this age [5].

The activity rate of young people has been growing steadily in recent years, even exceeding that of older adults. In fact, 50% of young people work part-time and an estimated 45% study at the same time during the school year [6]. Young people also hold more non-standard jobs than the rest of the working population. According to the definition [7], the term, work-related MSD, refers to damage caused by excessive strain on the musculoskeletal tissues. These injuries occur when the demand for work exceeds the adaptive capacity of the tissues [8]. The onset of an MSD suggests the

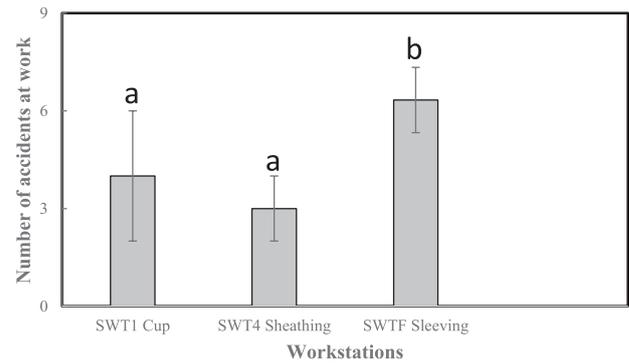


Fig. 4. Statistics of accidents at work in the company in 2021. Distribution of occupational accidents according to workstations. Data are the mean of three replicates (\pm SE). Each replicate was carried out with 100 employees. Different letters indicate significant differences ($P < 0.05$).

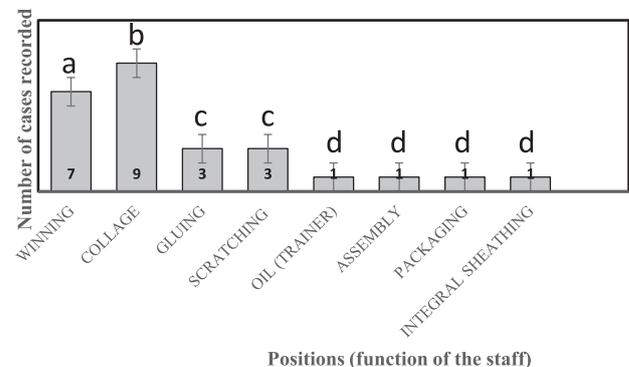


Fig. 5. Occupational Diseases registered until the end of 2021. Data are the mean of three replicates (\pm SE). Each replicate was carried out with 100 employees. Different letters indicate significant differences ($P < 0.05$).

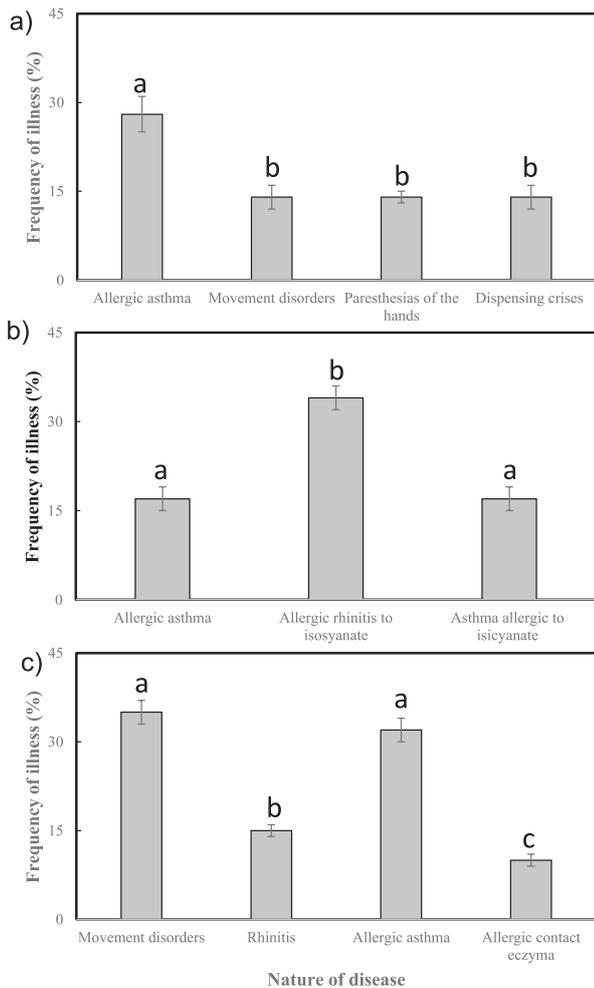


Fig. 6. Frequency symptoms of poisoning illnesses according to workstations. A), Sheathing; b), Gluing; c), Scraping. Data are the mean of three replicates (\pm SE). Each replicate was carried out with 100 employees. Different letters indicate significant differences ($P < 0.05$).

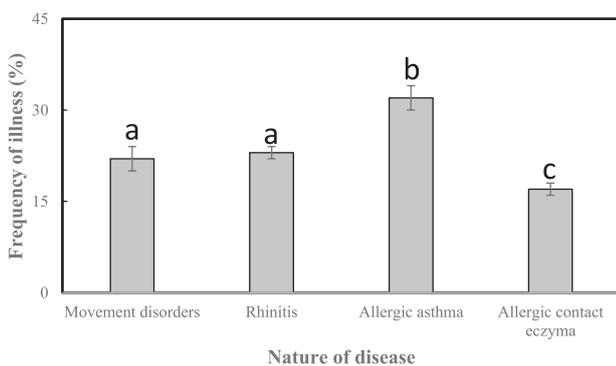


Fig. 7. Musculoskeletal Disorders and Allergy in 2021. Data are the mean of three replicates (\pm SE). Each replicate was carried out with 100 employees. Different letters indicate significant differences ($P < 0.05$).

gradual development of impairments that precede the injury, over a period of time, which varies according to exposure and the worker's ability to adapt, known as the

latency period. Herein, we sought to consider the mass of information currently available on young workers and occupational health and safety (OHS), and suggest some useful avenues for reflection on a preventative treatment approach. First, we present the results of a literature review on this subject followed by recently analyzed OSH indicators to stimulate a reflection on the processes of occurrence and the reporting of MSDs.

The prevalence of asthma and allergies as sign and symptoms of poisoning were doubled at the end of the last century, especially among the youngest age group [9]. However, in the early 2000s, some studies found a stabilization in the increase in prevalence of asthma and allergies [10], which was not found by other studies, particularly pediatrics studies [11]. Due to their major economic impact on public health, allergic diseases rank fourth in the world according to the World Health Organization (WHO). Respiratory allergy is often the first manifestation of allergy. Thus, it is important to diagnose allergy at the earliest convenience to implement preventive measures at an early stage.

Consulting the occupational physician is an important action for monitoring the health status of personnel and preventing any risk that may interrupt the production rhythm. The principle of a recommended medical check-up at the end of a career exists in some companies and administrations. Nevertheless, to better target the levers for real improvement in working conditions for everyone, these preventive visits must be carried out every three years, starting from the age of 55, as part of the employer's obligation, in terms of medical surveillance. Further, these routine visits must be systematic in the most difficult jobs [12].

Studies have revealed that people who visit the infirmary less frequently are at a greater risk of developing MSDs; this is because permanent monitoring of their health is not carried out. Allergy is a disease that requires excessive medical monitoring to prevent its adverse effect on an employee's health. Skills assessment (law of 2 July 2007, decrees of 26 December 2007 and 21 August 2008 and order of 31 July 2009) should be more extensively utilized to identify the skills of an employee and design trainings that are adapted to their mobilization [13]. The participatory approach, characterized by training during the work analysis performed by ergonomists, is also considered to be a condition for the success of the above approach [14]. Training is used to change the way in which employees see the problem to be resolved and how this resolution can be achieved.

Despite the difficulties associated with evaluating training [15], researchers interested in the training-ergonomic relationship emphasize, as the main change generated by this type of training, the evolution toward a more complex representation of work activity than that which prevailed before training [16, 17]. Indeed, it is important of involving managers to understand the ergonomic approach [18]. Employees working with carcinogenic alcoholic products must receive

specific training to ensure that they are informed of the undesirable effects of these products and the measures that can be taken to prevent these effects.

Discussion

MSDs are the most widespread occupational health problem in Europe [19]. In 1999, 4.1 million workers suffered from this type of disease, representing 53% of reported occupational diseases. As a result, surveys have been carried out among workers to measure the evolution of this health disorder. The number of people claiming to suffer from back pain rose from 30% to 33% in Europe between 1995 and 2000 and from 29% to 40% in France. In addition, at the EU level, 23% of workers revealed that they suffer from shoulder and neck pain, 13% from upper limb pain, and 12% from lower limb pain. Similar results were found in our study, where MSDs affected the oldest age group (61% of the >45 age group). This age category was mainly found to suffer from pain in the shoulder, back, and grip (scratching post).

MSDs, as a physical factor, explain only a small part of the variability in individual responses. As a result, other factors must be investigated, including: (1) Individual factors or socio-demographic factors: gender, age, habit and level of education, and (2) Cultural factors: which generally determine the time that an individual spends inside the home (this appears to be an important factor in MSD tolerance). The average age of the studied population was 32 years, compared to other Tunisian studies, which had an average age of 35 years [12]. In a Canadian study carried out in Quebec in 1999, the average age of the population exposed to MSDs was around 37 years [19]. Accordingly, the employees surveyed in the present analysis were younger than those surveyed in national and international studies. The increase in exposure to MSDs is the result of a natural process, which appears in many people after the age of 45; however, certain factors can accelerate its onset, including repetitive work or exposure to overload. In our study, we found that 63% of the company's employees aged 20-35 were exposed to MSDs. These employees were found to work in an environment with a high workload. In these conditions, the average age of the sample is a factor that defines the individual's vulnerability to the risk of MSDs. Particularly, the hours of exposure alone can cause MSDs.

Studies show that most of the employees surveyed in the company are trained staff. In fact, in the oldest age group, 85% of the workers were identified as trained staff. The presence of a prevention doctor in the company involved the occupational health and safety of employees that can be regularly monitored and addressed. Doctors and psychologists should ensure both managers and staff that are aware of their mission and services, as well as the problems associated with

occupational health (stress, psychosocial risks, exposure to noise, etc.) by hosting conferences and specific training [20-23]. With regard to employees' attitudes toward consulting doctors, 30% of employees in this company did not have regular consultations with the doctor, while 70% visited the doctor on a daily basis. Further, 21% of workers that are directly exposed to gases made occasional visits. As a result, it is rather difficult to diagnose the health state of these workers. Moreover, 19% of employees with intense exposure to MSDs rarely made medical visits, hence the complexity of their situation.

Despite the high level of employee awareness, employees still perform jobs that are associated with quantifiable levels of exposure to gas and MSDs. As a result, these employees find themselves in environments where working conditions are imposed and preventative measures are not effectively enforced. It is important to promote prevention in the workplace and to encourage employees to improve working conditions. With regard to toxicological nuisances, occupational deafness is often bilateral, complete, and irreversible, with no treatment available to restore hearing loss. The impact of poisoning alcoholic gases on the health state of employees was not a motivating factor for the demand and/or use of a gas protective equipment (EPICG). In fact, 22% of employees exposed to significant levels of alcohol emissions rarely or never used EPICG, despite its availability throughout the company. These employees believe that EPICGs are uncomfortable and do not provide full protection. Such feedback explains the lack of demand for this protective equipment, particularly among older employees, with 44% of employees over 45 years old rarely or never using this PPE. The personal protectors made available to employees must be worn as long as possible to take full advantage of their effectiveness. EPICGs are used in the event of insufficient general or collective prevention. They are two types of EPICGs: (1) Masks: Worn over the nose and mouth. Masks are made of silicone, rubber, or any other soft material; are available in several sizes; and can reduce the intensity of the emitted gases, and (2) Gloves: Generally, provide better protection. Gloves reduce the likelihood of direct contact with the skin; however, they are bulky and tight, which make them less tolerable despite their effectiveness. An indicator is a variable that measures, describes, or assesses, totally or partially, a state, situation, and/or the evolution of an activity or program [16]. In this study, we used the following indicators: statistics on occupational accidents and diseases recorded by the occupational health authorities. By monitoring these records, we were able to gain a clear picture of the real situation faced by employees, which in turn could facilitate intervention, if necessary. The monitoring of occupational Poisoning accident records for three months (March, April, and May) revealed that the frequency of this type of accident is higher in the SWTF (8 people in May) than in other sectors, and in the sheathing process than the cutting

process. The SWTF compartment, which primarily performs the sheathing activity, has the highest number of employees. Accordingly, it is considered the “red zone” of the company and requires exceptional surveillance. The breakdown of the workplace into sectors revealed that the jobs resulting in the greatest exposure to occupational risks were successive gluing, sheathing, followed by scraping, which is associated with a lower incidence of illness. The most widespread disease in the different work sectors was allergic rhinitis, which had a frequency of 34% for workers performing the gluing activity that required the use of glue (the main material) for the stain. Allergic rhinitis being a highly prevalent disease, according to literature [24]. Factors associated with triggering allergic rhinitis by pollen were male gender, older age group, smoking and persistent allergic rhinitis. Meng et al. [25] reported the role of environment and some other factors in allergic rhinitis pathogenesis. Several studies demonstrated the negative impact of allergic rhinitis on quality of life and occupational activities [26]. Rhinitis was declared as an occupational disease in 33% of cases and justified a workstation adjustment (54.8%) or a transfer to another workstation (35.7%) with the notion of a net improvement after eviction in 17.4% of cases and partial improvement in 65.2% of cases [27]. The MSDs represented by gestures and postures had high statistics (35% at the scratching post); the operators performing this task were found to be subjected to long periods of standing, which damages the spine and foot muscles, as well as greasy wrists caused by repetitive movements. Zare et al. [28] provide objective and quantitative data about time exposure, variability, and potential risk factors in the real workplace. A relationship was found between the percentage of time spent in awkward upper limb posture and musculoskeletal symptoms. Matching postural deviation patterns with present and absent perceived back and neck pain, and fatigue distinguish between groups, complementing known MSD contributors [29]. Sarah et al. [30] demonstrate the importance of swipe locations and suggest that the tablet interface design can be improved to induce more neutral thumb and wrist posture along with lower forearm muscle load.

Conclusion

Exposure to poisoning leads to fatal diseases such as cancer, liver or kidney failure, and others less severe like allergy and MSD. The average age of our sample population was 32 years old. The greatest number of employees exposed to higher levels of alcoholic poisoning was the younger age group (80% for the 20-35 age group). The most affected with MSDs were the oldest employees (61% for the >45 age group). Most of the employees were recognized to be trained staff, with 85% of employees. The obtained results showed that the jobs most associated with occupational risks are

successive gluing, sheathing, followed by scraping. The statistics of occupational illnesses and work accidents recorded that MSDs and allergy are the major problems that require preventive ergonomic studies to limit their undesirable effects on staff. Employees working with carcinogenic alcoholic products must receive specific training. The MSDs represented by gestures and postures had high statistics (35% at the scratching post). It is important for employees to attend medical visits, hence the complexity of their situations and to minimize the exposure to MSDs.

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Conflict of Interests

The authors declare no conflict of interest.

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