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Workplace Safety in Hospital Laboratories: Occupational Accidents and Work-Related Diseases

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Abstract: Workplace safety in hospital laboratories is crucial for the health and well-being of employees. Due to the potentially hazardous nature of the chemicals handled, workers are exposed to a variety of risks, ranging from occupational accidents to work-related diseases. The main objective of our study was to identify work-related accidents and occupational diseases associated with exposure to occupational hazards in medical analysis laboratories and to determine preventive measures. *Materials and method* : The sample for our cross-sectional descriptive study consisted of 113 individuals working in the hemobiology, biochemistry, and anatomical pathology laboratories. A questionnaire was designed to collect data, providing a precise assessment of occupational accidents and the risks faced by the employees. *Results* :18.87% of participants reported having suffered a work-related accident, with no significant correlation with gender ($p = 0.955$) or age ($p = 0.133$). Among these accidents, 66.7% were of a mechanical nature, including 36.1% involving skin injuries and 21% involving eye injuries. Investigations into the causes revealed that 32.05% of the accidents resulted from a lack of protective measures, 50.76% were attributable to negligence, and 17.23 % were related to emergency situations. Furthermore, employees working in a fixed daily position are at an increased risk of accidents ($p = 0.003$). Additionally, occupational diseases have also been reported, with 32.29% of participants affected by occupational allergies and 33.22% by skin sensitizations. Moreover, approximately 14.81% of participants suffered from respiratory diseases, while 13.15% had eye injuries. Finally, about 6.48 % of participants were diagnosed with occupational cancer. *Conclusion* : Our study highlighted that occupational accidents have

significant consequences on the health of employees, particularly concerning conditions related to exposure to chemical reagents. This underscores the urgent need to improve safety and prevention measures to ensure the protection of workers.

Keywords : Chemicals, Occupational accidents, Work-related diseases**.**

Introduction

Hospital laboratories are high-risk work environments. They combine, on one hand, the classic hazards of the workplace, such as occupational accidents, and, on the other hand, specific risks associated with their activities. Indeed, the daily handling of a wide variety of chemicals, some of which have potentially hazardous effects, poses a significant threat. These substances, available in various forms (liquids, powders, gases) and in varying quantities (from micrograms to kilograms), are used according to the needs of the analyses, which complicates risk management despite preventive efforts. (Cadet et al., 2024)

Workers are exposed to various hazards, ranging from immediate occupational accidents to work-related illnesses that may manifest after prolonged exposure. (INRS, 2017). Toxic, corrosive, flammable, or mutagenic chemicals can lead to acute poisoning through inhalation or direct contact. Some substances cause irritation or allergic reactions, while others, through accumulation, increase the risk of serious pathologies, such as cancers. (INRS, 2023b ; Roy et al., 2015). The effects of chemical exposure depend on several factors: the quantity and duration of exposure, the nature of the substance, the route of exposure, as well as the characteristics of the exposed individual (age, sex, medical history).(INRS, 2023b)

Understanding the various health effects resulting from exposure to chemicals allows for the identification and characterization of at-risk situations, the implementation of appropriate prevention and protection measures, and the prevention and detection of any poisoning following an incident or accident. (Cadet et al., 2024) Safety procedures and the provision of personal protective equipment (PPE) help to mitigate certain hazards; however, the complete elimination of risks remains challenging due to the unpredictable nature of certain incidents. (INRS, 2023a).

The primary objective of our study was to identify occupational accidents and work-related illnesses associated with exposure to occupational hazards in medical analysis laboratories and to determine preventive measures.

Materials and Method

This cross-sectional descriptive study was conducted among 113 employees working in three laboratories of a hospital-university center in eastern Algeria. The hematobiology laboratory accounted for 61% of the respondents, while the biochemistry and pathology-anatomy-cytology (PAC) laboratories contributed 14.2% and 24.8%, respectively. The vast majority of the staff voluntarily agreed to participate in the survey, resulting in a participation rate of 94.17%, thus ensuring a representative sample.

The data were collected during individual interviews using a previously developed and validated questionnaire to provide an accurate assessment of risks. This questionnaire was structured into four distinct sections, totaling 29 questions. Particular attention was given to the clarity and simplicity of the questions to facilitate understanding and ensure the reliability of the responses obtained. We opted primarily for closed-ended questions.

Questionnaire Structure

The first section collected personal data (age, sex, rank, level of education, marital status) and professional information (job position, work schedule, etc.), as well as medical history and toxic habits (tobacco, alcohol). The second section focused on occupational accidents and work-related illnesses. It facilitated the collection of data on the frequency and nature of accidents occurring in the workplace, as well as illnesses potentially related to short-term (acute poisoning) or prolonged exposure to chemical substances. The third section explored the use of individual and collective preventive measures, including the availability of protective equipment (gloves, masks, goggles, fume hoods, etc.), its actual use by staff, and perceptions of its effectiveness in risk prevention.

The fourth section addressed training in hygiene and safety. It aimed to evaluate the quality and frequency of training sessions provided and awareness-raising activities for staff regarding preventive measures and risk management.

Data Collection and Analysis

The data were entered and analyzed using SPSS version 25 software. Descriptive analyses were conducted to present the results, highlighting frequencies and percentages. Various statistical tests, including correlation and association tests (Chi-square test and Fisher's exact test), were used to explore potential relationships between the studied variables. For all analyses, a p-value of less than 0.05 was considered statistically significant.

Results and Discussion

Population Characteristics

The study involved a total of 113 workers. The population was predominantly female (87.61%). Males represented 12.39% of the participants, resulting in a sex ratio of 0.14. Laboratory technicians and biologists constituted the most represented categories of workers, accounting for a total of 47.79% of the participants. Residents followed with 28.32%, indicating a significant presence of training staff. The average age of the participants was 32.55 ± 7.69 years, with extremes ranging from 21 to 57 years. The majority of workers (82.24%) were aged between 20 and 40 years, while 15.46% were in the 40 to 60 age range.

These observations are consistent with the results of the study by Tait et al., conducted in 108 medical laboratories in Kenya, which included 204 employees with an average age of 30.1 ± 7.1 years. However, the female predominance was less pronounced in this study (51.5% women compared to 48.5% men). (Tait et al., 2018). Similarly, a study involving 234 laboratories in a hospital-university center in Turkey reported a female majority of 69.2%, which is close to our study; however, the predominant age group was 40 to 49 years (40.9%), contrasting with our results.(Boyacı, 2021). The data from our study indicated that 41.41% of the women in the three laboratories were married. A small percentage of 2.65% of the participants reported having toxic habits related to tobacco and/or alcohol.

Table 1. Characteristics of the study population

Characteristics		**Frequency (%)**
Age group	[20-40[years	82,24 %
	[40-60[years	15,46 %
	Over 60 years	20.3 %
Gender	Female	87,61 %
	Male	12,39 %
Level of Education	University	84.1 %
	Secondary	11.50 %
	Primary	4.42 %
Grade	Assistant Professors/Assistants	5.31 %
	Residents	28.32 %
	Laboratory Technicians and Biologists	47.79 %
	Administrative Secretaries	11.50 %
	Cleaning Staff	4.42 %
Toxic Habits:	Tobacco and/or Alcohol	2.65 %

Occupational Accidents (OA)

18.87% of workers reported having been victims of at least one occupational accident. This prevalence is lower than that reported in the study conducted by Appiagyei et al. in a public hospital in Ghana, where it was 29.7% over a period of 12 months. The annual incidence was estimated at 1.63 injuries per person, highlighting the increased exposure to occupational hazards for healthcare staff in these environments. (Appiagyei et al., 2021). Another study conducted in hospitals in Jeddah, Saudi Arabia, involving 387 participants, revealed that the overall prevalence of work-related accidents reached 52%. (Alameer & Noor Elahi, 2023)

These figures underscore the severity and recurrence of occupational risks in the healthcare sector, particularly in medical analysis laboratories, where the handling of chemical or biological products increases staff vulnerability. However, the statistical analysis conducted in our study did not show a significant correlation between work accidents and the sex ($r = 0.006$, $p = 0.955$) or age ($r = 0.162$, $p = 0.133$) of the respondents, suggesting that these characteristics are not major predictors of accidents in our sample. Regarding the nature of the accidents reported in the laboratories of our study, approximately 66.7% were mechanical in nature, 36.1% involved skin injuries, and 21% involved eye injuries. These types of accidents may result from improper handling of equipment or chemicals, highlighting the importance of increased vigilance. Blood exposure accidents, accounting for 32.5%, were observed in the biochemistry and hemobiology laboratories. This type of accident involved risks associated with exposure to infectious agents, often through needle stick injuries or contact with biological fluids.

A Lebanese study involving 220 participants reported a rate of 40.5% of mechanical accidents and 8.1% of biological accidents. These rates, which are lower than our results, may be explained by the availability of protective measures for 86.5% of the participants and by training and awareness initiatives, endorsed by 96.6% of the participants in that study. Regarding laboratory workers, it is noteworthy that women (85.9%) were significantly more exposed than men (14.1%) ($p = 0.044$). Age was not significantly associated with exposure to accidents ($p = 0.364$).(Nasrallah et al., 2022). Moreover, a study conducted in Kenya concluded that biological accidents were the most frequent, with 80% of respondents reporting exposure. Regarding chemical risks, the handling of unlabeled and unmarked products was the most common, affecting 38.2% of participants in the medical laboratories of Kajiado. (Tait et al., 2018)

In our study, according to the reports of the surveyed workers, negligence was the predominant factor, responsible for 50.76% of reported incidents, followed by a lack of protective measures, which contributed to 32.05% of accidents. Lastly, emergency situations or workload overload accounted for 17.23% of the accidents. Furthermore, the type of workstation appears to be a determining factor, with a significant association between the type of position and the frequency of accidents ($p = 0.003$). Employees with a fixed daily position are more likely to be victims of occupational accidents than those working on a rotating shift system. This trend may be explained by cumulative fatigue, monotony, or prolonged exposure to risks.

According to the study conducted in Ghana, multivariable analysis identified several factors influencing the occurrence of work-related injuries. Work-related stress was associated with an increased risk of accidents (adjusted OR: 2.68; 95% CI: 1.26-5.71). Additionally, employees working in laboratories had a significantly higher likelihood of sustaining injuries (adjusted OR: 3.26; 95% CI: 1.02-10.50).(Appiagyei et al., 2021). A study conducted in hospitals in Jeddah, Saudi Arabia, revealed that splashes to the eyes or mouth (20.4%) were the most frequent injuries. These incidents were significantly correlated with extended work hours ($p = 0.0001$) and insufficient use of personal protective equipment (PPE) ($p = 0.010$).(Alameer & Noor Elahi, 2023)

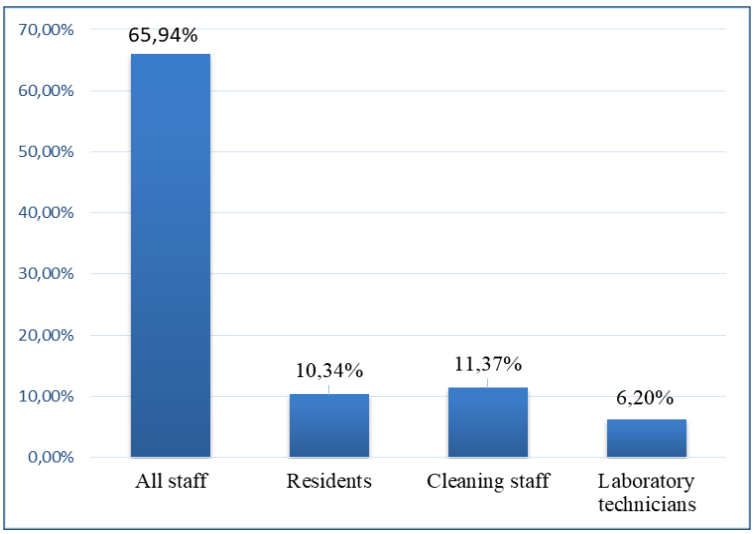

Figure 1. Distribution of occupational accidents by professional category in the three hospital laboratories

Similarly, the study conducted in Lebanon on 220 laboratory employees also highlighted concerning results. Full-time workers represented the majority of those exposed to occupational accidents (90.9%) and were significantly associated with the occurrence of accidents compared to part-time workers (9.1%) ($p <$

0.001).(Nasrallah et al., 2022). Occupational accidents in hospital laboratories disproportionately affect several categories of personnel. (Kouame et al, 2024). According to our data, 65.94% of the occupational accidents involved the entire hospital laboratory staff, encompassing various professional categories facing diverse risks.

Cleaning staff accounted for 10.34% of the cases. Their vulnerability primarily arose from their frequent exposure to chemicals and sharp objects, a situation exacerbated by often insufficient training in risk management. Residents, involved in 11.37% of the incidents, are particularly affected due to their direct participation in the handling of hazardous biological and chemical substances. Finally, laboratory technicians, who regularly handle biological samples and chemicals, were responsible for 6.20% of the reported accidents (Figure 1).

Presumed Work-Related Diseases (WRD)

Pathologies caused by chemicals can manifest several months or even years after exposure. (INRS, 2001). In our study, presumed work-related diseases were frequently reported, with 60.5% of cases attributed to prolonged contact and regular use of chemicals. The lack of preventive measures accounted for 31.6% of the cases. Furthermore, equipment-related issues were responsible for 7.1% of the diseases, while poor ventilation and excessive workload contributed marginally, accounting for 0.9% of the cases.

Dermatological Pathology

Prolonged exposure to chemicals is consistent with the reported symptoms. Indeed, 32.29% of workers suffered from occupational allergies, and 33.22% experienced skin irritations. Among them, 73.5% reported that the onset of these dermatological symptoms was closely related to the use of chemicals such as formaldehyde and xylene.

Respiratory Pathology

Furthermore, approximately 14.81% of participants reported respiratory diseases, with 55.67% attributing them to exposure to chemicals such as formaldehyde, xylene, and acetone.

Ocular Pathology

In addition, 13.15% of workers reported ocular injuries, which were also associated with the use of chemicals, particularly formaldehyde and acetone. A Turkish study revealed that 22.5% of laboratory workers (N=9/40) had been diagnosed with an occupational disease. Furthermore, no significant differences were observed between sexes ($p=0.233$) or age ($p>0.05$) regarding the incidence of occupational diseases. (Taskingul et al., 2024). Similarly, a Lebanese study indicated that 57.6% of participants experienced health issues related to accidents in the laboratories. The primary routes of exposure among participants, in order of significance, were inhalation (45.4%), contact with the skin or eyes (40.5%), and injuries (13.1%).(Nasrallah et al., 2022).

CMR Pathologies (Carcinogenic, Mutagenic, and Reproductive Toxicity)

14.63% of women (6 out of 41) reported having experienced infertility. Regarding pregnancy outcomes, 17.14% of women who had been pregnant stated that they had experienced at least one miscarriage. Additionally, 8.57% reported having given birth to a stillborn child (Table 2). The results suggest a possible link between laboratory work and difficulties with fertility or pregnancy complications, although the small sample size and study protocol do not allow for formal confirmation.

In this context, a Finnish study (1990–2006) compared pregnancy outcomes between laboratory technicians and teachers, suggesting a potential reduction in fetal growth. (Halliday-Bell et al., 2010). However, results from the Danish national cohort (1997–2003) indicated that only female technicians handling radio-immuno-assays or radiolabeled markers exhibited an increased risk of preterm birth and major malformations, without suggesting a heightened risk of overall reproductive failure.(Zhu et al, 2006)

Finally, several studies have revealed an increased risk of spontaneous abortions, perinatal mortality, congenital malformations, as well as a higher incidence of chromosomal abnormalities among laboratory-exposed workers. (INRS, 2001). Additional studies are needed to explore the relationship between laboratory work and gyneco-obstetric risks.

Table 2. Distribution of the frequency of occupational diseases among laboratory personnel by type of disease and chemical agents

Effect Type		**Frequency**	**Chemical Products**
Dermatical Pathology		33.22 %	Formaldehyde Xylene Detergents Latex Staining reagents
Respiratory Pathology		14,81 %	Formaldehyde Xylene Acetone Antiseptics Staining reagents
Ocular Pathology		13.15 %	Formaldehyde Acetone Detergents
CMR pathologies	Sterility	14.63 %	Formaldehyde
	Abortion	17.14 %	Chloroform
	Stillborn	8.57 %	Basic Fuchsin
	Cancers	6.48%	ADVIA PEROX

Approximately 6.48% of workers were affected by cancer, although no direct link to chemical reagents has been demonstrated. However, these cancers may be associated with CMR (carcinogenic, mutagenic, and reproductive toxic) reagents, such as ADVIA Perox, chloroform, formaldehyde, and basic fuchsin. Occupational cancers may appear 10, 20, or even 40 years after exposure. The cancer risk for operators in laboratories is still not well understood. An international cohort study initiated in 1986 showed an increased risk for cancers such as leukemias, lymphomas, and cancers of the pancreas, brain, bones, thyroid, breast, and uterus, although the conclusions are limited by methodological biases and the diversity of exposures. (INRS, 2001)

A cohort study conducted in Sweden evaluated the overall incidence rate and standardized incidence ratio (SIR) of cancer among laboratory personnel. It showed that the overall incidence of occupational cancers in laboratories was 2.24%. Among male laboratory workers, the SIR for brain tumors was 1.69 (CI: 0.62–3.68). For women, the SIR for malignant melanoma was particularly high, reaching 3.51 (CI: 0.96–8.98). Additionally, the SIR for breast cancer among women working in laboratories was 1.62 (CI: 0.78–2.98). These types of cancers are associated with exposure to organic solvents and chemical reagents, such as formaldehyde, as well as CMR substances (carcinogenic, mutagenic, and reproductive toxic).(Wennborg et al., 2001). Another case-control study conducted in Sweden, integrated into the Malmö Diet and Cancer Study cohort, revealed that women exposed to chemicals in the workplace had an increased risk of breast cancer (OR = 1.59, 95% CI: 1.11–2.29). This risk was proportional to the duration of exposure. In particular, women exposed for more than 10 years to solvents had an odds ratio of 3.06 (95% CI: 1.18–7.96)(Videnros et al., 2020).

Compliance with Occupational Accident and Disease Prevention Measures

Among the surveyed personnel, 31.86% reported not adhering to prevention measures. This non-compliance was attributed to negligence in 22.68% of cases, a lack of preventive resources in 10.31%, and other reasons, such as absence of training, in 2.06% of cases. Workers also reported several gaps in protection, which directly influenced occupational accidents and diseases. Fume hoods were missing in 24.78% of cases, followed by windows (20.35%) and protective creams (23%). Additionally, protective eyewear and gloves were deemed insufficient in 18.58% and 10.61% of cases, respectively.

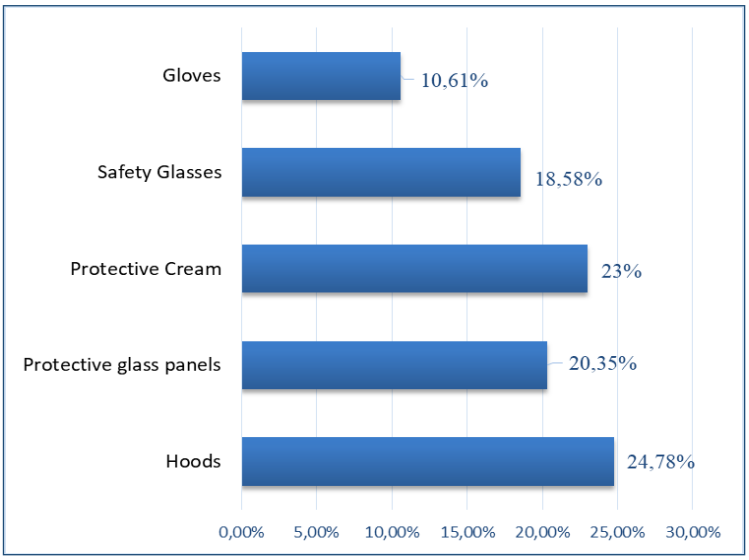

Figure 2. Distribution of ınsufficient protective measures reported by workers

Measures to Prevent and Reduce Occupational Accidents and Work-related Diseases

For 41.3% of the surveyed personnel, providing protective measures is considered the most effective solution for reducing the incidence of accidents. Approximately 30.2% believed that improving working conditions could also contribute to this reduction. Furthermore, 19% highlighted that raising awareness would play an important, though not decisive, role. Finally, only 9.5% of respondents viewed training as a relevant preventive measure, noting that it was not provided in 75.22% of cases.

Conclusion

This study highlighted the extent of the risks faced by hospital laboratory workers due to exposure to various chemicals. The results show a significant prevalence of occupational accidents and diseases, revealing gaps in prevention measures and the use of personal protective equipment. Factors such as negligence, lack of adequate training, and insufficient safety devices have been identified as key determinants in the occurrence of these incidents. This situation underscores the importance of proactive risk management and increased awareness of the dangers associated with handling chemical substances. The study thus emphasizes the need for ongoing attention to safety in these high-risk work environments to protect worker health and ensure a safer workplace.

Recommendations

- To enhance safety and reduce the risks of occupational diseases and work-related accidents, it is essential to:
- Strengthen personal protective equipment (PPE) by ensuring that all workers have access to adequate protection.
- Implement regular training programs to educate employees about the dangers of chemical products and best safety practices.
- Regularly assess and improve working conditions in laboratories to identify and rectify potential risks.
- Promote a safety culture where every employee feels responsible for their own safety and that of their colleagues, and where incidents can be reported without fear of retaliation.
- Establish clear emergency procedures for managing accidents or exposures, ensuring that all employees are trained in these protocols.
- Regularly monitor and evaluate health and safety incidents, as well as conduct frequent safety audits to ensure compliance with standards.
- Regularly assess the impact of chemicals used in laboratories..

Scientific Ethics Declaration

The authors declare that the scientific ethical and legal responsibility of this article published in EPHELS Journal belongs to the authors.

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