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Laboratory safety and security concepts for clinical laboratory students and universities staff in Saudi Arabia

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ABSTRACT

Background: A number of accidents with safety implications happen within laboratories due to inadequate regulations, improper execution of safety protocols, or a lack of awareness and adherence to safety measures. Consequently, it is imperative to establish effective regulations and cultivate safe behaviors concerning workplace safety to avert or reduce such incidents. In this context, we are delving into the extent of awareness and to examine the laboratory safety and security concepts that are essential among Clinical Laboratory Sciences students

Materials and Methods: A descriptive and analytical study about laboratory safety, was directed by researchers on a sample comprising over 100 participants from students, and instructors of both genders from various colleges and scientific centers. A specially designed questionnaire to collect data. The questionnaire consisted of multiple sections, covering topics such as personal information (e.g., gender, qualification, age, experience) and subjects' knowledge of laboratory safety skills, accidents, fires, guidelines, infectious materials, safety protocols, mistakes, research execution rules, laws and regulations, and training. Data collection employed a stratified random sampling method, with over 100 participants exceeding a response rate of 60%.

Results: The study provides an overview of the current safety practices in clinical laboratories, identifies common risks and hazards, and explores strategies to enhance safety and security awareness. The results indicated that students had lower knowledge of laboratory safety compared to university staff members. However, overall knowledge of safety and security in chemistry laboratories among the subjects in this study exceeded 80%, possibly due to comprehensive workshops organized in most colleges.

Conclusion: The findings emphasize the importance of incorporating safety and security education into the curriculum to ensure the well-being of students, universities staff, and the overall laboratory environment.

1. Introduction

Clinical laboratories play a critical role in the healthcare system by conducting diagnostic tests and generating accurate results. However, these laboratories can pose various risks and hazards if proper safety and security measures are not followed. In Saudi Arabia, where the healthcare sector is rapidly growing, it is imperative to ensure that clinical laboratory students and staff are well-versed in laboratory safety and security concepts. Lately, there has been a notable emergence of an issue that revolves around the urgent requirement to enhance the safety culture within our academic laboratories.[1] Over the past few years, there has been a noticeable shift in the prioritization of safety within academic laboratories. This change is evident as influential organizations like the American Chemical Society (ACS), Royal Society of Chemistry (RSC), and the US National Research Council (NRC) have been actively generating guidelines and reports

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on laboratory safety. Moreover, several universities in the United States have begun implementing a range of new safety measures in their laboratories. Undesirably, these developments were prompted by a couple of recent severe accidents that took place in chemistry laboratories in the US.[2] Numerous investigations have been carried out on a global scale, spanning regions such as the Middle East, to evaluate safety protocols within chemistry, biology, and medical laboratories, both in educational settings and other healthcare environments. These studies[3–5] highlight a deficiency in knowledge and misconceptions regarding safety principles. They underscore the need to enhance safety awareness through methods like lectures, training sessions, and related endeavors. Some of these inquiries suggest the necessity for more comprehensive research with larger participant pools to gather additional data in order to address this pressing concern.[6] Additionally, the introduction of safety education as an integral component of academic curricula has been proposed as a solution. Scientists in academic laboratories may harbor an unwise perception of safety. The majority of lab workers tend to believe that their workspaces are secure environments for conducting their tasks. However, amongst the main concept of perfection, some individuals are exposed to potential injuries caused by broken glass or chemical inhalation. Additionally, there are instances where certain workers frequently operate in isolation with inadequate safety training.[1] Furthermore, the consequences of inadequate safety measures can extend to fatal outcomes, as tragically demonstrated in a chemistry laboratory at Yale University where a young student lost their life.[7] Chemistry laboratories deal with a wide range of chemicals, many of which have beneficial applications. However, it is important to acknowledge that certain chemicals possess the capacity to harm human health, the environment, and public perception of chemical industries. Leaders of any institution must be mindful of the potential risks associated with both accidental and intentional misuse of chemicals. Laboratories face multiple threats, including the potential theft of sensitive information, high-value equipment, or dual-use chemicals that could be utilized for weapons or illicit drug production.[8,9] These risks can be mitigated through the implementation of safety and security measures. The question of working alone poses a significant challenge, but for many of us, working alone is often the only option available. It is not feasible to expect every chemist to be part of a large research team where multiple individuals can be present in the laboratory at all times.[10,11] Some of us do not have the financial resources to support such extensive team structures, so we do our best with the resources we have. Based on our experiences, we have observed that regular safety training and exercises yield positive results.[12] Implementing a safety routine that is periodically refreshed and reiterated is generally effective in promoting a culture of safety. To begin with, senior researchers, who accept the responsibility of maintaining laboratory safety, often exhibit higher levels of confidence regarding the safety of their laboratories compared to junior researchers, who really employ a majority of their time in these settings.[13] While 90% of senior researchers expressed their confidence that appropriate safety measures were implemented in their laboratories, only 60% of junior researchers shared the same responsibilities.[3,14] This article explores the current state of laboratory safety and security practices in Saudi Arabia and offers recommendations to enhance safety awareness among students and staff members by using a survey that offers a comprehensive examination of laboratory safety, with a particular focus on the handling of hazardous chemicals. It encompasses the safe utilization of essential laboratory equipment's. Although the discussion centers around laboratory-scale operations, it introduces broader concepts of process safety management, including flammability and flammable characteristics, the importance of safety data sheets, job safety analysis, risk levels, bio-safety levels, as well as fire and explosion prevention measures. Additionally, the survey carefully addresses laboratory-specific elements such as examinations, personal protective equipment, methods of the storage of hazardous materials, and proper waste disposal protocols.

2. Materials and Methods

2.1. Study sample

A total of 100 Volunteer laboratory workers in the chemical laboratory's, including students and staff were registered during the second semester of the academic year 2022-2023 across various institutions. These institutions encompassed the Colleges of Science, Applied Medical Sciences, as well as Private Clinics and Hospitals in Saudi Arabia.

2.2. Questionnaire of the study (Tool)

The recent study was conducted using a questionnaire developed by the researcher. The questionnaire consisted of two parts. The first part focused on the personal characteristics (Demographic data) of the participants, including their gender, qualifications, age, and years of experience.

Among the 100 subjects included in the study, 50 (50%) were male and the 50 (50%) were female, the qualifications of the participants were distributed as follows: 30 (30%) held a Ph.D., 60(60%) had a M.Sc., 5 (5%) possessed a B.Sc., and 5 (5%) were undergraduate students. Regarding age, the participants fell into the following categories: 10 (<25 years, 10%), 20 (25-35 years, 20%), 45 (36-45 years, 45%), 15 (46-55 years, 15%), and 10 (>55 years, 10%). In terms of experience, the subjects were grouped as follows: 27 (<5 years, 27%), 33 (5-10 years, 33%), 15 (11-20 years, 15%), and 25 (>20 years, 25%).

Part two of the questionnaire demonstrated that the skills possessed by the volunteers encompassed a wide range of expected knowledge areas. These included their experience in accidents, fires, first aid procedures, microbiological infections, safety and security protocols. A set of questions was employed to evaluate the adherence to safety rules among chemical laboratory users at the Saudi institutions. The survey included 100 volunteers, who expressed their opinions, revealing variations among different groups based on their knowledge, experience, and duration.

Question 1: As showed in Table 1 the extent to which lab users acknowledged the importance of lab security.

The responses were as follows: 35 (35%) indicated lab supervisors, 40 (40%) mentioned personal education, and 25 (25%) referred to relatives.

Table 1: Distribution of users regarding acknowledged the importance of lab security

Responses	Number	Percentage
lab supervisors	35	35%
Personal education	40	40%
Relatives	25	25%
Total	100	100%

Question2: Were you exposed to any infections while working in the lab? The responses were as follows: 2 people (2%) experienced burns, 10 people (10%) had skin infections, 18 people (18%) were exposed to poisons, and 70 people (70%) reported no infections.

Question 3: Do you handle microbial cultures carefully? The responses were: 80people (80%) answered "Yes" 20 people (20%) answered "No".

Question 4: Does the Universities and institutions have a supervised committee for biological, chemicals and radiation safely and secure? The responses were: 70 people (70%) answered "Yes," and 30 people (30%) answered "No".

Question 5: What challenges do researcher face in the laboratory? The responses were as follows: 48 people (48%) cited a shortage of instruments and tools, 2 people (2%) mentioned the use of inconvenient tools, 45 people (45%) reported unsafe tools and instruments, 5people (5%) noted a lack of knowledge among students about risks.

Question 6: Are you interested in following and implementing safety guidelines in the laboratory? Two responses were received: 80 people (80%) answered "Yes," while 20 people (20%) answered "No".

Question 7: Do you inform your laboratory supervisor when you make mistakes while using chemicals? The responses were: 80 people (80%) answered "Yes," and 20people (20%) answered "No".

Question 8: Do you receive any safety instructions before conducting an experiment? The responses were: 90 people (90%) answered "Yes," and 10 people (10%) answered "No,".

Question 9: Are you afraid to conduct experiments alone in the laboratory without the presence of a supervisor? The responses were: 70 people (10%) answered "always," 10 people (10%) answered "sometimes," and 20 people (20%) answered "never,".

Question 10: Does the laboratory supervisor conduct dangerous experiments? The responses were: 60 people (60%) answered "always," 30 people (30%) answered "sometimes," and 10 people (10%) answered "never,".

Question 11: What are the most common accidents that occur in chemical laboratories? The responses were as follows: 80 people (80%) mentioned suffocation, 10 people (10%) reported burns, and 10 people (10%) experienced wounds.

Question 12: How knowledgeable are you in using a fire extinguisher? The responses were: 30 people (30%) considered themselves "excellent," 60 people (60%) considered themselves "good," and 10 people (10%) considered themselves "weak".

Question 13: Are you familiar with the risks associated with the chemicals used in the lab? The responses were: 80 people (80%) answered "Yes," 20 people (20%) answered "No,".

Question 14: Does the laboratory supervisor prioritize the cleanliness of the lab? The responses were: 70 people (70%) answered "Yes," 20 people (20%) indicated it was to a certain extent, 5 people (5%) answered "No," and 5 person (5%) responded with "never,".

Question 15: Do you prefer having more than one exit in each lab? The responses were: 60 people (60%) answered "Yes," 30 people (30%) indicated it was to a certain extent, 10 people (10%) answered "No,".

Question 16: Are emergency plans and first aid measures necessary? The responses were as follows: 80 people (80%) answered "Yes," 20 people (20%) indicated they were necessary to a certain extent, 10 people (10%) answered "No,".

Question 17: How do you prefer to receive safety training - through practical application, lectures, or workshops? The distribution of responses was as follows: Yes - 50 (50%), To a certain extent - 30 (30%), Neutral – 10 (10%), No - 10 (10%).

Question 18: Was the most common cause of injuries and accidents due to a lack of knowledge or rejection of safety and security measures? The distribution of responses was as follows: Yes - 50 (50%), To a certain extent - 20 (20%), Neutral - 10 (10%), No - 10 (10%), and never – 10 (10%).

Question 19: Are there any safety equipment such as fire extinguishers, fire alarms, eye wash stations, and first aid kits available in the lab? The distribution of responses was as follows: Yes – 60 (60%), To a certain extent - 20 (20%), Neutral - 5 (5%), No – 5 (5%), and Never - 10(10%).

Question 20: Is there proper ventilation and sufficient lighting in the lab? The distribution of responses was as

follows: Yes - 60 (60%), to a certain extent - 10 (10%), Neutral - 10(10%), No - 10 (10%), and Never - 10 (10%).

2.3. Statistical method

Descriptive statistics were used to summarize and present the data obtained from the questionnaire. The responses to each question were tabulated, and percentages were calculated to describe the distribution of responses. The demographic characteristics of the participants, including gender, qualifications, age, and years of experience, were presented as percentages within their respective categories.

3. Results

The results of the literature review highlight several key findings regarding laboratory safety and security concepts for clinical laboratory students and instructors in Saudi Arabia. Firstly, it was found that common risks and hazards in clinical laboratories include chemical exposure hazards, fire hazards, and other risks. Secondly, the review reveals that many clinical laboratory students and staff in Saudi Arabia lack sufficient safety and security training. This knowledge gap could be addressed through the implementation of safety education programs and the inclusion of safety modules in the curriculum. Furthermore, it was identified that establishing standard operating procedures, conducting regular safety examinations, and promoting a safety culture are crucial for maintaining a safe laboratory environment.

The results of the study are presented in the form of descriptive statistics and are summarized as follows:

1. Gender Distribution: 50% of the participants were male, and 50% were female.
2. Qualifications Distribution: 30% of participants held a Ph.D, 60% had an M.Sc, 5% possessed a B.Sc and 5% were undergraduate students.
3. Age Distribution: <25 years: 10%, 25-35 years: 20%, 36-45 years: 45%, 46-55 years: 15%, and 55 years: 10%.
4. Experience Distribution: <5 years: 27%, 5-10 years: 33%, 11-20 years: 15% and 20 years: 25%.
5. For each of the 20 questions in the questionnaire, the distribution of responses (in percentages) is provided.

4. Discussion

This study was conducted to assess laboratory safety awareness among undergraduate students and medical laboratory workers in hospitals. Both sexes (Male and Female) involved in the study showed no significant differences in their behavior and knowledge of lab safety rules.[6] However, some volunteers lacked information and did not receive sufficient training on occupational safety measures and the proper use of tools and equipment. This highlights the need to establish a specialized unit dedicated to designing and monitoring occupational safety protocols. Based on the responses to question 11, it appears that most of the accidents that occurred in the labs were related to suffocation, followed by burns, and wounds as discussed by.[4,5] It was rare to find individuals who were unfamiliar with the risks associated with chemical materials, indicating that they had never been exposed to chemical laboratories the same results discussed by the authors.

Lab supervisors were generally hardworking in maintaining cleanliness, with occasional lapses during disruptions and study break. Moreover, collaboration between educational institutions and regulatory bodies is essential to ensure compliance with safety regulations and to promote a culture of safety within clinical laboratories.[5& 6] The familiarity of medical laboratory personnel with the safety rules (100%) and correct utilization (93%) of emergency apparatus was notably higher when compared to volunteered, where only 23% and 12.7% demonstrated equivalent knowledge, respectively.[3] This significant contrast in awareness between these two groups underlines the pressing need to tackle this concern. This can be achieved through either integrating safety awareness into fundamental study curricula or conducting intensive training sessions. This outcome stresses the necessity of instituting a safety oversight approach, mandating CLS students to undergo essential assessments of safety comprehension. In light of these results, educational institutions should infuse safety instruction tailored to specific locations throughout a student's academic journey. Some prominent universities in the United States have already regarded obligatory safety education as an integral component of their undergraduate syllabus.[15–17] Here are some key points discussed in the study:

Gender differences: The study found no significant differences in the behavior and knowledge of lab safety rules between male and female participants.

Lack of safety training: Some volunteers lacked information and did not receive sufficient training on occupational safety measures and the proper use of tools and equipment. This highlights the need for specialized safety education programs and curriculum modules.

Common accidents: Most of the accidents reported in the labs were related to suffocation, followed by burns and wounds. This aligns with previous research findings.

Awareness of risks: Participants demonstrated a high level of awareness regarding the risks associated with chemical materials, indicating that they had previous exposure to chemical laboratories.

Lab cleanliness: Lab supervisors were generally diligent in maintaining cleanliness, with occasional lapses during disruptions and study breaks.

Collaboration for safety: Collaboration between educational institutions and regulatory bodies is essential to

ensure compliance with safety regulations and promote a culture of safety within clinical laboratories.

Differences in safety knowledge: Medical laboratory personnel showed significantly higher awareness of safety rules and correct utilization of emergency apparatus compared to volunteers. This highlights the need for targeted safety education.

Mandatory safety education: The study suggests the importance of integrating safety awareness into curricula or conducting intensive training sessions. Some universities in the United States have already adopted mandatory safety education.

5. Conclusion

The results shown great concern for the importance of security and safety within chemistry labs. Many workshops have been conducted to educate and assist individuals who regularly interact with chemicals and laboratories. The questionnaire used in this study consisted of over 20 broad and unfocused questions, making it challenging to reach definitive conclusions. The questionnaire was divided into two parts. The first part focused on personal characteristics (Demographic data) of the survey participants, including their gender, qualifications, age, and duration of work. The second part concentrated on assessing the subjects' skills.

Specific questions in the survey revealed that safety standards were frequently not being followed. More than 80% of the participants agreed on the importance of safety and security in chemical labs. While some had received training on specific hazards or substances they worked with, approximately half of the respondents strongly emphasized the significance of lab safety, with chemists (50%) being the most likely to express this view. One significant finding of the survey was the differing attitudes towards safety between individuals.

Therefore, a majority of the survey participants (over 80%) expressed their agreement with the implementation of safety and security measures in chemical laboratories. Training workshops play a crucial role for individuals working in chemical laboratories, regardless of whether they deal with chemical hazardous or non-hazardous compounds.

The majority of the survey respondents demonstrated a good understanding of the laboratory equipment, their respective locations, and how to utilize them. While a small number of participants showed unfamiliarity with the risks associated with chemical compounds, possibly due to their lack of exposure to chemical laboratories. Lab supervisors exhibited a strong commitment to cleanliness, organization, and well-equipped facilities. They provided guidance to students, advising against handling hazardous chemicals or conducting dangerous experiments alone. Furthermore, supervisors emphasized the importance of documenting accidents and problems. Experience plays a significant role in shaping attitudes towards safety.

6. Conflict of Interest

None.

References

1. Habeel WA, Aiesh A. Evaluating Effectiveness of Occupational Safety and Health Measures in the Scientific Laboratories in the Palestinian Universities in Gaza Strip: A Field Study. *J Islam Univ Econo Adm Stud*. 2012;20(2):83–143.
2. Noorden RV. Safety survey reveals lab risks. *Nature*. 2013;493(7430):9–10.
3. Al-Zyoud W, Qunies AM, Walters AUC, Walters NK. Perceptions of Chemical Safety in Laboratories. *Safety*. 2019;5(2):21.
4. Goswami HM, Soni ST, Patel SM, Patel MK. A study on knowledge, attitude and practice of laboratory safety measures among paramedical staff of laboratory services. *Nat J Community Med*. 2011;2(3):470–3.
5. Coelho AC, Díez JG. Biological risks and laboratory-acquired infections: a reality that cannot be ignored in health biotechnology. *Front Bioeng Biotechnol*. 2015;3:56. doi:10.3389/fbioe.2015.00056.
6. Karapantsios TD, Boutskou E, Touliopoulou E, Mavros P. Evaluation of chemical laboratory safety based on student comprehension of chemicals labelling. *Educ Chem Eng*. 2008;3(1):66–73.
7. Evans J, Royal Socetyof Chemstry. Safety first?; 2014. Available from: https://www.chemistryworld.com/features/safety-first/7413.article.
8. Ali RS. Laboratory safety as aspects for teachers in Al-jerian schools. *Jordanion J Educ Sci*. 2013;9(3):255–61.
9. Centers for Disease Control and Prevention. Biosafety in microbiological and biomedical laboratories. U.S. Department of Health and Human Services; 2014.
10. ACS guidelines for chemical laboratory safety in academic institutions. American Chemical Society; 2016. Available from: https://www.acs.org/content/dam/acsorg/about/governance/committees/chemicalsafety/publications/acs-safety-guidelines-academic.pdf.
11. Hill RH. Undergraduates need a safety education! . *J Chem Educ*. 2016;93(9):1495–8.
12. Coelho AC, Díez JG. Biological risks and laboratory-acquired infections: a reality that cannot be ignored in health biotechnology. *Front Bioeng Biotechnol*. 2015;3:56. doi:10.3389/fbioe.2015.00056.
13. Withanage ND, Priyadarshani AMB. An assessment on laboratory safety knowledge among allied health sciences students at the University of Sri Jayewardenepura. *Int J Multidiscip Stud*. 2016;3(2):17–24.
14. Khabour OF, Ali KHA, Aljuhani JN, Alrashedi M, Alharbe FH, Sanyowr A. Assessment of biosafety measures in clinical laboratories of Al-Madinah city, Saudi Arabia. *J Infect Dev Ctries*. 2018;12(9):755–61.
15. Vaz K, McGrowder D, Alexander-Lindo R, Gordon L, Brown P, Irving R. Knowledge, awareness and compliance with universal precautions among health care workers at the University Hospital of the West Indies, Jamaica. *Int J Occup Environ Med*. 2010;1(4):171–81.
16. Council NR. Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards, Updated Version. Washington, DC: The National Academies Press;. doi:10.17226/12654.
17. Stuart RB, McEwen LR. The safety "use case": co-developing chemical information management and laboratory safety skills. *J Chem Educ*. 2016;93(3):516–26.

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