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Research Article

Occupational Health and Safety Risk Assessment and Mitigation in Chemistry Laboratories: A Case Study of Iğdır University

Okan Özbakır [1*]

[1] Iğdır Üniversitesi; okan.ozbakir@igdir.edu.tr
[*] Sorumlu Yazar; okan.ozbakir@igdir.edu.tr

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ABSTRACT

Encountering potential hazards in the work environment is a natural consequence of work life. Workplaces must take all safety precautions to protect the health of employees. Selecting appropriate experimental studies in a chemistry laboratory and adhering to Occupational Health and Safety (OHS) rules contribute to the development of chemistry education. Nowadays, both teaching staff and students experience deficiencies in their teaching areas and professional literature, and it is necessary to continually maintain studies in line with modernization and OHS principles in the education process. In this study, an OHS risk assessment was conducted in Iğdır University Chemistry laboratories, potential risks were identified, and the necessary measures were assessed in accordance with regulations. The importance of continuous training in the field of OHS for employees was emphasized. A total of 52 risks were identified in the laboratories in the study, 31 of which required immediate action. 13 risks were of medium severity and required planning for their elimination, and 8 risks were found to be acceptable. In addition to identifying what measures are necessary for management, risk assessment also significantly contributes to performance and motivation to work in a safe environment.

Keywords: Occupational risks, health and safety, chemical laboratory, hazards.

Kimya Laboratuvarlarında İş Sağlığı ve Güvenliği Risk Değerlendirmesi ve Önlenmesi: Iğdır Üniversitesi Örneği

ÖZET

İş ortamında olası tehlikelerle karşılaşmak, iş hayatının doğal bir sonucudur. İşyerleri, çalışanların sağlığını korumak için tüm güvenlik önlemlerini almalıdır. Kimya laboratuvarında uygun deneysel çalışmaların seçilmesi ve İş Sağlığı ve Güvenliği (İSG) kurallarına uyulması, kimya eğitiminin gelişimine katkı sağlar. Günümüzde, hem öğretim kadrosu hem de öğrenciler, öğretim alanlarında ve mesleki literatürde eksiklikler yaşarlar ve eğitim sürecinde modernizasyon ve İSG prensipleriyle uyumlu çalışmaları sürekli olarak sürdürmek gereklidir. Bu çalışmada, Iğdır Üniversitesi Kimya laboratuvarlarında bir İSG risk değerlendirmesi yapılmış, potansiyel riskler belirlenmiş ve gerekli önlemler düzenlemelere uygun olarak değerlendirilmiştir. Çalışanlar için alanında sürekli eğitimin önemi vurgulanmıştır. Çalışmada laboratuvarlarda toplam 52 risk belirlenmiş, bunlardan 31'i hemen harekete geçilmesi gereken riskler olarak belirlenmiştir. 13 risk orta düzeyde ciddiyete sahiptir ve ortadan kaldırılması için planlama gerektirmektedir, 8 risk ise kabul edilebilir bulunmuştur. Risk değerlendirmesi, sadece yönetim için hangi önlemlerin gerektiğini ortaya koymakla kalmaz, aynı zamanda motivasyonda önemli bir artışa katkı sağlar.

Anahtar Kelimeler: Mesleki riskler, sağlık ve güvenlik, kimya laboratuvarı, tehlikeler.

1. INTRODUCTION

The Occupational Safety and Health Law (6331 Law) establishes the general preventive principles and basic conditions for ensuring occupational safety and health, preventing work-related accidents, occupational diseases, and other health hazards at workplaces (Arabacı, 2018). This law particularly emphasizes the role of education and motivation in occupational safety and health. Education is a powerful tool in establishing desired attitudes towards OHS issues such as regular development of specialized knowledge and skills, optimizing the occupational environment, technical equipment safety, and working conditions. This implies that OHS issues need to be effectively integrated into lifelong education processes, including vocational education, skill development, retraining, postgraduate courses, and new skills and qualifications related to occupational safety. This approach tackles health preservation and risk avoidance strategies as part of education programs that prepare students for a profession (Şen et al., 2019). The improvement of working conditions and the prevention of occupational accidents and diseases play a crucial role in raising OHS to a higher level. Employers developing special programs and measures are considered the most effective method for effectively enhancing OHS (Tulukçu and Akbulut, 2016). Prevention is defined as a set of planned and applicable measures aimed at reducing the risks that may cause work accidents, occupational diseases, and other health problems in the workplace. These measures include procedures to be followed when employees are confronted with situations that seriously threaten their lives or health (Zile, 2018). Chemical substances and mixtures are among the important hazards that can cause health risks in the workplace from the perspective of OHS and can significantly affect the possible consequences. Risk prevention principles in chemical laboratories consist of fully understanding the effects of chemical substances and strict adherence to usage instructions. According to regulations, all chemical substances and mixtures should be labeled and made visible through visual signs such as symbols and pictograms. These labeling and marking methods aim to provide a warning against potential health threats that may arise during the handling of these chemicals. These symbols and pictograms provide information about the type of hazard and also associate the relevant hazard with its use, along with various other data based on classification, on each packaging unit (Drakvik et al., 2020). The Material Safety Data Sheet (MSDS), which provides detailed information about chemical products, is used to obtain information about all hazards of the substance or mixture, including environmental hazards, for the purpose of controlling chemicals in the workplace and to obtain advice on safety measures. It contains: Product and Manufacturer Information: manufacturer, company, or individual, and the name or trade name of the chemical substance. Hazard Identification: Classification and symbols of the chemical substance's hazards Composition/Ingredients: Contents and components of the chemical substance First Aid Measures: First aid measures are to be taken in case of exposure. Firefighting Measures: Precautions to be taken in case of a fire Accidental Release Measures: Precautions to be taken in case of leakage or spillage Handling and Storage: Recommendations for Safe Handling, Storage, and Use Exposure Controls/Personal Protective Equipment: Methods of Exposure Control and Recommendations for Personal Protective Equipment Physical and Chemical Properties: Physical and chemical characteristics of the chemical substance Stability and Reactivity: Stability status of the chemical substance and information on reactions with other substances Toxicological Information: Information on the health effects of the chemical substance Ecological Information: Information on the environmental effects of the chemical substance Disposal Considerations: Information on how to safely dispose of the chemical substance Transportation Information: Safe transportation rules and instructions for the chemical substance Regulatory Information: Compliance with relevant regulations and other regulatory information Each section contains important information about the safe use and handling of the chemical. Depending on the properties and level of danger of the chemical substance, these sections may contain different details and precautions (Yavuz, 2020). In a chemical laboratory, injuries can occur due to the effects of heat, chemicals, or objects (thermal, chemical, or mechanical injuries). Working with chemical substances should be done with absolute care and concentration. There can be various risks of injury (cutting, burning, and alkali burning) in chemistry laboratories (Güngör, 2020). For example, contact of hot, caustic, or corrosive chemicals with unprotected areas of the body, such as cleaning laboratory glassware, working with a gas burner, pulling rubber hoses onto glass tubes, etc. If injuries occur in a chemical laboratory, act quickly and use your common sense (Öner, 2020). When distilling flammable liquids (such as ether or gasoline), the student should be familiar with the properties of the chemicals they will be working with (boiling point, flash point, LD50) and follow proper safety instructions. This includes being cautious around heating elements, stove burners, and flames. Caustic and corrosive substances (such as strong mineral acids, alkaline metal hydroxides, and some organic compounds) should be used with extreme care and in accordance with occupational safety guidelines (Yılmaz and Bilici, 2020). Working with these chemicals should only be done in a fume hood. The use of personal protective equipment (protective clothing, a face shield, goggles, and gloves) is mandatory. This study was conducted to identify and evaluate the potential risks to which the personnel working in Iğdır University Chemistry Laboratories may be exposed. In addition to the small-scale and near-miss accidents that occurred during the studies carried out in the laboratory, the increase in the number of students working together with the disturbing odors emitted from time to time caused the safety conditions to be questioned. The increase in the number and quantity of hazardous chemicals used has also raised concerns. Considering the physical adequacy of the laboratories, it was understood that the users were aware of the deficiencies. The high level of OHS awareness among the employees has increased their expectations to work on taking security measures. The need for measures to be taken in terms of OHS in laboratories has increased due to both the dangerous materials used and the increasing number of employees. In this context, considering the importance of the work done, it is of great importance that laboratory hygiene standards are at a high level and that employees strictly follow the procedures in accordance with OHS rules. With this study, the risk assessment carried out in laboratories from the perspective of OHS will contribute to the quality, reliability, and international reputation of laboratories, as well as ensuring their physical safety.

2. MATERIAL METHOD

As a general principle, risk assessment studies begin with the identification of hazardous situations, sources of danger, and dangerous behaviors that may occur during the activities available or carried out in the laboratory. The risks caused by the sources of danger are determined, and the measures to be taken in accordance with the legislation are decided in order to eliminate these risks, and the implementation of these measures is ensured. Finally, the controls and review phase come in order to evaluate the performance of the measures taken. This study was conducted at the Chemistry Laboratories of the Iğdır University Engineering Faculty. This laboratory is extensively used for research conducted by undergraduate, graduate, and doctoral students, as well as faculty members. The use of the laboratory goes beyond normal working hours and includes an area where different researchers work on different projects involving different chemicals at different times or simultaneously. The research was conducted in March and April 2023. Within the scope of this study, observations were made by occupational safety experts in the laboratory environment, the chemicals used were examined in detail, planned and unplanned inspections were carried out, and comprehensive data collection methods were applied. Observations contribute to our understanding of the types of potential hazards to which employees are exposed during the activities carried out in the laboratory. Interviews with laboratory staff were conducted to determine their expectations about the safety measures needed. Informal interviews are based on candid and open dialogues with employees and provide an important opportunity to understand their motivation levels, safety expectations, and past near misses. A comprehensive literature review was also conducted in the field of occupational health. The literature review included current scientific studies, regulations, and best practices (Özkılıç, 2005). The combination of these methods enables the risks faced by employees to be identified in terms of OHS. In this regard, solution-oriented improvements were proposed by examining the relevant legislation. Within the scope of this study, on-site assessments have been conducted in order to identify the risks that may occur in the workplace and determine the probabilities of these risks occurring. These assessments aim to detect possible hazards and risk factors within the workplace. The matrix method has been utilized as the risk assessment methodology (Usanmaz and Ercan, 2020). This method is based on the use of a matrix to assess and classify different risk factors (Table 1). The risk values obtained through the matrix method have been determined based on the severity and probability of the risk (Table 2).

Table 1. Likelihood and severity rating table

Likelihood (l)	Rating	Severity (s)	Rating
1- Very Unlikely	Once a year	1- Should be Considered	No loss of working hours
2- Unlikely	Quarterly	2- Significant	No lost workdays
3- Middle	Once in a month	3- Serious	Minor injury
4- Highly Likely	Once a week	4- Very Serious	Death, Limb loss
5-Very High Probability	Every day	5- Catastrophe	Multiple deaths

$$RS(risk\ score) = l(likelihood)xs(severity)$$

These values (risk scores) guide the prioritization of potential risks in the workplace and the implementation of OHS measures. Based on the obtained risk level, different strategies are proposed for different risk levels. It is emphasized that appropriate procedures should be applied for the management of acceptable risks, necessary measures should be taken to control risks at a moderate level, and situations with a high risk level should be urgently addressed. With this method, objective evaluation and prioritization of risks in the workplace and the implementation of appropriate measures are ensured (Dikmen, 2022). This is considered an important step towards improving OHS standards and enhancing the safety of workers.

Table 2. Matrix methodology matrix.

Severity / Likelihood	1	2	3	4	5
1	Very Low Risk **1**	Low Risk **2**	Low Risk **3**	Low Risk **4**	Low Risk **5**
2	Low Risk **2**	Low Risk **4**	Low Risk **6**	Significant Risk **8**	Significant Risk **10**
3	Low Risk **3**	Low Risk **6**	Significant Risk **9**	Significant Risk **12**	Significant Risk **15**
4	Low Risk **4**	Significant Risk **8**	Significant Risk **12**	High Risk **16**	High Risk **20**
5	Low Risk **5**	Significant Risk **10**	Significant Risk **15**	High Risk **20**	Very High Risk **25**

Risk matrices are a preferred approach, representing a wide range of risk assessment methodologies. Similar to other risk assessment methods, risk matrices are created using rating factors developed to evaluate the risk level of a specific asset or event. Generally, risk matrices are used to estimate the dimensions of "probability" and "impact" by using only two rating factors. Therefore, the basic structure of the risk assessment tool is depicted in a matrix shape, as seen in Table 3. The analysis and evaluation of potential risks in this approach are based on critical combinations of these two main factors. While the probability factor reflects the likelihood of a specific risk occurring, the impact factor expresses the severity of the consequences of that risk. The values assigned to the cells of the matrix represent each probability and impact level. In this way, risk assessment is performed by combining the relevant factors to obtain a specific position for a risk on the matrix (Demirkan, 2015). Risk matrices are used as effective tools to visually represent complex risk analyses in a more understandable and efficient manner. This approach provides a useful guide to comparing different risk scenarios, identifying priority risks, and effectively allocating resources. In general, risk assessment methodologies are often used with 1-3, 1-4, or 1–5 scales to estimate the relevant risk level of a specific threat. As the risk associated with the hazard increases, the value of the corresponding rating factor also increases. It is common for the risk matrix to have different scale lengths for different rating factors. Therefore, the risk matrix may have unequal numbers of rows and columns. Risk assessment is based on scoring the "likelihood" and "severity" rating factors. When both factors receive high scores, the associated risk is considered high, while low scores indicate low risk. As shown in Table 3, if a cell is highlighted in red, the risk level of the corresponding event is high. Based on the results of the risk assessment, there are different action categories available to reduce the identified risk level (Buhurcu, 2016). Depending on the color and risk level of the matrix cell, different actions can be initiated, ranging from "no action needed" to "emergency intervention" (Table 3). Therefore, during the risk assessment, the methodology divides the groups into different categories, and the rankings and probabilities of the groups are expressed solely through group membership identifications (Figure 1). For these reasons, risk assessment methodologies are considered powerful tools for developing a process or system.

Table 3. Matrix methodology decision table.

16, 20, 25	**UNACCEPTABLE RISK** These risks should be studied immediately.
8, 9, 10, 12, 15	**RISK TO CONSIDER** These risks should be addressed as quickly as possible.
1, 2, 3, 4, 5, 6	**ACCEPTABLE RISK** May not require immediate action

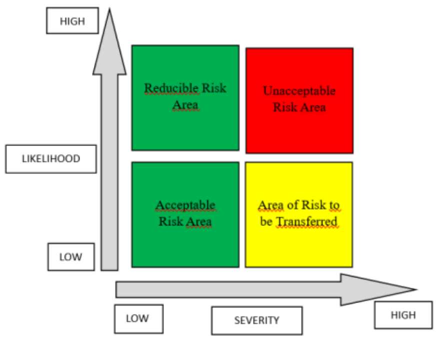

Figure 1. Risk decision graph

3. RESULTS AND DISCUSSION

The data obtained from field studies has been recorded and reported in risk assessment tables. After identifying hazards, the potential risks associated with each hazard have been determined. The probabilities of occurrence and severity of these risks have been identified, and risk scores have been calculated by multiplying these values. Based on the magnitude of the risk scores, the decision on the actions to be taken has been determined according to the decision table (Table 3). In terms of methodology, measures to eliminate hazards and reduce risks have been provided. With these measures, it has been possible to reduce the risks to an acceptable level (Tables 4, 6, 7, and 8).

Table 4. High risk assessment chart

Hazard Sourse	Hazard	Risk	Severity	The current situation	l	s	RRS	
Electrical Panels	Electrical Panels Are Inside the Laboratories	Electric Shock, Fire, Explosion	Death Or Fire	Panels in the lab. There are no authorized person names in and on the laboratory. also, there is no insulating mat. Panel fronts material that can cause fire vs.	4	5	220	High
Items left on the escape route	Items on the escape route block the escape route	Stuck, fall, jamming during evacuation	Multiple Deaths	No	4	5	220	High
Fire Alarm Button	Absence of Fire Alarm Button	Inability to ask for help in emergency situations	Injury, Explosion, Death	No	4	5	220	High
Doors made of normally flammable materials, no emergency doors fire	Confusion in Emergency Situations	Jamming, Crushing, Fire	Multiple Deaths	No	3	5	20	High
Paint and Thinner	Easily flammable material in laboratory environment or processing	Fire, Explosion	Multiple Deaths	No	4	5	20	High
Absence of Metal Cabinet for Consumables	Not storing in conditions suitable for hazard class	Fire, Explosion	Poisoning, Serious Injury, Death	No	4	4	116	High
Failure to Perform Periodic Maintenance	Lack of Maintenance and Misuse	Explosion as a result of machine failure	Multiple Deaths	No	4	5	16	High

Hazard Sourse	Hazard	Risk	Severity	The current situation	l	s	RRS	
Chairs And Tables	Failure to Meet Ergonomics Conditions	Waist And Joint Pains	Occupational disease	No	4	4	116	High
Gas Cylinders And Gas Detector	Unprotected Regulator	Gas Leakage, Explosion During Use	Multiple Deaths	No	3	5	15	High
Fire Extinguishers	Lack of Fire Extinguishers or Not Marking Their Locations	Failure to Interfere with Fire	Multiple Deaths	No	3	5	115	High

The condition of electrical panels in laboratories plays an important role in terms of OHS. The presence of electrical panels in laboratories can bring various risks, especially increasing the hazards of electric shock, fire, and explosion (Ordu and Bilir, 2017). The location, condition, and surrounding conditions of the panels have a significant impact on the emergence of these risks (Table 4). In accordance with regulations, necessary precautions should be taken when electrical panels are present in laboratories. These precautions include: electrical panels should be kept under lock and key, and a switch should be installed outside the panel to cut off the electricity in case of an emergency. Required safety and warning signs should be added to the electrical panels. These signs are used to alert workers about the electrical hazard and ensure that they behave cautiously when necessary. Electrical panels should be relocated outside of the laboratory and kept in a locked area. Labels containing the name, surname, and contact information of the authorized person should be affixed to the panels. This way, the authorized person can be easily reached, and intervention can be provided when necessary. Insulating mats should be placed in front of each panel to prevent the presence of materials that can cause fire. These mats reduce the risk of fire and increase the safety of the laboratory. Proper organization and management of electrical panels ensure the safety of employees by minimizing electrical-related risks in laboratories (Cortes and Cortes, 2023). These measures are of great importance in meeting OHS standards and reducing potential hazards (Table 4). During emergency situations, situations such as the presence of objects that can block emergency exit routes, the lack of fire alarm buttons, or the lack or improper marking of fire extinguishers can cause serious chaos and increase risks in the event of a fire. In this context, the risk level can increase to a high level. Keeping emergency exit routes clear and accessible, ensuring fire extinguishers are easily accessible, and ensuring effective use of fire alarms are of great importance for OHS (Ateş and Albayrak, 2022). In addition, during emergencies, emergency exit signs that provide guidance should be powered by an uninterrupted power source. If this is not possible, these signs should be replaced with phosphorescent green colors that are easily visible in the dark

(Table 4). Fire extinguishers should be suspended with a hanging apparatus at a height of 90 cm from the ground, in accordance with regulations. Fire cabinets should be arranged based on the principle that their distance does not exceed 30 meters on every floor and in every section separated by fire walls. These cabinets should be positioned near corridor exits and stair landings for easy visibility. Cabinets and enclosures containing fire hoses should be appropriately sized for their intended use. This design should facilitate the use of hoses and devices during fires and should not obstruct fire suppression operations. In addition, the fire alarm button should be placed in an appropriate location, and personnel in the workplace should be trained in fire drills and procedures. These measures enhance workplace safety by ensuring effective response during emergencies and minimizing risks. Having easily flammable materials present or handling them in a laboratory environment poses a serious risk potential. To minimize this risk, appropriate safety precautions need to be taken. Particularly, proper storage and handling of flammable materials such as paints and thinners are crucial. The following steps are recommended for safe storage of such materials (Marendaz et al., 2013): Flammable materials like paints and thinners should be stored in a locked area, away from fire, heat sources, and sunlight, in a well-ventilated area. When paintwork is being done, the laboratory should be completely emptied and should only be reopened for use after the necessary procedures have been carried out. The following measures should be taken for fire safety in laboratories: Each laboratory should have at least one fire extinguisher with a capacity of at least 6 kg. Fire extinguishers should be hung at an appropriate height (90 cm), and their visibility should be enhanced with markings. Fire drills should be conducted at least once a year, and employees should be instructed on how to use the fire extinguisher and what to do in case of emergencies. Emergency personnel should be identified, and their roles should be defined, so that effective intervention can be carried out during a fire. These measures represent important steps that need to be taken to ensure the safety of laboratory workers and facilities. They help minimize risks by enabling effective response during fire and other emergencies (Table 4). A clear distinction should be made between power installations and lightning protection installations. This is because lightning strikes can leap from power installations to other lines. The condition of the lightning rod cable should be regularly checked, and any damages should be promptly repaired. Additionally, regular annual maintenance should be performed to ensure the effectiveness of the lightning protection system. The positioning of the lightning rod cable is also of critical importance. Especially, it should be moved away from glass windows and iron railings to minimize the potential impacts of lightning strikes. This measure aims to enhance the effectiveness of the lightning protection system and minimize the risks that may arise (Topal and Şanlı, 2021). These methods encompass the precautionary measures taken to minimize potential hazards caused by lightning. The separation of power installations and lightning protection installations, as well as the regular maintenance and proper positioning of the lightning protection system, hold great importance in terms of OHS. This ensures the protection of facilities and the safety of employees by minimizing possible lightning impacts (Ateş and Albayrak, 2022).

Table 5. High risk assessment chart

Hazard Sourse	Hazard	Risk	Severity	The current situation	l	s	RRS	
Lightning Rod Installation	Absence of Lightning Rod Installation	Fire	Multiple Deaths	No	4	5	220	High
Failure to Hang the Fire Extinguisher in Compliance with the Regulation	Inability to Easily Reach the Cylinder in Case of Fire	Late Response to Fire	Injury	No	4	5	220	High
Lightning rod	Loss of Lightning Rod Cable	Lightning shock	Death	No	3	5	115	High
Food Lab	Working with Biological Agents	Infectious Diseases, Infection	Illness	No	3	5	115	High
Eye and Safety Showers	Absent or Corrupted	Failure to Intervene in Emergency Situations	Vision Loss, Chemical Poisoning	Eye Shower Available But Not Working, No Safety Shower	4	5	220	High
Ventilation	Lack of Ventilation	Exposure to Large Amounts of Chemicals	Chemical Poisoning, Throat Irritation, Lung Cancer	The Number of Persons Working in the Laboratories is High. Employees cannot work comfortably and have to bump into each other. Large amounts of chemicals are inhaled and only windows are used as ventilation.	4	5	220	High
Operating Instructions	Lack of	Employees not knowing what to expect, using wrong materials and equipment	Involuntary Harm to Machine, Equipment, or Self	Most of the Electrical Appliances and Machines Used Have No Instructions for Use.	4	5	220	High
Starting New Employee Or Working With New Students	Experience and Lack of Experience,	Ignorance, Near Miss and Accident Situations	Poisoning. Injury, Death	It is done.	4	5	220	High
Machines	Absence of Safety Valve	Lack of Emergency Response	Explosion, Fire	It should be checked.	4	5	220	High

Hazard Sourse	Hazard	Risk	Severity	The current situation	l	s	RRS	
Chemicals	Open chemicals	Broken, Spilled	Explosion, Fire	Chemicals Have Been Waiting in Cabinets for Many Years, Bottles and Caps Are Worn Out.	4	5	220	High

Taking appropriate measures for safety and emergency scenarios is vital in laboratory environments. In this context, emergency exit doors should be present in laboratories. Additionally, laboratory doors should have a width of over 100 cm and a self-closing feature (Table 5). The design of laboratory doors should be organized, considering safety and practical use. Therefore, they should be equipped with glass windows to prevent collisions and enable observation of the situation from the outside. Furthermore, laboratory doors should be designed to open outward. This approach increases the potential for quick and smooth evacuation in emergency situations. Proper design and placement of laboratory doors are considered an important step in effectively managing emergency situations and ensuring safety. These measures aim to ensure the well-being of employees and laboratory users and comply with OHS standards (Table 5). The use of or contact with chemical substances in a laboratory environment is of critical importance for personnel health and safety. Therefore, personnel working with such substances should be thoroughly informed about proper usage methods, the use of personal protective equipment, and the necessary precautions in case of contact with these substances (Ateş and Albayrak, 2022). Generally, laboratories work with dangerous chemical substances that can be harmful to human health. Therefore, it is a legal requirement to have the relevant Material Safety Data Sheet available before using any chemical substance in a laboratory environment. Labeling containers containing hazardous chemical substances is also of great importance. These labels should include the full name of the chemical, its hazard class, expiration date, and production date. Suitable storage areas and cabinets should be determined based on the type and hazard level of chemical substances. During the storage process, suitable, approved, and locked metal cabinets should be preferred. Chemicals should be stored in areas away from sunlight, cool, dry, and well-ventilated. Additionally, it is important not to store explosive, flammable, and acidic chemical substances together, ensuring compliance with appropriate storage principles. Storing explosive chemical substances in specialized explosive depots is also considered a vital measure (Topal and Şanlı, 2021).

Table 6. High risk assessment chart

Hazard Sourse	Hazard	Risk	Severity	The current situation	l	s	RRS	
Contingency Plan	Absence	Failure to Respond Quickly in Emergency Situations	Stamp, Crushing	None. Currently Under Construction.	4	5	220	High
Fire Extinguisher Cabinets	Absence	Failure to Respond Quickly in Emergency Situations	Stamp, Crush, Fire	Available in Corridors.	3	5	115	High
Fire Extinguisher Tubes	Absence	Failure to Respond Quickly in Emergency Situations	Fire, Burn, Death	Fire Cabinets Are Available in Corridors. But it is not enough.	4	5	220	High
Non-Ergonomic Postures	Standing Work	Low Back and Joint Pain	Musculoskeletal Disorder and Pain	Rests are made at regular intervals.	4	4	116	High
First aid training	Not to be taken	Inability to Intervene in Emergency Situations,	Serious Damages, Death	No One Has A First Aid Certificate, There Is No Trained Personnel	4	4	116	High
Medicine Cabinet	Absence,	Lack of Intervention in Emergency Situations, Mishandling	Serious Damages, Death	Medicine Cabinets Are Available But Materials Are Missing	4	4	116	High
Personal Protective Materials	Absence,	Absence of PPE	Skin Disorders such as Poisoning, Death, Eczema	No Kkd Usage Has Been Found.	4	5	220	High
Eating and Drinking Activities	Eating, Tea, Coffee etc. in the Laboratory. Drinking	Accidental Ingestion of Chemicals	Intoxication, Death	Employees Consume Beverages such as Tea and Coffee in the Laboratory.	4	4	116	High
Laboratory Staff	Lack of OHS Education	Employees Not Receiving OHS Training Appropriate for Their Jobs	Accident, Injury, Death	Employees have not received Basic OHS Training.	4	5	220	High
Storage of Chemicals	Incorrect Storage	Flash, Explosion, Fire	Death Injury	It is to be stored unlabeled and mixed in wooden cabinets.	4	5	220	High
All Employees	Failure to Take Covid 19 Precautions	Epidemic Disease Sickness,	Contagion, Death	Covid-19 Vaccines Partially Made	4	5	20	High

Gas cylinders used in laboratory environments should be stored safely in outdoor areas (Table 6). In order to detect gas leaks and intervene with an automatic gas shut-off system, gas detection detectors and automatic gas shut-off systems should be installed (Garchie et al., 2023). Early detection and intervention of fire is of great importance within the framework of building fire protection regulations. Therefore, buildings should be equipped with smoke detection systems, and sprinkler systems should be provided when necessary. Biological risk factors emerge in the form of biological agents such as viruses, bacteria, fungi, and parasites and can enter the body through respiration, skin contact, and eye contact. Hand hygiene should be carefully implemented to minimize these risks. Employees should take care to prevent the spread or transmission of unwanted substances and microorganisms, both to protect their own health and to protect their coworkers (Che et al., 2020). Regarding hand hygiene, the "5 indications (hand hygiene) rule" should be strictly followed in laboratories: Upon entering the laboratory, After contact with clinical materials After removing gloves After direct contact with laboratory surfaces Upon leaving the laboratory, Laboratory floors should have safety showers in easily accessible locations, and hot-cold water systems should be provided. These measures should be taken to minimize the risks that may occur during laboratory work and ensure the health of the personnel (Table 6). It is of great importance for every laboratory to have adequate ventilation; however, natural ventilation may sometimes be insufficient to provide the required level of ventilation. Therefore, forced ventilation systems should be used to ensure effective ventilation in laboratory environments. For the functionality and safety of laboratories, each laboratory should have at least two fume hoods. These fume hoods should have a strong metal structure, as their reliability and durability ensure the safety of the working environment. The number of fume hoods should be considered in relation to the number of laboratory users. Depending on the number of personnel, it may be necessary to increase the number of fume hoods. In order to protect the health of personnel, laboratory workers should have a chest X-ray at least once a year and be evaluated by an occupational physician. Especially employees working with chemicals are required to use gas masks instead of dust masks. This provides more effective protection against inhalable pollutants and aims to ensure the health and safety of the workers. The user instructions for the acquired machines should be requested from the relevant authorized companies, and these instructions should be affixed to the machines in a clear and visible manner. In order to enhance safety measures, each machine should be equipped with emergency stop buttons and safety valves. Unused chemical substances should be disposed of with appropriate disposal methods. Pouring them down the sink or sewer should be strictly prohibited. Unused chemicals should be delivered to special chemical waste repositories. These wastes should be stored in separate containers in designated areas of the school, not in laboratories. For this purpose, laboratory waste management procedures should be established and strictly adhered to (Kusumaningtyas and Satrio, 2022). The first aid materials and medicines that should be found in medicine cabinets are as follows: sterile gauze, cotton, bandages, adhesive tape, disinfectant solution, burn ointment, first aid brochure, body thermometer, and usage instructions. Employees must use personal protective equipment suitable for their work, such as a hat, gloves, an apron, gloves, and a mask. If possible, it would be appropriate to prefer clean shoes specially worn in the laboratory environment. These measures should be taken to increase laboratory safety, regulate chemical waste management, and protect the health of employees. In this way, the laboratory environment can be transformed into a safer and more efficient working area. Eating and drinking in the laboratory should be strictly prohibited or prevented. Each employee or new student should receive at least 1.5 hours of OHS orientation training. Since laboratories are classified as very dangerous, each employee should receive 16 hours of OHS training per year. The presence of a material safety data sheet for each chemical used in the laboratory is considered a legal obligation. Containers containing hazardous chemicals should be equipped with labels with specific information; these labels should include the full name of the chemical, hazard class, expiration and production dates, and other information. Depending on the type and hazard classification of the chemical substances, storage areas and cabinets should be arranged. Approved and appropriate storage cabinets should be used for the safe storage of chemical substances. For this purpose, locked metal storage cabinets should be preferred, and the use of wooden cabinets should be strictly avoided. Chemicals should be stored in a cool, dry, well-ventilated area, protected from light and heat. Chemical substances belonging to different hazard classes, such as flammable and explosive substances, acids, and bases, should be stored separately. Explosive substances should be kept in special explosive depots. Toxic substances should be stored in a different location from other hazard classes, preferably in a cool, well-ventilated area protected from light and heat. Oxidizing substances should be kept away from flammable and combustible materials. Corrosive chemicals should be stored on lower shelves (Tait, 2019).

Table 7. Significant risk assessment chart

Hazard Sourse	Hazard	Risk	Severity	The current situation	l	s	RRS	
Lambs	No Exproof	Fire	Cut Injury, Electric shock	No	3	4	12	Sig.
The Floor Is Dirty And Not Clean	Bacteria and Dirt on the Ground	Infection	Infection, Poisoning, Eczema, Skin Irritation Etc.	The floor was very dirty.	4	2	8	Sig.
Air Freshener, Perfume	Contact with the Chemical in the Respiratory Area and Eyes	Chemical Spraying	Intoxication, Allergic Reaction	No	5	2	10	Sig.

Hazard Sourse	Hazard	Risk	Severity	The current situation	l	s	RRS	
Power point	Broken Outlet	Electric shock	Electric shock Death	No	2	4	8	Sig.
Emergency Exit Direction Signs	Invisible in the event of a power outage	Not Finding the Emergency Exit Door	Multiple Deaths	No	2	5	110	Sig.
Electrical Devices	Having Electrical Connections Under the Tap	Electric shock	Death	No	2	4	8	Sig.
Cleaning equipment	Chemical Use, Reaction with Chemicals in the Environment	Intoxication, Death	Intoxication, Death	No	2	4	8	Sig.
Materials Put on the Cabinet	Materials on the Cabinet	Falling Under Falling Material	Serious Injury	No	3	3	9	Sig.
Extension Cables	Extension Cords Unsecured	Tripping, falling,	Electric Shock Serious Injury	No	2	5	110	Sig.
Glass Showcases	The Top of Glass Showcases Are Not Fixed	Showcase Cover Falling	Serious Injury	No	2	4	8	Sig.
Scattered Items	Items Blocking the Roads	Tripping, falling	Injury, Outpatient Treatment	No	4	2	8	Sig.
Air conditioning	Delayed or Not Performed Air Conditioning Maintenance	Legionella Bacteria Occurrence	Lung Diseases	No	4	3	112	Sig.
Electrical Installation	Clutter of Surface Mounted Installation	Electric shock	Death	No	2	4	8	Sig.

In terms of laboratory safety, lighting fixtures should be fire-resistant. It is important to regularly clean the laboratory floor; cleaning staff should be informed and warned about this issue. Cleaned floors should be dried, care should be taken in the selection of cleaning materials, and cleaning with chemical substances should be avoided. Additionally, sterilization should be regularly carried out at certain intervals. In the laboratory environment, effective ventilation should be provided instead of using room perfumes. If room perfumes are to be used, they should be hung in a high place, electrical sockets should be properly installed, and gaps should be filled with plaster. Unauthorized access to the electrical installation should be strictly prohibited. Materials used after cleaning should be sealed, chemical substances should be regularly categorized on shelves, and different cleaning materials should not be used simultaneously (Table 7). Gloves and protective masks should be used during the cleaning process; only plant-based and harmless products should be preferred as cleaning materials; and the use of chemical substances should be strictly prohibited (Table 7). All of these precautions should be taken to ensure laboratory safety and health. In this way, an effective working environment can be established, ensuring the safety of workers and the laboratory in general. Loose objects should not be left on top of cabinets in the building, and employees and students should be educated and made aware of this issue. When placing materials in the cabinet, the principle of placing heavy materials in the lower compartments and light materials in the upper compartments should be followed. Each item in the cabinet should be labeled and made identifiable (Ateş and Albayrak, 2022). The extension cords used inside the building must be securely fastened. Unsecured outlets and loose electrical wires are at risk of being exposed to external factors and being damaged, posing an electric shock hazard. Cable ties and channels should be used to keep the cables organized. Similarly, the cables you collect should be placed away from water sources. Unused faucets should be closed with blind plugs. Air conditioning units, for example, need to have their pollen filters and devices maintained once a year to prevent bacterial growth. In addition, hanging and scattering cables should be fixed, and broken cable channels should be replaced when necessary. The electrical installation should be checked at least once a year by authorized institutions or individuals, and leakage current relays should be installed, ensuring that grounding is done correctly (Karapantsios et al., 2008). Maintenance cards indicating that these controls have been performed should be kept by the school management. Fixing the glass display case doors used for exhibition purposes or replacing them with safer models is of great importance for the safety of the displayed material and visitors (Table 7).

Table 8. Low risk assessment chart

Hazard Sourse	Hazard	Risk	Severity	The current situation	l	s	RRS	
Cabinets	Unfixed Cabinets	Overturning the Cabinet	Death, Injury	No	1	4	4	Low
Cabinets	Broken Cabinet Handles	Cabinet Handles Cause Injury	Minor Injury	No	3	2	6	Low
Boards And Tables	Broken Board and Table Glasses	Broken Glass Causing Cuts	Injury, Outpatient Treatment	No	2	3	6	Low
Laboratory Devices	Irregularity of Devices	Trip, Fall, Crush	Minor Injury	No	3	2	6	Low
Lesson Board	Wood Screw Displaced	crush	Serious Injury	No	2	3	6	Low
Aspirator	Unhygienic Aspirator	Unhealthy Environment	Bacterial and Microbial Diseases	No	1	3	3	Low
Thermometer	Using a Mercury Thermometer	Falling and Breaking of Thermometer, Contact of Mercury to Humans	Poisoning	No	1	5	5	Lo

All unfixed cabinets within the premises need to be fixed to the wall. It is important to promptly fix any broken cabinet handles. In cases where it is not possible to obtain new handles, the protruding screws or nails need to be removed (Table 8). Broken glass in panels and frames should be replaced with new ones. Panels and frames should be fixed with at least three points for secure installation. Organizing laboratory equipment properly and removing unnecessary materials is important for maintaining an effective working order. The chalkboard should also be secured and provide safe usage. Additionally, the hose of the laboratory aspirator needs to be replaced and cleaned periodically. Using digital thermometers instead of mercury thermometers will provide safer and more accurate measurements.

4. CONCLUSION

The activities carried out in laboratories are generally risky and contain intense sources of danger. In the environment subject to the study, hazards that are expressed as very risky and that may cause deaths or even multiple deaths as a result of a possible accident if no precautions are taken have been identified. The presence of electrical panels in the laboratory makes the workplace very risky with the presence of flammable materials in the environment, as well as the risk score, the fact that the escape sections are covered with materials, the doors are not suitable for the work done, and there is no fire alarm system. This situation will ultimately create a high probability for the risk to occur and will cause the degree of severity to be high. The measures to be taken should be taken urgently to reduce the likelihood of the risk and, if possible, to reduce its severity. Risks assessed in the category of significant risks related to workplace order and organization can be eliminated by administrative solutions and ensuring hygiene conditions. Improvements to be made in the medium term should be considered in planning. In general, OHS procedures should be prepared in the laboratory, and periodic drills should be carried out on how to act in emergencies as well as what to do about the work. OHS training programs should be prepared before starting work and in certain periods. The aim of OHS education is to provide students with the knowledge and competencies necessary to develop their skills and abilities. Improving the quality and effectiveness of university education has become a primary goal today. The basis of this goal is to ensure that the content of education reflects scientific and technological developments. It is of great importance that future chemistry teachers and chemists receive OHS training during their academic preparations and obtain the most up-to-date information in this field. This preparation stands out as a measure to prevent health and financial losses. A large number of students who have completed their university studies work as teachers in vocational schools or high schools and manage laboratory work. For others, their work involves emphasizing OHS requirements. The content of the training should ensure that the acquired knowledge, skills, and abilities are valuable in future jobs or in everyday practice. Chemistry laboratory work is closely related to the validation and advancement of theoretical knowledge, the development of skills, and, most importantly, the adoption of safe working practices.

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