

Assessing The Level Of Students' Awareness With Safety Rules Within Educational Laboratories At Jadara University In Jordan

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Abstract

Educational laboratories, particularly those used in chemistry and pharmacy, are vital environments for acquiring theoretical knowledge and practical skills. However, they also present potential hazards, necessitating strict adherence to safety protocols. This study aimed to assess the level of students' awareness regarding safety rules within educational laboratories at Jadara University in Jordan. A questionnaire-based survey was conducted among 110 students (60 pharmacy and 50 chemistry students) at Jadara University. The questionnaire consisted of 20 items evaluating students' awareness of laboratory safety rules. Data was analyzed using descriptive statistics and independent samples t-test. The overall mean score for students' awareness of safety procedures was 3.285 (65.6%), indicating a moderate level of awareness. There was no statistically significant difference in safety awareness between chemistry and pharmacy students ($t = 1.30$, $p > 0.05$). Students showed high awareness of some critical safety rules, such as the prohibition of inhaling chemicals (86.72% agreement), and the need for immediate washing after chemical exposure (85.09% agreement). However, lower awareness was observed for rules regarding proper waste disposal and mobile phone usage in laboratories.

While students demonstrated awareness of some key safety procedures, there is room for improvement in certain areas. The study recommends implementing regular safety workshops, integrating safety rules into course curricula, and providing comprehensive safety guides to enhance overall laboratory safety awareness among students.

Keywords: Awareness, Safety Rules, educational Laboratories. Jadara University

1. INTRODUCTION

The experts (1) emphasize that educational laboratories—such as those used in chemistry and pharmacy—are vital environments for acquiring both theoretical knowledge and practical skills. These settings allow students to apply what they learn in real-world contexts. However, (2) indicate that working in laboratories also presents potential hazards, including the handling of dangerous chemicals, use of sharp glassware, and exposure to toxic fumes. Therefore, strict adherence to safety and security protocols is crucial to ensure the well-being of students, instructors, and the surrounding environment.

According to international standards, the American Chemical Society (2016) outlines a set of fundamental safety rules that students must follow while working in laboratories, as follows:

- a) Wearing appropriate personal protective equipment (such as gloves, goggles, and lab coats.
- b) Handling and storing chemicals according to scientific safety guidelines, and properly disposing of chemical waste in an environmentally responsible manner.

c) Being familiar with first aid procedures and emergency response strategies in the event of an accident.

So,(3) define laboratory safety as a set of procedures designed to protect students, laboratory technicians, equipment, and the environment from potential hazards. These hazards include the handling of chemicals, sharp instruments, and various types of laboratory equipment.

Concerning student behavior, (4) report that many laboratory safety violations occur due to students neglecting basic precautions. E.g., some students fail to wear essential personal protective equipment such as lab coats and goggles, bring food into the laboratory, or wear inappropriate footwear like slippers.

Additionally, (5) highlights the concerns related to laboratory technicians, noting that some technical assistants do not adequately inspect materials and equipment before experiments, which increases the risk of accidents.

The authors (6) emphasize the critical importance of fostering a sense of rights and responsibilities among learners, researchers, and professionals working in laboratory settings. They point out that a significant challenge lies in the fact that some undergraduate institutions lack well-equipped laboratories, formal training in safety protocols, comprehensive chemical safety plans, and effective quality control systems.

As academics,(6). advocate for the implementation of active safety programs within educational institutions. Such programs promote positive values and responsible behaviors among students and laboratory assistants. They also argue that safety education not only helps learners to correct common misconceptions but also enhances their understanding of key safety principles, leading to a more comprehensive and informed approach to laboratory work.

In this context, (7)emphasize the importance of raising awareness about safe laboratory practices and cultivating a responsible mindset among students and staff. They highlight the critical role of safety education in transforming students' attitudes toward laboratory safety, noting that a well-informed attitude significantly contributes to accident prevention. Furthermore, they call for continued research and initiatives aimed at promoting safety awareness; as such efforts are essential in reducing accidents and fostering a safe educational environment.

Similarly, (8) affirm the vital role of safety in educational laboratories, stressing its importance in protecting both students and laboratory technicians from injuries and accidents. He argues that working in laboratories necessitates strict adherence to established safety procedures in order to minimize potential risks.

By the same vein (9) highlight the importance of addressing the factors that hinder students' commitment to laboratory safety measures. These factors may include the unavailability of personal protective equipment or the lack of clear and consistent safety guidelines, both of which can lead to non-compliance with safety procedures.

Similarly, (10)emphasize that students who undergo continuous, hands-on training in safety protocols demonstrate a higher level of adherence to safety practices compared to those who receive only theoretical instruction. They also underscore the crucial role of laboratory supervisors in guiding students and fostering a culture of safety, which significantly contributes to reducing risks and reinforcing safe behavior in laboratory settings.

Due to the significance of this subject, numerous studies have been conducted. One such study is by(11), titled "*An Assessment of Laboratory Safety Training in Undergraduate Chemistry Programs.*" The study aimed to develop and implement a survey to evaluate how safety principles and cultural expectations are integrated into undergraduate chemistry curricula. The findings revealed inconsistencies in the incorporation of safety training across various programs, emphasizing the

urgent need for standardized safety education to ensure consistent adherence to safety protocols among students.

The study was conducted by (12), it aimed at assessing university students' awareness of laboratory safety. A sample of 335 students participated in the research by completing a questionnaire that evaluated their familiarity with chemical hazard symbols, attitudes toward laboratory safety, safety practices, and knowledge of emergency procedures. The results revealed that 63.58% of the students did not meet the expected level of safety awareness. Their average scores ranged between 2.20 and 2.56, indicating weak performance. Moreover, the study found that students demonstrated poor ability in identifying safety pictograms and responding appropriately to laboratory emergencies.

Another study carried out by (13), which aimed to evaluate the safety requirements and practices in teaching laboratories at Bule Hora University Health Institutes. The study involved a random sample of 17 academic staff members and laboratory assistants from two departments. Data collection was done using a self-administered questionnaire and an observational checklist. The findings indicated that only 33.3% of the essential safety requirements were met, and many safety practices were rarely followed by the participants. The study concluded that the teaching laboratories had inadequate safety requirements and poor safety practices.

A study was done by (14) titled "Adherence to Safety Practices and Risks Associated with Toxic Chemical Exposure among Postgraduate Students," involving students from the Biology, Chemistry, and Biochemistry departments. The research focused on assessing students' knowledge and compliance with safety practices, protective measures, and the risks linked to toxic chemicals. To gather data, a questionnaire was distributed to 83 students. The findings revealed that while most students (78%) had received laboratory safety training, only 34% were able to recognize all the warning signs related to hazardous chemicals. The study highlighted varying degrees of adherence to safety protocols and stressed the necessity of comprehensive safety training to reduce risks connected to toxic chemical exposure.

The study conducted by (15) examines undergraduate students' perceptions of chemical safety in laboratories. The participants were drawn from the Biomedical Engineering, Pharmaceutical, and Chemical Engineering departments at the German Jordanian University in Jordan. An anonymous survey was administered to a randomly selected sample of 174 students. A 32-item questionnaire was designed to assess students' knowledge and attitudes and to fulfill the study's objectives. The findings revealed that while students were generally familiar with chemical hazard warning signs, there was a clear need for enhanced safety training and awareness programs to bridge the gap between theoretical knowledge and practical application.

To assess students' awareness of laboratory safety, (16) conduct a study employed a survey method covering topics such as safety regulations and the role of Occupational Safety, Health, and Environment (OSHE) within the laboratory setting. A questionnaire was distributed to a sample of 30 university students. The findings indicated that while most students demonstrated a good level of awareness regarding laboratory safety, some still failed to adhere to established safety rules.

Previous studies have consistently emphasized the urgent need for ongoing and comprehensive safety training programs. Several researchers, including (13), (12), and (11), reported low levels of safety awareness among students. In contrast, studies by (16) and (15) found a relatively high level of safety awareness. These findings align with the current study, which also observed a strong commitment to following safety rules among participants.

The researchers, who teach chemistry and pharmacy courses at Jadara University in Jordan, conducted this study to assess students' awareness of laboratory safety rules. They observed that many students do not adhere to the safety regulations established by the university, viewing this lack of compliance as a serious concern. Therefore, conducting such studies is essential to raise students'

awareness and emphasize the importance of following safety protocols in educational laboratories. Ultimately, the researchers hope that this work will contribute to addressing the gap in attention to safety studies at the academic level.

Objectives of the Study

The study aimed at evaluating the level of chemistry and pharmacy students' awareness of safety procedures in educational laboratories at Jadara University in Jordan. It also aimed at assessing the differences in the level of chemistry and pharmacy students' awareness of safety procedures according to the specialty variable.

Questions of the Study

The questions of the study are as follows:

1. What is the level of chemistry and pharmacy students' awareness about safety procedures in educational laboratories at Jadara University in Jordan?
2. What is the level of chemistry students' awareness about safety procedures in educational laboratories at Jadara University in Jordan?
3. What is the level of pharmacy students' awareness about safety procedures in educational laboratories at Jadara University in Jordan?
4. Are there any statistically significant differences at $\alpha = 0.05$ level in safety awareness rules between chemistry and pharmacy students in educational laboratories at Jadara University in Jordan?

Significance of the Study

The significance of this research lies in its unique focus, as it is the first study of its kind conducted at Jadara University. It evaluates the level of awareness regarding safety procedures among students in the fields of chemistry and pharmacy. While there are existing studies on laboratory safety, few have specifically addressed the context of Jordanian university students. This research helps to support students, lecturers, and decision-makers in enhancing training programs within Jordanian universities. Furthermore, it may contribute to the development of an effective awareness model that links students' behavior with their understanding of safety practices in laboratory settings.

Limitations of the Study

This study has several limitations.

First, it was targeted to pharmacy and chemistry students' first year (2024-2025) at Jadara University. Second, the research was conducted during the end of second semester of the 2024/2025 academic year, and the results may differ if repeated in other semesters. Lastly, the study relied exclusively on a self-administered questionnaire, without incorporating other data collection methods such as interviews or direct observations.

2. METHODOLOGY

This study's methodology includes details about the sample, the data collection tool—a questionnaire designed to meet the study's objectives—along with the process of validating and testing its reliability, followed by data analysis.

The Sample of the Study

The study aimed first year pharmacy and chemistry students at Jadara University in Jordan. Inclusion criteria were set to include all pharmacy and chemistry students enrolled in laboratory courses during the first and second semesters (2024/2025). The study population consists of (202) students, (146) from the pharmacy major and (56) from the chemistry major. A random sample of (110) students was selected, representing approximately 54% of the total population, distributed as follows: (60) pharmacy and (50) chemistry. In order to represent the population, the total sample size was determined to be (110) students. The sample selection took into account the representation of different specializations, but the number of members of the chemistry major sample was increased to

(50) students, even though the chemistry population does not exceed (56) students. This was done in order to ensure adequate representation of this specialization due to the small number of its members compared to the pharmacy major, and to allow for more accurate statistical analyses and comparisons.

Data Collection

The study used a questionnaire to achieve the objectives, the questionnaire was drafted from surfing the net, and investigating a number of the previous studies such as Al-Zyoud, et al. (2019) on laboratory safety awareness, it modified to fit the context of Jadara University. To achieve the validity, the questionnaire was sent online to four experts from various universities in Jordan, who assessed the clarity, relevance, and coverage of the items. They were asked to determine its appropriateness for measuring students' understanding of safety protocols in educational laboratories. Their comments and recommendations were taken into consideration and some redundant items or had similar meanings were deleted, and minor wording adjustments were made based on their feedback. These steps ensured that the questionnaire effectively measured students' awareness of laboratory safety. The final version of a Likert-scale questionnaire was conducted with 20 validated items, it enabled students to express their perceptions of safety rules using a five-point scale: "Strongly Agree," "Agree," "Neutral," "Disagree," and "Strongly Disagree," assigned numerical values of 5, 4, 3, 2, and 1, respectively.

The questionnaire was also evaluated using two types of reliability: internal consistency using Cronbach's alpha, and cross-time reliability using test-retest (correlation coefficient). A computed Cronbach's alpha value was 0.8, indicating all items in the questionnaire are well interrelated meaning they measure the same concept consistently. The researchers administrated the questionnaire to a sample of 10 students as the first test, and then retested the same sample after two weeks. The correlation coefficient ($r = 0.9$) was found, that indicates a very good reliability of the instrument. This means that the questionnaire produces similar results over time. Appendix (1) contains the final questionnaire.

Data Analysis

The questionnaire was distributed to students, and their responses were collected for analysis. Data was analyzed statistically-descriptive and inferential-using SPSS version 25. Descriptive statistical analyses included calculating means, standard deviations, frequencies, and percentages for all variables. For inferential analyses, t -test was used to examine the differences in safety awareness between academic majors. The statistical significance level was considered to be $\alpha < 0.05$. Evaluating the differences between pharmacy students and chemistry students, t -test for independent samples was used, by this way, the inferential and descriptive analysis was performed.

The criteria used, and to determine the overall average for a specific item, the researchers computed the mean based on the responses of all 110 students. As an example, the responses to the first item "Adherence to in-laboratory safety instructions is essential" were analyzed as follows:

- 45 students selected *Strongly Agree* (St.agree) $\rightarrow 45 \times 5 = 225$ points
- 15 students selected *Agree* $\rightarrow 15 \times 4 = 60$ points
- 8 students selected *Neutral* (Ne) $\rightarrow 8 \times 3 = 24$ points
- 17 students selected *Disagree* $\rightarrow 17 \times 2 = 34$ points
- 25 students selected *Strongly Disagree* (Str.Dis) $\rightarrow 25 \times 1 = 25$ points

The total score for this item was 368 points. To find the average score: $368 \div 110$ students = 3.34. This corresponds to a percentage of: $(3.34 \div 5) \times 100 = 66.8\%$. Based on the scoring criteria, this result indicates a moderate level of awareness.

The following table presents the criteria used to interpret the levels of students' awareness:

Table1: The criteria of students' awareness

Str. Dis (v. low awareness)	Disagree (low awareness)	Ne.(moderate awareness)	Agree (high awareness)	Str. Agree v.high awareness)
*1-1.8	1.81 -2.6	2.61-3.4	3.41-4.2	4.21-5
20% -36%	37% -52%	53% -68%	69% -84%	85% -100%

*(interval width is 0.8 for strongly disagree, while others, each one is 0.79~0.8), and (internal width percentage is 16 for the first category, while the others, each one compute 15). It is suitable for this study

3. RESULTS AND DISCUSSIONS

The most significant findings from all questions will be covered in this section of the research. The averages, percentages, and standard deviations for each item will be given in response to all items of the first question without going into detail. In contrast, the answers of (2, 3, and 4) questions will only be summarized, and the researchers will explain and justify their key findings.

For answering Q1: *What is the level of chemistry and pharmacy students' awareness about safety procedures in educational laboratories at Jadara University in Jordan?* The overall mean score was 3.285, representing 65.7%, with a standard deviation of 3.20. Table 2 presents the averages arranged in descending order and outlines the four levels of the sample's awareness regarding adherence to safety rules in the laboratories, as follows:

Veryagree level

The veryagree level scored the average of 4.26, corresponding to 85.23%. This level includes three items (3, 13, and 12) with the mean score ranging from (4.33-4.2) and percentages between 86.7% and 84% as shown in table 2. The highest-ranked item, number 3, states that "It is forbidden to inhale chemicals during experiments." Notably, 86.72% of participants agreed with this statement, with a mean score of 4.33.

The second highest rank goes to item 13, which states, "In case of direct exposure to chemicals, the affected area should be washed with plenty of water." The participants mostly agreed with this statement, with 85.09% responding affirmatively and a mean score of 4.25.

The third rank is held by item 12, which states, "It is forbidden to carry out any experiment that is not scheduled or seen on social media without consulting the laboratory supervisor." The majority of participants agreed with this rule, with 84% affirming it and an average score of 4.2.

Agree Level

The "Agree" level scored an average of 4.03 corresponding to 80.73%. This level includes eight items (7, 11, 4, 16, and 14) with mean scores ranging from 4.15 to 3.80 and percentages between 83.00% and 76.00%.

The fourth rank is assigned to item 7, which states, "Chemicals should be disposed of safely and not poured down the drain." The participants agreed with this, with 83.09% responding affirmatively and a mean score of 4.15.

The fifth rank belongs to item 11, which states, "Closed footwear should be worn while working in the educational laboratory." The majority of participants agreed with this guideline, with 80.86% responding affirmatively and a mean score of 4.01.

The sixth rank is assigned to item 4, which states, "No chemical should be tasted in the laboratory." According to Table 2, 80.00% of participants agreed with this rule, with a mean score of 4.0.

Table 2: Percentages, average, and standard deviation in descending order for all students

rank	key	1	2	3	4	5	Sum	Aver	%	st.d
	item	all	all	all	all	all				
The first: Veryagree level										
1	3	5	10	6	11	78	477	4.33	86.7	1.04
2	13	2	17	5	13	73	468	4.25	85.0	0.96
3	12	8	10	2	22	68	462	4.20	84.0	0.91
The second: Agree level										
4	7	12	7	7	10	74	457	4.15	83.00	0.86
5	11	8	10	16	14	62	442	4.01	80.36	0.72
6	4	10	7	18	12	63	441	4.00	80.00	0.71
7	16	16	10	7	7	70	435	3.95	79.09	0.66
8	14	11	22	4	14	59	418	3.80	76.00	0.51
The third: Neutral level										
9	1	25	17	8	15	45	368	3.34	66.9	0.05
10	9	22	21	12	13	42	362	3.29	65.81	0.01
11	15	22	25	16	14	33	341	3.10	62.00	0.19
12	2	38	9	19	14	30	319	2.90	58.00	0.39
13	8	33	21	11	15	30	318	2.89	57.81	0.39
The fourth level: Disagree level										
14	17	17	27	16	17	24	307	2.79	55.81	0.49
15	6	37	23	4	22	24	303	2.75	55.09	0.53
16	19	43	12	18	11	26	295	2.68	53.63	0.6
17	10	42	26	12	13	17	267	2.42	48.54	0.86
18	18	43	24	15	13	15	263	2.39	47.81	0.89
19	20	41	26	21	9	13	257	2.33	46.72	0.95
20	5	45	30	12	15	8	241	2.19	43.81	1.09

The seventh rank goes to item 16, which states, “The laboratory supervisor must be someone experienced in handling incidents within the laboratory.” The participants largely agreed with this, with 79.09% in support and a mean score of 3.95.

The eighth rank is for the item 14, which states, “The locations of water sources needed for safety must be known before starting work inside the laboratory.” As indicated, the participants agreed on the availability of a water source inside the laboratory, with 76% affirming this and a mean score of 3.8.

Neutral Level

The neutral level scored an average of 3.01, representing 60.02%. It includes five items with mean scores ranging from 2.89 to 3.34 and percentages between 57.81% and 66.9%. Notably, the ninth

rank is held by item 1, which states, "Adherence to in-laboratory safety instructions is essential." Participants responded neutrally to the importance of following safety rules in the lab, with 66.9% choosing a neutral option and an average score of 3.34.

The tenth rank goes to item 9, which states, "Glass bottles should be used to temporarily store chemicals until they are safely disposed of." Participants responded neutrally to this statement, with 65.81% selecting a neutral option and a mean score of 3.29.

The eleventh rank is for item 15, which says, "The presence of a first aid kit inside the laboratory is both a necessity and not a luxury." The participants' responses were neutral regarding the availability of a first aid kit in the lab, with 62% neutral and an average score of 3.1.

The twelfth rank belongs to item 2, which states, "It is necessary to wear proper clothing while working in the laboratory." Participants responded neutrally to this statement, with 58% selecting a neutral option and a mean score of 2.9.

The thirteenth rank is assigned to item 8, which says, "Dedicated places should be provided for clothes and bags away from the laboratory work area." The sample showed a neutral response to this, with 57.81% neutral and an average score of 2.89.

The Disagree Level

The disagree level recorded an average score of 2.95, representing 59.0%. It includes items 17, 6, 19, 10, 18, 20, and 5, with mean scores ranging from 2.19 to 2.79 and percentages between 43.81% and 55.81%. The fourteenth rank is item 17, which states, "Excess chemicals may be returned to the main packaging for preservation." Participants generally disagreed with this statement, with 55.81% expressing disagreement and a mean score of 2.79.

The fifteenth rank belongs to item 6, which states "Do not use cracked or broken glassware." Participants generally disagreed with this statement, with a mean score of 2.79 and 55.81% expressing disagreement.

The sixteenth rank is assigned to item 19, which says, "It is necessary to perform chemical calculations before starting the practical part of the experiment." The sample showed disagreement with this, with 53.63% disagreeing and an average score of 2.68.

The seventeenth rank is for item 10, which states, "Eating and drinking are not allowed in the laboratory, even when very hungry." The participants tended to disagree with this rule, with 48.54% expressing disagreement and a mean score of 2.42.

The eighteenth rank belongs to item 18, which says, "Chemical waste should be disposed of in designated areas and not in regular sinks." The sample showed disagreement with this statement, with 47.81% disagreeing and an average score of 2.39.

The nineteenth rank goes to item 20, which states, "It is not allowed to use a mobile phone during practical experiments." Participants generally disagreed with this rule, with 46.72% expressing disagreement and a mean score of 2.33, indicating a low level of compliance for this important safety guideline.

The twentieth rank is assigned to item 5, which says, "It is forbidden to play with glassware or misuse it." The participants tended to disagree with this statement, with 43.81% disagreeing and an average score of 2.19.

For answering Q2: *What is the level of chemistry students' awareness about safety procedures in educational laboratories at Jadara University in Jordan?*

Averages, percentages, and standard deviations were calculated. The overall mean score is 3.219, representing 64.4%, with a standard deviation of 0.625. A review of Table 3 reveals five distinct levels of chemical students' awareness, detailed as follows:

Veryagree Level

The veryagree level scored the average of 4.32, corresponding to 86.40%. This level includes two items (3, and 13) with the mean score ranging from (4.34-4.3) and percentages between 86.8 % and 86.0%. The highest-ranked item, number 3, states that “It is forbidden to inhale chemicals during experiments.” Notably, 86.8% of the participants’ veryagreed with this statement, with a mean score of 4.34, and a standard deviation of 1.85. The second highest rank also goes to item 13, which indicates, “In case of direct exposure to chemicals, the affected area should be washed with plenty of water.” Participants agreed with this statement, showing 86% agreement and a mean score of 4.3. Comparing the two tables (2 and 3), the same items hold the first and second ranks for all students as well. This confirms that students have a good understanding of these important safety measures.

Table 3: Results of chemistry students in answering the questions in descending order

Rank	Q	Ch(1)	Ch(2)	Ch(3)	Ch(4)	Ch(5)	Aver	%	st.d	T.test
The first: Veryagree Level										
1	3	2	6	3	1	38	4.34	86.8	1.85	1.34
2	13	1	8	2	3	36	4.30	86.0	1.83	1.30
The second: Agree level										
3	7	7	1	4	5	33	4.12	82.4	1.73	1.12
4	16	6	4	3	3	34	4.10	82.0	1.72	1.10
5	4	5	2	10	0	33	4.08	81.6	1.71	1.08
6	12	4	5	1	14	26	4.06	81.2	1.70	1.06
7	11	4	4	9	3	30	4.02	80.4	1.68	1.02
8	9	5	8	2	10	25	3.84	76.8	1.61	0.84
The third : Neutral Level										
9	19	10	5	5	6	26	3.78	75.6	1.59	0.78
10	17	2	12	8	7	21	3.66	73.2	1.55	0.66
11	14	2	17	3	4	24	3.62	72.4	1.54	0.62
12	1	10	7	8	10	15	3.26	65.2	1.51	0.26
13	18	8	12	5	12	13	3.2	64.0	1.5	0.2
The fourth : Disagree level										
14	15	12	15	13	5	5	2.52	50.4	1.67	-0.48
15	6	23	12	1	7	7	2.26	45.2	1.8	-0.74
16	20	19	18	5	5	3	2.1	42	1.9	-0.9
17	10	20	22	1	4	3	1.96	39.2	1.99	-1.04
The fifth: Very. Disagree level										
18	2	33	4	3	10	0	1.8	36.0	2.09	-1.2
19	5	25	15	7	3	0	1.76	35.2	2.12	-1.24
20	8	28	16	4	2	0	1.6	32.0	2.24	-1.4

Agree Level

The “Agree” level achieved an average score of 4.04, equivalent to 80.8%. This level includes six items (7, 16, 4, 12, 11, and 9) with corresponding percentages of 82.4, 82, 81.6, 81.2, 80.4, and 76.8, respectively. The last at agree level, and the eighth rank belongs to item 9, which states, “Glass bottles should be used to temporarily store chemicals until they are safely disposed of.” Participants agreed with this statement, with 76.8% responding affirmatively and an average score of 3.84.

Neutral Level

The neutral level has an average score of 3.5, representing 70.0%. It includes five items (19, 17, 14, 1, and 18) with mean scores ranging from 3.78 to 3.20 and percentages between 75.6%.and 64%. Notably, the ninth rank is held by item 19, which states, “It is necessary to carry out chemical calculations before starting the practical part of the experiment.” Participants responded neutrally to this statement, with 75.6% selecting a neutral option and an average score of 3.78.

The last item ranked 13th in the neutral level is item 18, which states, “Dispose of chemical waste in designated places and do not throw it in the normal sink.” Chemistry students responded neutrally to this statement, with 64% selecting neutral and an average score of 3.2. Laboratory safety rules consistently emphasize the importance of disposing of chemical waste in properly labeled and approved containers to ensure safe handling. This rule is crucial because:

- a) Chemicals can harm the environment, including plants and animals.
- b) Mixing chemicals with water may cause dangerous reactions or explosions.
- c) Improper disposal can damage plumbing systems.

Disagree level

The disagree level has an average score of 2.21, representing 44.2%. It includes four items (15, 6, 20, and 10) with mean scores ranging from 1.96 to 2.52 and percentages between 39.2% and 50.4%. The fourteenth rank is item 15, which states, “The presence of a first-aid kit inside the laboratory is a necessity, not a luxury.” Chemistry students tended to disagree with this statement, with 50.4% expressing disagreement and a mean score of 2.52. However, first aid equipment is essential in laboratories due to the risks students may face. This response may suggest that chemistry students undervalue the importance of first aid and lack sufficient awareness about its necessity.

The last item in the disagree level is item 10, which states, “It is not allowed to eat and drink in the laboratory even if you feel very hungry.” Chemistry students mostly disagreed with this rule, with 39.2% expressing disagreement and a low average score of 1.96. Interestingly, this item holds the same 17th rank in both Table 1 and Table 3, but its average score and percentage are lower compared to the overall results in Table 2. This may indicate that the students either have a negative attitude toward this rule or were previously unaware of its importance.

Very Disagree Level

The very disagree level has an average score of 1.78, representing 35.6%. It includes three items (2, 5, and 8) with mean scores ranging from 1.6 to 1.8 and percentages between 32% and 36%. Item 2, which states, “It is necessary to wear proper clothing while working in the laboratory,” is ranked 18th here, compared to its 12th rank in the overall student table. This indicates a “very disagree” level among chemistry students regarding the importance of wearing proper clothing in the lab, with 36% disagreeing and an average score of 1.8. This poor result suggests that this crucial safety rule may not be adequately observed or valued in the laboratory.

The lowest-ranked item, number 20, is item 8, which states, “It is necessary to provide dedicated places for clothes and bags away from the working area of the laboratory.” Chemistry students gave this item the lowest level of agreement, with only 32% agreeing and an average score of 1.6.

This safety measure is essential to maintain an organized and safe laboratory environment and to prevent accidents, as scattered bags and clothes can increase the risk of fire or chemical exposure.

For answering Q3: *What is the level of pharmacy students' awareness about safety procedures in educational laboratories at Jadara University in Jordan?*

Table 4 shows the average scores, standard deviations, and percentages that were calculated. The overall mean score is 3.34, representing 66.8%, with a standard deviation of 0.209. The results fall into the following levels:

Veryagree Level

The veryagree level has a mean score 3.38, and a percentage of 85.77%. It includes three items (3, 12, and 13) with a percentage ranging (86.66, 86.33, and 84.33%). The top-ranked item is question 3, which states, "It is forbidden to inhale chemicals during experiments." The pharmacy students showed strong agreement with this, at 86.66%, with a mean score of 4.33 and a standard deviation of 1.15.

This item occupied also the first rank in the table 2 for all students and in table 3 for chemistry students. By this, it is emphasized for the good knowledge about such value. On other words, the high level for this item is because it is a safety basic rule that always taught in chemistry classes, and teachers often warned students not to inhale chemicals for its risk in health. Regarding pharmacy students, the result may be referred to their caring of human being, and to prevent sickness.

The second highest rank goes to item 12, which states, "It is forbidden to carry out any experiment that is not scheduled or seen on social media without consulting the laboratory supervisor," with an agreement percentage of 86.33%. Compared to other results, this item ranks sixth in Table 2 for all students (81.2%) and third in Table 3 for chemistry students (84%). Ignoring the planned procedures for experiments can pose serious risks, such as unsafe reactions, explosions, or the release of toxic gases. Therefore, it is essential to have the experiment reviewed by the responsible person to ensure that all safety protocols are followed in the laboratory.

The third rank is assigned to item 13, which previously held the second position. This item states, "In case of direct exposure to chemicals, the affected area should be washed with plenty of water," with an agreement percentage of 84.33% and a mean score of 4.21. This indicates that students are aware of this important safety rule, understanding that rinsing the affected area with ample water helps to quickly remove harmful chemicals. Prompt washing reduces the risk of burns and serious injuries—the sooner water is applied, the less damage occurs to the skin and eyes.

Agree Level

This level has a mean score of 4.05 and a percentage of 81.1%. It includes seven items (7, 11, 8, 4, 14, 16, and 2), with percentages ranging from 83.66% to 76.33% (specifically: 83.66, 80.33, 79.33, 79, 79, 76.66, and 76.33).

The fourth rank is assigned to item 7, which states, "Chemicals should be disposed of safely and not poured down the drain." The participants agreed with this, with 83.66% responding affirmatively and a mean score of 4.18. It occupied nearly the same level by all students, but it has achieved the third level by chemistry students.

The last at agree level, and the 10th rank in the agree level for pharmacy students is item 2, which states, "It is necessary to wear proper clothing while working in the laboratory," with an agreement percentage of 79.33% and a mean score of 3.96. This represents a good level compared to chemistry students, where the same item ranks 18th with a much lower percentage of 36%.

The difference can be explained by the fact that pharmacy students are accustomed to wearing white lab coats, which likely contributes to their higher awareness and agreement. They understand that wearing a lab coat with long sleeves helps protect against harmful chemicals, such as acids, that can damage the skin and eyes.

Neutral Level

The neutral level has a mean score of 3.1 with a percentage of 62.0%, and it includes six items (15, 1, 6, 9, 17, and 10) with respective percentages of 71.66, 68.33, 63.33, 56.6, 56.33, and 56.33. The 11th rank is item 15, which states, “The presence of a first-aid pharmacy inside the laboratory is a necessity, not a luxury,” with a percentage of 71.66% and an average score of 3.58. This item falls within the neutral level for pharmacy students, while in the chemistry students’ results (table 2), it is ranked 14th at the disagree level, with 50.4% and an average of 2.52.

This difference may be attributed to pharmacy students’ greater recognition of the first aid pharmacy as a vital safety component in the lab. Additionally, they are more accustomed to treating minor injuries immediately. Pharmacy students receive training in first aid and medication use, which enhances their understanding of how to properly utilize first aid equipment.

Table 4: The results of pharmacy students’ responses in descending order

	key	1	2	3	4	5	aver	%	std	t.test
rank	Q	Ph	Ph	Ph	Ph	Ph				
The first: VeryAgree Level										
1	3	3	4	3	10	40	4.33	86.66	1.15	8.89
2	12	4	5	1	8	42	4.31	86.33	1.25	8.11
3	13	1	9	3	10	37	4.21	84.33	1.18	7.97
The second: Agree level										
4	7	5	6	3	5	41	4.18	83.66	1.37	6.67
5	11	4	6	7	11	32	4.01	80.33	1.29	6.07
6	8	5	5	7	13	30	3.96	79.33	1.31	5.69
7	4	5	5	8	12	30	3.95	79.0	1.32	5.56
8	14	9	5	1	10	35	3.95	79.0	1.52	4.82
9	16	10	6	4	4	36	3.83	76.66	1.6	4.01
10	2	5	5	16	4	30	3.81	76.33	1.35	4.65
The third: Neutral Level										
11	15	10	10	3	9	28	3.58	71.66	1.59	2.82
12	1	15	10	0	5	30	3.41	68.33	1.76	1.82
13	6	14	11	3	15	17	3.16	63.33	1.58	0.81
14	9	17	13	10	3	17	2.83	56.6	1.59	-0.8
16	17	15	15	8	10	12	2.81	56.33	1.48	-0.95
15	10	22	4	11	9	14	2.81	56.33	1.62	-0.87
The fourth: Disagree level										
17	5	20	15	5	12	8	2.55	51.00	1.46	-2.37
18	20	22	8	16	4	10	2.53	50.66	1.46	-2.46
19	19	33	7	13	5	2	1.93	38.66	1.26	-9.56
The fifth: Strongly Disagree level										
20	18	35	12	10	1	2	1.72	34.33	1.00	-13.7

The 15th rank is for item 10, which states, "It is not allowed to eat and drink in the laboratory even if you feel very hungry," with a percentage of 56.33% and an average score of 2.81. This falls within the neutral level for pharmacy students, whereas in table 2 for chemistry students, it ranks lower at the disagree level with a percentage of 39.2% and an average of 1.96, indicating a low level of awareness. Eating and drinking in laboratories is prohibited because:

- a) Chemicals in the lab can be toxic or harmful.
- b) Food or drinks may become contaminated with chemical particles without the person noticing. As a result, consuming contaminated food or drink can cause illness or even poisoning.

Disagree level

The disagree level has a mean score of 2.33 with a percentage of 46.6%, and it includes three items (5, 20, and 19) with percentages of 51.00%, 50.66%, and 38.66%, respectively. The 17th rank is for item 5, which states, "It is forbidden to play with glassware or use it wrongly." Pharmacy students disagreed with this statement at a rate of 51.0%, with an average score of 2.55. From the researchers' perspective, this item should have received a higher level of agreement, as students are generally aware that laboratory glassware is fragile and can cause cuts when broken. Furthermore, some glassware contains hazardous chemicals that can cause fires or chemical burns if broken or misused.

The 19th rank is assigned to item 19, which states, "*It is necessary to carry out chemical calculations before the start of the practical part of the experiment.*" Pharmacy students disagreed with this statement, with a percentage of 38.66% and an average score of 1.93. In contrast, in the chemistry students' table (Table 3), this item ranks 9th within the neutral level, with a percentage of 75.6% and an average of 3.78. This indicates that chemistry students scored significantly higher than pharmacy students on this item. This discrepancy can be attributed to two key reasons:

- a) Chemistry students are generally more trained in preparing and handling chemicals, and they frequently practice calculations related to molarity and other quantitative aspects.
- b) Chemistry students spend more time conducting experiments in the lab, where precise chemical calculations are essential. In contrast, pharmacy students primarily focus on pharmacology, dosage preparation, and patient care, rather than in-depth chemical lab work.

At last, students should aware of this rule because calculations help in using correct amount of chemicals (grams, or moles), by this, wastes and dangerous reactions are reduced, likewise, calculations help students for safe mixing of materials.

Very Disagree Level

The last rank is assigned to item 18, which states, "*Dispose of chemical waste in the designated places, and do not throw it in the normal sink.*" Pharmacy students showed the lowest level of agreement with this item, with only 34.33% and an average score of 1.72. This is the lowest score among all items, despite the fact that proper chemical waste disposal is a critical component of safety regulations in educational laboratories. As previously discussed in question 2, this rule is essential for preventing environmental damage, avoiding harmful chemical reactions (e.g., with water), and protecting laboratory infrastructure. The low awareness level among pharmacy students may reflect limited exposure to hands-on chemical lab procedures, unlike chemistry students, who are typically more engaged in laboratory practices from earlier educational stages.

Regarding the use of mobile phones in laboratories, the consistently low ranking of item 20, "*It is not allowed to use a mobile phone during practical experiments,*" draws the researchers' attention. Across the three student groups, this item was ranked 19th, 16th, and 18th, with corresponding agreement percentages of 46.72%, 42%, and 50.66%, respectively. These results indicate a general disregard for this important safety rule. In educational laboratories, the use of mobile phones is typically prohibited for several reasons:

- a) Mobile phones can distract students, and even a minor lapse in focus may lead to hazardous chemical reactions.
- b) Phones themselves are at risk of damage when exposed to heat, chemicals, or liquids commonly present in labs.
- c) Students may miss crucial steps in the experimental procedure if their attention is diverted to their devices.

Therefore, this safety rule should be emphasized more in laboratory instructions and awareness programs.

For answering Q4: "*Are there any statistically significant differences at $\alpha = 0.05$ level in safety awareness rules between chemistry and pharmacy students in educational laboratories at Jadara University in Jordan?*"

To answer this question and compare the average scores of pharmacy and chemistry students, an independent samples **t-test** was conducted, as shown in Table 4. The table presents the number of students in each group, their respective means, standard deviations, degrees of freedom (df), and the calculated *t*-value.

Based on the results presented in the table, there are no statistically significant differences attributed to students' specialties (chemistry or pharmacy). The calculated *t*-value is 1.30, which is less than the critical *t*-value of 1.99 at the 0.05 significance level ($\alpha = 0.05$). Additionally, the difference between the mean scores of the two groups is relatively small (0.12), indicating that both chemistry and pharmacy students exhibit similar levels of awareness regarding laboratory safety procedures.

Table 4: The result of t.test to evaluate the differences ascribed to specialty

Specialty	Students	Average	df	Standard.D	t.test	α
Chemistry	50	3.22	108	0.625	1.30	0.05
Pharmacy	60	3.34		0.209		

Although a slight numerical difference was observed between the two mean scores, this difference was not statistically significant and may be attributed to intra-sample variation or random effects. Therefore, it cannot be concluded that there is a fundamental difference in the performance of chemistry and pharmacy students in terms of their awareness of laboratory safety procedures.

Ending the results, it could be seen that the results of items in Table (2) were presented in detail. Regarding questions Q2 and Q3, it is not feasible to analyze every item due to space limitations. Therefore, the researchers will focus on selected items representing the highest and lowest ranks within each level to ensure a balanced and meaningful analysis.

4. Recommendations and Suggestions

Based on the above results and discussions, the researchers recommend the following:

- a) At the beginning of each semester, awareness workshops should be organized, directed to students on safety rules inside laboratories.
- b) Integrate laboratory safety rules into the study plans of practical courses with evaluating them.
- c) Distribute an exemplified guide containing safety rules to students, and to be hung inside the laboratories.
- d) The academic and technical staff must be trained on the latest awareness methods and preventive measures within the laboratory environment.

The researchers suggest to those interested in this field the following:

- a) Conducting similar studies in other universities inside Jordan.
- b) Diversify research tools to include direct observation and interviews, as well as questionnaires.

- c) Study the impact of awareness safety programs on changing students' behavior in laboratories, through a comparison between before and after the implementation of these programs.
- d) Conducting a study on safety equipment in educational laboratories, in terms of their efficiency and validity.
- e) Regular assessments should be carried out for university laboratories to verify their preparedness and to ensure the presence of essential safety equipment, including fire extinguishers, first aid kits, and accessible emergency exits.

5. CONCLUSION

This study aimed to assess the level of students' awareness regarding safety rules and procedures within laboratories at Jadara University in Jordan. The sample included 110 students, comprising 60 pharmacy students and 50 chemistry students. Participants responded to a 20-item Likert scale questionnaire, with response options ranging from 1 to 5. The study adhered to scientific research procedures, including an introduction supported by theoretical background and previous studies, sample selection methods, and the development and validation of the questionnaire. Data analysis was conducted using SPSS, employing statistical tools such as percentages, means, and standard deviations, followed by a discussion of the results and their possible interpretations.

The findings of the study revealed a variation in students' awareness of laboratory safety rules. While some students demonstrated adherence to basic safety guidelines, others showed a lack of adequate knowledge regarding the appropriate procedures to follow in laboratory settings. Statistical analysis indicated no significant differences between pharmacy and chemistry students, with a computed *t*-value of 1.30 compared to the critical value of 1.99. Based on these findings, the study proposed several recommendations, most notably the integration of safety protocols into university curricula and the organization of awareness workshops aimed at safeguarding both students and laboratory environments.

The researchers hope that this study will contribute to fostering a culture of safety awareness within universities, and serve as a foundation for expanding similar research in the future. The importance of this study lies in its focus on the level of student commitment to laboratory safety, which can have a positive impact on student well-being, and the overall educational environment. Accordingly, it is essential to enhance awareness and provide hands-on safety training programs within academic institutions. Ultimately, the researchers believe this study can help in bridging the existing gap in safety rule implementation at the academic level, encouraging greater responsibility, and precaution among students and faculty alike.

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Appendix (1)

Dear Participant

This questionnaire aims to assess the extent of compliance with safety procedures within laboratories. Please read each statement and determine the extent to which you agree with it.

Section I: General Information, specialty ()

Section II: Safety procedures in the laboratory

Dear student, choose the answer that expresses your opinion according to the following scale: (1) Very Disagree, (2) Disagree, (3) Neutral, (4) Agree, (5) Very Agree

n	Items	1	2	3	4	5
1	Adherence to in-laboratory safety rules is essential.					
2	It is necessary to wear proper clothing while working in the laboratory.					
3	It is forbidden to inhale chemicals during experiments.					
4	No chemical may be tasted in the laboratory.					
5	It is forbidden to play with glassware or use it wrongly.					
6	Do not use cracked or cracked glassware.					
7	Chemicals should be disposed of in a safe manner and not poured into a drain.					
8	It is necessary to provide dedicated places for clothes and bags away from the working area of the laboratory.					
9	Glass bottles should be used to temporarily store chemicals until they are safely disposed of.					
10	It is not allowed to eat and drink in the laboratory even if you feel very hungry.					
11	Closed footwear should be worn while working in the laboratory.					

12	It is forbidden to carry out any experiment that is not scheduled or seen on social media without referring to the laboratory supervisor.					
13	In case of direct exposure to chemicals, the affected area should be washed with plenty of water.					
14	The locations of water sources needed for safety must be known before starting work inside the laboratory.					
15	The presence of a first-aid pharmacy inside the laboratory is a necessity, not a luxury.					
16	The laboratory supervisor must be someone with experience in dealing with incidents within the laboratory.					
17	Excess chemicals may not be returned to the main packaging for preservation.					
18	Dispose of chemical waste in the designated places, and do not throw it in the normal sink.					
19	It is necessary to carry out chemical calculations before the start of the practical part of the experiment.					
20	It is not allowed to use a mobile phone during practical experiments					