Student's Awareness Regarding laboratory Hazards at Fayoum University

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Abstract

Background: University laboratories involve various hazards during the research and course activities, which might affect health and safety of students, including chemical, physical, electrical, and biological risk factors. accounting for both death and disability, the fraction of the global burden of disease due to hazards is 24% (WHO 2019). **Aim of the study:** This study aims to assess awareness of university students regarding laboratory hazards at Fayoum University. **Design:** A descriptive analytical design was used to conduct this study. **Setting:** The study was carried out at 4 Facilities are (Agriculture ,science ,pharmacy and Engineering)affiliated of El-Fayoum University. **Sample:** A Stratified random sample was used and including strata students from 2nd, 3rd and 4th grade of Faculties. **Tools of data collection:** it consisted of two tools used in data collection: **1 st tool** consists of 3 parts demographic characteristics of university students, University Students knowledge regarding laboratory hazards**,** and University students precaution or safety measures regarding laboratory hazards.**2nd tool:** observational checklist sheet for laboratory include two parts it was standardized tool comes from (**NIHDRM, 2016**) consists of 2 parts Self-Reported using personal protective measures and Health standers for laboratory. **Result :**74% of studied students were had satisfactory knowledge about laboratory hazards. While 24% of studied students were had unsatisfactory knowledge about laboratory hazards. 87% of them had unsafe self-reported protective measures about laboratory hazards. While 95.3% of them had unsafe total standers for laboratory Health and self-reported protective measures about laboratory hazards. Additionally there was statistically significant reference between studied students practice and personal protective /safety measures. Also there was statistically significant reference between studied student's and knowledge & precaution or safety measures toward laboratory hazards. **Conclusion: In the light of the current study findings, it can be concluded that,** additionally there was statistically significant reference between studied students practice and personal protective /safety measures. Also there was statistically significant reference between studied student's and knowledge & precaution or safety measures toward laboratory hazards. **Recommendations: Based on the current study finding the following recommendations were proposed:** Developing and implementing of health education programs to increase their knowledge, practice of students regarding laboratory hazards .

Keywords: Awareness, Laboratory Hazards, University students.

Introduction:

Laboratories in colleges and universities play a critical role in regular-class teaching and academic research, undertaking the mission of training talents and exploring the science unknowns However, during experiments in laboratories for teaching and research, the faculty and students are exposed to machines, processes, and chemicals with inherent hazards of high temperature, high pressure, flammability, and toxicity. The existence of these hazards present high risks and could result in catastrophic accidents. Laboratory accidents can occur due to lacking knowledge of hazards, inadequate hazard identification and prevention, and deviation from experimental procedures. Due to increased laboratory accidents and awareness in colleges and universities, laboratory safety has become one of the important issues ***(Ayi & Hon, 2020).***

University laboratories involve various occupational hazards during the research and course activities, which might affect health and safety of both researchers and students, including chemical, physical, electrical, mechanical, as well as ergonomic and psychosocial risk factors ***(Muhammet Gul (2020).***

Laboratory activities must be planned and organized carefully because of the danger they may cause, Most of the laboratories in natural sciences fields widely use chemicals of different

types and hazard levels. Chemistry is one of the fields that intensively and extensively use chemicals for laboratory classes and other experimentations. These chemicals are inorganic and organic in nature and could be in the form of gas, liquid, or solid. These chemicals may be corrosive, explosive, easily oxidizing, flammable, polluting, irritating, radioactive, or toxic to human beings, and may pollute the environment ***(Winter 2019).***

Chemical hazards

Is a type of occupational hazard caused by exposure to chemicals. ***(Steve,et, al,2019)***

Biological hazards.

Are infectious agents such as bacteria, virus, fungi or parasites which may be transmitted via contact with contaminated objects, body secretions, tissues or fluids. ***(Burchinal et al., 2020).***

Physical hazards:

Physical hazards are a type of occupational hazard that involves environmental hazard that can cause harm with or without contact. ***(Burchinal et al., 2020).***

Electrical Hazards Even the most experienced research professional can overlook basic safety principles when working with electricity. ***(CDC & NCEH, 2018)***.

Among the 81•5% who reported exposure to biological hazard, 93•9% had direct skin contact with infectious materials. There are 2.5 accidents per week in academic laboratories worldwide**(C D C 2020).**

Awareness is a state wherein a subject is aware of some information when that information is directly available to bring to bear in the direction of a wide range of behavioral actions. The concept is often synonymous to consciousness and is also understood as being consciousness itself **(Guertin 2019).**

The student should have proper awareness and right attitude towards the protection of natural resources is of great concern in the modern world.. The purpose of environmental education is to acquaint and sensitize college students to the environmental problems and concern, in order to instill upon them, the apt social attitude and healthy approach towards environmental protection. Therefore, it is required to measure their level of awareness and attitude towards environmental concerns ***(Thomas, 2020).***

Personal Protective Equipment (PPE) is protective gear needed to keep workers safe and protection against infectious materials while performing their jobs PPE prevents contact with an infectious agent or body fluid that may contain an infectious agent, by creating a barrier between the potential infectious material and the health care worker **(Wang et al., 2022).**

For the purpose of this site, PPE will be classified into categories: eye and face protection (face shields and goggles), hand protection (disposable gloves), body protection (Lab coat), respiratory protection (Mask), and hearing protection (ear plugs). Each category includes its own corresponding safety equipment that will be described below (Subpart et al., 2019).

Community health nurses providing services play key roles in disease and injury prevention, disability alleviation (**John Willy et al., 2020).** The responsibilities of the community health nurse in relation to environmental factors include monitoring, assessing, educating, advocating, and role modeling **(John Willy, et al, 2020).** Community health nurses assess environmental health hazards present in the community, the factors contributing to them, and the effects that result. Then use this information to plan interventions to address environmental health problems affecting the population, these interventions can occur at the primary, secondary, or tertiary level of prevention **(John Willy et al., 2020)**

Significance of the study

According to data presented from WHO about chemicals involved in UN intentional acute poisonings (methanol, ethylene glycol, kerosene, pesticides etc….) about 3,489,814 Daly's and about 61,523 deaths worldwide (WHO 2019).

In Egypt In 2019, Mortality and burden of disease from unhealthy environment and hazards: 14.8 million people died as a result of living or working in an unhealthy environment, representing 25% of all deaths. When accounting for both death and disability, the fraction of the global burden of disease due to hazards is 24% (WHO 2019).

Aim of the study

This study aims to assess awareness of university students regarding laboratory hazards through:

1- Assessing university students knowledge about laboratory hazards.

2- Assessing laboratory health hazards among university students.

3- Assessing university students practices toward laboratory hazards.

4- Assessing personal and protective devices among university students.

Research Questions:

1) What are the laboratory health hazards among university students?

2) What are the Student's knowledge about laboratory hazards?

3) What are different safety measures among university students regarding laboratory hazards?

4) Is there a relation between laboratory hazards and personal protective /safety measures?

5) Is there relation between university student's knowledge & precaution or safety measures toward laboratory hazards?

Subjects and Methods:

Research design:

A descriptive analytical design was used to conducted this study.

Setting:

The study was conducted at faculties of science**,** Agriculture, Pharmacy and Engineering affiliated to Fayoum University **(Fayoum University:** is a public university located in the Egyptian city of Fayoum in northern Egypt. From 1976 to july 2005, Fayoum University was affiliated to Cairo University. In August 2005, it was established as an independent campus with 2,000 faculty members, it contains 4 faculties and enrollment of about 25,000 students.

Sampling:

A Stratified random sample of 300 including strata students from 2nd, 3rd and 4th grade of Faculties including Agriculture**,** science, Pharmacy and Engineering affiliated to Fayoum University.

Sample size and calculation :

The estimated sample size is out from 300 faculty students selected from 2nd, 3rd and 4th grade according to sample equation .

$$n = \frac{N \times p(1-p)}{\left[\left[N-1 \times \left(d^2 \div z^2\right)\right] + p(1-p)\right]}$$

n= 1110

p= 0.05

z= 1.96

d= 0.05

N= 268

Tools of data collection:

Two tools were utilized for data collection:

First Tool: An interviewing Questionnaire designed by the investigator based on reviewing related literatures related to laboratory hazards. The tool was collecting the data required and it was written in simple Arabic language It was divided into 4 parts:

Part I: Socio-demographic characteristics of university students and their parents : university students and their Parents data about Student age, gender, faculty name, educational grade, residence, Father and mother's education, father and mother's job and family income.

Part II: University Students knowledge regarding laboratory hazards:

It was used to assess University student's knowledge about laboratory hazards adopted from ***(Sheffield, et al, 2017)*** and modified by investigator divided to: Definition of laboratory hazards, types of hazards (chemical, physical, biological and electrical hazards), each type of laboratory hazards include (Definition –Types - Methods of transmitted –Signs and symptoms and complications).

Scoring system:

For the student's knowledge it's divided to: Correct answer was scored (one point) and incorrect answer or don't know was scored (zero point). All items were summed up , the total score =22 knowledge score was classified **(Satisfactory)** level if the score ≥ 50%from (11-22)

(Un satisfactory) level if the score less than < 50% from (0-10).

Part III: University student's precaution or safety measures regarding laboratory hazards:

It was adopted from ***(Sheffield et al. (2017)*** and modified by investigator. It included 20 closed ended questions such as: (Read the instructions related to health and safety hanging on the door of the laboratory, don't eat, drink, smoke or apply cosmetics (including lip balm), Don't insert or remove contact lenses, Don't bite nails or chew on pens. Don't mouth pipette, Use appropriate barrier precautions to prevent skin and mucous membrane exposure,

including**:** wearing gloves at all times and masks, gowns**,** Wash hands thoroughly and other skin surfaces after gloves are removed and immediately after any contamination**,** wear lab coat, wear eye glasses, wear face mask, handling test tubes carefully, Safety of laboratory instruments examined and confirmed before use, such as test tubes, chemical preservation tubes, burets, and test, Chemicals taken outside the laboratory, Clean the laboratory tools after use, Put the laboratory tools in the correct places after use, Turn off all heating devices, faucets and gas and water valves when they are not in use, Immediately report any leakage, accident, or injury when it occurs, Use the fire extinguisher correctly when a fire occurs).

Scoring system:

For student reported precaution or safety measures toward laboratory hazards was scored: (One point) for done and (Zero point) for not done.

All items were summed up , the total score =20 practice score was classified: **(Done)** level if the score ≥50%from(10-20) and **(Not Done)** level if the score <50% from (0-9).

Second tool:

Observational checklist sheet for laboratory include two parts:

Part I: Self-Reported using personal protective measures it was adopted from ***(NIHDRM, 2016)*** and modified by investigator such as (coats and vests - eye glasses, hearing protection- mask and face mask- head cover and hats - gloves –foot mask).

Part II: (Health standers for laboratory) laboratory environment assessment sheet it was adopted from ***NIHDRM (2016)*** and modified by investigator such as Designer Qualifications, Environmental Permits policy specific guidance of a general laboratory (laboratory location – laboratory area and height – specifications of ceiling and walls of doors – Doors and emergency exit and ventilation –lighting – preparation and preparation room (hazardous materials storage, and compressed gases, glass of shatter resistant, laboratory sinks, Chemical storage shelves) - Quality standards in scientific laboratories **(**Designated storage space for lab carts, practices and personal protective equipment storage).

Scoring system:

for laboratory health standers and personal protective measures were scored: (One point) for safe ppm. and(Zero point) for un safe ppm.

All items were summed up , the total score =24 knowledge score was classified: **(Safe)** level if the score ≥60 form (11-24) and **(Un safe)** level if the score <60from (0-10).

Operational Design:

The operational design included preparatory phase, content validity, a pilot study, ethical consideration and field work.

A) The preparatory phase:

This phase start prior to the development of the tool by reviewing up-to-date literature from national and international resources (books, magazines, the internet, end research)related to the study.For data and to get acquainted with the various aspects of research problem.

B) Pilot study:

It was carried out on 10% (14) of Students under the study to test the applicability, clarity and the efficiency of the tools. Students in the pilot study chosen randomly and then was included from the study sample later. There were no modifications found after pilot study. The pilot included in the study sample.

C) Content validity:

It was established to assure content validity by a panel of expertise composed of 3 professors of community health nursing who revised the tool for clarity, relevance, comprehensiveness, understanding, and ease of implementation, and according to their opinion, minor modifications were applied.

Content validity of the tools and the necessary modifications was done accordingly.

d) Content reliability:

Reliability of the tools were tested by Cronbach's Alpha test of reliability, the tools proved to be strongly reliable tools .

Items	No. of cases	N of Items	Alpha Cronbach
Knowledge	10	22	0.811
Practice	10	26	0.629
PPE	10	19	0.602

Ethical considerations:

The research approval was obtained from scientific ethical committee in faculty of nursing at Ain Shams university before starting the study. The investigator clarified the objective of the study to the students included in the study to gain their confidence and trust. The investigator assured maintaining anonymity and confidentiality of subjects' data. students were informed that they are allowed to choose to participate or not in the study and that they have the right to withdraw from the study at any time.

Administrative Design:

To carry out the study in the selected setting, official letters were issued from Dean of the faculty of nursing, Ain Shams University explaining the title and the aim of the study to obtain the permission for collecting of the data; this letters were obtained from the directors of the facilities at Fayoum University.

Operational Design:

Preparatory phase: It included reviewing of past, current, national and international related literature and theoretical knowledge of various aspects of the study using books, articles, internet, periodicals and magazines were done to develop tools for data collection and to get acquainted with the various aspects of the research problems.

Pilot study:

Apilot study was carried out on 10% (14) of Students under the study to test the applicability, clarity and the efficiency of the tools. Students in the pilot study chosen randomly and then was included from the study sample later. There were no modifications found after pilot study. The pilot included in the study sample.

Fieldwork:

• An approval was obtained from scientific research ethical committee Faculty of Nursing – An Shams University.

• The approval to conduct the study was obtained orally from participant Students after explaining the aim of the study.

• Voluntary participation and confidentiality were assured by the investigator for each Student through clarifying to them that all information will be used for scientific research only.

• The investigator introduced herself, gave a brief explanation of informed consent for participation.

• Sample was collected during the period of Students attending at (Agriculture, science, Pharmacy and Engineering) Fayoum University from 9a.m to 2p.m.

• Data was collected during the periodic meetings of Students while there were studying in their facilities.

• Data collection was started and finished at 5 months from the begging of March 2022 to end of July 2022.

• The structured interviewing questionnaire sheet was read, explained and choices were recorded by the investigator from each participant in the study individually. It took about 20- 30 minute to be filled.

Statistical Design:

The statistical analysis of data was done by using the computer software of Microsoft Excel Program and Statistical Package for Social Science (SPSS) version 22. Data were presented using descriptive statistics in the form of frequencies and percentage for categorical data, the arithmetic mean (X) and standard deviation (SD) for quantitative data. Qualitative variables were compared using chi square test (X) 2, P-value to test association between two variables and Pearson correlation test (R- test) to the correlation between the study variables.

Degrees of significance of results were considered as follows:

- P-value > 0.05 Not significant (NS)
- P-value ≤ 0.05 Significant (S)
- P-value ≤ 0.01 Highly Significant (HS).

Results:

Table (1): shows that 47.3% of studied students their age were 20 years old with mean age 20.91±.925. As regarding gender, 58.3% of them were female and 41.0% of them were from faculty of agriculture. As regarding educational grade 42.7% of them were second year. Furthermore 69.7% of them were lives in urban.

Table 2: shows that (57.7& 85.0%) of Studied Students had correct knowledge about Definition &Types of laboratory hazards. Also (65.3% &65.7) of Studied Students had correct knowledge about Definition &Types of chemical hazards and (86.0% & 80.35%) of Studied Students had correct knowledge about

Methods of occurrence & Complications of Chemical hazards.

Table 3: shows that (60.0%& 77.0%) of Studied Students had correct knowledge about Definition &Types of Biological laboratory hazards. Also (64.3% &76.0%) of Studied Students had correct knowledge about Methods of occurrence & Complications of Biological hazards.

Table 4: shows that (52.0%& 47.7%) of Studied Students had correct knowledge about types & occurrence of Physical laboratory hazards. While (73.7% &65.7%) of Studied Students had Incorrect knowledge about Signs and symptoms & Complications of Physical hazards.

Table 5: shows that (91.3%& 80.3%) of Studied Students had correct knowledge about Definition & Complications of Electrical laboratory hazards. Also (74.0% &67.3%) of Studied Students had correct knowledge about Methods of occurrence & Signs and symptoms of Electrical hazards. While 53.0% of Studied Students had incorrect knowledge about Types of Electrical laboratory hazards.

Figure 1: shows that 85% of Studied Students had Satisfactory knowledge about laboratory hazards and Biological hazards While (59% &20%) of Studied Students had Unsatisfactory knowledge about Physical hazards & Electrical hazards.

Figure (2): shows that 76% of Studied Students had satisfactory knowledge about laboratory hazards. While 24% of Studied Students had unsatisfactory knowledge about laboratory hazards.

Figure 3: shows that 88.3% of Studied Students not done precaution or safety measures toward laboratory hazards While 11.7% of Studied Students were done precaution or safety measures toward laboratory hazards.

Figure 4: shows that 95.3 % of total standers for laboratory Health and observational -reported protective measures toward laboratory hazards were Unsafe while 4.7% of total standers for laboratory Health and observational -reported protective measures toward laboratory hazards were safe.

Table 6: shows that there are statistically significant reference between studied students laboratory health hazards and personal protective /safety measures when P-value was < 0.05.

Table 7: shows that there are statistically significant reference between studied students practice and personal protective /safety measures when P-value was < 0.05.

Table 8: shows that there are statistically significant reference between studied student's and knowledge & precaution or safety measures toward laboratory hazards when P-value was < 0.05.

Table 1: Number and percentage Distribution of the Studied University Students according to their Demographic Characteristics (n=300)

Demographic Characteristics	No	%
Age(years)		
20	142	47.3
21	42	14.0
22	116	38.7
Mean ± SD	20.91±.925	
Gender		
Male	125	41.7
Female	175	58.3
Faculty		
Agriculture	123	41.0
Science	75	25.0
Engineering	57	19.0
Pharmacy	45	15.0
Educational Grade		
Second year	128	42.7
Third year	49	16.3
Fourth year	123	41.0
Residence		
Urban	209	69.7
Rural	91	30.3

Table 2: Number and Percentage Distribution of Studied University Students according to their Score Level of Knowledge regarding Chemical Laboratory Hazards (n=300)

knowledge items	Correct		Incorrect	
	No	%	No	%
Definition of laboratory hazards	173	57.7	127	42.3
Types of laboratory hazards	255	85.0	45	15.0
Chemical hazards				
Definition of chemical hazards	196	65.3	104	34.7
Types of chemical hazards	197	65.7	103	34.3
Methods of occurrence chemical hazards	258	86.0	42	14.0
Signs and symptoms of chemical hazards	222	74.0	78	26.0
Complications of chemical hazards	241	80.3	59	19.7

Table 3: Number and percentage Distribution of Studied university Students according to their score level of knowledge regarding Biological Laboratory Hazards (n=300)

knowledge items	Correct		Incorrect	
	No	%	No	%
Biological Hazards				
Definition Biological Hazards	180	60.0	120	40.0
Types of biological hazards	231	77.0	69	23.0
Occurrence of biological hazards	193	64.3	107	35.7
signs and symptoms of biological hazards	167	55.7	133	44.3
Complications of biological Hazards	228	76.0	72	24.0

Table 4: Number and percentage Distribution of Studied university Students according to their score level of knowledge regarding Physical Laboratory Hazards (n=300)

knowledge items	Correct		Incorrect	
	No	**%**	**No**	**%**
Physical Hazards				
Definition Physical Hazards	137	45.7	163	54.3
Types of physical hazards	156	52.0	144	48.0
Occurrence of Physical hazards	143	47.7	157	52.3
Signs and symptoms of physical hazards	79	26.3	221	73.7
Complications of physical hazards	103	34.3	197	65.7

Table 5: Number and Percentage Distribution of Studied University Students according to their Score Level of Knowledge regarding Laboratory Electrical Hazards (n=300).

knowledge items	Correct		Incorrect	
	No	**%**	**No**	**%**
Electrical Hazards				
Definition Electrical Hazards	274	91.3	26	8.7
Types of electrical hazards	141	47.0	159	53.0
Occurrence of electrical hazards	222	74.0	78	26.0
Signs and symptoms of electrical hazards	202	67.3	98	32.7
Complications of electrical hazards	241	80.3	59	19.7

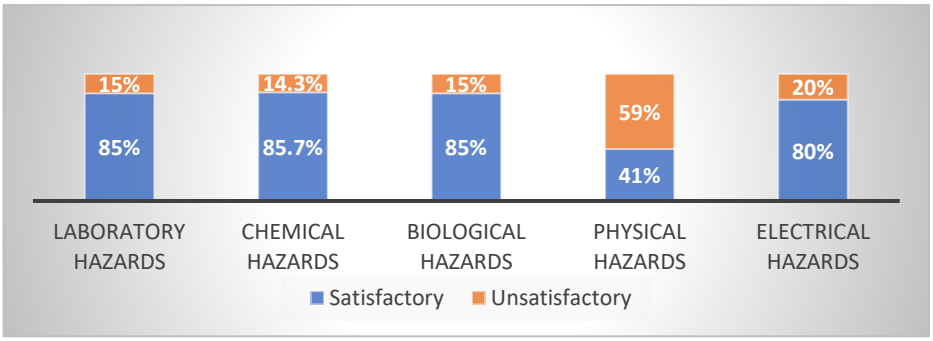

Figure (1): Percentage Distribution of Studied Students according to their Total Subscale knowledge Score regarding Laboratory Hazards (n=300)

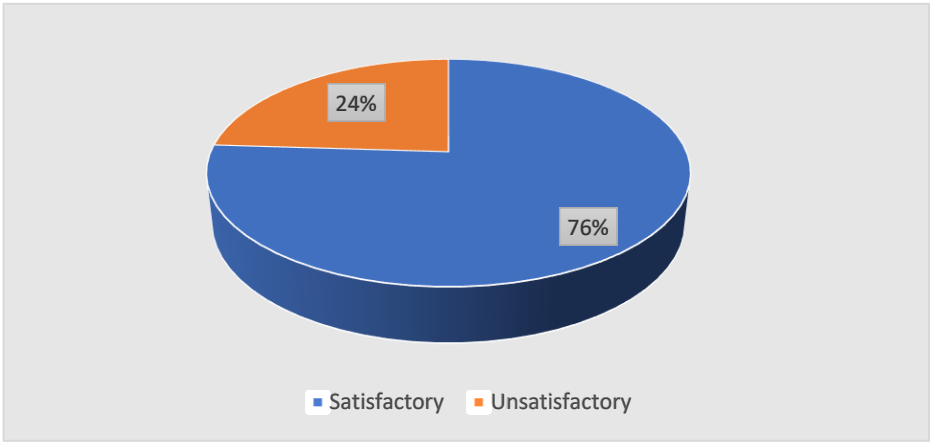

Figure (2): Percentage Distribution of Studied Students according to their Total Knowledge regarding Laboratory Hazards (n=300)

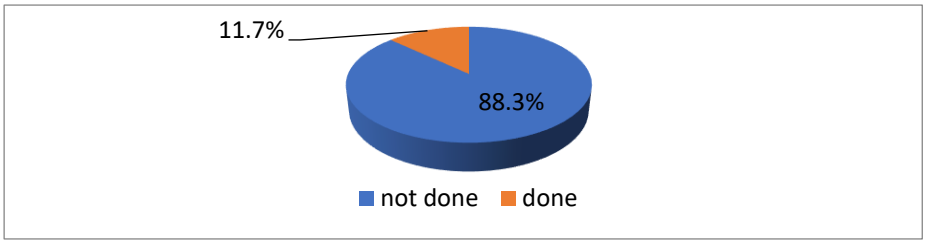

Figure3: Percentage Distribution of Studied Students according to their total self-reported precaution or safety measures toward laboratory hazards (n=300)

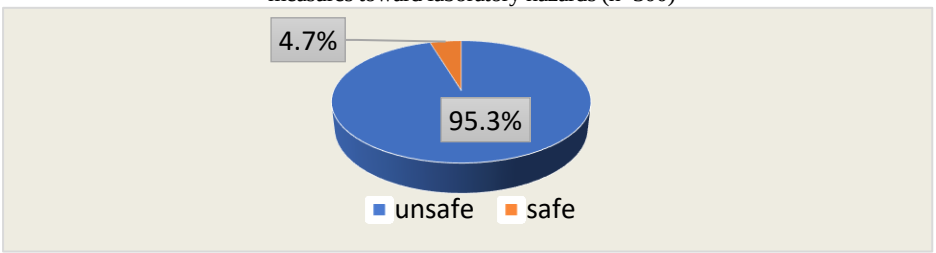

Figure 4: Percentage Distribution of Studied Students according to their Total Standers for Laboratory Health and Observational -Reported Protective Measures toward Laboratory Hazards (n=300) All Total practice

Table 6: Relation of Studied Students Laboratory Health Hazards and Personal Protective /Safety Measures (n=300)

Items	Unsafe PPE		Safe PPE		χ^2 Test	P value
	No	%	No	%		
Low health hazards	179	59.7	23	7.7	1.42	0.233
High health hazards	82	27.3	16	5.3		

Table 7: Statistical Relation between Laboratory Hazards and Personal Protective /Safety Measures (n=300) According to Research Question (No:4) :Is there a relation between laboratory hazards and personal protective /safety measures?

Items	Unsafe PPE		Safe PPE		χ^2 test	P value
	No	%	No	%		
Unsafe practice	226	75.3	39	13	5.921	0.015* S
Safe practice	35	11.7	0	0		

Table 8: Relation of University Student's knowledge & Precaution or Safety Measures toward Laboratory Hazards (n=300)

According to Research Question (No:5) : Is there a relation between university student's knowledge & precaution or safety measures toward laboratory hazards?

Items	Unsafe PPE		Safe PPE		χ^2 test	P value
	No	%	No	%		
Unsatisfactory Knowledge	72	24	0	0	4.637	0.031*S
Satisfactory knowledge	214	71.3	14	4.7		

Discussion:

Laboratory safety involves skills and accountability development and must be an integral part of any chemistry curriculum. Building a laboratory safety culture requires a broad commitment from all levels of the educational institution. Faculty need to assume responsibility for continuing review of safety issues with students in teaching and research laboratories, the faculty must lead by example.

At the administrative level, this will involve implementing a chemical hygiene plan in line with any efforts on chemical hygiene/safety at the campus and addressing the safe handling, storage and disposal of chemicals. Eyewash and showers must be in operating condition, and fume hoods with proper sashes are essential. Anyone who works or visits the laboratory must wear goggles and should not be allowed to eat food or drink. A clean, uncluttered laboratory is more likely to encourage careful work. Development of safety skills may be divided into four emphasis areas ***(Bakhtiar et al., 2020).***

Part 1: Socio demographic Characteristics of studied university students

As regard to demographic characteristics of studied students, the current study result showed that less than half of studied sample their age was 20 years old the mean SD of age was 20.91±.925. Also more than half of them were female.

Moreover; more than two fifths of them were from faculty of agriculture. Regarding educational grade more than two fifths of them were the second year. Furthermore more than two thirds of them were from urban areas .

This result was supported with ***Kavalela et al. (2019)*** who applied study in Malaysia among 30 participants to assess awareness and safety among students and technicians research chemical laboratories and found that 66% highly percentage of the studied students were females. While 25.9% one quarter of them were undergraduate and 59% more than half of them had Master degree. Also on the same line with ***Abu-Siniyeh & Al-Shehri***

(2021) who conducted a study in Saudi Arabia among 142 students to investigate the levels of laboratory safety awareness among undergraduate medical science students and laboratory workers at major hospitals in Taif and found that highly percentage of the studied students were the second year of educational grade

Part 2: Knowledge of university Students regarding laboratory hazards

Concerning to score level of knowledge of the studied students regarding chemical laboratory hazards, the current study result showed that more than half of studied students had correct knowledge about definition of laboratory hazards & most of them had correct knowledge about types of laboratory hazards. Also less than two thirds of them had correct knowledge about definition &types of chemical hazards respectively. And most of them had correct knowledge about methods of occurrence & complications of chemical hazards respectively .

The present study result was supported with ***Innocent et al. (2022)*** who applied study in Nigeria among 94 respondents, entitled "Examination of Common Occupational Hazards among Healthcare Workers in a University Healthcare Center in Southeastern Nigeria" and found that highly percentage of the studied nurses had knowledge about definition of occupational health hazards. also in the same line with ***Papadopoli et al. (2020)*** who applied study in Italy among 237 participants entitled " Chemical risk and safety awareness, perception, and practices among research laboratories workers in Italy" and showed that, although researchers are aware of most investigated chemical hazards and on how they may affect health, they are not very confident on how to protect themselves, since the knowledge on PPE is far from satisfactory.

And matched with ***Mehrifar et al. (2016)*** who conducted study in Iran among 175 students entitled "Assessment of awareness and comprehension of chemical hazard symbols among chemistry students" and revealed that the majority of the respondents were familiar with hazard signs of laboratory chemicals. Also this result was similar with ***Al-Zyoud et al. (2019)*** who applied study among 174 students In Jordan to investigates the state of the perceptions of chemical safety in laboratories among undergraduate students of the biomedical engineering and pharmaceutical and chemical engineering departments and found that the students demonstrated fair to good knowledge and understanding of chemical hazard warning signs

This result may be due to orientation program from the faculty regarding laboratory hazards.

As regard to score level of knowledge of the studied students about biological laboratory hazards, the current study result showed that less than two thirds of studied students had correct knowledge about definition of biological laboratory hazards and more than three quarters of them had correct knowledge about types of Biological laboratory hazards. Also less than three quarters of them had correct knowledge about methods of occurrence & more than three quarters of them had correct knowledge about complications of biological hazards.

This result was supported with ***Mohammed, & Meidan (2018)*** who conducted study in Benghazi among 68 participants entitled "Assessment of knowledge, Attitude and Practice

of Biological Hazards among Health Workers in Medical Laboratories in Benghazi Medical Center" and found that a significant number of lab workers had knowledge about biological hazards. While this result was contrasted with ***Ahmed & Shareef (2019)*** who applied study among 95 participants in Iraq entitled "Assess occupational health and safety measures' knowledge and experienced types of hazards" and found that half of the studied subjects had knowledge about concept and types of health hazards.

As regard ***Zahar & Fazir (2020)*** who applied study in Malaysia entitled "Understanding clinical waste management and the risk of cross-contamination diseases in Malaysian Public Healthcare Facilities" and reported that biohazards are referred to as biological substances that pose a threat to the health of living organisms.

As regard to ***Ibrahim (2017)*** who applied study among 1870 students in Khartoum to investigate occupational hazards among undergraduate dental students at university of science and technology dental Hospital and showed that 50% half of them had a lot of information about biological hazards, 10% one tenth of them had a minimal amount and 4% minority of them had no information. Also ***Magnaghi et al. (2021)*** who applied pilot survey among 124 participants in Italy entitled "Describing nurses' awareness of biological risk in delivering care" and showed that student nurses' awareness and knowledge about biological risk appeared almost limited. While 86.3% most of them performed specific education on biological risk.

This result may be due to the studied students were the second year regarding educational grade had previously knowledge about biological laboratory hazards.

Concerning to score level of knowledge of the studied students regarding physical laboratory hazards, the current study result showed that around half of studied students had correct knowledge about types &occurrence of physical laboratory hazards respectively. While less than two thirds of them had incorrect knowledge about signs and symptoms & less than three quarters of them had incorrect knowledge about complications of physical hazards.

This result was in accordance with ***Tait (2019)*** who conducted study in Kenya among 204 sampled respondents entitled: Occupational safety and health status in medical laboratories in Kajiado County, Kenya" and showed that all of the studied students reported occurrence of physical hazards. Also in the same line with ***Shrestha & Karki (2019)*** who conducted study in Nepal among 61 participants entitled "Knowledge regarding Occupational Health Hazards among Nurses in a Hospital, Rupandehi, Nepal" showed that more than half of the studied nurses had high knowledge regarding occupational health hazards. And in the same line with ***Sabita et al. (2018)*** who applied study in Nepal among 339 n participants entitled "Knowledge and preventive practice of occupational health hazards among nurses" and showed that (92%) majority of the studied sample were aware about the physical hazards. as regard ***Gaikwad, et al. (2018)*** who applied study among 200 participants in A Study to Assess the Knowledge Regarding Physical Health Hazards among the 2nd year and 3rd year GNM Students in Selected Nursing School of Pune City" and found that 58.5 % more than half of the studied students had good knowledge related to physical hazards also define A physical hazards as ` a factor within the hospital environment that can harm the body.

From the researcher point of view potentially effective laboratory safety programs and workshops are extremely important to the students program.

As regard to score level of knowledge of the studied students about Electrical laboratory hazards, the current study result showed that the majority of studied students had correct knowledge about definition of electrical laboratory hazards and most of them had correct knowledge about complications of electrical laboratory hazards. Also less than three quarters of them had correct knowledge about methods of occurrence also more than two thirds of them had correct knowledge about signs and symptoms of electrical hazards. While more than half of them had incorrect knowledge about types of electrical laboratory hazards .

This result was supported with ***Elsayed & Mekhmier (2017)*** who applied study among 78 participants in Egypt entitled Awareness of Electricity Workers Regarding Occupational Health Hazards: Preventive Study" and showed that the studied students had low level of knowledge pre educational program regarding meaning, causes, types, factors and preventive measures of electricity hazards, while this result improved post intervention program. Also this result was in accordance with ***Zhang et al. (2021)*** who applied study in China among 100 participants entitled "Research on the hidden dangers and countermeasures of electricity safety in college students' apartments" and found that students didn't know much about the safe use of

electricity: on the one hand, they turn a deaf ear to electricity safety requirements, rules, and regulations, and even have resistance; on the other hand, they didn't know enough about the safety risks of electricity use, and they do not fully understand the serious consequences of fire, leakage, and electric shock, and they are blindly confident or fluke. Also ***Joseph et al. (2021)*** who applied study in Karachi-Pakistan among 157 participants entitled "Assessing the nurse's knowledge regarding occupational hazards, its pre-disposing and preventive factors" found highly percentage of the participants had good knowledge regarding occupational health hazards.

Concerning to total subscale knowledge score regarding laboratory hazards, the current study result showed that most of studied students had satisfactory knowledge about laboratory hazards and biological hazards While more than half of them had unsatisfactory knowledge about physical hazards & one fifth of them had unsatisfactory knowledge about electrical hazards .

This result was contrasted with ***Ismail et al. (2022)*** who applied study among 522 student in Egypt to assess the hazards of practical training at outpatient clinics as perceived by secondary technical nursing students in Port Said City and found that 30% less than one third of them had satisfactory level of knowledge related to general information about hazards.39.8about two fifths of them had satisfactory knowledge about physical hazard, 32.3% about one third of them had satisfactory knowledge about chemical, biological hazard respectively.

Also disagreed with ***Elsayed & Mekhmier (2017)*** who showed that none of the studied subjects had good total knowledge scores regarding electricity hazards, while this result improved post intervention program.

Regarding to total knowledge about laboratory hazards, the current study result revealed that more than three quarters of studied students were had satisfactory knowledge about laboratory hazards.While less than one quarter of studied students were had unsatisfactory knowledge about laboratory hazards .

This result was in disagreement with ***Hussein & Shifera (2022)*** who applied study among 300 participants in Ethiopia to assessed the chemistry laboratory safety knowledge, attitude, and practice (KAP) of teachers and laboratory technicians in secondary schools and showed that 75% more than half of them scored as moderate and 60% less than two thirds of them scored good knowledge about chemistry laboratory safety. Also this result was contrasted with ***Ismail et al. (2022)*** who found that 58.1% more than half of the students had unsatisfactory knowledge about hazards. And disagreed with ***Amare et al. (2021)*** who applied study among 151 students in Ethiopia to assess exposure to occupational health hazards among nursing and midwifery students during clinical practice and found that the overall knowledge 29.8% less than one third of them had good knowledge, 32.5% about one third of them had fair knowledge and 37.7% less than two fifths of them poor knowledge about occupational hazards. Also, these findings incongruent with ***Masih et al. (2021)*** who conducted study among 85 participants in India to explore Knowledge Assessment on Hospital Related Occupational Hazard among Student Nurses of Selected College in Delhi, India and found that 59% more than half had moderate knowledge, 26% more than one quarter had poor knowledge and 15% less than one fifth had good knowledge.

Additionally ***Withanage & Priyadarshani (2016)*** who applied study among 229 students in Sri Lanka entitled " An Assessment on Laboratory Safety Knowledge among Allied Health Sciences Students at the University of Sri Jayewardenepura" and observed that Students' overall knowledge towards the laboratory safety precautions as follow; 7.4% minority of them had excellent, 27.5% more than one quarter of them had good, more than one fifth of them had moderate and 42.4% less than half of them had poor. Students had a "good" knowledge in relation to safety laboratory practices, personal protective equipment, traceability and waste disposal. Knowledge regarding gas, chemical storage and glassware hazards was "moderate". But knowledge was "poor" regard to safety equipment, emergency procedures, health awareness, laboratory equipment and instruments.

These results was contrasted with ***Awan et al. (2017)*** who applied study in Pakistan among 200 participants entitled "Assessment of knowledge, attitude and practices regarding occupational hazards among Nurses at Nawaz Sharif Social Security Hospital Lahore Pakistan" identified the mean level of knowledge was unsatisfactory among the studied nurses.

From the researcher point of view, this result may be due to less than half of the study sample from second grade of education and they have enough knowledge regarding hazards in clinical laboratory setting and may be due to orientation and posters on the walls in the faculty.

Part 5: Observational checklist for protective measures of laboratory

Concerning to observational -reported protective measures toward laboratory hazards, the current study result showed that less than two thirds of coats and vests & the majority of gloves of hands were unsafe. Moreover all of head cover and hats were unsafe and most of earplugs were unsafe while less than three quarters of eyeglasses & most of mask and face mask were safe .

In the same line with ***Sabita et al. (2018)*** who showed that 68.7% more than two thirds of the studied sample wears facemask and 49.9% less than half of them wear gown/apron. Also ***Peyton & Skorupa (2021)*** in a study entitled " Integrating CUREs in ongoing research: undergraduates as active participants in the discovery of biodegrading thermophiles" and found that students always wear lab coats and nitrile gloves, with protective eye equipment required for handling pressurized materials

As regard to observational-reported protective measures toward laboratory hazards, the current study result showed that most of total self-reported protective measures about laboratory hazards were unsafe. While the majority of total standers for laboratory Health and self-reported protective measures about laboratory hazards were unsafe .

This result was contrasted with ***Ramadan et al. (2022)*** who found that 77.9% more than three quarters of the studied students had satisfactory total practices level, while 22.1% more than one fifth of them had unsatisfactory total practices level. And was disagreed with ***Bouchoucha et al. (2021)*** who applied study among 321 participants in Australia entitled "An investigation into nursing students' application infection prevention and control precautions" and reported that 80 %most of nursing students had compliance with strategies of infection control. However, also this finding disagree with ***Rayan et al. (2021)*** who conducted study in Egypt among 91 students entitled "Effect of training program regarding occupational health hazards on nurse interns' knowledge and practice " and stated that minority of nurse interns had satisfactory practice level regarding occupational health hazards at programmable phase.

From the investigator point of view, the habit of practices of protective measures and hygiene among students during training needs to be organized, and students must be made aware of the importance of this habit to prevent laboratory hazards. Lack of enough practice is one of the major risks of laboratory hazards

This result may be due to lack of sufficient space in most laboratories, absence of safety guide lines, lack of safety officer, absence of accident book, and lack of lined budget for safety.

Part 6: Statistical relation between studied variables laboratory hazards and personal protective / safety measures

As regard relation between demographic characteristics of university student's and knowledge, the current study result showed that there are highly statistical significant relation between Age, gender, college and Educational grade of the studied students and their total knowledge about Laboratory Hazards. Meanwhile, there is no statistically significant difference between residence of university student's and total knowledge .

This result was in the same line with ***Dhahir, & Al Mayahi (2021)*** who conducted a study among 150 participants in Iraq entitled "Assessment of Health Workers Knowledge toward Occupational Health and Safety Program in Alkut City's Primary Health Care Centers" and reported that there was a significance relation among health worker's knowledge about occupational health and safety program with their age.

In contrast, this result disagreed with ***Faris et al. (2018)*** who applied study among 300 participants in Iraq to assess Knowledge, Attitude and Practice of Occupational Hazard among Nursing Staff at Teaching hospitals reported that there was no statistically significant relation between age of nursing students and their total knowledge about hazards.

From the researcher point of view, it may be related to difference of age of students associated with improving and updating their knowledge about occupational hazards. Also increasing age of nursing students leads to increasing their awareness regarding occupational hazards.

Regarding relation between demographic characteristics of university student's and practice, the current study result reveals that, there are highly statistical significant relation between all of demographic characteristics of university student's and practice toward laboratory hazards .

This result was supported by ***Faris et al. (2018)*** who showed that there was significant association between nurses' practice level and gender, so there was a highly significant association between nurses' practice level and years of experience, while there was a non-significant association between nurses' practice

level and other variables (age, level of education, and training related course).

Also in the same line with ***Shamkh et al. (2022)*** who conducted study among 80 participants in Iraq entitled Occupational Hazards among Nurses at Primary Health Care Centers in Al-Amara City/ Iraq and found that there is a high significant relationship between nurses' socio-demographic data and occupational hazards when ($P < 0.01$), while variables (residence and marital status), confirm that there is a significant association at ($P < 0.05$).

As regard to Relation of Studied Students Laboratory Health Hazards and Personal Protective /Safety Measures, the current study result showed that there are statistically significant reference between studied students laboratory health hazards and personal protective /safety measures when P-value was < 0.05 (Table, 14). In the same side with ***Nabil et al. (2018)*** who applied study in Egypt among 458participants entitled "Occupational health hazards among faculty of nursing students in Zagazig University" and clarified that there was a statistically significant relation between the use of personal protective equipment and the physical, psychological and ergonomic hazards (p value < 0.05),

As regard to relation between studied students laboratory hazards and personal protective /safety measures, the current study result showed statistically significant reference between studied students practice and personal protective /safety measures when P-value was < 0.05

This result was supported with ***Faris et al. (2018)*** who revealed that there was significant association between students nurses knowledge, attitude and protective measures practices of occupational Hazard. While this result was disagreement with ***Abuduxike et al. (2021)*** who applied study in Cyprus among 233 participants entitled "An Assessment of the Knowledge, Attitude, and Practice toward Standard Precautions among Health Workers from a Hospital in Northern Cyprus" and showed that there were no statistically significant differences practice, and standard precautions

Concerning relation of university student's knowledge & precaution or safety measures toward laboratory hazards, the current study result showed that there was statistically significant reference between studied student's and knowledge & precaution or safety measures toward laboratory hazards when P-value was < 0.05 (Table 16). This result was disagreement with ***Abuduxike et al. (2021)*** who showed that there were no statistically significant differences found between knowledge and standard precautions.

In the same side with ***Nabil et al. (2018)*** who applied study in Egypt among 458participants entitled "Occupational health hazards among faculty of nursing students in Zagazig University" and clarified that there was a statistically significant relation between having previous knowledge about occupational health hazards& the high use of PPE (p= 0.016)

Conclusion

In the light of the current study findings, it can be concluded that:

74% of studied students were had satisfactory knowledge about laboratory hazards. While 24% of studied students were had unsatisfactory knowledge about laboratory hazards. 87% of them had unsafe self-reported protective measures about laboratory hazards. While 95.3% of them had unsafe total standers for laboratory Health and self-reported protective measures about laboratory hazards. Additionally there was statistically significant reference between studied students practice and personal protective /safety measures. Also there was statistically significant reference between studied student's and knowledge & precaution or safety measures toward laboratory hazards.

Recommendations

Based on the current study finding the following recommendations were proposed:

- Increase awareness of university students regarding laboratory hazards & it's protective measures by organized programs.
- Design pamphlets for safety measure and universal precautions and keep it available for each laboratories.
- Continues guidelines &directed to university students regarding commitment to using personal protective equipment.
- Encourage direct supervise the students during work and ensure that they follow safety precautions.

Further study:

- Replication of the study with large sample size in different sittings to generalize of the results

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