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CASE STUDY

ASSESSMENT OF BIOSAFETY PRACTICES IN UNDERGRADUATE & POSTGRADUATE STUDENTS IN AN ACADEMIC INSTITUTE IN ISLAMABAD

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ABSTRACT

Objective: Biosafety defines a set of rules that should be followed for the "containment" of biological agents, to protect the individual lab worker and the environment from its potential hazard.

Methods: We conducted a cross-sectional, exploratory kind of study to assess the level of awareness among the undergraduate and postgraduate students of an academic institute in Islamabad and to see whether they differed in this awareness on the basis of their maturity and lab work experience. A total of 136 subjects were selected on the basis convenience sampling.

Results: In most of the individual aspects, we could not detect a significant difference in knowledge about biosafety precautions in our two groups, but in overall awareness levels, we found out that postgraduate candidates were significantly better, which can be attributed to their higher percentage having present or past lab experience.

Conclusion: The study highlights the need to have awareness sessions for all batches and for compulsory biosafety courses as early as possible in their course works to make their lab experience safe.

Keywords: Biosafety practices, Biosafety awareness, Personal protective equipment, Biohazard

INTRODUCTION

Biosafety is the application of knowledge, techniques and equipment to prevent personal, laboratory and environmental exposure to potentially infectious agents or biohazards. The infectious agents need to be handled and manipulated under appropriate containment conditions, which confine and reduce the potential exposure of the personnel working in the lab.

Laboratory acquired infections have become major concern all over the world. Published reports of Laboratory Acquired Infections (LAIs) first appeared around the start of the twentieth century. By 1978, four studies by Pike and Sulkin collectively identified 4,079 LAIs resulting in 168 deaths occurring between 1930 and 1978. These studies found that the ten most common causative agents of overt infections among workers were *Brucella* spp., *Coxiella burnetii*, hepatitis B virus (HBV), *Salmonella typhi*, *Francisella tularensis*, *Mycobacterium tuberculosis*, *Blastomyces dermatitidis*,Venezuelan equine encephalitis virus, *Chlamydia psittaci*, and Coccidioides [1]. The fundamentals of containment include the microbiological practices, safety equipment, and facility safeguards that are meant to protect the individuals working in the labs.

There exists a need for educating the scientific community in this regard. In a globalized world where the need for consistency is present, biosafety and bioethics do not cancel but exchange information in order to forward rational procedures and actions in biotechnology [2].

Bioresearch related laboratory work involving high-risk or high-consequence pathogens and for arthropod-borne diseases has stimulated renewed interest in biosafety matters, particularly for work in containment. The implementation of various guidelines and technologies will promote state-of-the-art research while minimizing risk to laboratory animals, researchers, and the environment [3].

Personal safety is the right of every individual of the society. For this purpose different surveys and seminars can be conducted to spread awareness in the masses. We found that there was a need for assessment of awareness levels at academic institutes in Islamabad, which would give us a very clear picture of the knowledge of biosafety and Good Microbiological Techniques (GMTs) of the students that are working in laboratories for their research work. Our study was focused on assessing the level of biosafety awareness among the students of one academic institute. We assumed that due to the difference in their maturity levels and experience, the undergraduates and postgraduates would differ significantly in their awareness levels.

The potential risk of infection by any pathogenic microorganism raises a series of questions about the actual incidence of laboratory-acquired infections, about their prevention, effectiveness of safety measures and the role of Material Safety Data Sheets (MSDS) in various laboratories. [1]

Laboratory Biosafety manual published by WHO (World Health Organization) is an adequate piece of writing having sufficient information regarding biosafety levels, risk groups of microorganisms, safety equipment, transport and disposal of contaminated waste and contingency plans and emergency procedures [4].

Work safety awareness requires lab workers to be well aware of principles and procedures involved in receiving and processing specimens, personal protective equipment (PPE), use of centrifuge and other instruments, eating and drinking in lab, cigarette smoking, use of cosmetics, responding to injuries and accidents that can occur in the laboratory, dealing with contamination of the workplace, and disposal of biological and chemical waste [5].

The workplace attitudes of laboratory personnel were found to be poor in a study conducted in Lagos state, Nigeria [6]. Similarly, in another study also conducted in Nigeria, the investigators found the level of awareness and practice of safety precautions among laboratory workers to be below average [7]. In Karachi, Pakistan, a study conducted on a population of health care workers found that

only 8% of the laboratories had proper waste management plans and biosafety cabinets, 89% of the facilities did not practice the use of personal protective equipments (PPEs) and 95% of the hospitals dumped their wastes openly without any prior treatment like autoclaving or incineration. Moreover, majority of the health care workers reported that they were not provided with proper facilities for handling infectious wastes [8].

At the academic location, all of the students are required to enter the laboratories for their research work. They need to have a certain level of awareness of what they are putting themselves into, so that they can take necessary precautions to protect themselves from different chemical, physical, and biological hazards. For this purpose, we designed a study that is basically exploratory in nature. The variables included in the pre- survey questionnaire for the assessment of awareness about lab space management were; the use of personal protective equipment assessing how frequently the individuals observed basic rules such as reuse of gloves, wearing of lab coats and avoiding contact lenses. Other basic practices observed were the eating and drinking habits in lab, chemical handling and hand washing practices. It also assessed equipment handling, lab emergency response in case of spills or accidents, and general hazard level awareness of people.

It was hypothesized that undergraduate and postgraduate students of an academic institute would differ in their level of awareness of biosafety precautions depending on their maturity and exposure to lab work. The population that we studied was very diverse that came from different backgrounds where majority had no working experience in molecular biology labs prior to getting admitted in the institution.

The areas that we covered in our study focused on equipment handling, lab space management, lab emergency response, use of personal protective equipments (PPE) and hazard levels.

METHODS

Study design: Cross-sectional study

Study setting: The study was conducted in the diagnostic and research laboratories of an academic institute in Islamabad, Pakistan.

Study period: February 2011- August 2011

Study subject: Undergraduate and Postgraduate students with and without experience of working in diagnostic and research laboratories of the institute were considered as study subjects.

Sample size: The study sample for pre-evaluation includes a total of 136 students where 98 students were undergraduates and 38 were postgraduates.

Sampling technique: Convenience non-probability sampling technique was used for selecting under and postgraduate students.

Data collection

Survey

A designed questionnaire was used for the survey from students at the institute, which was based on twenty-two (22) questions. This was done to roughly evaluate the biosafety knowledge especially of the people with lab-work experience and also of those with no experience of working in the lab. Many variables were involved in the study. These variables were characterized into; variables for lab space management, variables for equipment handling, variables for lab emergency response, and variables for the hazard levels.

Analysis

The data from the survey was entered and analyzed by statistical package SPSS (Statistical Package for Social Science).

RESULTS

A total number of 136 students were surveyed about their compliance with standard biosafety precautions. These students included 98 (72.1%) undergraduate students and 38 (27.9%) postgraduate students. The study included 92% postgraduates and 61% undergraduates who had the experience of working in the lab.

Lab Space Management: The result analysis of use of personal protective equipment is given in Table-1and it says that out of 136, 107 (79.2%) students agreed upon re-using gloves for the sake of saving money, 109 (80.7%) students usually wear lab-coat during all kinds of lab procedures, and 112 (82.9%) students also preferred wearing contact lenses during lab work. Regarding eating and drinking inside the labs, 131 (97%) of the students do that and regarding hand washing, 120 (88.8%) students says that they do hand washing before and after doing the lab work. Chemical handling inside the lab space showed that 121 (89.6%) students knew that 70 percent ethanol is a widely used disinfectant in labs while only 65 (48.1%) had the knowledge that which microorganism is the most resistant to disinfection.

Table 1: Knowledge of lab space management among undergraduate and postgraduate students.

	Lab space Management (p-value=0.047)						
	Personal protective equipment			Eating /Drinking during work	Hand Washing Practices	Chemical handling	
	Re-use gloves	Wearing lab coat	Wearing contact lenses			Widely used disinfectant	Most resistant to disinfection
UG(98)	(77.5%) 76	(86.2%) 81	(80.6%) 79	(95.9%) 94	(87.7%) 86	(87.7%) 86	(46.9 %) 46
PG(38)	(81.6%) 31	(77.7%) 28	(89.1%) 33	(97.3%) 37	(89.4%) 34	(92.1%) 35	(50%) 19
Total (136)	(79.2%) 107	(80.7%) 109	(82.9%) 112	(97%) 131	(88.8%) 120	(89.6%) 121	(48.1%) 65

Equipment Handling: In Table-2 out of 136, 126 (92.6%) students know how to detect an unlabeled material in the laboratory. 117 (86%) students know how to use the autoclave but only 54 (39.7) students had the awareness about biological safety cabinets (BSCs) and laminar flow hood.

Table 2: Finding of equipment handling among students.

	Equipment Handling (p-value=0.252)		
	Detecting unlabeled material	Use of autoclave	Awareness about BSCs
UG(98)	(92.8%)91	(84.6%)83	(47.9%)47
PG(38)	(92.1%)35	(89.4%)34	(18.4%)7
Total(136)	(92.6%)126	(86%)117	(39.7%)54

Hazard Level Awareness: In Table-3,

80 (59.2%) students had the awareness about the biohazard sign, 122 (90.3%) students were aware of the potential harms from exposure to UV light, only 19 (14%) students know if Ethidium bromide is radioactive.

64 (47.4%) students know about all the risk groups of pathogens, 114 (84.4%) know about that hazards associated with recombinant microbes, 92 (68.1%) students know about centrifugation hazards and 71 (52.5%) know proper waste disposal methods.

Table 3: Hazard level awareness among students.

	Hazard Level Awareness (p-value=0.525)						
	Biohazard Sign	**Uv-light harms**	**Ethidium bromide**	**Risk group**	**Recombinant microbe hazards**	**Centrifugation hazard**	**Waste Disposal**
UG(98)	(66.2%) 61	(90.8%) 89	(12.2%)12	(53%) 52	(81%) 80	(64%) 63	(47.9%) 47
PG(38)	(50%) 19	(86%) 33	(18.4%)7	(31.5%) 12	(89.4%) 34	(76.3%) 29	(66.1%) 24
Total (136)	(59.2%) 80	(90.3%) 122	(14%) 19	(47.4%) 64	(84.4%) 114	(68.1%) 92	(52.5%) 71

Lab Emergency Response: In Table-4, out of total 136 students, 81 (59.5 %) students had the knowledge if biosafety or bio- security was involved in prevention of accidental disease transfer in the laboratory. 93 (68.3%) students know how to respond in case of skin contact with chemicals, while 93 (68.3%) how to clear any biological spillage in the lab.

Table 4: Lab emergency response among students.

	Lab Emergency Response (p-value=0.177)		
	Prevent accidental disease transfer	**Skin contact with chemicals**	**Clearing of biological spillage**
UG(98)	(51%)50	(69.3%)68	(65.3%)64
PG(38)	(81.5%)31	(65.7%)25	(76.3%)29
Total (136)	(59.5%)81	(68.3%)93	(68.3%)93

DISCUSSION

Laboratories are a work haven of research institutes but lab workers are exposed to a number of occupational hazards and dangers daily in their routine work, be it physical, chemical, or biological. There need to be stringent control and regulations not only to maintain the integrity of the workplace but also the safety of an individual worker in the lab. Laboratories for biological research maintain this level by introducing the concept of biosafety – A set of rules and regulations for the safety of the lab personnel from infectious, and possibly deadly, biological agents. It also involves instructions for the containment of biological materials and their safe disposal to protect the environment and innocent populations living by from the harmful effects of these germs. Standard microbiological practices and techniques are designed for the purpose of "containment" and are required to be strictly followed by lab workers [9].

For this reason, laboratory workers should be well aware of Good Microbiological Techniques (GMTs) and Biosafety Precautions for theirs and others secure existence. For the purpose of analyzing the level of this awareness and to instill the sense of awareness into current and prospective laboratory-based researchers, we conducted a project on the awareness about biosafety among students of an academic institution in Islamabad, from February 2011 to August 2011.

A questionnaire based survey was conducted to assess the levels of biosafety in a sample taken from the target population. Our results indicate that seminars and campaigns are needed to make the students fully aware of the importance of biosafety, and the principles themselves.

The study aimed to establish the difference in awareness of biosafety levels between undergraduate and postgraduate students. The undergraduate and postgraduate populations that we studied were a very diverse population coming from different backgrounds and with majorly no previous working experience in a molecular biology lab previously. The undergraduate population had twelve years of education and the postgraduates ranged from veterinarians and medical doctors to pharmacists before joining the institute.

The questionnaire designed for the purpose of study, used to measure a range of variables related to biosafety starting from awareness of biohazard sign and dangers of different materials and chemicals typically found in a microbiological or molecular biology laboratory, to equipment handling and lab emergency response, and workplace attitudes expected of study subjects.

Hazard Level Awareness: The difference between undergraduates and postgraduates in their hazard level awareness was found out not to be significant, with a p-value of 0.525 (versus the alpha level set at 0.05), suggesting that both the groups were equal in knowledge in regard to awareness of hazard level e.g. in knowing the dangers of chemicals commonly housed and worked with in labs, or to recognize hazard symbols, etc. It can be a common perception that postgraduates might have had more knowledge and, thus, the p-value should have indicated a significant difference between the two groups. This can be explained by the fact that majority of our postgraduate population came from a different background, mainly pharmaceuticals, where there is not a need to follow biosafety precautions. Hence, they no significant difference was found out to be present between junior and senior students.

Lab Emergency Response: The variable measured the responsiveness and expected reaction in case of a lab emergency. The p-value for the difference between under- and postgraduates was insignificant again with respect to lab emergency response, with the value standing at 0.117. This again points to the same fact that in case of lab emergency response, the level of knowledge between our youngsters and older group of students was equal.

Equipment Handling: This variable assessed the knowledge of undergraduates and postgraduates about common equipment in biological laboratories like the autoclave and the biological safety cabinet. The p-value for this aspect of the questionnaire was again found out to be more than the alpha level of 0.05, at 0.252, rendering the difference between undergraduates and postgraduates unimportant from the aspect of equipment handling as well.

Workspace Management: The questions in this part analyzed the workplace attitudes of current lab workers, and those expected from prospective lab workers. Interestingly, the p-value for this facet was found to be less that 0.05 and stood at 0.047, indicating a statistically significant difference to be present between undergraduate and postgraduate students in this regard. Furthermore, postgraduates were found to be more knowledgeable and better in their attitudes at their work bench. This can be explained by the fact that, proportionately, more postgraduate

students were working in the lab, or had previous lab experience; about 92% versus 61% of undergraduate population.

Overall Biosafety Awareness Level: Overall, out of 136 students, around 48% students showed an excellent level of awareness of biosafety principles. Moreover, the level was found to be quite significantly different between undergraduates and postgraduates with the p-value at 0.009 (Table 5). In their separated categories, 44% undergraduates were well aware of biosafety rules whereas 58% of those that represented the postgraduate populations were found to be better aware, indicating that postgraduates had better understanding and implementation of biosafety regulations. This can be explained very clearly by comparing the percentages of the younger and older students who had worked or were working in laboratories: 92% of postgraduates had lab experience, as their degrees comprise more on research and wet-lab, but only 61% of undergraduate students had any kind of lab exposure to date.

Table 5: Chi- square test of the survey conducted from the undergraduate and postgraduate students.

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	27.949[a]	13	.009
Likelihood Ratio	30.875	13	.004
Linear-by-Linear Association	.268	1	.605
N of Valid Cases	136		

CONCLUSION

Our study indicates that although postgraduate students are found to be better aware in their overall awareness levels, there was really no significant difference in their knowledge of lab emergency response, equipment handling, and hazard levels than their undergraduate counterparts. As postgraduate studies are based more on lab work and research, this highlights a big gap in their knowledge and emphasizes a need to train them before they enter laboratories. There was also found to be a trend of exposing the undergraduate students to lab work before they have had their compulsory course on Biosafety precautions. Hence, a similar level of seriousness is required at the level of undergraduates and they should also be trained and taught the principles of biosafety early on, before they enter laboratories, or should be trained adequately by the lab staff upon their introduction.

Moreover, there is a need to raise this awareness level by all means possible, be it compulsory course works or seminars. The importance of biosafety precautions can never be undermined and awareness is the first step to make lab workers realize the occupational hazards they are exposed to and how they can stay safe at their workplace.

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