Original Article

Assessment of awareness and comprehension of chemical hazard symbols among chemistry students

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Abstract

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Background: Laboratory activities must be planned and organized carefully because of the danger they may cause. The purpose of this study was to assess students' awareness and comprehension of chemical hazard warning signs at the Departments of Chemistry of Razi University, Kermanshah, Iran.

Materials and Methods: This descriptive study was carried out to assess students' awareness and comprehension of chemical hazard warning signs. Data were collected from 175 students enrolled in Chemistry Laboratory Classes during the second semester of the year 2012-2013. The participants were selected randomly. The collected data was entered into SPSS software and analyzed using descriptive statistical methods.

Results: The results of the study revealed that the majority of the respondents (81%; n = 143) were familiar with hazard signs of laboratory chemicals. After obtaining information on their level of awareness about potential hazards of laboratory chemicals, the respondents were also requested to match chemical properties with the corresponding labels or pictograms.

Conclusions: The results indicated that the students had a high level of familiarity and understanding of hazard warning signs. The study also surveyed the preferred labeling technique and revealed that the majority favored the use of both colors and signs.

Keywords: Chemical Hazard, Awareness, Comprehension, Chemistry, Students.

Introduction

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 (1). Accidents due to laboratory chemicals are highly probable during the performance of experiments by inexperienced employees and students who are not well aware of the dangers or risks associated with the majority of chemical in their laboratory. It is wrong to conclude that chemicals are totally hazardous or risky. They can be beneficial if they are correctly handled and utilized (2).

Thus, it seemed necessary to carry out a survey to assess situations in order to acquire

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preliminary information about the general status of students in the Department of Chemistry of Razi University, Kermanshah, Iran, in this regard. This study is anchored to the concept of Globally Harmonized System of Classification and Labeling of Chemicals (GHS). This concept was adopted by the UN Economic and Social Council (ECOSOC) in July 2003. The goal of the system is to harmonize the existing classification of chemicals according to their hazards and communicate the related information through labels and safety data sheets. Chemical can be dangerous and risky; thus, knowing the meanings of chemical hazard symbols aid their safe use (3). Chemical accidents mostly occur due to the neglect of safety precautions or the absence of related precautionary symbols on the chemicals (4). The unsound management and use of chemicals poses threats to human well-being at many levels (5). According to the results of the study by Karapantsios, the traditional method of teaching safe-handling and hazard-labeling is inadequate, more effective teaching methods are necessary to improve the awareness of labeling and the safe handling of chemical substances (6).

Awareness is the ability to directly know and perceive, to feel. Comprehension is defined as the level of understanding of a text/message. This understanding arises from the interaction between the written words and how they trigger knowledge outside the text/message. The present study assessed the awareness of students of hazards and risks of laboratory chemicals and the comprehensibility of hazard warning signs of chemicals. Specifically, it aimed to ascertain if students can correctly match chemical properties with the corresponding pictograms, identify their preferred ways to communicate hazard and risk information of laboratory chemicals, and correlate awareness and understanding with Specifications symbol. The results will provide information about hazard warning sign comprehensibility among students and help the Department of Chemistry take correct measures as regarding laboratory management.

Material and Methods

The descriptive research method was employed in this study to ascertain students' familiarity with and understanding of chemical hazard signs. Moreover, the study determined the students' preferred method of labeling hazardous chemicals in the laboratory. A total of 175 students, 95 girls and 80 boys, participated in the study. They were randomly selected from among students enrolled in Chemistry Courses during 2012-2013.

Figure 1: Symbols used in the study

The purpose of the study was explained to all participants and their consent was obtained. A structured questionnaire, prepared in Persian, was used for data collection. To approve its reliability, the questionnaire was distributed among 30 patients who had the inclusion criteria and the Cronbach's α coefficient of the questionnaire was calculated as 0.71, 0.84, 0.80, 0.86, and 0.71. To determine its content validity, the questionnaire was sent to 8 cancer experts and their feedback was applied. The data was collected through a checklist, and then, entered into SPSS software (version 19, SPSS Inc., Chicago, IL, USA) and analyzed using descriptive statistical methods.

The inclusion criteria consisted of being a chemistry student in Razi University in the second semester of the year 2012-2013. The exclusion criteria were lack of completion of the questionnaire by the end of the study period and those participate in the study were Dissuasion. In this study, 8 symbols of hazardous chemicals were used to assess students' awareness and comprehension (Figure 1).

Questionnaires were distributed among the respondents by their respective head of laboratory. Respondents were requested to complete the questionnaires immediately after receipt, without any discussion among themselves. The primary data were gathered, and then, analyzed using simple quantitative analyses such as frequency count, arithmetic means, and ranking.

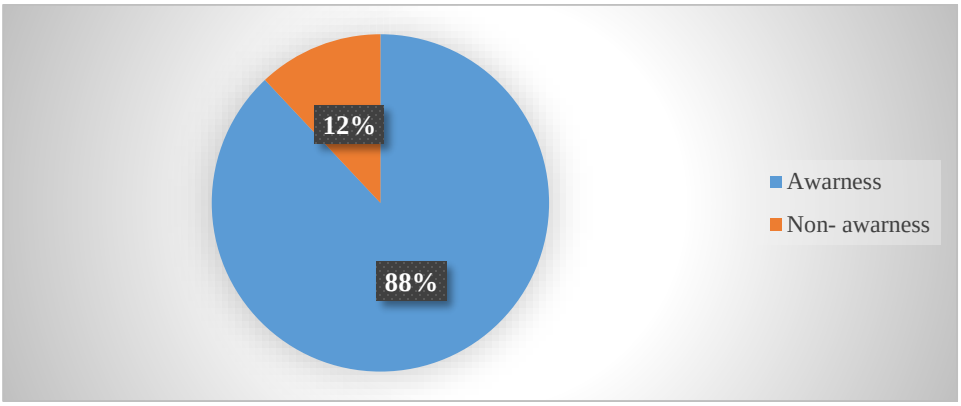

Figure 2: Distribution of respondents based on awareness of potential hazard

Results

Our results showed that the majority of the respondents (88%; n = 155) reported to be aware of the potential hazards of laboratory chemicals both for the environment and them. On the other hand, a small percentage of students who participated in the survey (12%; n = 20) stated that they were not well aware of the hazards that chemicals pose for them (Figure 2). This result could account for the observed reluctance of some students in the use of protective gadgets like goggles and laboratory gowns. Furthermore, the survey revealed that the majority of the respondents (81%) claimed to be aware of warning symbols, but the remaining 32 students (19%) reported that they were not aware of the hazard symbols of laboratory chemicals (Figure 3). The reasons stated by the students included lack of attention to the labels of the chemicals (58%), lack provision of orientation for them (22%), and the difficulty of remembering and understanding most symbols (30%).

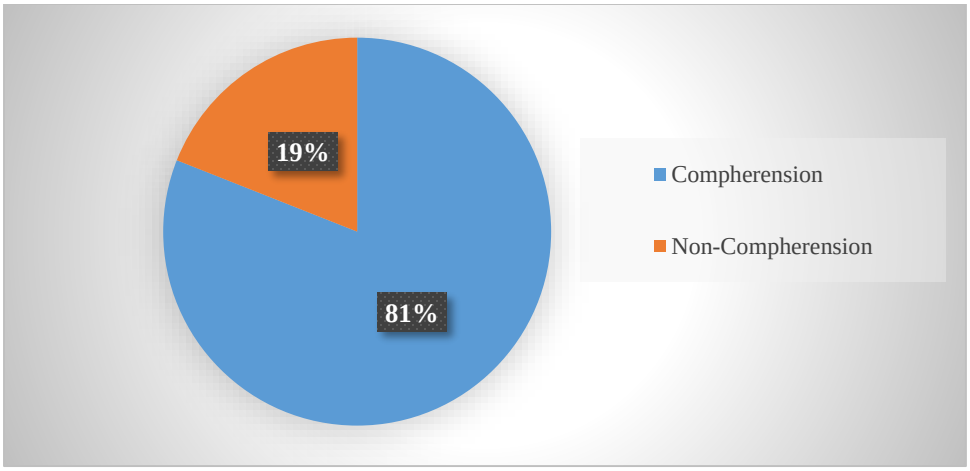

Figure 3: Distribution of subjects based on awareness of potential hazards

The majority of the subjects reported that they were aware of the hazards of laboratory chemicals with high familiarity with hazard signs of laboratory chemicals.

In order to evaluate the respondents' knowledge of hazard warning signs of commonly used laboratory chemicals, the students were requested to match chemical properties with the corresponding labels or pictograms. The properties of the laboratory chemicals presented to the students were toxic, flammable, explosive, oxidizing, irritant, polluting, radioactive, and corrosive. Table 1 presents the number of respondents who correctly matched the properties of chemicals with the corresponding pictograms of hazard warning signs.

As shown in table 1, only 57%, 13%, and 45% of the respondents were able to match the flammable, explosive, and toxic signs, respectively. Furthermore, the percentages attained in the other properties were relatively lower. These results indicate that the students have a very low understanding of hazard warning signs.

The students' preferred ways of effective communication of the potential hazards and risks of laboratory chemicals were also surveyed. Table 2 shows that the majority of the subjects preferred the use of both colors and symbols and regarded it as the best way for effective communication of information regarding chemical hazards. Rank means in table refere the highest score (percentage) between different variables.

Table 1: Frequency distribution of participants who correctly matched properties of chemicals with signs

Properties of chemicals	**N (%)**
Flammable	85 (57)
Explosive	20 (13)
Toxic	67 (45)
Irritant	48 (32)
Polluting	34 (23)
Radioactive	16 (11)
Oxidizing	11 (7)
Corrosive	11 (7)

Table 2: Preferred communication methods of hazards and risks of laboratory chemicals

Preferred Ways	N	%	Rank
Colors	15	8	3
Symbols	36	20	2
Colors and Symbols	124	72	1
No idea	0	0	4

Discussion

A related study in Zambia by Banda and Sichilongo surveyed the impact of chemical hazard label elements in four target sectors (7). The survey revealed that the level of education, gender, and/or age did not influence the respondents' perception of the extent of hazard. However, familiarity with or frequency of the use of chemicals and acquaintance with chemical label elements significantly affected the extent of perceived hazards posed by a given chemical (8). The study also suggested that in order for chemical hazard symbols to be effective, they must not be too abstract to the client, but should contain features that are known or easily understood. Based on the present study, regarding the preferred way of communicating the potential hazards of the chemicals, the majority of the students chose the use of both color and symbols.

The reasons stated by the students for their lack of awareness included inattention to chemical labels, lack provision of orientation for them, and difficulty to remember and understand most symbols. Adane and Abeje reported that only 26.5%, 14.45%, and 12% of their subjects were able to correctly match flammable, toxic, and irritant, respectively, with their associated signs (9). This finding supports the results of the present study. Results of similar studies by Nicol and Tuomi (10) and Warhurst et al. (11) showed that pictograms or signs of flammable and toxic properties of chemicals were the most easily identifiable. Awareness begins with the identification of hazardous chemicals. A hazardous substances program and appropriate engineering control is necessary to train and educate researchers and students in order to prevent and control expected exposure to hazardous substances according to the recommendations of the National Institute for Occupational Safety and Health (NIOSH). A course entitled "Laboratory Safety" should be included in the curriculum to increase awareness and safety culture level among students.

Protection from hazardous chemical exposure depends on safety programs established by employers (12). The results of the study revealed that the majority of the respondents believed that they were aware of the hazards of laboratory chemicals with high familiarity with hazard signs of laboratory chemicals.

Conclusion

Based on the presented findings, it can be concluded that despite the students' claim that they were not only aware of the potential hazards of chemicals in the laboratory, but were also familiar with their corresponding hazard signs, the majority of the respondents exhibited poor understanding of the matter. Regarding the preferred way of communicating the potential hazards of chemicals, the majority of the students choose the use of both color and symbols. In line with these conclusions, the researchers put forward a set of recommended actions and guidelines to the Laboratory Committee of the concerned department. With the end goal of prevention of chemical hazards exposure due to lack of awareness, familiarity, and understanding that lead to incorrect handling of chemicals, corrective measures in the areas of student orientation, teachers' instructions, and

labeling of chemicals in the laboratories were included in the recommended plan of action.

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Conflict of Interest: None declared

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