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Appraisal of Biosafety Measures in Governmental Medical Laboratory Personnel: Knowledge, Attitude, Practice (KAP) Study

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Abstract

Laboratory staff is always exposed to a variety of hazards according to their work nature and so, they must be conscious at all times. This study is aimed at the assessment of safety awareness to get knowledge attitude and practice among governmental medical laboratory staff in Khartoum state. **A** descriptive cross-sectional study performed on 210 Sudanese governmental medical laboratory staff working in 15 governmental hospitals lab. Data was collected by direct interviews using structured, pretested, closed ending questions, coded and designed by researcher questionnaire developed, and validated using universal guidelines data analyzed by using the statistical package of social science (SPSS). The study result shows that there is good awareness in some of the safety awareness domains and weakness in others, the result of the comparison of the laboratory specialist scores mean and laboratory assistant scores mean to show that there is a significant difference between them and also there is no significant difference between mean scores of BSc holder and MSc holder medical laboratory specialist, correlation and association result shows that there is a strong negative correlation between experience and scores in medical laboratory specialist and weak negative correlation between experience and scores in medical laboratory assistant. Relative weakness in medical laboratory safety awareness was revealed, which reinforce health authorities, the administration of medical laboratory, universities, and hospitals must intensify courses and training programs about medical laboratory safety and establish functional and active, and well-implemented occupational safety policy systems that will be supervised by safety officers.

Keywords: Medical laboratory staff, Laboratory safety, Hazards, Awareness

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Introduction

The current state of knowledge of secure laboratory working practices remains elusive, so there is an imperative necessity for both globally recognized agreed codes of standard precautions, as well as the innovation of regulations for the medical surveillance of laboratory workers, it is critical to use attitude measures to see and understand events based on specific tendencies to establish a unified construction. The practice of safety measures is characterized as the request for guidelines and knowledge that ultimately resulted in action. A great practice is a creative process that is concerned with the advancement of resources and information and is carried out properly (Thirunavukkarasu *et al*., 2021). The World Health Organization is establishing such guidelines in an attempt to safeguard the health of workers who are involved in the investigation of other people's illnesses (Akagbo *et al*., 2017). A laboratory hazard could cause damage or injury. These hazards are classified as biological, chemical, physical, electrical/mechanical, high voltage apparatus, machinery with moving parts, or psychological. Every worker in a laboratory should be aware of the possible risks in their working place. It is critical for Laboratory staff that they practice in a secure environment (Akagbo *et al*., 2017).

Employer by law is responsible to make safety equipment available according to biosafety level facility and the employee must flow all safety rules, safety equipment like safety shower, eye wash, fire extinguishers, fire blanket, spill kits, first aid supplies, mechanical pipetting device, chemical fume hood, biological safety cabinet, and chemical storage equipment (safety carries, approved safety cans, steel safety cabinet with safety closing door, explosion-proof refrigerators, gas cylinder supports, valve caps and hand carts (Balasubramanya *et al*., 2016; Akagbo *et al*., 2017). Many laboratory workers are daily exposure to biological hazards, these hazards are present in various sources in the laboratory such as blood and body fluids, culture specimens, body tissue, cadavers, and laboratory animals, as well as other workers mainly they are blood borne and airborne pathogen (Lloyd *et al*., 2016; Lemessa, & Solomon, 2021). Principally, occupational safety and preventive measures focus on strengthening and sustaining the optimal physical, mental, and social well-being of employees across all occupational categories (McMakin & Lundgren, 2018; Reda *et al*.,

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2021). There's a need to evaluate laboratory workers' knowledge, attitudes, and practices concerning their predilection to exposure to workplace injuries have become critical. As a result, endeavors aimed at prohibiting workplace hazards by enhancing laboratory workers' safety-related attitudes, behaviors, and practices are strongly recommended. As a result, by reducing laboratory workers' exposure to occupational accidents, safety regulations and metrics in the facilities where they collaborate would vastly enhance (Markovic-Denic *et al*., 2015; Senthil *et al*., 2015). So present study aimed to the assessment of safety awareness to get knowledge attitude and practice among governmental medical laboratory personnel in Khartoum state/Sudan.

Materials and Methods

Methods

A descriptive cross-sectional study was conducted by laboratory staff, medical laboratory specialists, and medical laboratory assistants who are working in governmental hospitals in Khartoum state/Sudan, during the period from August 2021 to February 2022. Trainees and laboratory cleaners were excluded from participation in the study. A total of 300 subjects participated in the study, who enrolled using the nonprobability sampling method, (namely convenience sampling method was followed to select the participants)

A well-constructed, the pretested questionnaire was designed and administered to study subjects, it had 20 Closed-ended questions altogether in the following items which were divided into four domains:

- Baseline data (include Work Experience, qualification, etc.)
- Knowledge questions (4 items about the easy access of e-lectures, etc.)
- Attitude questions
- Practice questions

The answers were graded on 3 points Likert scale from 1-3 (scale: 1- disagree, 2- Somewhat agree 3-agree). Before the administration of the questionnaire, validation by two medical educationists was done. Informed consent was also taken from the participants. A Mean was calculated for items with scores ranging from 17-85. The Mean score came out to be 43. Those with a score of more than 43 were considered to have a negative attitude towards laboratory safety, and preventive measures, and those who scored less than the Mean (less than 43) were considered to have a positive attitude.

Data collected by direct interviews Questionnaire filled at the rest time of medical laboratory specialist and medical laboratory assistant.

Statistical Analysis

The calculated data, and all other sociodemographic characteristics, were assessed using the SPSS (version 26) program. The level of significance was calculated by a p-value of 0.05.

Results and Discussion

A total of 210 subjects participates in the study, 178 (84.8%) of them are laboratory specialists among them (130/73% are BSc degree holders, while 32 (15.2%) of them are laboratory assistants. **Table 1** describes the frequency of baseline, demographic data, and respondent's characteristics such as (age, education level, and specialist). The half of subjects (50.5%) had work experience ranging from 1 to 5 years old.

Statistically significant differences were revealed among occupational categories and educational levels concerning safety awareness (P-value 0.01, 0.06) respectively. The overall findings are summarized in **Table 2**.

Table 3 displys the awareness level based on knowledge questions were summarized in **Table 4** there is good awareness of safety equipment, biological safety, chemical safety, and physical safety, as 150 (71.4%), 197 (93.8%), and 204 (97.1%) of respondent have had well knowledge about protective suit should be worn, route of transmission of an infectious agent, and importance of good ventilation inside the laboratory. nevertheless, there are weaknesses and low knowledge in compressed gas hazards, fire safety, disposable of hazard material, safety sign, electrical safety, and sample transportation (P-value 0.001).

Regarding the attitude of participants on laboratory safety practices, a relative high attitude (94.3%) was revealed in the area of good dealing samples in terms of spillage, 188 (89.5%) have well attitudes about the best ways of putting on and taking off gloves, as well as (60%) having fair attitude in case of problem in machines such as centrifuge, and storage of chemicals. Data is summarized in **Table 4**.

Table 5 illustrates the frequency of practices of participants towards laboratory safety practices, where an overall practices pattern in conceptions of best ways of sterilizing and hand washing, discarding and get rid of wastes in suitable trash box, moreover; superior practicing and caring of laboratory machines and devices are relatively good (73.3%, 82.9%, 78.1%) respectively. However; very poor practicing regarding discarding and getting rid of disposable sharps and containers 78.6%, and 81.9% did not know appropriate fire extinguishers and their uses.

The result of correlation and association shows that there is a strong negative correlation between experience and scores in medical laboratory specialists (r= -0.157*, and P-value = 0.04) and there is a weak negative correlation between experience and scores in medical laboratory assistants (r= -0.17 \ P-value 0.36). the result showed in **Figures 1 and 2**.

Table 1. Baseline data of study participants

Parameters	Frequency n=210	Percent (%)
Work Experience		
1-5 Years	106	50.5
5-10 Years	49	23.3
10-20 Years	43	20.5
More than 20 years	12	5.7
Occupational position		
Assistants	32	15.2
Specialists	178	84.8

Total	210	100
Qualification of Lab specialist		
BSc	130	73
MSc	48	27
Total	178	100

Table 2. Comparison of safety awareness means among occupational categories and educational level

		N	Minimum	Maximum	Mean ± sd	P. value
Assistants	score%	32	**30**	**75**	50.3±11.4	0.01
Specialists	score%	**178**	**25**	**90**	56.04±12	
B. Sc	score%	**130**	**25**	**80**	54.9±12.1	0.06
M. Sc	score%	**48**	**35**	**90**	58.8±11.5	

Table 3. Knowledge of participants on Laboratory safety practices

	Knowledge questions	High knowledge	Low knowledge	P value
1	What type of shoe is worn in the lab?	150 (71.4%)	60 (28.6%)	0.001
2	What does the second letter in the abbreviation PEE mean?	122 (58.1%)	88 (41.9%)	0.063
3	The ways of transmission of infectious agent	197 (93.8%)	13 (6.2%)	0.001
4	According to your experience, is ventilation important in laboratory safety	204 (97.1%)	6 (2.9%)	0.001
5	Teratogenic substance means	141 (67.1%)	69 (32.9%)	0.001
6	How many fire extinguishers must be in the lab?	41 (19.5%)	169 (80.5%)	0.001
7	How many containers should use for sample transportation	51 (24.3%)	159 (75.7%)	0.001
8	Electric shock safety sign	50 (23.8%)	160 (76.2%)	0.001
9	Radiological symbol	79 (37.6%)	131 (62.2%)	0.001
10	Ethanoic acid hazard symbol	60 28.6%)	150 (71.4%)	0.001

Table 4. Attitude of participants among Laboratory safety practices

	Attitude questions	High Attitude	Low Attitude	P value
1	What would be if the centrifuge didn't have a cap?	129 (61.4%)	81 (36%)	0.001
2	How do you put on and take off gloves?	188 (89.5%)	22 (10.5%)	0.001
3	How do you deal with spills?	198 (94.3%)	12 (5.7%)	0.001
4	Where is the place for gas cylinders	6 (2.9%)	204 (97.1%)	0.001
5	Chemicals are stored according to	126 (60%)	84 (40%)	0.001

Table 5. Practice of participants toward Laboratory safety practices

	Practice questions	High Practice	Low Practice	P value
1	Wash hands with soap and water	154 (73.3%)	56 (26.7%)	0.001
2	The appropriate fire extinguisher is selected according to	38 (18.1%)	172 (81.9%)	0.001
3	What after a venous blood sample is drawn	45 (21.4%)	165 (78.6%)	0.001
4	Household waste should be thrown into the colored bag	164 (78.1%)	46 (21.9%)	0.001
5	Do you care to unplug the device from the power after the finish	174 (82.9%)	36 (17.1%)	0.001

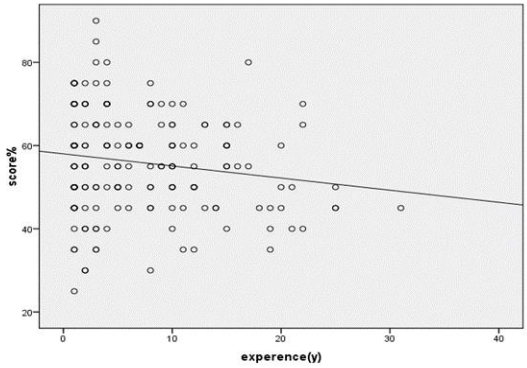


Figure 1. Correlation of experience to safety awareness score among lab. Specialists

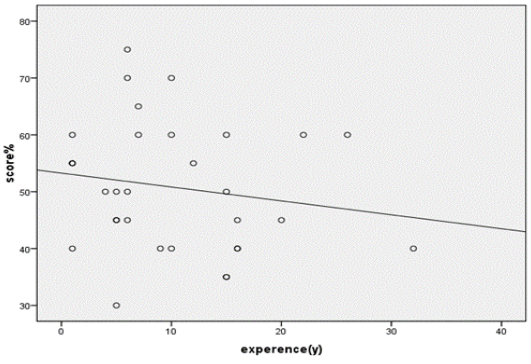


Figure 2. Correlation of experience to safety awareness score among lab assistants

A highlight of the significance of accomplishing the basic safety goal of reducing hazards and injuries is the critical role of medical laboratory management, certainly, a strong understanding of potential consequences and practical safety guidelines to protect the foregoing must be considered and emphasized (Alshalani & Salama, 2019). Hence current cross-sectional survey was designed

to assess safety awareness among governmental medical laboratory staff in the Khartoum state of Sudan, to get knowledge attitude and practice.

Medical laboratories are hazardous workplaces, where workers face a wide range of biological hazards and physical incidents, chemicals, fire, etc. There is a consensus that workers should prepare enough in terms of training to better their skills and knowledge and also, to provide them with proper PPE. Almost all guidelines and measures are listed in manuals, which must be available for workers, but acquired knowledge about biosafety, and the adherence to such measures, need to be well reviewed, especially since faulty practices could lead to serious health problems.

Present study revealed that laboratory personnel had significant moderate levels of knowledge, which come in contact with study conducted by Aluko *et al.* in Nigeria (Aluko *et al*., 2016) show that there is poor compliance of occupational safety measures despite with high awareness of occupational health safety also clinical health workers with more than 10 years of experience had better awareness which agree in some point in our study which show positive impact in some of safety knowledge (safety equipment, biological safety, chemical safety and physical safety) and negative low knowledge in (in compressed gas hazard, fire safety, disposable of hazard material, safety sign, electrical safety and sample transportation) and disagree with our study which show that there is negative correlation between year of experience and safety awareness, also similar study conducted in Riyadh Saudi Arabia revealed that a positive attitude and knowledge towards occupational safety practices among medical laboratory staff. Also, there was a significant positive correlation between both nationality and age group and occupational safety practices and the observation checklist showed that almost most of the occupational safety subscales parameters were followed to a good extent in the assessed labs except for the use of PPE and electrical safety measures. This study mainly disagrees with our study which shows a poor impact in some of the safety awareness domains and a good impact in others. Also, the study of assessment of radiation safety awareness among medical doctors shows that it is the appreciable overall mean score of radiation safety awareness among medical doctors but week in some point of radiation safety our study revealed that there are points of positive knowledge and another weakness aria of medical laboratory safety knowledge and awareness with negative correlation with experience.

The lack of knowledge may be attributed to inadequate training during both undergraduate education and service. Previous studies concluded that the lack of proper knowledge of biomedical waste management influences the appropriate practice of waste management (Bianco *et al*., 209; Naithan *et al.*, 2021), and this potential problem emphasizes the need for intervention.

With regard attitude of participants regarding Laboratory safety practices, the study confirms and expands on the evidence that indicates the effectiveness of attitude practices among our study subjects, in terms of chemical storage, spillage or accident, so significantly good attitude was revealed. Chemical compounds should not be combined unless specific recommendations are implemented, and they must be provided in the correct order. Chemicals should be used from easily manageable containers, hazardous substances should be categorized with a definition of their potential threat, such as toxic substances, corrosive, highly explosive, highly flammable, teratogenic, or cancerous, mouth pipetting is undesirable, and the same basic guidelines for handling biohazardous materials apply to molecularly hazardous materials; which specifies, never seem to get these materials in or on bodies, clothes, or work area. Chemical disposal regulations are in place at the state and national levels and should be followed. However statistically insufficient and poor attitude regarding the proper place for gas cylinders, as a consequence, efforts that promote their attitude are warranted (El-Gilany *et al*., 2017).

Direct association between safety inspectors and firefighting prevention officers is obligated, and the consequences of fire on the potential dissemination of contaminated surfaces must be taken into account. This may influence whether fire should be extinguished or contained. It is preferable to have the assistance of local fire prevention officers in training laboratory staff in fire prevention and fighting, immediate action in the event of a fire, and the use of fire-fighting equipment. Fire precautions, instructions, and escape routes should be prominently displayed in each room, as well as in corridors and hallways. A radiation safety strategy must include environmental aspects, such as posting caution signs in all areas where radioactive particles are used or stored and limiting access to only permanent employees. Just trained staff should work with radioactive materials, and users must be supervised to ensure that the maximum acceptable dose of radiation is not overestimated. Radiation monitors must be assessed on a routine basis to identify the level of exposure for laboratory staff members, and files must be maintained. Our finding is the same as reported in a study carried out by Wader *et al*. noted that their respondents have a negative attitude towards laboratory safety measures (Wader *et al*., 2013).

Moreover, the practices of participants towards laboratory safety practices, and overall practices pattern in conceptions of best ways of sterilizing and hand washing, discarding and get rid of wastes in suitable trash box, moreover; superior practicing and caring of laboratory machines and devices are relatively good (73.3%, 82.9%, 78.1%) respectively. However; very poor practicing regarding discarding and getting rid of disposable sharps and containers 78.6%, and 81.9% didn't know appropriate fire extinguishers and their uses. This point also highlights the significance of periodic training for such workers in terms of improving their practices.

Lack of knowledge of the basics of correct practice during routine laboratory tests such as pipettes, working in microscopes, operating microtomes, and use of cell counters, and keyboards in computer workstations may lead to occupational injuries. So employers can reduce the possibility of work-related injuries by making some simple changes in the workplace (Al-Abhar *et al.*, 2017; Almutairi *et al*., 2020).

When it comes to the safe handling and disposal of chemicals, medical, biological, radioactive, and other substances that require a comprehensive understanding of their characteristics and potential risks, those who generate hazardous waste have an ethical and legal responsibility, as defined by applicable local, state, and

federal regulations, to protect both the individual and the environment, there are four fundamental waste disposal methods: flushing down the drain to the sewer system, incineration, landfill burial, and recycling, any crashes involving personal injuries, no matter how minor, must be assessed and managed immediately by supervisor and senior laboratory staff in charge (Fadeyi *et al*., 2011; Osungbemiro *et al*., 2016).

Relative weakness in knowledge, attitude, and practice revealed among respondents in medical laboratory safety awareness may be attributed to the limited number of highly qualified personnel as the strong negative correlation between experience and scores in medical laboratory specialists (r= -0.157*, and P-value = 0.04) and there is a weak negative correlation between experience and scores in medical laboratory assistant (r= -0.17 \ P-value 0.36).

The study recommends that, regular training for health workers on medical laboratory safety knowledge for medical laboratory specialists and medical laboratory assistants as well as for health employees, and workers who have direct contact with medical laboratory hazards. Hospitals should establish functional and active and well-implemented occupational safety policy systems that will be supervised by safety officers which will increase productivity and overall be safe for medical laboratory workers and the community. Universities must focus on intensifying the curriculum course regarding safety knowledge and preventive measures.

Conclusion

Generally, there was a positive knowledge of the safety of equipment, biological safety, chemical safety, and physical safety of occupational safety knowledge. Also, there is weakness in compressed gas hazards, fire safety, disposable of hazard material, safety sign, electrical safety, and sample transportation of occupational safety knowledge among the medical laboratory staff that works in governmental hospitals in Khartoum, Sudan.

There is a noticeable difference between medical laboratory specialist occupational safety awareness and medical laboratory assistant occupational safety awareness also there is no significant difference between BSc and MSc holder medical laboratory specialist also, the study revealed that there is a strong negative correlation between medical laboratory specialist knowledge and year of experience and week negative correlation between some parameters in medical laboratory assistant. So, the study concludes that there is a general weakness in medical laboratory safety awareness.

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Ethics statement: Approval was obtained from Alzaim Alazhari university, the Sudan ministry of the health research department, and hospitals. Research purpose and objective explained to participant in clear and simple words. All participants signed informed consent before participation, as well as their right to withdraw at any time without any deprivation. The remaining data was not used by another researcher before participant approval.

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