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Assessment of Safety Measures in Selected Science Laboratories across the Six Geopolitical Zones in Nigeria

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Abstract- Science laboratory is central to scientific advancement and innovation. Laboratory safety aimed at preventing laboratory risks, hazards and protecting laboratory personnel from hazardous material exposure. Controlling a hazard at its source is the best way to protect students, employees, and visitors. This study was conducted to evaluate science laboratories' safety measures across the six Geo-political zone of Nigeria. A total of one hundred and eighty (180) laboratories were engaged in the studies comprising thirty (30) laboratories from each of the geopolitical zones of the Country. The use of a structured questionnaire via Google form link was employed. The questionnaire covered administrative and procedural control, emergency procedures, waste disposal, training, personal protective equipment, engineering control, hazard identification, risk assessment, and laser and radiation safety measures. The study provides comprehensive results for the level of compliance in the use of safety measures in the University, Polytechnic, Post-basic school, and General science laboratories- laboratory services. The study revealed that there was no significant difference between the mean of various types of laboratories in the institutions ($F(5, 175) = .289$, $p > 0.05$) and across the six geopolitical zones of Nigeria ($F(4, 176) = .116$, $p > 0.05$). The total average for safety measures used range from 20.6% (Engineering Control Safety Measures) to 69.4% (Personal Protective Equipment Safety Measures) across the zones against the ideal standard of 100%. Conclusively, the low level of safety measure is a setback to science laboratory advancement and all laboratory personnel must strictly follow laboratory safety standard

Keywords- Assessment, Safety Measures, Science Laboratory, and Compliance

I. INTRODUCTION

Nigeria is the most populated country on the African continent a country in West Africa, bordering Niger in the north, Chad in the northeast, Cameroon in the east, and Benin in the west. Its coast in the south is located on the Gulf of Guinea in the Atlantic Ocean. The federation comprises of thirty-six (36) states and a Federal Capital Territory, where the capital, Abuja, is located, (Emily, 2021). Currently, Nigeria as a nation is divided into six geopolitical zones; North East, North West, North

Central, South-South, South East and South West (Savage, 2020).

Virtually, all the states located within the zones have science laboratories where experiments, analysis, diagnosis and other research works are carried out; in post-basic school laboratory, tertiary institution, private and research laboratories. With the steady increase in the number of science laboratories across the country and incidence of quackery operating science laboratory, there is a need to assess safety measures of these laboratories and ascertain the level of compliance in order to protect lives and laboratory components (Owili-Mensah, 2017).

The laboratory is one of the most important fields of practice where practical experiments are carried out to transfer knowledge from concepts, principles, and theories to tangible results that can be observed, measured, controlled and re-tested in different conditions and according to new variables (Fagih, 2018)

According to the Occupational Health and Safety Administration, OSHA (2021), the different types of hazards workers can encounter while in laboratories include chemical (hazards like carcinogens, toxins irritants, corrosives, and sensitizers), biological (hazards such as blood and body fluids, culture specimens, body tissue and cadavers, and laboratory animals, as well as other workers), physical (hazard like ergonomic, ionizing radiation, non-ionizing radiation and noise hazards), radiation and safety (hazards like an electric shock and electrocutions, small bench-top fires, and slips rips, and falls) (Tarlengco, 2020).

Laboratory safety is aimed at preventing laboratory risks, and hazards and protecting laboratory personnel from hazardous material exposure. Its effective implementation will prevent toxic contamination, secure the property and equipment from damage, and manage an organized and safe laboratory environment (Tarlengco, 2020).

According to the Occupational Safety and Health Administration, OSHA (2011), the control measures generally need for safety in the laboratory include the followings; the use of engineering controls, administrative controls, work practices and personal protective equipment (PPE). Achieving awareness of the safety measures of students and teachers and abiding by the instructions when performing laboratory practices serve as a moral charter that should be observed when performing laboratory experiments (Environmental Health and Safety, EHS, 2012). This study was to assess the safety measures in selected science laboratories across the six geopolitical zones in Nigeria.

II. MATERIALS AND METHODS

1. Research Design

In this study, the descriptive-correlation method of research was used. The descriptive method describes the data and characteristics of what is being studied. At the same time, the correlation method measures the relation between two or more variables.

2. Research Environment

The research was conducted in Science Laboratories across the six geopolitical zones of Nigeria where the respondents are working. A total of 180 laboratories, 30 from each of the six geopolitical zones were assessed.

3. Research Instrument

The use of a questionnaire via Google form link was adopted and sent to the e-mail of Technologists/Scientists practicing in science laboratories across the six geopolitical zones of Nigeria in different sectors of the economy. The details (emails and phone numbers) of some selected Technologists/Scientists and other laboratory personnel working in the six geopolitical zones were collated through Association of Science Laboratory Technologists of Nigeria (ASLTON) members. Then, a structured questionnaire was sent via Google form to their emails and Whatsapp numbers for responses.

A modified Question regarding the usage of safety standards and safety measures in the science laboratory was used as described by Izzo (2022)

and the University of Newcastle Australia (2010). The questionnaire covered administrative and procedural control, emergency procedures, waste disposal, training, personal protective equipment, engineering control, hazard identification, risk assessment, and laser and radiation safety measures (Izzo, 2022).

4. Respondents of the Study

The respondents of the study were composed of Scientists, Technologists, and Science Teachers practicing in Post-basic school laboratories, Polytechnic Laboratories, University Laboratories, and General Laboratory Services across the Six Geopolitical Zones of Nigeria.

5. Data Collection Procedure

Ethical clearance was obtained from the Nigerian Institute of Science Laboratory Technology for permission to conduct a study and obtained relevant data from scientists and Technologists practicing in various Science laboratories across the six geo-political zones of Nigeria.

6. Statistical Treatment

Data were entered and analyzed using SPSS version 26.0, 2019, computer software. Comparisons were made using the F-test. A P-value of <0.05 was considered indicative of a statistically significant difference.

III. DATA ANALYSIS, INTERPRETATION AND DISCUSSION OF RESULTS

1. Results of Data Analysis

Question 1: What is the current level of compliance with Safety measures used in selected science laboratories across the six geopolitical zones of Nigeria?

The data analysis of safety measures used in selected science laboratories across the six geopolitical zones of Nigeria shows administrative and procedural control, emergency procedure, waste disposal, training, personnel protective equipment, engineering control, hazard Identification, risk assessment, laser, and radiation are presented in Table 1,2,3,4,5,6,7,8,9,10 respectively addresses question 1. The administrative and procedural control of safety measures used in selected science laboratories across the six geopolitical zones of Nigeria in Table

4.1 showed the level of compliance and non-compliance within the zones. In the analysis, North-central has the highest level of compliance with 70% while North-east has the lowest level of compliance with 26%. A total average of 56.1% level of compliance was recorded for the zonal level of compliance. The emergency procedure of safety measures used in selected science laboratories across the six geopolitical zones of Nigeria in Table

4.2 shows the level of compliance and non-compliance within the zones. In the analysis, North-west had the highest level of compliance with 66.7% while North-east had the lowest level of compliance with 16.7%. A total average of 43.9% was recorded for the zonal level of compliance. The waste disposal of safety measures used in selected science laboratories across the six geopolitical zones of Nigeria in Table 3 showed the level of compliance and non-compliance within the zones. In the analysis, the North-west have the highest level of compliance with 80% while North-east and South-east have the lowest level of compliance with 36.7%. A total average of 62.8% was recorded for the zonal level of compliance. The training of safety measures used in selected science laboratories across the six geopolitical zones of Nigeria in Table

4 showed the level of compliance and non-compliance within the zones. In the analysis, North-central has the highest level of compliance with 83.3% while North-east had the lowest level with 23.3%. A total average of 56.1% was recorded for the zonal level of compliance. The Personal Protective Equipment safety measures used in selected science laboratories across the six geopolitical zones of Nigeria in Table 5 showed the level of compliance and non-compliance within the zones. In the analysis, the South-east had the highest level of compliance with 80% while the North-east had the lowest level of compliance with 63.3%. A total average of 69.4% was recorded for the zonal level of compliance. The engineering

control of safety measures used in selected science laboratories across the six geopolitical zones of Nigeria in Table 6 showed the level of compliance and non-compliance within the zones. In the analysis, North-east has the highest level of compliance with 26.7% while South-south had the lowest level of compliance with 10%. A total average of 20.6% was recorded for the zonal level of compliance. The hazard identification of safety measures used in selected science laboratories across the six geopolitical zones of Nigeria in Table

7 showed the level of compliance and non-compliance within the zones. In the analysis, South-south had the highest level of compliance with 83.3% while North-central had the lowest level of compliance with 46.7%. A total average of 61.1% was recorded for the zonal level of compliance. The risk assessment safety measures used in selected science laboratories across the six geopolitical zones of Nigeria in Table 8 showed the level of compliance and non-compliance within the zones. In the analysis, the South-west have the highest level of compliance with 36.7% while North-central had the lowest level of compliance with 26.7%. A total average of 31.1% was recorded for the zonal level of compliance. The laser safety measures used in selected science laboratories across the six geopolitical zones of Nigeria in Table 4 showed the level of compliance and non-compliance within the zones. In the analysis, South-south had the highest level of compliance with 53.3% while South-east had the lowest level of compliance with 36.7%. A total average of 43.9% was recorded for the zonal level of compliance. The radiation safety measures used in selected science laboratories across the six geopolitical zones of Nigeria in Table 4.10 showed the level of compliance and non-compliance within the zones. In the analysis, Southwest have the highest level of compliance with 73.3% while Northeast has the lowest level of compliance with 53.3%. A total average of 59.4% was recorded for the zonal level of compliance.

Question 2: What is the current level of compliance with safety standard by operational science laboratories in various institutions across the six geopolitical zones of Nigeria?

The data analysis for the level of compliance to safety standards by operational science laboratories across the six geopolitical zones of Nigeria showing the institutions; university, Polytechnic, laboratory services, and post-basic school are presented in Tables 11, 12, 13,14,15,16,17,18,19 and 20 respectively addresses question 2. The Administrative and procedural control safety measures among operational science laboratories across the six geopolitical zones of Nigeria in Table

11 showed the level of compliance and non-compliance of laboratories in university, polytechnic, laboratory services, and post basic school laboratories. In the analysis, University laboratories have the highest level of compliance with 83.3% while Polytechnic had the lowest level of compliance with 22.2%. A total average of 56.1% was recorded for the institutional level of compliance. The waste disposal safety measures among operational science laboratories across the six geopolitical zones of Nigeria in Table 13 showed the level of compliance and non-compliance of laboratories in university, polytechnic, laboratory services, and post basic school laboratories. In the analysis, laboratory services have the highest level of compliance with 88.9% while Polytechnic has the lowest level of compliance with 35.2%. A total average of 62.8% was recorded for institutional level of compliance. The training safety measures among operational science laboratories across the six geopolitical zones of Nigeria in Table 14 showed the level of compliance and non-compliance of laboratories in university, polytechnic, laboratory services, and post basic school laboratories. In the analysis, Laboratory services have the highest level of compliance with 77.8% while Polytechnic had the lowest level of compliance with 37%. The total average of 56.1% was recorded for institutional level of compliance. The personal protective equipment safety measures among operational science laboratories across the six geopolitical zones of Nigeria in Table 15 showed the level of compliance and non-compliance of laboratories in university, polytechnic, laboratory services and post basic school laboratories. In the analysis, post-basic school laboratories have the highest level of compliance with 100% while Polytechnic had the

lowest level of compliance with 29.9%. The total average of 69.4% was recorded for institutional level of compliance. The engineering control safety measures among operational science laboratories across the six geopolitical zones of Nigeria in Table 16 showed the level of compliance and non-compliance of laboratories in university, polytechnic, laboratory services and post basic school laboratories. In the analysis, Laboratory services have the highest level of compliance with 61.1% while Post-basic schools have the lowest level of compliance with 0%. The zero percent (0%) indicate the engineering control is not available in post-basic school. The total average of 20.6% was recorded for institutional level of compliance. The hazard identification safety measures among operational science laboratories across the six geopolitical zones of Nigeria in Table 17 showed the level of compliance and non-compliance of laboratories in university, polytechnic, laboratory services and post basic school laboratories. In the analysis, post-basic school laboratories have the highest level of compliance with 77.8% while Polytechnic has the lowest level of compliance with 37%. The total average of 61.1% was recorded for institutional level of compliance. The risk assessment safety measures among operational science laboratories across the six geopolitical zones of Nigeria in Table 18 showed the level of compliance and non-compliance of laboratories in university, polytechnic, laboratory services and post basic school laboratories. In the analysis, Laboratory services have the highest level of compliance with 66.7% while post-basic school laboratories have the lowest level of compliance with 0% (100% non-compliance). The total average of 31.1% was recorded for institutional level of compliance. The laser safety measures among operational science laboratories across the six geopolitical zones of Nigeria in Table 19 showed the level of compliance and non-compliance of laboratories in university, polytechnic, laboratory services and post basic school laboratories. In the analysis, Laboratory services have the highest level of compliance with 77.8% while post-basic school laboratories have the lowest level of compliance with 0%. The total average of 15.3% was recorded for institutional level of compliance. The radiation safety measures among operational science laboratories across the six geopolitical zones of Nigeria in Table 20 showed the level of compliance and non-compliance of laboratories in university, polytechnic, laboratory services and post basic school laboratories. In the analysis, Laboratory services have the highest level of compliance with 72.2% while post-basic school laboratories have the lowest level of compliance with 0%. The total average of 36.5% was recorded for institutional level of compliance.

Question 3: What is the difference in the level of safety compliance among the science laboratories available in Nigeria?

The data analysis of safety measures used in selected science laboratories across the six geopolitical zones of Nigeria showing difference in the level of safety compliance among the science laboratories available in Nigeria in Table 21 addresses question 3. The difference in safety compliance among the science laboratories available in Nigeria showed in Table 21 reveals that there is no significant difference in the level of safety compliance among the science laboratories available in Nigeria; $F(4, 176) = .116$, $p > 0.05$). The table however revealed that general laboratory servies ($\bar{x} = 60$) have higher safety compliance, followed by Biological Science laboratories ($\bar{x} = 52$), then Chemical Science Laboratories ($\bar{x} = 49.67$) and lastly Physical Science Laboratories ($\bar{x} = 49$). Scores above the grand mean (grand $\bar{x} = 51$) shows a higher likelihood to comply with safety measures. While the result shows that the differences in compliance observed among these institutions are not significant, it is however worthy of note that the general science laboratories have more compliance with safety measures compared to other forms of laboratories.

Question 4: What is the difference in safety compliance among the operational science laboratories in various institutions across the six geopolitical zones in Nigeria?

The data analysis of safety measures used in selected science laboratories across the six geopolitical zones of Nigeria showing the difference in safety compliance across the six

geopolitical zones in Nigeria in Table 22 addresses question 4. The difference in safety compliance among the laboratories across the six geopolitical zones of Nigeria in Table 22 reveals that there is no significant difference in the level of safety compliance in science laboratories across the geopolitical zones in Nigeria; $F(5, 175) = .289$, $p > 0.05$).

Table 1: A cross-tabulation of the administrative and procedural control safety measures in selected laboratories across the six geopolitical zones in Nigeria

Zone	Administrative and Procedural Control	
	Non-compliance	Compliance
South West	36.7%	63.3%
South South	33.3%	66.7%
North Central	30.0%	70.0%
North West	36.7%	63.3%
North East	73.3%	26.7%
South East	53.3%	46.7%
Total	43.9%	56.1%

Table 2: A cross-tabulation of the emergency procedure safety measures in selected laboratories across the six geopolitical zones in Nigeria

Zone	Emergency Procedure	
	Non-compliance	Compliance
South West	56.7%	43.3%
South	36.7%	63.3%
North Central	46.7%	53.3%
North West	33.3%	66.7%
North East	83.3%	16.7%
South East	80.0%	20.0%
Total	56.1%	43.9%

The table however revealed that laboratories in the south south ($\bar{x}$= 54.8) have higher safety compliance, followed by those in the North West ($\bar{x}$= 53.7), then north central ($\bar{x}$= 52.4); south west ($\bar{x}$= 50.9); south east ($\bar{x}$= 48.45) and north east ($\bar{x}$= 46.1). Scores above the grand mean (grand $\bar{x}$= 51.1) shows a higher likelihood to comply with safety measures. While the result shows that the differences in compliance observed among these zones are not significant, it is however worthy of note that the laboratories located in the south-south region have more.

Table 3: A cross-tabulation of the waste disposal safety measures in selected laboratories across the six geopolitical zones in Nigeria

Zone	Waste Disposal	
	Non-compliance	Compliance
South West	30.0%	70.0%
South South	23.3%	76.7%
North Central	23.3%	76.7%
North West	20.0%	80.0%
North East	63.3%	36.7%
South East	63.3%	36.7%
Total	37.2%	62.8%

Table 4: A cross-tabulation of the training safety measures in selected laboratories across the six geopolitical zones in Nigeria

Zone	Training	
	Non-compliance	Compliance
South West	16.7%	83.3%
South South	23.3%	76.7%
North Central	43.3%	56.7%
North West	40.0%	60.0%
North East	76.7%	23.3%
South East	63.3%	36.7%
Total	43.9%	56.1%

Table 5: A cross-tabulation of the pera sonnel protective equipment safety measures in selected laboratories across the six geopolitical zones in Nigeria

Zone	Personnel Protective Equipment	
	Non-compliance	Compliance
South West	36.7%	63.3%
South South	30.0%	70.0%
North Central	33.3%	66.7%
North West	23.3%	76.7%
North East	40.0%	60.0%
South East	20.0%	80.0%
Total	30.6%	69.4%

Table 6: A cross-tabulation of the engineering control safety measures in selected laboratories across the six geopolitical zones in Nigeria

Zone	Engineering Control	
	Non-compliance	Compliance
South West	76.7%	23.3%
South South	90.0%	10.0%
North Central	80.0%	20.0%
North West	80.0%	20.0%
North East	73.3%	26.7%
South East	76.7%	23.3%
Total	79.4%	20.6%

Table 7: A cross-tabulation of the hazard Identification safety measures in selected laboratories across the six geopolitical zones in Nigeria

Zone	Hazard Identification	
	Non-compliance	Compliance
South West	30.0%	70.0%
South South	16.7%	83.3%
North Central	53.3%	46.7%
North West	40.0%	60.0%
North East	50.0%	50.0%
South East	43.3%	56.7%
Total	38.9%	61.1%

Table 8: A cross-tabulation of the risk assessment safety measures in selected laboratories across the six geopolitical zones in Nigeria

Zone	Risk Assessment	
	Non-compliance	Compliance
South West	63.3%	36.7%
South South	70.0%	30.0%
North Central	73.3%	26.7%
North West	70.0%	30.0%
North East	66.7%	33.3%
South East	70.0%	30.0%
Total	68.9%	31.1%

Table 9: A cross-tabulation of the laser safety measures in selected laboratories across the six geopolitical zones in Nigeria

Zone	Laser	
	Non-compliance	Compliance
South West	56.7%	43.3%
South South	46.7%	53.3%
North Central	56.7%	43.3%
North West	60.0%	40.0%
North East	53.3%	46.7%
South East	63.3%	36.7%
Total	56.1%	43.9%

Table 10: A cross-tabulation of the Radiation safety measures in selected laboratories across the six geopolitical zones in Nigeria

Zone	Radiation Safety	
	Non-compliance	Compliance
South West	26.7%	73.3%
South South	33.3%	66.7%
North Central	43.3%	56.7%
North West	43.3%	56.7%
North East	46.7%	53.3%
South East	50.0%	50.0%
Total	40.6%	59.4%

Table 11: A cross-tabulation of the administrative and procedural control safety measures among operational science laboratories in various institutions in Nigeria

Institution	Administrative and Procedural Control	
	Non-compliance	Compliance
University	16.7%	83.3%
Polytechnic	77.8%	22.2%
Laboratory Services	38.9%	61.1%
Post-Basic School	38.9%	61.1%
Total	43.9%	56.1%

Table 12: A cross-tabulation of the emergency procedure safety measures among operational science laboratories in various institutions in Nigeria

Institution	Emergency Procedure	
	Non-compliance	Compliance
University	35.2%	64.8%
Polytechnic	98.1%	1.9%
Laboratory Services	61.1%	38.9%
Post-Basic School	33.3%	66.7%
Total	56.1%	43.9%

Table 13: A cross-tabulation of the waste disposal safety measures among operational science laboratories in various institutions in Nigeria

Institution	Waste disposal	
	Non-compliance	Compliance
University	22.2%	77.8%
Polytechnic	64.8%	35.2%
Laboratory Services	11.1%	88.9%
Post-Basic School	33.3%	66.7%
Total	37.2%	62.8%

Table 14: A cross-tabulation of the training safety measures among operational science laboratories in various institutions in Nigeria

Institution	Training	
	Non-compliance	Compliance
University	42.6%	57.4%
Polytechnic	63.0%	37.0%
Laboratory Services	22.2%	77.8%
Post-Basic School	33.3%	66.7%
Total	43.9%	56.1%

Table 15: A cross-tabulation of the personnel protective equipment safety among operational science laboratories in various institutions in Nigeria

Institution	Personnel Protective Equipment	
	Non-compliance	Compliance
University	24.1%	75.9%
Polytechnic	70.4%	29.6%
Laboratory Services	22.2%	77.8%
Post-Basic School		100.0%
Total	30.6%	69.4%

Table 16: A cross-tabulation of the engineering control safety measures among operational science laboratories in various institutions in Nigeria

Institution	Engineering Control	
	Non-compliance	Compliance
University	70.4%	29.6%
Polytechnic	81.5%	18.5%
Laboratory Services	38.9%	61.1%
Post-Basic School	100.0%	0%
Total	79.4%	20.6%

Table 17: A cross-tabulation of the hazard Identification safety measures among operational science laboratories in various institutions in Nigeria

Institution	Hazard Identification	
	Non-compliance	Compliance
University	63.0%	37.0%
Polytechnic	57.4%	42.6%
Laboratory Services	27.8%	72.2%
Post-Basic School		100.0%
Total	38.9%	61.1%

Table 18: A cross-tabulation of the risk assessment safety measures among operational science laboratories in various institutions in Nigeria

Institution	Risk assessment	
	Non-compliance	Compliance
University	61.1%	38.9%
Polytechnic	57.4%	42.6%
Laboratory Services	33.3%	66.7%
Post-Basic School	100.0%	0%
Total	68.9%	31.1%

Table 19: A cross-tabulation of the laser safety measures among operational science laboratories in various institutions in Nigeria

Institution	Laser safety measures	
	Non-compliance	Compliance
University	79.6%	20.4%
Polytechnic	81.5%	18.5%
Laboratory Services	77.8%	22.2%
Post-Basic School	100%	0%
Total	84.3%	15.3%

Table 20: A cross-tabulation of the Radiation safety measures among operational science laboratories in various institutions in Nigeria

Institution	Radiation Safety	
	Non-compliance	Compliance
University	55.6%	44.4%
Polytechnic	70.4%	29.6%
Laboratory Services	27.8%	72.2%
Post-Basic School		100.0%
Total	40.6%	59.4%

Table 21: F-test summary showing the difference in safety compliance among the science laboratories available in Nigeria

Laboratories	N	Mean	St. Dev	Sum of Square	df	Mean of Square	F	Sig
Physical Science Lab	54	48.995	15.1412	1573.677	3	524.56	1.995	.116
Chemical Science Lab	54	49.672	14.9196	46278.95	176	262.95		
Biological Science Lab	54	52.031	18.1716	47852.63	179			
General Science Lab	18	59.956	16.8046					
Total	180	51.064	16.3503					

Table 4.22: F-test summary showing the difference in safety compliance across the geopolitical zones in Nigeria

Laboratories	N	Mean	St.Dev	Sum of Square	df	Mean of Square	F	Sig
South west	30	50.916	15.671	1655.011	5	331.002	1.25	.289
South South	30	54.851	18.559	46197.62	175	265.504		
North Central	30	52.370	15.545	47852.63	179			
North West	30	53.742	18.743					
North East	30	46.053	13.286					
South East	30	48.453	15.283					
Total	180	51.064	16.350					

2. Discussion

The monitoring and evaluation of safety measures in science laboratories and the enforcement of laboratory safety rules play key roles in the level of compliance of various institutions to safety measures. The non-compliance as a result of incompetence could be address through training and engaging competent hands. Training and retraining of laboratory personnel to acquired relevant knowledge, skills and abilities is most needed for effective use of resources in achieving set goals and objectives.

The modified method described by Izzo (2022) and University of Newcastle Australia (2010) on science laboratory safety standard and safety measures are in line with national science laboratory technology policy (NSLTP). The policy is meant to serve as a standard guide for laboratory procedures, operations, instrumentations, and design of essential infrastructure (Ijagbone, 2010) in Nigeria.
The level of compliance by operational science laboratories in different institutions across the six geopolitical zones of Nigeria covered administrative and procedural control, emergency procedure, waste disposal, training, personal protective equipment, engineering control, hazard identification, risk assessment, laser and radiation safety measures. In the analysis, North-west has the highest level of compliance in emergency procedures (66.7%) and waste disposal (80%), other safety measure used were above 50%, except for engineering control that have 20% level of compliance which is inadequate considering its importance (HSEwatch, 2022).

The lowest level of compliance recorded in risk assessment (26.7%) and Hazard identification (46.7%) in North-central fall below 50% and indication that routine risk assessment and hazard identification were not strictly followed as contain in the laboratory safety guidelines (OSHA, 2018). A close look at the result obtained from the data analysis confirmed South-west have highest level of compliance in risk assessment (36.7%), training (83.3%) and radiation safety (73.7%). Although the zone has the highest level of compliance in risk assessment, 37% is low; an indication that periodic risks assessment is not enforced in most of the laboratories. The highest level of compliance in training and radiation safety indicated enforcement of these safety measures within the zone. The location of NISLT Headquarter in the zone from inception of the institute and the proximity has being of great advantage for those in the South west zone to attend the short term professional training for laboratory personnel.

The result from South-east having highest level of compliance in Personal protective equipment (80%) but lowest level of compliance in laser (36.7%), waste disposal (36.7%) and radiation safety (50%). The use of PPE become necessary when hazard cannot be eliminated (OSHA, 2015). A waste disposal level of compliance below 50% calls for concern in the zone because improper disposal of laboratory waste will not only affect the laboratory but also the environment (Health and Safety Executive, 2022).

The result of data analysis from South-south has highest level of compliance in Laser (53%) and Hazard identification (83.3%). Although the zone has highest level of compliance in Laser, the non-compliance (47%) is significant. Also, the lowest level of compliance recorded in engineering control (10%), falls below 50%. The results from North-east have the highest level of compliance in engineering control (26.7%) but the lowest in administrative and procedural control (26.7), waste disposal (36.7%), and training (23.3%). The level of compliance recorded in all the safety measures used were below average (50%). The university laboratories have the highest level of compliance in administrative and procedural control (83%), Laboratory Services have the highest level of compliance in waste disposal (88.9), laser safety (22.2%), radiation safety (72.2%) training (77.8%), Engineering control (61.1%) and risk assessment (66.7%). Post-basic schools had the highest level of compliance in emergency procedures (66.7), personal protective equipment (100%) and hazard identification (100%). More so, nil recorded in engineering control, laser and radiation safety measures in the level of compliance indicate the safety measures are not applicable. Polytechnic has lowest compliance in radiation safety (29.6%), laser safety (18.5%), Engineering control (18.5%), and Personal protective equipment (29.6%). risk assessment (42.6%), training (37%), waste disposal (35.2%), emergency procedures (1.9%), and administrative and procedural control (22.2%). The polytechnic recorded lowest level of compliance in nine (9) out of ten (10) safety measures used. All the level of compliance falls below 50% and the level of compliance in emergency procedures calls for serious concern. This is so serious for an institution that produce laboratory technologist meant to manned science laboratory. The results of no significant difference between the mean of various types of laboratories in the institutions ($F(5, 175) = .289$, $p > 0.05$) and across the six geopolitical zones of Nigeria ($F(4, 176) = .116$, $p > 0.05$) shows that there is no clear difference in the level of compliance among the various institutions assessed. The mean of these laboratories; South-south ($\bar{x} = 54.8$), North-west ($\bar{x} = 53.7$) and North-central ($\bar{x} = 52.4$), even though have no significant differences in the level of compliance among the zones their means are slightly above grand mean of 51.1 and show more level of compliance than other zones.

Most of the respondents are aware of the laboratory safety standard and regulations except for quackery that are not licensed to practice in the laboratory. They agreed with the study that indicates 82.4% of the respondents were aware of laboratory safety standards and regulations (Oladotun, et al., 2022).

IV. CONCLUSION

The laboratories in the six Geopolitical Zones studied have been found to have low level of compliance to safety standards. The results of no significant difference between the mean of various types of laboratories in the institutions and each of the six geopolitical zones of Nigeria shows that there is no clear difference in the level of compliance among the various institutions assessed.

The total average for safety measures levels of compliance range from 20.6% (Engineering Control Safety Measures) to 69.4% (Personal Protective Equipment Safety Measures) across the zones against the ideal standard of 100%. The low level of compliance to safety measure is a setback to science laboratory advancement and all laboratory personnel must strictly follow laboratory safety standard to checkmate unsafe act and unsafe condition.

Recommendations

The following are recommended based on the findings from the research work.

- NISLT should mandate various institutions that runs science laboratory to have In-house training and external refresher training for laboratory personnel working in various science laboratory institutions and document evidence of such training for verifications.
- Science Laboratory Safety should be treated directly as a core course in all the levels for Science laboratory technology undergraduate curricula in the polytechnic and university.
- NISLT should organize annual Short-term training on laboratory safety for all the personnel working in a science laboratory in all 36 states and the Federal Capital Territory of Nigeria.
- The Institute should evaluate level of safety compliance annually through monitoring and enforcement committee on Laboratory safety from each of the six geopolitical zones of Nigeria.
- The lowest level of compliance by polytechnic laboratories among other institutions calls for more focus on these laboratories by NISLT and the activities of non-compliance laboratories should be stopped.
- There should be a national committee on laboratory safety; to reveal the state of science laboratories in Nigeria.
- NISLT should certified science laboratory safety officer to enforce laboratory safety standard in Nigeria.

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