Laboratory Diagnosis and Management of Covid-19 Cases: Creating A Safe Testing Environment

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Research article

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Abstract

BACKGROUND

COVID-19 disease has had a profound impact worldwide since it was discovered in Wuhan, China, in December 2019. Laboratory testing is crucial to prompt identification of positive cases, initiation of treatment and management strategies. However, medical scientists are vulnerable to infection due to the risk of exposure in the laboratory and the community. This study sought to determine the awareness of laboratory safety measures, assess the personal efforts of medical scientists in creating a safe laboratory environment for testing and examine the laboratory safety enabling factors.

METHODS

An internet-broadcasted and validated questionnaire was developed to obtain data from 131 medical scientists in Nigeria. The data generated were analyzed using IBM SPSS Statistics version 25.

RESULTS

The majority of the respondents had a high awareness of laboratory safety measures (60.3%, mean ± SD= 52.4 ±2.4) and demonstrated good personal efforts in creating a safe laboratory testing environment (63%, mean ± SD= 48.5±5.9). The level of awareness of laboratory safety measures was significantly associated with respondents’ level of education ($\chi^2 = 6.143; p = 0.046$) and influences respondents’ efforts in creating a safe laboratory testing environment (F-ratio = 7.529, p = 0.007).

However, just a few respondents could convincingly attest to the availability of adequate and appropriate PPE with proper utilization training (45.1%), adequate rest and other welfare packages (45.8%) as well as access to appropriate Biological Safety Cabinets (BSCs) and other essential equipment in their laboratories (48.8%).

Furthermore, a significant association existed between the availability of laboratory safety enabling factors and respondents’ efforts in creating a safe environment for testing with the p-value ranging between <0.0001 to 0.003.

CONCLUSION

This study revealed that despite the high awareness of safety measures and good personal efforts of the study participants in creating a safe laboratory-testing environment, there was poor availability of safety facilities, equipment, support and welfare packages required to enhance their safety. It is, therefore, crucial to provide necessary laboratory biosafety equipment and PPE in order not to compromise medical scientists’ safety as they perform their duties in COVID-19 pandemic response.

Background

Since the turn of the third decade in the new millennium, the COVID-19 pandemic has been ravaging the world, after it was first discovered in Wuhan. To date, many lives have been lost to this deadly virus - as of 10 January 2020, there are more than 90 million confirmed cases globally, and more than 1.9 million deaths\(^1\). In Nigeria, there are 99,063 confirmed cases and 1,350 deaths \(^2\).

The governments and health institutions of various countries have put many strategic plans in place to aid their responses to contain and manage the effect of the pandemic on the health of their populace. Central and pertinent to
these responses are the roles that the medical scientists play as part of the multidisciplinary healthcare team in ensuring reliable, accurate and timely diagnosis, monitoring of positive patients, therapeutic drug monitoring/surveillance, confirmation of recovery, validation of testing protocols, invention and development of novel vaccines. Reports showed that most of the COVID-19 patients require regular laboratory testing to ensure adequate staging, prognosis, therapeutic monitoring and epidemiological surveillance [3].

World Health Organization’s (WHO) Recommendations on Laboratory Safety Standards

WHO recommends that every laboratory conducting COVID-19 testing should be appropriately equipped, staff must be properly trained in the technical and safety procedures as well as in the essential containment practices. Risk assessment must be conducted to ascertain the laboratory’s competency to perform testing safely, to identify and mitigate risk, as well as to put necessary and appropriate risk control measures in place. WHO also emphasizes that good microbiological practices and procedures (GMPP) should be adequately observed and that the preliminary processing of all samples should be performed in a biological safety cabinet (BSC) validated for use and properly maintained while routine viral testing of specimens should be performed in a biosafety Level 2 (BSL-2) laboratory with a certified Class II BSC. Procedures that involve viral concentration are expected to be done in a BSL-2 laboratory with unidirectional airflow and BSL-3 precautions. Biosafety Level 3 (BSL-3) laboratory is required for virus isolation in cell culture and disinfectants with known potency against enveloped viruses such as hypochlorite or phenolic compounds are required to be utilized in the laboratory to reduce contamination. Procedures that minimize aerosols and droplets generation must be adopted and appropriate personal protective equipment (PPE) must be worn by all laboratory staff handling specimens. Specimens from suspected or confirmed COVID-19 patients must be placed in a secondary container to reduce spillage or breakage and must be transported as Category B, UN3373 “Biological Substance” while viral cultures or isolates are required to be transported as Category A, UN2814, “infectious substance, affecting humans” [4].

Due to the risk of exposure in the laboratory in addition to the risk of exposure in the community, the laboratory staff are vulnerable to infection. Reports indicate that more than 90,000 healthcare workers are infected worldwide less than 6 months into the pandemic [5] and the numbers are yet increasing. Therefore, the importance of ensuring a safe environment in the laboratory cannot be overemphasized.

This study was designed to determine the awareness of laboratory safety measures among medical scientists, assess the personal efforts of medical scientists in creating a safe testing environment, and to examine the laboratory safety-enabling factors.

Methods

The descriptive cross-sectional survey was conducted in Nigeria among medical scientists from May 14 to May 28, 2020. The recruitment process was designed to capture participants from the six-geopolitical zones in Nigeria using the Snowball sampling method. One hundred and thirty-one medical scientists participated in the survey. To be eligible for recruitment, participants must be medical scientists practicing in Nigeria and must give written informed consent to participate in the survey. All the participants were assured of absolute respect, confidentiality and anonymity.

Survey Instrument
Internet-broadcasted structured questionnaire was developed for the survey. It was designed using Google forms and the link was sent to participants through WhatsApp. The prospective participants were encouraged to send out the link to other scientists and online platforms. The overall internal consistency of the questionnaire was measured using Cronbach’s Alpha to be 0.8. The questionnaire sought information on respondents’ socio-demographic, awareness of laboratory safety measures, personal efforts in creating a safe laboratory environment for testing and laboratory safety enabling factors. The demographics section had six items, the level of awareness of laboratory safety measures and the personal efforts in creating a safe testing environment sections had 10 items each, while the laboratory safety enabling factors section had 12 items. All responses were recorded on a six-point Likert scale. Strongly agree and agree responses were reported as agree while strongly disagree and disagree responses were reported as agree.

**Data Analysis**

The questionnaires were checked for completeness before analysis. The obtained data were entered and cleaned to ascertain accuracy as well as completeness. The 6-points Likert Scale questions were coded from 1 to 6. “Strongly disagreed” was coded as 1, “Disagree” was coded as 2 “Slightly Disagree” was coded as 3, “Slightly Agree” was coded as 4, “Agree” was coded as 5, and “Strongly Agree” was coded as 6. The maximum obtainable score for questions on the level of awareness of laboratory safety measures and personal efforts in creating a safe laboratory environment was 60 while that of laboratory safety enabling factors was 72. The scoring of the level of awareness of laboratory safety measures and personal efforts in creating a safe environment were determined based on the mean score. The overall mean score for the level of awareness was 49.7 (± 4.8) while that of personal efforts in creating a safe environment was 48.5 (± 5.9). The respondents’ scores below these mean scores were categorized as poor while scores above these mean scores were categorized as good.

Data analysis was done using IBM *SPSS Statistics version 25*. Descriptive statistics (frequency distribution, mean ± SD), inferential statistics which involved bivariate analysis (Chi-square ($\chi^2$) test and multivariate linear regression model were explored. The confidence level was set at 95% and the significant level at $p < 0.05$.

**Results**

One hundred and one participants were involved in this study. Eligible participants were medical scientists working in Nigeria. Respondents’ socio-demographic characteristics, awareness of laboratory safety measures, personal efforts in creating a safe laboratory testing environment, association between awareness of laboratory safety measures and demographics as well as the laboratory safety enabling factors were reported. In addition, the influence of awareness and years of experience on personal efforts of respondents to create a safe testing environment as well as the association between personal efforts to create a safe laboratory testing environment and laboratory safety enabling factors were reported.

**Socio-Demographic Characteristics of Subjects**

The modal age group of the respondents was between 20 and 29 years old (42.0%) while the mean age of the respondents was 32.5 ± 9.9 years. The majority of the respondents were males (64.1%), graduates (64.1%), Christians (81.7%), with years of work experience between 1 and 9 years (70.2%) and with the present level at work between levels 1 and 5 (61.1%) (Table 1).

**Awareness of Laboratory Safety Measures**
Most of the respondents strongly agreed that laboratory safety is important and essential to the success of any medical laboratory (98.5%) and access to appropriate Biological Safety Cabinets (BSCs) is critical in the containment of SARS-CoV-2 (87%) (Table 2). The overall mean awareness score was 49.7 (± 4.8) and the majority of respondents (60.3%) scored above the mean; therefore, they were classified as having a high awareness of laboratory safety measures (See Fig. 1 in SI). The awareness level of laboratory safety measures was significantly associated with the level of education ($\chi^2 = 6.143; p = 0.046$) of medical scientists (See Table 1 in SI). The awareness level of laboratory safety measures also had a significant influence on the personal efforts of the study participants in creating a safe laboratory testing environment (F-ratio = 7.529, $p = 0.007$) (See Table 2 in SI).

**Personal Efforts in Creating a Safe Laboratory-Testing Environment.**

Table 3 showed that most of the respondents had participated in laboratory safety (75.6%) and PPE training (64.2%) in the last 1 year. The majority (77.1%) of the study participants knew the emergency contact numbers to use during emergencies, as well as how and when to report accidents, incidents or near misses in the laboratory (91.6%). The results also demonstrated that almost all of the respondents always use personal protective equipment (PPE) (90.1%), regularly carry out adequate decontamination of bench surfaces (90.8%), clearly label all containers with their contents (97%) and often wash hands (97%) when working in the laboratory. Not less than 93.9% of respondents attested to always removing PPE before leaving the laboratory and refrained from eating, drinking, applying cosmetics and handling contact lenses in the laboratory. The overall mean personal effort score was 48.5 (± 5.9) (Supplementary Fig. 2) and most of the survey participants (63%) had good personal safety practices as they scored above the mean.
|                                 | Frequency (n = 131) | Percentage (100%) |
|---------------------------------|---------------------|-------------------|
| **Age (in grouped years): [32.5 ± 9.9 years]** |                      |                   |
| 20–29 years                     | 55                  | 42.0              |
| 30–39 years                     | 44                  | 33.6              |
| 40–49 years                     | 20                  | 15.3              |
| 50–59 years                     | 10                  | 7.6               |
| **Gender:**                     |                      |                   |
| Male                            | 84                  | 64.1              |
| Female                          | 47                  | 35.9              |
| **Religion:**                   |                      |                   |
| Christianity                    | 107                 | 81.7              |
| Islam                           | 23                  | 17.6              |
| Agnostic                        | 1                   | 0.8               |
| **Highest Education:**          |                      |                   |
| Graduate                        | 84                  | 64.1              |
| Post-graduate                   | 39                  | 29.8              |
| Fellowship                      | 8                   | 6.1               |
| **Years of experience (grouped): [7.5 ± 8.1 years]** |                      |                   |
| < 1 year                        | 92                  | 70.2              |
| 1–9 years                       | 16                  | 12.2              |
| 10–19 years                     | 12                  | 9.2               |
| 20–29 years                     | 4                   | 3.1               |
| 30–39 years                     |                      |                   |
| **Present post/Level at work:** |                      |                   |
| 1–5                             | 80                  | 61.1              |
| 6–10                            | 21                  | 16.0              |
| 11–15                           | 16                  | 12.2              |
| >15                             | 14                  | 10.7              |
| **Total**                       | 131                 | 100.0             |
| Awareness variables                                                                 | Strongly agree n (%) | Agree n (%) | Slightly agree n (%) | Slightly disagree n (%) | Disagree n (%) | Strongly disagree n (%) |
|------------------------------------------------------------------------------------|----------------------|-------------|----------------------|-------------------------|----------------|-------------------------|
| Laboratory safety is an important and essential component to the success of any medical laboratory | 118 (90.1)           | 11 (8.4)    | 2 (1.5)              | 0 (0.0)                 | 0 (0.0)        | 0 (0.0)                 |
| It is important to understand and follow instructions in the Laboratory Safety Manual | 118 (90.1)           | 13 (9.9)    | 0 (0.0)              | 0 (0.0)                 | 0 (0.0)        | 0 (0.0)                 |
| Laboratory safety practices are never impacted by biological, chemical, radiological, fire, and electrical hazards | 8 (6.1)              | 15 (11.5)   | 4 (3.1)              | 4 (3.1)                 | 47 (35.9)      | 53 (40.5)               |
| It is critical to have access to SOPs that document safety procedures              | 86 (65.6)            | 25 (19.1)   | 6 (4.6)              | 0 (0.0)                 | 9 (6.9)        | 5 (3.8)                 |
| Processes that emit vapors, gasses, or fumes should be adequately captured by local ventilation (hoods, snorkel) | 80 (61.1)            | 38 (29.0)   | 7 (5.3)              | 1 (0.8)                 | 3 (2.3)        | 2 (1.5)                 |
| It is important for laboratory equipment with potential hazards routinely inspected and maintained or serviced as recommended | 106 (80.9)           | 24 (18.3)   | 1 (0.8)              | 0 (0.0)                 | 0 (0.0)        | 0 (0.0)                 |
| It is important to have access to chemical/biological spill kits                  | 91 (69.5)            | 32 (24.4)   | 2 (1.5)              | 1 (0.8)                 | 3 (2.3)        | 2 (1.5)                 |
| It is important to have access to fully stocked first-aid kits                    | 113 (86.3)           | 14 (10.7)   | 1 (0.8)              | 0 (0.0)                 | 2 (1.5)        | 1 (0.8)                 |
| Good housekeeping practices are less essential in ensuring laboratory safety      | 16 (12.2)            | 14 (10.7)   | 8 (6.1)              | 8 (6.1)                 | 46 (35.1)      | 39 (29.8)               |
| Access to appropriate Biological Safety Cabinets (BSCs) is critical in the containment of SARS-CoV-2 | 87 (66.4)            | 27 (20.6)   | 12 (9.2)             | 1 (0.8)                 | 1 (0.8)        | 3 (2.3)                 |
| In the last 1 year, I have participated in laboratory safety training | Strongly agree n (%) | Agree n (%) | Slightly agree n (%) | Slightly disagree n (%) | Disagree n (%) | Strongly disagree n (%) |
|---|---|---|---|---|---|---|
| 50 (38.2) | 49 (37.4) | 13 (9.9) | 5 (3.8) | 8 (6.1) | 6 (4.6) |
| I know the emergency contact numbers to contact when an emergency occurs | 53 (40.5) | 48 (36.6) | 14 (10.7) | 0 (0.0) | 11 (8.4) | 5 (3.8) |
| I know how and when to report accidents, incidents or near-misses in the Laboratory | 57 (43.5) | 63 (48.1) | 7 (5.3) | 1 (0.8) | 1 (0.8) | 2 (1.5) |
| I clearly label all containers with their contents | 96 (73.3) | 31 (23.7) | 2 (1.5) | 1 (0.8) | 1 (0.8) | 0 (0.0) |
| I have completed PPE training within the last 1 year | 50 (38.2) | 34 (26.0) | 17 (13.0) | 6 (4.6) | 17 (13.0) | 7 (5.3) |
| I always use personal protective equipment (PPE) when working in the laboratory | 80 (61.1) | 38 (29.0) | 9 (6.9) | 0 (0.0) | 4 (3.1) | 0 (0.0) |
| I regularly carry out adequate decontamination of bench surfaces, all wastes and other materials in the laboratory | 86 (65.6) | 33 (25.2) | 7 (5.3) | 3 (2.3) | 2 (1.5) | 0 (0.0) |
| I eat, drink, apply cosmetics, and handle contact lenses in the laboratory | 1 (0.8) | 3 (2.3) | 1 (0.8) | 3 (2.3) | 29 (22.1) | 94 (71.8) |
| I wash my hands often – especially after handling infectious materials, before leaving the laboratory working areas, and before eating | 113 (86.3) | 14 (10.7) | 1 (0.8) | 0 (0.0) | 3 (2.3) | 0 (0.0) |
| I always remove my PPE before leaving the laboratory | 103 (78.6) | 20 (15.3) | 4 (3.1) | 1 (0.8) | 3 (2.3) | 0 (0.0) |

**Laboratory Safety Enabling Factors**

This study revealed that most respondents opined that safety enabling factors such as sufficiently trained medical scientists (58%), reviewed, updated protocols and working practice policies (74%), training and awareness plans, as well as Standard Operating Procedure (SOP) (74.1%) were available in their laboratories. The majority also confirmed that staff was informed of the risk associated with SARS-CoV-2 infection (80.9%), that the process for incident reporting and investigation existed (72.5%) and that sufficient space was available in the laboratories where they work (69.5%). More than half of the respondents agreed that adequate supplies of required disinfectants and other materials were ensured (67.2%), that procedures were in place to ensure materials can be transported safely to and from the laboratory (67.2%) and that good general security controls were in place including those required to address out of hours work times (63.3%).
However, just a few respondents could convincingly attest to the availability of adequate and appropriate PPE with proper utilization training (45.1%), adequate rest and other welfare packages (45.8%), as well as access to appropriate Biological Safety Cabinets (BSCs) and other essential equipment in their workplaces (48.8%). (Table 4).

Interestingly, a strong association existed between respondents’ personal effort in creating a safe laboratory testing environment and all the laboratory safety-enabling factors explored in this study (See Table 3 in SI).
Table 4
Laboratory Safety Enabling Factors

| Enabling Factor                                                                 | Strongly agree n (%) | Agree n (%) | Slightly agree n (%) | Slightly disagree n (%) | Disagree n (%) | Strongly disagree n (%) |
|--------------------------------------------------------------------------------|----------------------|-------------|----------------------|-------------------------|----------------|-------------------------|
| Sufficiently trained Medical scientists are available in my place of work       | 43 (32.8)            | 33 (25.2)   | 23 (17.6)            | 7 (5.3)                 | 15 (11.5)      | 10 (7.6)                |
| Reviewed, updated protocols and working practice policies are available and communicated (e.g. a safe work practices, decontamination) in my place of work | 49 (37.4)            | 48 (36.6)   | 21 (16.0)            | 4 (3.1)                 | 8 (6.1)        | 1 (0.8)                 |
| Training and awareness plans, as well as Standard Operating Procedure (SOP) compliance programs are in place for all staff | 55 (42.0)            | 42 (32.1)   | 16 (12.2)            | 8 (6.1)                 | 8 (6.1)        | 2 (1.5)                 |
| Adequate and appropriate PPEs are supplied (including disposable gloves, solid-front or wrap-around gowns, or coveralls with sleeves that fully cover the forearms, eye protection (goggles or face shield), and respiratory protection (US6NIOSH-certified N95 or equivalent, or higher protection), are available and staff are trained in their use | 36 (27.5)            | 23 (17.6)   | 31 (23.7)            | 7 (5.3)                 | 15 (11.5)      | 19 (14.5)                |
| Provisions for adequate rest and other welfare issues (e.g. workplace stress, concern for family members) are available in my place of work | 32 (24.4)            | 28 (21.4)   | 23 (17.6)            | 14 (10.7)               | 18 (13.7)      | 16 (12.2)                |
| All staff (i.e. scientific and support) are informed of the risk associated with SARS-CoV-2 infection, symptoms, reporting procedures and support from the organization/hospital in the event of illness | 65 (49.6)            | 41 (31.3)   | 14 (10.7)            | 5 (3.8)                 | 4 (3.1)        | 2 (1.5)                 |
| Process for incident reporting and investigation exists in my place of work      | 52 (39.7)            | 43 (32.8)   | 22 (16.8)            | 8 (6.1)                 | 6 (4.6)        | 0 (0.0)                 |
| Sufficient space, including storage of specimens and other materials (e.g. waste), is available in my place of work | 50 (38.2)            | 41 (31.3)   | 23 (17.6)            | 4 (3.1)                 | 9 (6.9)        | 4 (3.1)                 |
| Access to appropriate Biological Safety Cabinets (BSCs) and other essential equipment is ensured in my place of work | 37 (28.2)            | 27 (20.6)   | 31 (23.7)            | 11 (8.4)                | 18 (13.7)      | 7 (5.3)                 |
| Adequate supplies of required disinfectants and other materials are ensured at my place of work | 45 (34.4)            | 43 (32.8)   | 24 (18.3)            | 4 (3.1)                 | 13 (9.9)       | 2 (1.5)                 |
| Procedures are in place to ensure materials can be transported safely to and from the laboratory | 47 (35.9)            | 45 (34.4)   | 26 (19.8)            | 6 (4.6)                 | 6 (4.6)        | 1 (0.8)                 |
| Good general security controls are in place including those required to address out of hours work times | 37 (28.2)            | 46 (35.1)   | 25 (19.1)            | 10 (7.6)                | 6 (4.6)        | 7 (5.3)                 |
Discussion

Medical scientists are constantly at risk of exposure to infectious agents in the course of their work especially in the era of the COVID-19 pandemic where laboratory test results underscore efficient pandemic response. Laboratory safety requires an awareness of exposure risks, compliance to safe laboratory practices, adherence to standard operating procedures and use of containment equipment in the laboratory. Studies have shown that when laboratory staff are aware and adhere to the recommended safety precautions, the risk for laboratory-acquired infections becomes lower \[^6\].

However, awareness and biosafety are big issues in laboratory settings in developing countries as standard operating procedures (SOPs) are lacking and less efficient \[^7\].

With Nigeria coping with the challenges of the COVID-19 pandemic, ensuring a safe testing environment is the core of laboratory diagnosis and management of COVID-19 cases.

This study was designed to determine the awareness of laboratory safety measures, assess personal efforts of medical scientists in creating a safe environment for testing, and examine the laboratory safety-enabling factors.

Most of the study participants (60.3%) were found to possess high-level of awareness of laboratory safety measures and the level of awareness of laboratory safety measures was significantly associated with their level of education \(\chi^2 = 6.143; p = 0.046\). Respondents displayed in-depth awareness of the importance of laboratory safety practice; understanding and following instructions in the laboratory safety manual as well as standard operating procedures; local ventilation; proper maintenance of laboratory equipment, access to chemical/biological spill kits and fully stocked first-aid kits.

In addition, study participants had a good orientation about good housekeeping practices and the importance of access to appropriate Biological Safety Cabinets (BSCs) in the containment of SARS-CoV-2. These findings are incongruent with the results of the study conducted among laboratory staff of two public health facilities in Nigeria. According to this study, many respondents (41.5%) were found to be unaware of laboratory safety practices and 25.4% of respondents do not observe safety practice in the laboratory \[^8\]. The difference in the level of awareness in these two studies may be due to the increased laboratory safety education, training and campaigns especially in this era of the COVID-19 pandemic.

The study found that the majority of the respondents (63%) showed good personal effort in creating a safe laboratory testing environment by regularly participating in laboratory safety and PPE training, by prompt reporting of accidents, incidents or near-misses in the laboratory and adequate decontamination of bench surfaces, all generated wastes and other materials in the laboratory. Most of the respondents also carried out proper labeling of containers with their contents and regular hand washing. Most respondents attested to regular use of personal protective equipment (PPE) when working in the laboratory and not eating, drinking, applying cosmetics or handling contact lenses in the laboratory. These personal efforts from medical scientists reinforce a safe environment in the laboratory, which enhances the provision of quality, efficient and effective laboratory services which are essential in productive COVID-19 pandemic response. The study conducted among personnel who worked in various laboratories and hospitals in Denizli, Turkey yielded similar results where study participants displayed good personal efforts in enhancing optimum laboratory safety \[^9\].
It was also revealed in this study, that safety awareness has a positive impact on safety practice as awareness of laboratory safety measures had a significant influence on personal efforts of medical scientists in creating a safe laboratory-testing environment. This is in agreement with the result of a study in Pakistan in which the participating healthcare workers showed good knowledge/awareness of COVID-19 disease and displayed good safety practices [10].

Even though most of the medical scientists in this study demonstrated good personal efforts in creating a safe laboratory-testing environment, there were, however, inadequate supply of appropriate PPEs as well as poor training in their use, inadequate provisions for rest and other welfare packages, poor access to appropriate Biological Safety Cabinets (BSCs) and other essential equipment. This discovery is an aberration to the recommended WHO laboratory biosafety standard and may jeopardize the safety of medical scientists, reduce the chance of obtaining timely, accurate and reliable laboratory results which are important for effective and efficient COVID-19 pandemic responses such as diagnosing, managing, determining treatment and prognostic outcomes, as well as the overall patient safety. This is consistent with previous findings in some research facilities in Nigeria in which study participants attested to poor availability of PPE and no access to biosafety level (BSL)-1–4 facilities [11].

Interestingly, a strong association existed between the personal efforts of respondents in creating a safe laboratory testing environment and laboratory safety enabling factors. This further substantiates the importance of availability and accessibility of safety equipment, tools, supplies and materials in the laboratory.

**Conclusion**

The respondents displayed a high level of awareness of safety standards and great personal efforts in creating a safe laboratory-testing environment by observing safety protocols. However, it was evident that there was poor availability of safety facilities, equipment, support and welfare packages required to enhance the safety of these medical scientists as they play their roles as part of front line workers in the battle against the deadly COVID-19 disease. The safety of medical scientists should constitute a major concern as the pressure to increase COVID-19 testing with short turnaround times increases. In order not to compromise the safety of medical scientists and the efficiency of laboratory test results, we advocate for the provision of biosafety devices, PPEs in medical laboratories across Nigeria and zeal boosting welfare and support packages especially in this critical time in the world's history. Adequate training in the use of PPEs, in laboratory biosafety practices and maintenance of biosafety equipment, should be prioritized.

Lastly, policies on safety practices should be reinforced and enforced.

However, it is important to note that the participants’ responses may be liable to recall bias as responses were given online and were largely dependent on the honest report of the real-life experiences. Also due to the limited number of study participants and the potential for sample clustering, it may be difficult to generalize the study findings. Therefore, more studies with multi-dimensional measures and expanded inclusion such as focus groups, in-depth interviews with the inclusion of medical scientists who are located in rural areas with limited internet access, are warranted.

**Abbreviations**

WHO - World Health Organization
Declarations

Ethics Approval and Consent to Participate

We carried out this study following the Declaration of Helsinki. Universities were closed due to lockdown, so the Primary Healthcare Department, Ife-East Local Government, Ile-Ife, Nigeria ruled that no formal ethics approval was required in this particular case. The study participants gave written informed consent to participate in the survey and we gave an assurance of absolute respect, confidentiality and anonymity to the study participants.

Consent for Publication

The study participants gave informed consent to publish their responses.

Availability of Data and Materials

The datasets supporting the conclusions of this article are included in the article.

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Competing Interests

The authors declare that they have no financial and non-financial competing interests.

Authors’ Contributions

TTLA conceived, designed, monitored data collection, and drafted the manuscript. OIA monitored data analysis and reviewed the draft. Both authors approved the final version of the manuscript.

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