Assessing Biosafety Knowledge Among Research Laboratory Personnel in the Bobo Dioulasso Province of Burkina Faso

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Abstract

Biosafety is a crucial aspect of risk prevention and quality management systems in laboratory practice. The study aimed to assess the knowledge of the research institutes' personnel regarding biosafety measures in their respective laboratories. A cross-sectional survey was conducted between April and June 2022 among research institute laboratory personnel in the Bobo Dioulasso province. Data were collected with a self-administered questionnaire. Data analysis was performed with Stata version 14.1 and presented using frequency tables.

Sixty-three participants completed the study questionnaire. Overall, 93.6% of the participants had a low to medium level of knowledge. 63.5% declared to have attended a biosafety training course. The level of knowledge in biosafety increased significantly with age (χ^2=10.706; p=0.03) and level of education (χ^2=15.303; p=0.004) and did not differ by professional status. Overall knowledge was low for pictograms (61.9%), laboratory safety levels (57.1%), risk groups of biological agents (55.6%) and high for waste segregation (100%) and management of spillage of a biological sample on the floor (73.0%). The study data reveal a lack of knowledge of some aspects of biosafety among laboratory personnel. There is a need for research institutes to implement a biosafety policy and to strengthen biosafety training programs for their laboratory personnel.

Keywords: Biosafety, Knowledge, laboratory personal, Bobo Dioulasso, Burkina Faso.

Titre : Evaluation des Connaissances en Biosécurité du Personnel des Laboratoires de Recherche dans la Province de Bobo Dioulasso du Burkina Faso

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Résumé

La biosécurité est un élément important des systèmes de gestion de la qualité dans la pratique des laboratoires. L'étude visait à évaluer les connaissances du personnel de laboratoires des instituts de recherche et universités vis-à-vis des mesures de biosécurité dans leurs laboratoires respectifs. Une étude transversale a été menée auprès du personnel de laboratoire des instituts de recherche et universités entre avril et juin 2022. Les données ont été recueillies à l'aide d'un questionnaire auto-administré. L'analyse des données a été effectuée avec Stata version 14.1 et présentée à l'aide de tableaux de fréquence. Soixante-trois (63) participants ont rempli le questionnaire de l'étude. Dans l'ensemble, 93,65% des participants avaient un niveau de connaissance faible à moyen. 63,49% ont affirmé avoir déjà participé à un cours de formation de biosécurité. Le niveau de connaissance augmente de façon significative avec l'âge (χ^2=10.706 ; p=0,03) et le niveau d'étude (χ^2=15.303 ; p=0,004) et ne diffère pas selon le statut professionnel. Les connaissances étaient globalement faibles pour les pictogrammes (61,90%), les niveaux de sécurité des laboratoires (57,14%), les groupes de risque des agents biologiques (55,56%) et élevées pour la séparation des déchets (100%) et la gestion du déversement d'un échantillon biologique sur le sol (73,02%).
L'étude révèle une connaissance insuffisante de la biosécurité parmi le personnel de laboratoire, soulignant la nécessité pour les instituts de recherche de mettre en place une politique de biosécurité et de renforcer les programmes de formation en biosécurité de leur personnel.

Mots clés : Biosécurité, connaissance, personnel de laboratoires, Bobo-Dioulasso, Burkina Faso.

Introduction

Biosafety is integral to maintaining high standards in laboratory quality management. It is an important tool for measuring compliance with accreditation and certification standards. Knowledge and application of biosafety principles ensures that procedures are properly managed and regulated at all levels of laboratory management and potential infectious pathogens are handled with only minimum risk to laboratory personnel. In recent years, research on infectious pathogens has increased due to the emergence and re-emergence of new infectious agents and diseases (CARON et *al*., 2022). In addition, to compensate for the limitations related to the resistance developed by parasites and mosquitoes, many approaches use microorganisms (conventional or genetically modified) in laboratories in the control of diseases (BILGO et *al*., 2018; GNAMBANI et *al*., 2020). Research laboratories represent one of the most exposed sectors to infectious risks (MINISTERE DE LA SANTE ET DE L'HYGIENE PUBLIQUE, 2022). Technicians who work with various species of microorganisms (bacteria, viruses, parasites and fungi) are at high risk of infection if proper protective measures are not implemented. In addition, they may be exposed to chemical and physical hazards. Standard precautions like wearing personal protective equipment (laboratory gowns, gloves, safety glasses and visor), hand washing are strongly recommended in the laboratories. Laboratory-acquired infections (LAI) are common worldwide and many cases are reported (SEWELL, 2000; JAOUHARI, 2022). A review of reported cases attests to the diversity of incriminated biological agents and the preeminence of LAI in research laboratories (SEWELL, 2000). Between 2016 and 2021, nine cases of infection were reported in Canada (JAOUHARI, 2022).

Hence, biosafety measures in laboratories become a crucial issue that must be tracked. The knowledge of these measures by the personnel becomes paramount. A thorough knowledge of these measures promotes their proper implementation and leads to an improvement in the prevention of occupational risks of pathogen transmission. Few studies have focused on laboratory biosafety in Africa (ELDUMA, 2012; ASHUR et *al*., 2017; ODETOKUN et *al*., 2017) and these studies have reported a low level of knowledge and practice of biosafety measures among laboratory personnel (SHOBOWALE et *al*., 2015; BAJJOU et *al*., 2019). In Burkina Faso, to our knowledge, few studies to date have evaluated the knowledge and practices of biosafety measures in Research Laboratories. The aim of this study was therefore to assess the level of knowledge of biosafety measures among research laboratory personnel in Burkina Faso.

I. Methods

I.1. Study population

A cross-sectional study was conducted to assess biosafety knowledge and practices among laboratory personnel in main research centers in Bobo-Dioulasso province in Burkina Faso. The target group of this study included laboratory technicians (permanent personnel and trainees). The survey was conducted from April to June 2022. The institutes involved in this survey were CIRDES (Centre International de Recherche-Developpement sur l'Élevage en zone Subhumide), l'INSTech (Institut des Sciences et Techniques), l'IRSS (Institut de Recherche en Sciences de la Santé) and UNB (Université Nazi BONI).

I.2. Data collection tools and procedures

A structured, self-administered questionnaire was used to collect data. Information sought included socio-demographic characteristics such as age, gender, education level, laboratory experience, specialty, biosafety training. The study examined knowledge of laboratory pictogram warning signs, classification of pathogens into risk groups and biosafety levels, waste management, personal protective equipment. The questionnaire was developed based on previous studies (SHOBOWALE et *al*., 2015; BAJJOU et *al*., 2019; ABU-SINIYEH & AL-SHEHRI, 2021; FONDATION MERIEUX, 2022;) and standard biosafety texts (GOUVERNEMENT DU CANADA, 2016). The questionnaire was approved by two researchers from the Institute of Research in Health Sciences (IRSS) and pre-tested on biosafety master students from Nazi Boni University.

The objectives of the study were explained before the questionnaires were distributed, and participants were informed that they could voluntarily withdraw from the study at any time. The questionnaires were completed under the supervision of the investigators and returned to them after completion. Participants were instructed to complete the questionnaires without consulting another person or referring to the literature.

The study was approved by the institutional ethics committee of the Institute of Research in Health Sciences (Supplementary file 1). Before data collection, a request was sent to the head of each research institute for approval to conduct the study in their department (Supplementary file 2,3). Written informed consent was obtained from each participant.

I.3. Data management and analysis

Returned questionnaires were checked for inconsistency. The collected data were entered into Epi data version 3.1 for cross-checking and exported to Stata version 14.1 for analysis. Descriptive statistics were used to describe the data. The Chi2 test was used to measure the correlation between demographic variables and biosafety knowledge of research laboratory personnel. A p-value < 0.05 was considered as the cut off for statistical significance.

A numerical scoring system was developed to assess participants' general knowledge. Since most of the questions were multiple choice or checkbox type questions, the answers were first transformed into correct or incorrect. For example, the response to the question regarding pictogram identification was "1" if the participant wrote the appropriate letter and "0" if he indicated another letter or checked the box "I don't know what this symbol represents". To the question "Biological agents are classified into risk groups. This classification is based on...:", the proposed answers were "duration of illness caused by the biological agent", "infectious dose", "clinical signs of infection", "availability of effective treatments", "mode of transmission". Each right answer was scored "1" and each wrong answer was scored "-1". The score for the question was the sum of the points.

Participants received an overall score ranging from 0 to 30 points. The highest score was given to the participants who accumulated the most correct answers. The levels knowledge were categorized based Bloom's cutoff (AKALU et *al*., 2020; ALZAHRANI et *al*., 2021), as follows:

- Good if the score was between 80 and 100%,
- Moderate if the score was between 60 and 79%,
- Poor if the score was below 60%.

II. Results

In total, 63 laboratory technicians were included in this study. Most of the participants were from the public sector (57.1%) and were male (63.5%). The majority of participants (54.0%) were aged under 30 years old, and 36.5% had a master's level of education or higher. The data reveal that most of participants (63.5%) had received biosafety training. Global knowledge score was ranged from 5 to 27 points. These scores were normally distributed with a mean of 15.9 ± 6.9.

Overall, a majority of participants (61.9%) had low knowledge score of biosafety measures, those with good knowledge levels were predominantly in the public sector (11.1%) compared to participants in the private sector (0%). The analysis showed a statistically significant difference between participants with master level and participants with less level education ($P<0.05$). Globally, participants present a low knowledge level even with those have been performing biosafety training. Table III shows the levels of knowledge according to characteristics of participants. The levels of knowledge increased significantly with age ($\chi^2=10.706$; $P=0.03$) and education ($\chi^2=15.303$; $P=0.004$) and did not differ with experience or institute status (public or private).

Table I: Sociodemographic parameters

Characteristics	No. (%)
Sector	
Public	36 (57.1%)
Private	27 (42.9%)
Age (year)	
21 - 25	17 (27.0%)
26 - 29	12 (19.0%)
≥ 30	34 (54.0%)
Sexe	
Male	40 (63.5%)
Female	23 (36.5%)
Education	
GCE- A levels	16 (25.4%)
Bachelor	24 (38.1%)
Master and more	23 (36.5%)
Experience (year)	
Less than 1	12 (19.0%)
1 – 5	27 (42.9%)
5 – 10	12 (19.0%)
10 and more	12 (19.0%)
Professional status	
Trainee	34 (54.0%)
Officer	29 (46.0%)
Biosafety training	
Yes	40 (63.5%)
No	23 (36.5%)

Table II: Level knowledge of biosafety measures by public or private sector

Sector	Low No. (%)	Moderate No. (%)	Good No. (%)	χ^2; P
Public	20 (55.6)	12 (33.3)	4 (11.1)	3.614; 0.164
Private	19 (70.4)	8 (29.6)	0	
Total	39 (61.9)	20 (31.8)	4 (6.4)	

Regarding pictogram knowledge, the data show that the majority of participants (61.9%) had a low level of knowledge. Participants with a good level of pictogram knowledge represented 19.1% of the sample. Furthermore, participants from the public sector exhibited better pictogram knowledge compared to those from the private sector.

Determining required containment level and risks mitigating related to pathogen microorganism handling is an important point to prevent accidental transmission of pathogens. Most of participants showed a low level of knowledge to the question related to criteria of the classification for biological agents (58.3%). However, less than half of the participants (42.8%) did not answer correctly the question related to categories number of laboratory according to containment levels.

In total, 55.6% of participants from the public sector and 47.6% from the private sector demonstrated a moderate to good level of knowledge regarding the criteria for choosing and using a biological safety cabinet (BSC). When asked about handling risk group 2 biological agents in a BSC, the majority of participants (63.6%) provided an incorrect answer. However, 58.7% answered correctly regarding the performance of manipulations in a BSC within a level 2 laboratory. As for wearing personal protective equipment (PPE) while working with biological samples, 52.4% of participants answered correctly.

All participants correctly answered the question about to biological waste and household waste separation. Also, 88.9% of participants answered correctly the question concerning inactivating biological waste before disposal.

The majority of participants also correctly answered questions about what to do if an acid (or base) comes into contact with the eyes (91.7%) and how to handle spills of a biological sample on the bench (or floor) (72.2%). However, the half of participants had a poor level of knowledge of hands washing appropriate period when working in laboratory.

Table III: Level of knowledge and significant difference between participants' characteristics

Variables	Low No. (%)	Moderate No. (%)	Good No. (%)	χ^2; P
Gender				
Male	24 (60.0)	13 (32.5)	3 (7.5)	0.312;
Female	15 (65.2)	07 (30.4)	1 (4.4)	0.855
Sector				
Public	20 (55.6)	12 (33.3)	4 (11.1)	3.614;
Private	19 (70.4)	08 (29.6)	0	0.164
Age (year)				
21 - 25	12 (70.6)	5 (29.4)	0	
26 - 29	4 (33.3)	5 (41.7)	3 (25.0)	10.706; 0.030
≥ 30	23 (67.7)	10 (29.4)	1 (2.9)	
Education				
GCE- A levels	15 (93.8)	1 (6.3)	0	
Bachelor	14 (58.3)	10 (41.7)	0	15.304; 0.004
Master	10 (43.5)	9 (39.1)	4 (17.4)	
Experience (year)				
Les then 1	07 (58.3)	04 (33.3)	1 (8.3)	
[1 – 5[	15 (55.6)	10 (37.0)	2 (7,4)	2.127; 0.908
[5 - 10[	09 (75.0)	03 (25.0)	0	
10 and more	08 (66.7)	03 (25.0)	1 (8.3)	
Professional status				
Trainee	20 (58.8)	11 (32.4)	3 (8.8)	0.834;
Officer	19 (65.5)	9 (31.0)	1 (1.5)	0.659
Biosafety training				
Yes	22 (55.0)	16 (40.0)	2 (5.0)	3.509;
No	17 (73.9)	4 (17.4)	2 (8.7)	0.173

Table IV: Knowlegde levels toward laboratory pictograms

Variables	Chemical signs				Biohazards signs				All pictograms			
	Low No. (%)	Moderate No. (%)	Good No. (%)	χ^2; P	Low No. (%)	Moderate No. (%)	Good No. (%)	χ^2; P	Low No. (%)	Moderate No. (%)	Good No. (%)	χ^2; P
Sector												
Public	13 (36.1)	12 (33.3)	11 (30.6)		30 (83.3)	0	6 (16.7)		18 (50.0)	11 (30.6)	7 (19.4)	
Private	19 (70.4)	5 (18.5)	3 (11.1)	7.445; 0.024	23 (85.2)	1 (3.70)	3 (11.1)	1.673; 0.433	21 (77.8)	1 (3.7)	5 (18.5)	7.770; 0.021
Total	32 (50.8)	17 (27.0)	14 (22.2)		53 (84.1)	1 (1.6)	9 (14.3)		39 (61.9)	12 (19.1)	12 (19.1)	
Gender												
Male	17 (42.5)	14 (35.0)	9 (22.5)		31 (77.5)	0	1 (4.4)		22 (55.0)	8 (20.0)	10 (25.0)	
Female	15 (65.2)	3 (13.0)	5 (21.7)	4.097; 0.129	22 (95.6)	1 (1.5)	8 (20.0)	3.651; 0.161	17 (73.9)	4 (17.4)	2 (8.7)	2.934; 0.231
Total	32 (50.8)	17 (27.0)	14 (22.2)		53 (84.1)	1 (1.6)	9 (14.3)		39 (61.9)	12 (19.1)	12 (19.1)	
Age (year)												
21-25	12 (70.6)	2 (11.8)	3 (17.6)		16 (94.1)	0	1 (5.9)		14 (82.4)	1 (5.9)	2 (11.8)	
26-29	5 (41.7)	3 (25.0)	4 (33.3)	5.021;	8 (66.7)	0	4 (33.3)	5.534;	5 (41.7)	3 (25.0)	4 (33.3)	5.917;
≥ 30	15 (44.1)	12 (35.3)	7 (20.6)	0.285	29 (85.3)	1 (2.9)	4 (11.8)	0.237	20 (58.8)	8 (23.5)	6 (17.7)	0.205
Total	32 (50.8)	17 (27.0)	14 (14.2)		53 (84.1)	1 (1.6)	9 (14.3)		39 (61.9)	12 (19.1)	12 (19.1)	
Education level												
GCE- A levels	9 (56.3)	5 (31.3)	2 (12.5)		16 (100)	0	0		11 (68.8)	5 (31.3)	0	
BSc	14 (58.3)	4 (16.7)	6 (25.0)	3.470;	21 (87.5)	1 (4.2)	2 (8.3)	9.796;	16 (66.7)	3 (12.5)	5 (20.8)	7.038;
Master	9 (39.1)	8 (34.8)	6 (26.1)	0.482	16 (69.6)	0	7 (30.4)	0.044	12 (52.2)	4 (17.4)	7 (30.4)	0.134
Total	32 (50.8)	17 (27.0)	14 (22.2)		53 84.1)	1 (1.6)	9 (14.3)		39 (61.9)	12 (19.1)	12 (19.1)	
Experience												
Less than 1	8 (66.7)	2 (16.7)	2 (16.7)		10 (83.3)	0	2 (16.7)		8 (66.7)	2 (16.7)	2 (16.7)	
1-5	13 (48.2)	9 (33.3)	5 (18.5)	7.224;	22 (81.5)	0	5 (18.5)	5.337;	18 (66.7)	3 (11.1)	6 (22.2)	7.370;
5-10	8 (66.7)	1 (8.3)	3 (25.0)	0.301	11 (91.7)	0	1 (8.3)	0.501	9 (75.0)	2 (16.7)	1 (8.3)	0.288
More than 10	3 (25.0)	5 (41.7)	4 (25.0)		10 (83.3)	1 (8.3)	1 (8.3)		4 (33.3)	5 (41.7)	3 (25.0)	
Total	32 (50.8)	17 (27.0)	14 (22.2)		53 (84.1)	1 (1.6)	9 (14.3)		39 (61.9)	12 (19.1)	12 (19.1)	
Biosafety training												
Yes												
No	13 (56.5)	5 (21.7)	5 (21.7)	0.607;	32 (80.0)	0	7 (17.5)	1.589;	24 (60.0)	5 (12.5)	11 (27.5)	6.640;
Total	19 (47.5)	12 (30.0)	9 (22.5)	0.738	21 (91.3)	1 (2.5)	2 (8.70)	0.452	15 (65.2)	7 (30.4)	1 (1.4)	0.036
	32 (50.8)	17 (27.0)	14 (22.2)		53 (84.1)	1 (1.6)	9 (14.3)		39 (61.9)	12 (19.1)	12 (19.1)	

Table V: Specific knowledge of biological safety equipment and waste management

	Level of knowledge				
	Sector	**Low Incorrect response**	**Moderate Intermediate response**	**Good Correct response**	**χ^2; P**
Laboratories are classified into containment levels. How many containment levels are there?	Global Public Private	36 (57.1%) 20 (55.6%) 16 (59.3%)	-	27 (42.9%) 16 (44.4%) 11 (40.7%)	0.086; 0.769
Risk group 2 biological agents are handled in a biological safety cabinet (BSC) of class …	Global Public Private	40 (63.5%) 23 (63.9%) 17 (63.0%)	-	23 (36.5%) 13 (36.1%) 10 (37.0%	0.006; 0.940
In a BSL-2 laboratory, all manipulations must be performed in a biological safety cabinet (BSC)	Global Public Private	26 (41.3%) 12 (33.3%) 14 (51.9%)	-	37 (58.7%) 24 (66.7%) 13 (48.2%)	2.183; 0.140
PPE such as "gowns, gloves, glasses" are only required when working with biological agents in laboratory	Global Public Private	30 (47.6%) 16 (44.4) 14 (51.9%)	-	33 (52.4%) 20 (55.6%) 13 (48.2%)	0.339; 0.560
Hazard biological waste must be separated from household waste	Global Public Private	0 0 0	-	62 (100%) 36 (100%) 27 (100%)	
Biological waste must be inactivated with bleach or other disinfectant before disposal	Global Public Private	07 (11.1%) 03 (8.3%) 04 (14.8%)	-	57 (88.9%) 33 (91.7%) 23 (85.2%)	0.656; 0.418
At what moment, should you wash your hands when working in the laboratory	Global Public Private	32 (50.8%) 22 (61.1%) 10 (37.0%)	27 (42.9%) 12 (33.3%) 15 (55.6%)	04 (6.4%) 02 (5.6%) 02 (7.4%)	3.622; 0.164
Biological agents are classified into risk group. This classification in based on …	Global Public Private	37 (58.7%) 20 (55.6%) 17 (63.0%)	20 (31.8%) 12 (33.3%) 08 (29.6%)	06 (9.5%) 04 (11.1%) 02 (7.4%)	0.433; 0.805
There are several classes of biological safety cabinets (BSC). The choice and use of a BSC depend on …	Global Public Private	33 (52.4%) 21 (58,3%) 12 (44.4%)	18 (28.6%) 08 (22.2%) 10 (37.0%)	12 (19.1%) 07 (19.4%) 05 (18.5%)	1.760; 0.415
When an acid (or base) comes in contact with your eyes, what think should you do first?	Global Public Private	08 (12.7%) 03 (8.3%) 05 (18.5%)	-	55 (87.3%) 33 (91.7%) 22 (81.5%)	1.444; 0.230
What should you do when a biological sample is spilled on the bench or the floor	Global Public Private	17 (27.0%) 10 (27.8%) 07 (25.9%)	-	46 (73.0%) 26 (72.2%) 20 (74.1%)	0.027; 0.870

III. Discussion

Biosafety is the set of principles and practices implemented to prevent unintentional exposure to infectious substances and toxins or their accidental release. The success of a laboratory biosafety program depends on several considerations. Laboratory personnel play a key role in the implementation of a biosafety program. Preventing the risks associated microorganisms handling requires laboratory personnel participation with a good knowledge of biosafety measures. The level of knowledge among laboratory personnel was not satisfactory: 61.9% of participants had a poor level of knowledge and only 6.4% of participants had a good level of knowledge. In a study conducted in Lybia, ASHUR et *al.* (2017) reported that the level of knowledge in biosafety was poor among laboratory workers. A similar result was observed in Ethiopia by Yazié (YAZIE et *al.*, 2019). In our study, we noticed that the level of knowledge was low among young participants (P=0.03) whereas it improved with the level of education of the participant (P=0.004). This situation could be explained that oldest participants are the most certified, and they have acquired more knowledges during their academic training and laboratory practice.

The difference in levels of knowledge between participants of public and private sectors was not significant. In both cases, most of the participants showed a low level of biosafety knowledge (55.6% in public sector vs 70.4% in private one). Our results are consistent with previous studies conducted in Yemen, where the knowledge level did not differ in public and private sector (AL-ABHAR et *al.*, 2017). Diverse chemicals and biohazard pictograms were included in the questionnaire for identification by participants in order to assess their familiarity with signage. Data showed that participants had a low level of chemical and biohazard signage knowledge. Up to 80% of the participants had low to moderate levels signage knowledge. Ignorance of the pictograms can lead to incidents or accidents in laboratories. Previous studies have demonstrated a positive correlation between the lack of knowledge signage and the occurrence of laboratory accidents (OMIDVARI et *al.*, 2015; HILL, 2016). Participants who have received a biosafety training had a higher signage knowledge than those without training (P=0.036), which indicated the need for appropriate training of laboratory personnel.

Participants knowledge of containment principles, containment equipments, biosafety levels, pathogens and their classification by risk group was low. This observation was noticed in both public sector and private sector. Good biosafety practice requires the understanding of the risk group of pathogens, the knowledge of hazards associated to their handling and biosafety equipments and its operation (OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION, 2011). For most of participants who have already received a biosafety training, the low level of knowledge could have resulted from inadequate training or a poor ownership of training objectives by participants. Laboratory personnel is the first line of defense for protecting themselves and others from exposure to hazardous agents. Protection depends on the conscientious and competent use of good microbiological and chemical practices and the proper use of safety equipment. Inadequate knowledge of such equipment is a serious problem, as it can compromise all laboratory protective measures and increase the risk of exposure to pathogens. Improving biosafety knowledge in laboratory is essential for safe practices and personnel well-being. Indeed, the skills of workers must be evaluated regularly and refresher courses must be organized for them (MINISTERE DE LA SANTE ET DE L'HYGIENE PUBLIQUE, 2022). A good waste management minimizes the risks to workers in the laboratory and reduces the risk of releasing hazardous material into the environment. Most of participants in our study had correctly answered questions related to waste management; 73.0% to 100% demonstrated a good level of knowledge of this topic.

Conclusion

This study was conducted to assess biosafety knowledge among research laboratory personnel. Biosafety knowledge among public and private research laboratory personnel were low. Several gaps need to be filled, such as the lack pictograms knowledge, pathogens group risks and required biosafety levels in different situations. It is essential to strengthen biosafety training programs to ensure that the application of knowledge becomes not only a necessity but also a daily safety culture embraced by laboratory personnel.

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Author contributions

Conceptualization, A.S., E.M.D.B., R.W.S., M.G.B., A.G.O. and A.D.; Methodology, A.S., E.M.D.B., and R.W.S.; Data collection, A.S. and R.W.S.; data curation, A.S., E.M.D.B., and R.W.S; writing-original draft preparation, A.S. and E.M.D.B., Funding acquisition, E.M.D.B. All authors have read and agreed to the published version of the manuscript.

Competing interests

The authors declare that they have no competing interests

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