

Evaluation of Biosafety Protocols in Clinical Laboratories in Derna, Libya

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Abstract

Medical laboratory staff in clinical laboratories face occupational hazards, and without proper protective standards, their health and safety may be at risk. This study evaluated clinical laboratory staff's understanding of and adherence to biosafety protocols in Derna, Libya. Both the public and private sectors were used to hire clinical laboratory staff. To accomplish the study's goal, a standardised self-administered questionnaire was employed. The survey involved 55 workers, of whom 78.2% were female, and 21.8% were male. About 74.5% of the workers had prior knowledge of biosafety, but 49.1% of the workers were not trained in laboratory safety. 47.3% used to eat and drink in the lab, 74.5% used protective lab coats, and the majority (74.5%) complied with medical waste disposal regulations. A small number of staff members have received training, but most laboratories in Derna adhere to safety procedures.

Keywords. Biosafety; Clinical Laboratories; Survey; Training.

Introduction

Medical laboratories are vital parts of contemporary healthcare systems, offering critical services for public health response, illness surveillance, treatment monitoring, and diagnosis. However, because biological agents that may contain infectious pathogens are frequently handled and manipulated, these facilities also pose inherent dangers to patients, laboratory staff, and the general public. Therefore, limiting laboratory-acquired illnesses (LAIs), unintentional exposures, and the discharge of biological hazards requires effective biosafety practices. The World Health Organisation (WHO) defines biosafety as "the containment principles, technologies, and practices that are implemented to prevent unintentional exposure to biological agents or their accidental release" [1]. The cornerstone of modern laboratory biosafety practice is the WHO Laboratory Biosafety Manual (4th Edition), which outlines risk-based approaches to containment, risk assessment, engineering controls, and administrative procedures customised to the type of biological work performed [1].

Numerous studies from both developed and developing nations show ongoing discrepancies between official biosafety guidelines and actual practice in clinical laboratories, despite the availability of globally recognised standards. For instance, laboratory-acquired infections continue to be a global concern, highlighting the fact that biosafety protocol compliance is far from universal and frequently impacted by differences in administrative control, infrastructure, training, and adherence to safety culture [6]. These disparities are further shown by empirical data from regional research. A cross-sectional survey of clinical laboratory workers in Al-Madinah City, Saudi Arabia, revealed that while over two-thirds reported receiving formal safety training and the majority followed basic safety precautions like using personal protective equipment (PPE) and disposing of waste, unsafe behaviours like eating, drinking, and using mobile phones in lab areas were still commonly seen [9]. While general awareness of biosafety concepts was high, only a small percentage of laboratory staff in Morocco had received formal biosafety training, indicating that knowledge did not always translate into safe practices. This study was conducted in neighbouring North Africa [7].

The availability of standard operating procedures (SOPs), proper waste segregation and disposal, incident recording systems, biosafety cabinets, and staff training programs were all found to be seriously lacking in an evaluation of clinical laboratory biosafety and biosecurity conditions in Tripoli, Libya. There were systematic gaps in rules, compliance, and organisational commitment, as evidenced by the fact that many participating laboratories lacked necessary infrastructure or frequently failed to execute fundamental biosafety procedures [8]. These results demonstrate the intricate interactions between institutional rules, training programs, resource distribution, and laboratory culture that influence the implementation of biosafety. Additionally, they highlight the necessity of context-specific evaluations and interventions, especially in resource-constrained environments like Derna City, Libya, where there is still a dearth of research. Despite the vital role clinical laboratories play in the provision of local healthcare, there hasn't yet been a thorough published evaluation of the biosafety procedures in these establishments in Derna City. In order to find gaps, guide focused actions, and improve laboratory safety culture, a thorough assessment of biosafety knowledge, procedures, and infrastructure is desperately needed.

Methodology

Study design

A cross-sectional study was carried out online using Google Forms to collect data from public and private laboratories in Derna city, Libya. The online cross-sectional study followed the Internet E Survey Results Reporting Checklist [10]. The study's reporting conformed to the guidelines for improving the reporting of observational studies in epidemiology [11].

Data Collection and the Study Questionnaire

Data were collected between November 26 and December 1, 2025. The survey was sent by social media to groups specific to medical laboratories. A total of 55 workers were collected from both public and private medical laboratories to accomplish this goal.

The questionnaire was created using previously published research. There were 20 questions on the survey, each with a possible response. There were four sections to the questionnaire. Demographic factors, including age, gender, occupation, educational background, specialisation, field of work, years of experience, and role, were covered in the first section. In the second section, general questions about Participants' knowledge of biosafety laboratories. The behaviours of participants that were connected to laboratory safety were covered in the third section. The final section discussed how employees felt about biosafety.

Statistical Analysis

The SPSS program (version 17, USA) was used to display demographic and categorical information in frequency tables. A p-value of less than 0.05 was regarded as significant.

Result

The study assessed the medical laboratory staff in Derna City's understanding of lab safety procedures. (Table 1) shows the General information about the participants. To provide context for these findings, the majority of participants (78.2%) were female, and over half (58.2%) fell within the 25–34 age range. Furthermore, 85.5% of those surveyed had a bachelor's degree in medical laboratory sciences, and 9.1% had a master's degree. Additionally, 49.1% had one to five years of experience, and 78.2% of them work in the public sector.

Table 1. General information about the participants

Variable	Category	Number of subjects (percentage)
Gender	Female	43 (78.2)
	Male	12 (21.8)
Age	<25	10 (18.2)
	25-34	32 (58.2)
	35-44	10 (18.2)
	>45	3 (5.5)
Academic degree	Diploma	3 (5.5)
	BSc	47 (85.5)
	Master	5 (9.1)
Years of experience	<1	9 (16.4)
	1-5	27 (49.1)
	>5	19 (34.5)
Place of work	Public sector	43 (78.2)
	Private sector	12 (21.8)

(Table 2) shows Participants' knowledge of biosafety. In total, 41 respondents (74.5%) said they had previously learned about biosafety, and 4 (7.3%) said they didn't. Six respondents (10.9%) did not grasp biological hazard symbols, while 36 respondents (65.5%) confirmed understanding these symbols. Twenty-seven respondents (49.1%) reported no training, and just 18 (32.7%) had previously undergone biosafety instruction. Just 6 respondents (10.9%) reported knowing about biosafety levels (BSL 1–4), compared to 38 (69.1%) who said they didn't know. This indicates a remarkably low level of awareness.

Table 2. Participants' knowledge of biosafety

Variable	Yes (%)	No (%)	Not Sure (%)
Prior knowledge of biosafety	41 (74.5)	4 (7.3)	10 (18.2)
Understanding biological hazard symbols	36 (65.5)	6 (10.9)	13 (23.6)
Prior training in biosafety	18 (32.7)	27 (49.1)	10 (18.2)
Do you know (BSL 1–4)	6 (10.9)	38 (69.1)	11 (20)

Additionally, the study evaluated the typical laboratory work methods of laboratory personnel, as shown in Table 3. The findings showed that 74.5% of participants reported wearing gloves, and the same proportion (74.5%) wore laboratory coats during work. Additionally, 87.3% washed their hands after removing gloves, while 74.5% indicated that biological waste was disposed of in designated containers, and 41.8% of employees always use their mobile phones in the laboratory, and 34.5% of employees sometimes use their mobile phones in the laboratory.

Table 3. Practices of laboratory technicians in Derna

Variable	always	sometimes	rarely	never
Wear Gloves	41 (74.5)	13 (23.6)	1 (1.8)	0 (0)
Wear Lab Coat	41 (74.5)	12 (21.8)	2 (3.6)	0 (0)
Use of personal protective equipment	18 (32.7)	25 (45.5)	8 (14.5)	4 (7.3)
Handle blood samples with Care	48 (87.3)	6 (10.9)	0 (0)	1 (1.8)
Wash your hands after removing gloves	48 (87.3)	7 (12.7)	0 (0)	0 (0)
Use protective barriers when handling infectious samples	30 (54.5)	14 (25.5)	4 (7.3)	7 (12.7)
Dispose of biological waste in designated containers	41 (74.5)	10 (18.2)	3 (5.5)	1 (1.8)
Eating or drinking in the lab	16 (29.1)	26 (47.3)	9 (16.4)	4 (7.3)
Use mobile in laboratory	23 (41.8)	19 (34.5)	11 (20)	2 (3.6)

In Table 4, Workers' attitudes towards biosafety. A huge majority of participants strongly agreed that the adoption of biosafety measures protects both workers and patients (83.6%), while the remaining respondents agreed with this statement (16.4%), and none disagreed. Nearly half of the participants strongly agreed (49.1%) that further biosafety training is necessary, an equal percentage agreed (49.1%), and only a small minority disagreed (1.8%).

Table 4. Workers' attitude towards biosafety

Variable	I strongly agree	Agree	Not agree
The biosafety application protects workers and patients.	46(83.6)	9(16.4)	0(0)
I need additional training on biosafety	27(49.1)	27(49.1)	1(1.8)

Discussion

A total of 55 laboratory employees working in governmental and private clinical laboratories in Derna City, Libya, were evaluated for biosafety practices. The findings demonstrated a mixed pattern of biosafety practices, with important gaps in biosafety training, knowledge, and some routine laboratory behaviours, despite relatively good adherence to several basic preventive measures. These findings are consistent with previous evidence from Libya indicating that biosafety implementation in clinical laboratories remains variable and that gaps in training, standard procedures, waste management, and safe laboratory practices continue to exist. Only 18 participants (32.7%) in the present study reported having previously attended biosafety training. This finding indicates limited exposure to formal biosafety education among laboratory personnel. A similar situation was reported in a study conducted in diagnostic clinical laboratories in Tripoli by Ben Ashur et al., in which formal biosafety training programs were not available for 88.3% of laboratory technicians. [8] Although the percentage of participants without training was lower in the current study (67.3%) than that reported in Tripoli (88.3%), the proportion remains substantial and indicates that biosafety training is still an important area requiring improvement in clinical laboratories in Libya.

The WHO Laboratory Biosafety Manual emphasises introductory, refresher, and competency-based training as important components of an effective biosafety program [1]. Therefore, insufficient training may contribute to differences in knowledge and inconsistent application of biosafety practices among laboratory workers. A particularly concerning finding in the current study was that only 6 participants (10.9%) reported knowing about Biosafety Levels 1–4. This represents a substantial gap in basic biosafety knowledge. Although awareness of BSL classifications alone cannot be considered a complete measure of biosafety competence, understanding laboratory containment levels is important for recognising biological hazards and applying appropriate control measures. The CDC describes BSL-1 through BSL-4 as a framework for increasing levels of containment and emphasizes the application of appropriate microbiological practices in laboratory environments [3,4]. The low level of awareness identified in the present study therefore suggests a need for strengthening theoretical biosafety education among laboratory personnel.

Regarding personal protective equipment (PPE), 41 participants (74.5%) reported wearing laboratory coats and gloves. This represents a relatively positive finding and indicates that basic protective practices are followed by the majority of participants. Interestingly, the percentage was higher than that reported in the Tripoli study, where 64.8% of laboratory technicians routinely used gloves and laboratory coats [8]. The difference may indicate some improvement in PPE adherence among laboratory workers in Derna; however, direct comparison should be interpreted cautiously because the two studies were conducted at different times and used different study populations and methodologies. PPE should nevertheless be considered only one component of a comprehensive biosafety program and should not replace appropriate risk assessment, engineering controls, safe laboratory practices, and training [1,3]. Hand hygiene was another area of relatively good compliance in the current study. Forty-eight participants (87.3%) reported washing their hands after removing gloves. This finding is encouraging because hand hygiene is an important measure for reducing the

potential transmission of infectious materials. CDC recommendations emphasise washing hands after removing gloves, after handling potentially hazardous materials, and before leaving the laboratory [5]. However, because the current study relied on self-reported practices, the reported level of compliance may not necessarily reflect actual behaviour. Consequently, routine monitoring and direct observation may be useful for confirming and reinforcing appropriate hand hygiene practices. In contrast, eating and drinking inside the laboratory represented an important unsafe practice. Sixteen participants (29.1%) reported that they always ate or drank in the laboratory. This finding is concerning because eating and drinking in laboratory work areas can increase the possibility of exposure to contaminated materials. A comparison with the Tripoli study further demonstrates that inappropriate food-related practices have been reported previously in Libyan laboratories. In that study, 57.5% of laboratory technicians reported storing food, drinks, medicine, or cosmetics inside the laboratory [8].

Although the measures are not identical—the present study assessed eating or drinking, whereas the Tripoli study assessed storage—the findings from both studies suggest that food-related activities remain an area requiring stronger institutional control and staff education. The use of mobile phones in the laboratory was also relatively common in the current study, with 23 participants (41.8%) reporting that they always used cell phones while working in the laboratory. Mobile phones can potentially become contaminated through frequent handling, particularly when used in areas where biological specimens are processed. They may also create distractions during laboratory procedures. Interestingly, the Tripoli study similarly investigated the relationship between laboratory work and the use of phones or computers, reporting that 52.0% of technicians removed their gloves when using a computer or phone [8]. These findings suggest that personal electronic devices should be explicitly addressed within laboratory biosafety policies, including clear procedures for hand hygiene, glove removal, and cleaning or restricting device use in laboratory work areas. Regarding biological waste disposal, 41 participants (74.5%) reported disposing of biological waste in approved containers. This finding indicates relatively good compliance among the majority of participants. However, approximately one-quarter of respondents did not report this practice, indicating that waste management remains an area for improvement. The current findings can be compared with the considerably poorer waste-management practices reported in the Tripoli study. In that study, 77.6% of respondents reported that waste was not properly segregated, 77.6% reported the absence of separate containers for sharps, and 82.1% reported the absence of procedures for liquid biological waste disposal. In addition, only 21.9% reported that regulated biological materials were appropriately decontaminated before disposal. Compared with these findings, the higher reported use of approved biological-waste containers in the present study may indicate better adherence to basic waste-disposal practices in the surveyed laboratories in Derna. Nevertheless, further assessment of segregation, sharps disposal, decontamination, and final disposal procedures is required before concluding that waste-management practices are adequate. Taken together, the comparison with previous findings from Tripoli demonstrates both similarities and differences between laboratory workers in the two Libyan cities. Both studies identified important gaps in formal biosafety training and inappropriate laboratory behaviours. However, the present study showed a higher reported use of laboratory coats and gloves (74.5%) compared with 64.8% in Tripoli, and a relatively high proportion of participants reported appropriate biological waste disposal.

On the other hand, the very low awareness of BSL classifications in the present study (10.9%) highlights a specific knowledge gap that should receive greater attention. These differences may reflect variations in institutional policies, availability of training, laboratory resources, staff characteristics, or the timing of data collection, and therefore should not necessarily be interpreted as evidence of a general difference between Derna and Tripoli. Overall, the findings suggest a gap between practical preventive behaviours and formal biosafety knowledge among laboratory personnel in Derna City. Several basic practices, such as PPE use, hand hygiene, and biological-waste disposal, were reported by a relatively high proportion of participants, while formal training, knowledge of BSL classifications, and appropriate laboratory conduct showed important deficiencies. A similar discrepancy between individual laboratory practices and institutional biosafety systems has previously been reported in Libyan laboratories. The Tripoli study, for example, reported limited availability of written SOPs, biosafety cabinets, accident records, medical surveillance programs, and formal biosafety training [8]. The findings emphasise the need for systematic and continuous biosafety training programs for clinical laboratory personnel in Derna City. Such programs should include risk assessment, standard microbiological practices, appropriate PPE use, hand hygiene, specimen handling, sharps safety, biological-waste segregation and disposal, decontamination, emergency procedures, accident reporting, and appropriate use of personal electronic devices within laboratory areas. Training should combine theoretical education with practical demonstrations and periodic competency assessments. The WHO Laboratory Biosafety Manual recommends a risk- and evidence-based approach in which laboratory personnel are able to identify hazards, assess risks, and implement appropriate control measures [1]. The need for continued biosafety improvement is also supported by findings from other Libyan settings. Recent work involving healthcare workers in Benghazi reported a gap between risk awareness and formal safety training, while lack of safety training was associated with accidental exposure to biological materials. [12] Although that study involved healthcare workers rather than exclusively laboratory personnel, it further supports the importance of structured occupational safety training within the Libyan healthcare system.

Conclusion

The study demonstrates that biosafety practices among laboratory workers in Derna City are characterised by relatively good adherence to several basic protective behaviours, particularly PPE use, hand hygiene, and biological waste disposal, but substantial deficiencies remain in formal training, knowledge of biosafety levels, and appropriate laboratory conduct. Comparison with previous findings from Tripoli indicates that several of these challenges are not unique to Derna and have previously been documented in other Libyan clinical laboratory settings. Strengthening routine biosafety education, refresher training, written SOPs, monitoring of compliance, and institutional biosafety policies may help improve laboratory safety and reduce occupational risks. Given the relatively small sample size of 55 participants, larger multicenter studies involving laboratories from Derna and other Libyan cities are recommended to provide a more representative assessment of biosafety practices across Libya.

Conflict of interest. Nil

References

1. World Health Organization. Laboratory biosafety manual. 4th ed. Geneva: World Health Organization; 2020.
2. World Health Organization. Laboratory biosafety manual, 4th ed. Decontamination and waste management. Geneva: World Health Organization; 2020.
3. Centers for Disease Control and Prevention, National Institutes of Health. Biosafety in microbiological and biomedical laboratories (BMBL). 6th ed. Atlanta, GA: U.S. Department of Health and Human Services; 2020.
4. Centers for Disease Control and Prevention. Biosafety levels. Atlanta, GA: Centers for Disease Control and Prevention; 2024.
5. Centers for Disease Control and Prevention. Guidelines for safe work practices in human and animal medical diagnostic laboratories. MMWR Suppl. 2012;61(1):1–102.
6. Kimman TG, Smit E, Klein MR. Evidence-based biosafety: a review of the principles and effectiveness of microbiological containment measures. Clin Microbiol Rev. 2008 Jul;21(3):403–25. doi: 10.1128/CMR.00014-08. PMID: 18625678; PMCID: PMC2493080.
7. Bajjou T, Sekhsokh Y, Amine IL, Gentry-Weeks C. Knowledge of biosafety among workers in private and public clinical and research laboratories in Morocco. Appl Biosaf. 2019 Mar 1;24(1):46–54. doi: 10.1177/1535676018797140. Epub 2019 Mar 1. PMID: 36034632; PMCID: PMC9093238.
8. Ben Ashur A, Abdulwahed E, Magrahi H, Elyounsi N, Annajar B. Assessment of biosafety and biosecurity aspects in diagnostic clinical laboratories in Tripoli, Libya. AlQalam J Med Appl Sci. 2017 Aug;1(1):64–9.
9. Khabour OF, Al Ali KH, Aljuhani JN, Alrashedi MA, Alharbe FH, Sanyowr A. Assessment of biosafety measures in clinical laboratories of Al-Madinah city, Saudi Arabia. J Infect Dev Ctries. 2018 Sep 30;12(9):755–61. doi: 10.3855/jidc.10081. PMID: 31999634.
10. Eysenbach G. Improving the quality of Web surveys: the Checklist for Reporting Results of Internet E-Surveys (CHERRIES). J Med Internet Res. 2004 Sep 29;6(3):e34. doi: 10.2196/jmir.6.3.e34. Erratum in: doi:10.2196/jmir.2042. PMID: 15471760; PMCID: PMC1550605.
11. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP; STROBE Initiative. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. BMJ. 2007 Oct 20;335(7624):806–8. doi: 10.1136/bmj.39335.541782.AD. PMID: 17947786; PMCID: PMC2034723.
12. Yousif B, Abuzreda A, Aleawami ME, Albrouni AA, Alamami HK, Elmesmary GA, Elmesmary AG. Assessment of occupational hazards in healthcare facilities in Benghazi, Libya—2024: a cross-sectional study. Libyan J Public Health Pract. 2026;2(2):7–18.