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Assessment of Knowledge, Attitude and Practice of Biosafety among University's Laboratory Staff

Nik Nurfatin Athirah Nik Mohd Razali[1], Nurul Izzah Abdul Samad[1], Nursuhaili Mohd Amin[2], Mohd Firdaus Yhaya[3], Herdianti Hatta[4] and Nurul Ainun Hamzah[1,*]

[1]School of Health Sciences, Universiti Sains Malaysia, Health Campus, Kubang Kerian, Kelantan 16150, Malaysia
[2]School of Occupational Safety and Health, Faculty of Allied Health Professions, AIMST University, Bedong, Kedah 08100, Malaysia
[3]School of Dental Sciences, Universiti Sains Malaysia, Health Campus, Kubang Kerian, Kelantan 16150, Malaysia
[4]Masters in Public Health Study Program, Faculty of Health Sciences, Universitas Ibnu Sina, Batam 29444, Indonesia

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***Correspondence:**
Nurul Ainun Hamzah
Address: School of Health Sciences, Universiti Sains Malaysia, Kubang Kerian 16150, Malaysia.
Email: nurulainun@usm.my

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ABSTRACT
Background: Biosafety is crucial for protecting laboratory staff from infectious agents and hazardous biological materials. Inadequate knowledge of unsafe practices may increase the risk of laboratory-acquired infections and accidents. This study assessed the knowledge, attitude, and practice (KAP) of biosafety and related factors among laboratory staff. **Methods:** A cross-sectional study was conducted among 150 laboratory staff recruited through stratified and random sampling. Data were collected using a validated, self-administered questionnaire that assessed knowledge, attitude, and practice related to biosafety. Descriptive analysis, one-way ANOVA, Pearson correlation and multiple linear regression were performed to examine differences and associations. **Results:** The findings revealed that laboratory staff demonstrated moderate knowledge (74.8%), good attitudes (95.5%), and good practices (93.7%) towards biosafety. Significant differences in knowledge [F (2,147) = 23.7, $p < 0.001$] and practice [F(2,147) = 21.36, $p < 0.001$] were observed across schools. A moderate positive correlation was found between practice and knowledge ($r = 0.518$, $p < 0.01$) and between practice and attitude ($r = 0.342$, $p < 0.01$). Higher education was associated with better knowledge and attitudes, while longer years of employment were negatively associated with knowledge. No demographic factors significantly predicted practice. **Conclusions:** Laboratory staff demonstrated positive attitudes and good practices but showed only moderate knowledge of biosafety. Regular training, continuous education, and standardised biosafety programs are crucial for enhancing knowledge and maintaining safe laboratory practices. This study provides essential evidence to strengthen biosafety training and policies in Malaysian universities, supporting safer laboratory environments and improved institutional preparedness.

Keywords: Biosafety; occupational health; safety practices; laboratory staff; KAP

1. INTRODUCTION

Biosafety is a fundamental component of occupational health and safety in laboratories, aimed at minimising exposure to infectious agents and hazardous biological materials that may cause illness or laboratory-acquired infections (LAIs).[1-3] Laboratory workers, including scientists, technologists, and technicians, are routinely exposed to biological hazards such as pathogenic microorganisms, bloodborne viruses, and other biological specimens during their daily tasks.[4,5] This difference highlights the importance of continuous biosafety education and standardised training programs to strengthen safety culture in laboratories. Moreover, differing findings on the role of experience and education in shaping biosafety practices remain debated, with some studies showing positive associations while others report inconsistent results.[6,7] Inadequate knowledge, poor attitudes, and unsafe practices have been associated with higher risks of accidents, pathogen release, and cross-infections, which can have severe implications for individual health and institutional safety.[8-10]

Recent studies in Asia and Africa have consistently shown that while laboratory workers often demonstrate positive attitudes toward biosafety, their knowledge levels may remain moderate, and their actual practices often do not align with safety guidelines. For example, in Togo, only 49.1% of laboratory professionals demonstrated good biosafety knowledge, despite 62.4% reporting positive attitudes and 77.6% practising good biosafety measures.[11] Similarly, in Lesotho, knowledge gaps persisted among laboratory staff, despite favourable attitudes and acceptable practices being widely reported.[12] In Saudi Arabia, Aldhamy et al. (2023) observed that while laboratory technicians expressed strong attitudes toward infection prevention and control, inconsistencies were evident in the implementation of these practices.[6] More recently, a nationwide assessment in China found that although training uptake was high across CDC laboratories, adherence to specific biosafety practices varied, indicating gaps in translating knowledge and attitudes into consistent behaviors.[7]

The Knowledge, Attitude, and Practice (KAP) framework has been widely applied in health and safety research to evaluate not only evidence-based awareness but also behavioural tendencies and actual adherence to recommended practices.[13] Knowledge reflects an individual's understanding of biosafety principles, such as proper use of personal protective equipment (PPE) or containment procedures. Attitude encompasses perceptions, beliefs, and willingness to adopt safety measures, while practice represents the actual application of biosafety precautions in daily laboratory work.[14] Several studies have demonstrated a positive relationship between higher knowledge and better biosafety practices, although in some contexts, attitudes appear to play a stronger mediating role.[15-17] Therefore, assessing KAP provides a holistic understanding of biosafety behaviours and identifies gaps, allowing for the most effective interventions, such as training, awareness programs, or policy reinforcement.

In Malaysia, evidence on biosafety knowledge, attitudes, and practices among laboratory staff remains limited, particularly within teaching hospital campuses. A personnel member has to manage diverse biosafety levels and handle various biological hazards. Understanding the determinants of biosafety-related behaviours is crucial for enhancing workplace safety and ensuring compliance with national and international biosafety standards.[18] Therefore, this study aimed to assess the knowledge, attitude, and practice (KAP) of biosafety among laboratory staff and to examine associated sociodemographic and occupational factors. The findings are expected to provide evidence to guide the development of tailored interventions and reinforce institutional biosafety programs, thereby promoting safer laboratory environments in academic settings. Furthermore, the absence of multi-school investigations in Malaysian universities leaves uncertainty regarding the influence of factors such as educational background, years of service, and biosafety training history on compliance. Addressing this gap is crucial not only to safeguard laboratory personnel but also to enhance institutional preparedness and adherence to regulatory requirements. This study was conducted to address the existing knowledge gap by systematically evaluating biosafety knowledge, attitudes, and practices among laboratory staff at a Malaysian university health campus, thereby generating evidence to inform policy, training, and institutional biosafety strengthening.

2. METHODS

2.1 Study Design

This study employed a cross-sectional design to assess the knowledge, attitude, and practice (KAP) of biosafety among laboratory staff. This study design enables the simultaneous collection of exposure variables (sociodemographic and occupational characteristics) and outcomes (KAP scores), providing a snapshot of the current biosafety status within the study population. The study was conducted at Universiti Sains Malaysia (USM) Health Campus, Kubang Kerian, Kelantan, between October 2022 and June 2023. Three schools with active teaching and research laboratories participated in this study: the School of Health Sciences (SHS), the School of Medical Sciences (SMS), and the School of Dental Sciences (SDS). These schools operate laboratories under diverse biosafety levels (BSL-1 to BSL-3) and involve handling of microorganisms, blood, and other potentially infectious specimens.

2.2 Study Population, and Sampling

The study population consisted of permanent laboratory staff aged between 20 and 60 years, with at least one year of working experience.

Eligibility criteria

Participants were eligible if they were (i) full-time laboratory staff employed by the university, (ii) actively engaged in laboratory activities involving biological materials, and (iii) had at least one year of continuous service.

Exclusion criteria

Staff on short-term or temporary contracts, trainees, administrative personnel, and those not directly involved in laboratory operations were excluded to ensure homogeneity of biosafety exposure and experience.

The total eligible population consisted of 217 staff members (SHS = 51, SMS = 152, SDS = 14). The sample size was calculated using G*Power software (version 3.1.9.2) for a one-way ANOVA with a medium effect size (f = 0.25), a significance level of 0.05, and a power of 0.80. The minimum required sample was 159, and with an additional 10% to account for non-response, the final target sample was 175, corresponding to a sampling fraction of 0.81 (175/217).

Stratified random sampling was applied to ensure proportional representation from each school, thereby reducing sampling bias and enabling a meaningful comparison of biosafety KAP across different laboratory environments. Within each stratum, simple random sampling was used to select participants from official staff lists. Based on proportional allocation, the planned sample distribution was 41 (SHS), 123 (SMS), and 11 (SDS).

2.3 Study Instrument

Data were collected using a structured, self-administered questionnaire adapted from previously validated KAP instruments on biosafety and laboratory safety.[16,19] The questionnaire was designed to assess knowledge, attitudes, and practices related to biosafety among laboratory staff. The questionnaire was prepared in both English and Malay to ensure comprehensibility for all participants. The estimated time required for completion was 20–25 minutes.

The questionnaire consisted of four main sections:

a. Sociodemographic and occupational characteristics – including age, gender, education level, years of employment, school affiliation, and biosafety level of the laboratory.
b. Knowledge on biosafety – 18 items in multiple-choice and true/false formats, assessing understanding of biosafety principles such as biosafety levels, hazard symbols, classification of infectious agents, use of personal protective equipment (PPE), and safe handling of biological materials. Each correct answer was scored 1, while incorrect or "do not know" responses were scored 0. The total possible score ranged from 0 to 18. Knowledge levels were categorized as: Poor (60%, ≤10 points), Moderate (60–79%, 11–14 points), and Good ((≥80%, 15–18 points). A higher score indicates better knowledge.
c. Attitudes towards biosafety – 12 items assessed using a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). Items covered perceptions, beliefs, and willingness to adopt biosafety measures, such as adherence to standard precautions, safe handling of specimens, and responsibility for workplace safety. The total possible score ranged from 12 to 60. Attitude level was categorised as Negative (<80%, ≤47 points) and Positive (≥80%, ≥48 points). A higher score reflects a more positive attitude.
d. Biosafety practices – 18 items assessed on a 5-point frequency scale (1 = never to 5 = always). Items evaluated actual behaviours, including use of PPE, hand hygiene, safe disposal of biological waste, and compliance with institutional biosafety policies. The total possible score ranged from 18 to 90. Practice levels were categorised as Poor <80%, ≤71 points) and Good (≥80%, ≥72 points). A higher score indicates better biosafety practices.

Content validity was established through expert review by occupational health and biosafety specialists. A pilot test was conducted with a small group of laboratory staff (excluded from the final sample) to improve clarity. Reliability analysis, using Cronbach's alpha, demonstrated satisfactory internal consistency across the domains (knowledge = 0.78, attitude = 0.82, practice = 0.85).

2.4 Data Collection Procedure

Data were collected from October 2022 to June 2023. Prior to distribution, ethical approval was obtained from the Human Research Ethics Committee of Universiti Sains Malaysia (JEPeM/23010014) dated 5 April 2023, and permission was granted by the participating schools. Participants were informed of the study's objectives, the voluntary nature of their participation, and the confidentiality of their data. Later, a written consent was obtained from them. Questionnaires, including information sheets and consent forms, were distributed in hard copy through designated coordinators at each school. Respondents were given one week to complete the questionnaires, and reminders were provided to improve response rates. Completed forms were returned in sealed envelopes. Responses were anonymised and coded with unique identifiers accessible only to the research team to maintain confidentiality.

2.5 Data Analysis

Completed questionnaires were checked and coded before being entered into IBM SPSS version 27 for analysis. Descriptive statistics (frequency, percentage, mean, standard deviation) were used to summarise respondent characteristics and KAP scores. One-way analysis of variance (ANOVA) was conducted to compare mean KAP scores between three schools. Pearson's correlation test was used to assess relationships among knowledge, attitude, and practice scores. Multiple linear regression (MLR) analysis was performed to identify sociodemographic and occupational predictors of KAP scores. Statistical significance was set at $p < 0.05$.

3. RESULTS

3.1 Sociodemographic Characteristics of the Respondents

A total of 150 laboratory staff participated in this study, giving a response rate of 85.7%. The majority were female (62.7%), while 37.3% were male. The mean age of the respondents was 38.9 ± 5.8 years, with most participants aged 30–49 years (53.3%). In terms of education, 58.6% held a degree or master's qualification, 36.7% had STPM/Diploma, and 4.7% reported secondary-level education (MCE/SPM). Regarding work experience, 74.0% had more than 10 years of employment, whereas 26.0% had between 1 and 10 years. Respondents were distributed across the three schools: 105 (70.0%) from the School of Medical Sciences (SMS), 34 (22.7%) from the School of Health Sciences (SHS), and 11 (7.3%) from the School of Dental Sciences (SDS). Most staff (72.0%) worked in BSL-2 laboratories, followed by BSL-1 (24.0%), BSL-3 (2.7%), and BSL-4 (1.3%).

3.2. Knowledge, Attitude, and Practice Score

Table 1 shows a summary of the KAP scores of biosafety among laboratory staff. The overall mean knowledge score was 74.8%, reflecting a moderate level of biosafety knowledge. More than half of the respondents demonstrated moderate knowledge, while a smaller proportion achieved poor or good scores. These findings indicate variability in the understanding of biosafety principles such as hazard symbols, infectious agent classification, and PPE use. Attitude scores were markedly higher, with a mean of 95.5% and almost all respondents were classified as having a positive attitude toward biosafety. Respondents consistently agreed with the importance of compliance, responsibility for laboratory safety, and adherence to biosafety procedures. Practice scores were also strong, with a mean of 93.7%, corresponding to a good level of biosafety practice (range 58.9–100%). Most staff reported frequent and consistent use of PPE, hand hygiene, and safe disposal of biological waste. However, a small proportion showed lower compliance in areas such as waste segregation and use of biological safety cabinets. Taken together, these results highlight an imbalance: attitudes and practices were generally positive and good, but knowledge remained moderate, suggesting a gap between awareness and factual understanding.

Table 1. Knowledge, attitude and practice score of biosafety

Domain	Percentage		Level
	Mean ± SD	**Range**	
Knowledge (K)	74.8±13.9	38.9-100	Moderate
Attitude (A)	95.5±8.1	40-100	Good
Practice (P)	93.7±8.1	58.9-100	Good

3.3 Comparison of KAP Scores between Schools

Table 2 shows significant differences in knowledge and practice scores of biosafety between schools, while attitudes were similar. Knowledge was significantly lower among SDS staff as compared to SMS and SHS [$F(2,147) = 23.7$, $p < 0.001$]. Similarly, practice scores differed significantly between schools [$F(2, 147) = 21.36$, p

< 0.001], with SDS staff reporting lower levels of compliance than those in SMS and SDS. In contrast, attitudes toward biosafety did not differ significantly [F(2,147) = 2.21, p = 0.114], indicating a consistently positive outlook across faculties. These findings suggest that while positive attitudes were uniform, gaps in knowledge and practices varied, likely due to differences in institutional resources, training opportunities, and laboratory environments.

Table 2. Comparison of the knowledge, attitude, and practice scores of biosafety between schools

School	Mean (SD)	F statistic	df	p-value
Knowledge (K)				
SMS	18.10 (2.6)	23.720	2	<0.001**
SHS	18.47 (3.0)			
SDS	12.09 (3.9)			
Attitude (A)				
SMS	57.32 (5.1)	2.208	2	0.114
SHS	58.03 (2.8)			
SDS	54.55 (6.2)			
Practice (P)				
SMS	84.41 (6.1)	21.360	2	<0.001**
SHS	86.41 (5.0)			
SDS	72.27 (11.8)			

SMS: School of Medical Sciences, SHS: School of Health Sciences, SDS: School of Dental Sciences; **Significant at p<0.001

3.4 Correlation Between Knowledge, Attitude, and Practice Scores

Table 3 demonstrated a moderate positive correlation between knowledge and practice (r = 0.518, p < 0.01), suggesting that higher knowledge levels were associated with safer laboratory behaviours. A weaker but significant positive correlation was found between attitude and practice (r = 0.342, p < 0.01), indicating that positive perceptions contributed to safer practices. However, the correlation between knowledge and attitude was weak and not statistically significant (r = 0.136, p = 0.096). This suggests that knowledge does not necessarily translate into stronger biosafety attitudes, and that attitudes may be shaped more by institutional culture than by technical understanding.

3.5 Factors Associated with KAP Scores

Multiple linear regression analysis identified education level and years of employment as significant predictors of knowledge score (Table 4). Education level was positively associated with knowledge (Adj B = 2.20, 95% CI: 0.42–3.97, p = 0.016) and attitude (Adj B = 5.05, 95% CI: 1.26–8.84, p = 0.009). This indicates that staff with higher qualifications demonstrated better knowledge and more positive attitudes. Conversely, years of employment were negatively associated with knowledge (Adj B = –2.06, 95% CI: –2.96 to –1.16, p < 0.001), suggesting that staff with longer service tended to have lower knowledge scores, possibly due to limited refresher training. However, no significant predictors were identified for practice scores (p > 0.05), indicating that safe practices were consistently maintained across staff regardless of demographic or occupational characteristics.

Table 3. Correlation of knowledge, attitude, and practice on biosafety

Domain	r value	p-value
Knowledge & attitude	0.136	0.096
Knowledge & practice	0.518	p<0.01*
Attitude & practice	0.342	p<0.01*

*Significant at p<0.05

4. DISCUSSION

Overall, laboratory staff demonstrated moderate knowledge, consistently positive attitudes, and good practices toward biosafety. Although knowledge levels varied, attitudes and practices remained strong, indicating that safe behaviours are well-established despite gaps in understanding. Significant differences in knowledge and practice were noted between schools, with dental laboratory staff scoring lower than those in medical and health sciences. Correlation analysis showed that both knowledge and attitudes were positively associated with practices, with knowledge having a more substantial effect. Regression analysis further indicated that higher education was positively associated with better knowledge and attitudes. At the same time, longer years of service were negatively linked to knowledge, suggesting potential overconfidence or a lack of regular refresher training among experienced staff.

The pattern of moderate knowledge alongside strong attitudes and practices found in this study reflects results from recent international KAP studies. In Sudan, Ahmed et al. (2022) reported that although awareness in certain safety domains was relatively high, deficiencies persisted in others, and years of service correlated negatively with biosafety knowledge.[1,20] Similarly, Halatoko et al. (2024) in Togo found that only 49.1% of laboratory professionals demonstrated good knowledge, although most staff reported positive attitudes and good

Table 4. Predictors of knowledge, attitude, and practice scores on biosafety among laboratory staff

	SLR[a]		MLR[b]		
	β (95% CI)	*p*-value	Adj β (95% CI)	t-statistics	*p*-value
	Knowledge (R^2 = 0.224)				
Constant	15.920(11.997,19.843)				
Age (years)	0.020(-0.050,0.090)	0.571	-0.021(-0.090,0.048)	-0.605	0.546
Gender					
Female	-0.346(-1.183,0.492)	0.416	-0.507(-1.271,0.258)	-1.310	0.192
Male	references				
Education level					
Degree/Master	2.399(0.541,4.258)	0.012*	2.198(0.422,3.974)	2.447	0.016*
Sijil STP/Diploma	0.940(-0.959,2.839)	0.329	1.011(-0.797,2.819)	1.105	0.271
MCE/SPM	references				
Employment (years)	-2.121(-2.980, -1.261)	<0.001*	-2.059(-2.958, -1.160)	-4.526	<0.001*
	Attitude (R^2 = 0.092)				
Constant	50.948(42.134,59.762)				
Age (years)	-0.082(-0.216,0.053)	0.233	-0.022(-0.169,0.125)	-0.296	0.768
Gender					
Female	-0.589(-2.205,1.026)	0.472	-0.577(-2.184,1.030)	-0.710	0.479
Male	references				
Education level					
Degree/Master	5.023(1.355,8.690)	0.008*	5.053(1.263,8.844)	2.635	0.009*
Sijil STP/Diploma	3.636(-0.111,7.384)	0.057	3.943(0.082,7.805)	2.019	0.045*
MCE/SPM	references				
Employment (years)	1.042(0.734,2.819)	0.248	1.046(-0.902,2.931)	1.046	0.297
	Practice (R^2 = 0.272)				
Constant	71.274(59.403,83.145)				
Age (years)	-0.014(-0.218,0.190)	0.892	-0.008(-0.206,0.190)	-0.081	0.936
Gender					
Female	0.910(-1.520,3.341)	0.460	0.881(-1.284,3.046)	0.805	0.422
Male	references				
Education level					
Degree/Master	2.484(-2.848,7.815)	0.359	2.261(-2.844,7.366)	0.875	0.383
Sijil STP/Diploma	-2.803(-8.251,2.646)	0.311	-1.137(-6.339,4.064)	-0.432	0.666
MCE/SPM	references				
Employment (years)	0.583(-2.100,3.266)	0.668	0.796(-1.785,3.377)	0.610	0.543

[a]Simple Linear Regression; [b]Multiple Linear Regression; *Significant at p<0.05; **significant at p<0.001

practices. Significantly, prior training was strongly associated with knowledge, but not necessarily with practice or attitude.(11) Ts'aletseng et al. (2024) in Lesotho also noted high compliance in healthcare waste management despite variability in knowledge levels.(12)

Comparable findings have been reported across South and Southeast Asia. Imdad et al. (2024) observed that laboratory staff in Pakistan generally reported good practices and attitudes, though knowledge gaps remained in technical biosafety domains.(10,21) Similarly, Ramos et al. (2025) found that Filipino medical technologists had moderate knowledge but strong biosafety practices, with education level and prior training emerging as significant predictors of safer behaviours.(14) In Ethiopia, Tadesse et al. (2025) noted that biosafety practices varied across institutions and were influenced mainly by the availability of resources and ongoing training opportunities.(8)

Other studies reinforce these observations across diverse laboratory environments. In China, Tang et al. (2024) found that outdated information technology infrastructure posed significant challenges for biosafety monitoring in psychiatric hospital laboratories, thereby undermining compliance.(22) Padde et al. (2022) reported that although students and staff in academic laboratories demonstrated positive attitudes and baseline compliance, technical knowledge in biological risk management remained inadequate.[9] Similarly, a cross-sectional study among laboratory students in Vietnam by Bui et al. (2024) found only moderate biosafety knowledge (~68.6%), suggesting that weak foundational understanding at pre-professional stages may contribute to subsequent professional gaps.[23] These findings highlight that the knowledge–practice gap is a common trend observed across countries and institutional contexts. While attitudes and practices are often sustained through organisational culture, policy enforcement, and peer norms, knowledge is more vulnerable to decay over time without continuous training and reinforcement.

Education levels played a significant and positive role in predicting both knowledge and attitudes, supporting evidence that higher academic qualifications enhance understanding and commitment to biosafety standards.[1,2,18] In contrast, years of employment were negatively associated with knowledge. Similar findings have been reported from Sudan and other contexts, indicating that long-serving staff may become complacent or fail to update themselves with current guidelines.[6,7] By contrast, age and gender were not significantly associated with any KAP outcomes in this study. This result is consistent with findings from Pakistan, Saudi Arabia, and Vietnam, where no significant gender or age differences were observed in biosafety compliance.[5,8,17] For example, Bui et al. (2024) reported that although academic performance and education influenced biosafety knowledge, gender differences were not consistent across KAP domains.[17] Similarly, Halatoko et al. (2024) in Togo found that training and education were more important predictors than demographic variables such as age or sex.[9] From the perspective of the Health Belief Model (HBM), biosafety behaviours are more strongly influenced by perceived risk, cues to action, and institutional policies rather than by demographic traits. Once safety protocols are standardised and enforced, demographic differences become less relevant.[24] These findings suggest that institutional systems, training, and workplace culture play a more decisive role in shaping biosafety practices than age or gender.

This study also demonstrates the importance of strengthening biosafety interventions within Malaysian universities, particularly in faculties with smaller laboratory settings such as dental schools. University management should implement more continuous professional development (CPD) and deliver refresher training on biosafety to ensure that all staff, regardless of seniority, consistently update their knowledge and skills. Evidence from China suggests that inspection-based interventions can significantly enhance compliance with biosafety protocols, supporting the notion that institutional monitoring systems are crucial for maintaining a safe culture.[25] Faculty-specific biosafety modules, routine drills, and integration of biosafety education into curricula could further reduce the observed knowledge–practice gap.

A significant strength of this study is its focus on academic laboratory staff, a population that is often overlooked in comparison to hospital-based laboratory personnel. The use of stratified random sampling and a validated questionnaire enhanced the representativeness and reliability of the findings. However, the single-campus design limits generalizability to other Malaysian universities, and reliance on self-reported practices may introduce reporting bias. Future research should expand to multi-campus and multi-university studies across Malaysia to capture institutional variations in biosafety culture. Longitudinal research designs could assess the sustainability of biosafety training outcomes, while qualitative studies may provide deeper insights into motivational and organisational barriers to compliance. Together, such approaches would help design interventions that are both evidence-based and contextually tailored.

5. CONCLUSION

This study demonstrated that laboratory staff possessed moderate biosafety knowledge, consistently positive attitudes, and good practices. Knowledge and practice varied significantly across schools, with dental laboratory staff performing at a lower level than their counterparts in medical and health sciences. Knowledge and attitudes were positively associated with safer practices, while education level was a positive predictor of both knowledge and attitude. In contrast, years of employment were negatively associated with knowledge. The findings highlight a knowledge–practice gap that is consistent with global evidence. Although biosafety practices are generally well maintained through institutional systems, gaps in knowledge particularly among long-serving staff underscore the need for continuous education and refresher training. It is recommended that universities strengthen their biosafety programs through faculty-specific training, periodic audits, and the integration of biosafety education into their curricula. Multi-institutional and longitudinal studies are further needed to monitor the effectiveness of such interventions and to ensure sustainable improvements in biosafety culture across academic laboratories.

Ethical Approval

This study received ethical approval from the Human Research Ethics Committee (HREC) of Universiti Sains Malaysia (USM) under protocol code (JEPeM/23010014) dated 5 April 2023.

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Competing Interests

All the authors declare that there are no conflicts of interest.

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Underlying Data

Derived data supporting the findings of this study are available from the corresponding author on request.

REFERENCES

1. Ahmed HK, Eisa IM, Abdallah EI, Hamouda DG, Omer AE, Eltayeb LB. Appraisal of Biosafety Measures in Governmental Medical Laboratory Personnel: Knowledge, Attitude, Practice (KAP) Study. Journal of Biochemical Technology. 2022;13(3):13–18. http://dx.doi.org/10.51847/eohg7ngyvx
2. Berche P. Laboratory-associated infections and biosafety. La Presse Médicale. 2026;55(3):104277. http://dx.doi.org/10.1016/j.lpm.2025.104277
3. Krishnan U, Mary T. A Cross Sectional Study on Knowledge, Attitude and Practice of Laboratory Biosafety In The Light Of Covid -19 in a Ter- tiary Care Hospital. Indian Journal of Medical Microbiology. 2021;39:S78. http://dx.doi.org/10.1016/j.ijmmb.2021.08.270
4. Blacksell SD, Dhawan S, Kusumoto M, Le KK, Summermatter K, O'Keefe J, et al. Laboratory-acquired infections and pathogen escapes worldwide between 2000 and 2021: a scoping review. The Lancet Microbe. 2024;5(2):e194–e202. http://dx.doi.org/10.1016/s2666-5247(23)00319-1
5. Almutairi NS, Md Tamrin SB, Guan NY, How V. Review knowledge, attitude and practice among workers towards occupational safety and health. Malaysian Journal of Medicine and Health Sciences. 2020;16(1):297-303.
6. Aldhamy H, Maniatopoulos G, McCune VL, Mansi I, Althaqafy M, Pearce MS. Knowledge, attitude and practice of infection prevention and control precautions among laboratory staff: a mixed-methods systematic review. Antimicrobial Resistance & Infection Control. 2023;12(1):57. http://dx.doi.org/10.1186/s13756-023-01257-5
7. Niu Y, Ma Y, Yang C, Zhang Y, Yang T, Wu H, Li Y, Gao Q, Zhou L, Wang L. The state of biosafety across China's CDC microbiology laboratories: a nationwide assessment. Frontiers in Public Health. 2024;12:1436503. https://doi.org/10.3389/fpubh.2024.1436503
8. Tadesse MT, Tefera Y, Tesfaye A, Hailu D. Biosafety management practices among clinical laboratory professionals in Debre Berhan Town governmental hospitals, Ethiopia: A cross-sectional study. Health Science Reports. 2025;8(1):e70361. https://doi.org/10.1002/hsr2.70361
9. Padde JR, Sharma S, Mhatre S, Amini S. Assessment of biosafety and biorisk management practices among medical laboratory students in two institutions in Uganda. Biosafety and Health. 2022;4(4):226–234. https://doi.org/10.1016/j.bsheal.2022.08.005
10. Imdad S, Dar R, Akhtar R, Shakoor M, Ali M, Asif M, et al. Knowledge, Attitude and Practice (KAP) of Laboratory Safety among Laboratory Workers. Pakistan Journal of Health Sciences. 2024;114–118. http://dx.doi.org/10.54393/pjhs.v5i12.2390
11. Halatoko WA, Sondou E, Sopoh GE, Kassegne A, Katawa G, Salou M, et al. Knowledge, attitudes and practices in biosafety and biosecurity in medical biology laboratories in Togo, 2021. Frontiers in Environmental Health. 2024;3:1387476. http://dx.doi.org/10.3389/fenvh.2024.1387476
12. Siimane TM, Nts'ihlele ME. Healthcare waste management knowledge, attitudes and practices of laboratory workers at a regional hospital, Lesotho. African Journal of Laboratory Medicin]. 2024;13(1):a2485. http://dx.doi.org/10.4102/ajlm.v13i1.2485

13. Vhanda D, Mwenje J, Vhanda R, Chinowaita K, Chitungo IJB, Dzinamarira T. Evaluating the Knowledge, Attitudes and Practices of Medical Laboratory Professionals Towards Implementing Enterprise Risk Management in Harare, Zimbabwe: A Cross-Sectional Study. Health Science Reports. 2025;8(6):e70931. http://dx.doi.org/10.1002/hsr2.70931
14. Ramos HL, Diola J, Ortega MaC. Knowledge and Practices on Biosafety among Medical Technologists in Ilocos Sur. Journal of Interdisciplinary Perspectives. 2025;3(8):345–358. http://dx.doi.org/10.69569/jip.2025.432
15. Aldhamy H, Maniatopoulos G, McCune VL, Mansi I, Althaqafy M, Pearce MS. Knowledge, attitude and practice of infection prevention and control precautions among laboratory staff: a mixed-methods systematic review. Antimicrobial Resistance & Infection Control. 2023;12(1):57. http://dx.doi.org/10.1186/s13756-023-01257-5
16. Sharma B, Kumar S. Knowledge, attitude, and practice of safety precautions among laboratory technologist of clinical microbiology laboratory. International Journal of Medical Science and Public Health. 2020;9(4):253-257. http://dx.doi.org/10.5455/ijmsph.2020.10289201918022020
17. Deepthi PV, Shameena PM, Varma S, Navajeevraj MN. Assessment of Knowledge, Attitude, and Practice Regarding Safety Laboratory Measures During COVID-19 Pandemic – A Cross-Sectional Study Among Oral Pathologists in Kerala. Journal of Indian Association of Public Health Dentistry. 2022;20(1):59–62. http://dx.doi.org/10.4103/jiaphd.jiaphd_50_21
18. Alquraini RA, Allehyani MM, Almogati MWS, Alsulami AA, Alsulami BO, Alotaibi YMS, Alotaibi FF, Almalki MY, Al-Zahrani ABAA, Al-Ahmadi AMH, Alshamrani NE, Alrashidi MN, Al-Ataibi TA, Al-Zahrani AHM, Alotaibi FEO, Alosaimi AJS, Alotaibi SJH, Alshamrani SE, Alhazmi NS. Assessment of knowledge, attitude and practice on laboratory occupational safety and health among healthcare workers. Journal of Positive Psychology and Wellbeing. 2022;6(2):2735–2743.
19. Abhayaratne AJ, Samarasinghe YJ, Francis UMGS, Wickramaratne IWMJ, Gunathilake MDU. An assessment of the knowledge, attitudes and practices among medical laboratory technicians on biosafety precautions in selected government healthcare institutions in Colombo District, Sri Lanka. Intternational Journal of Science and Healthcare Research. 2020;5(1):78-85.
20. 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. The Journal of Infection in Developing Countries. 2018;12(09):755–761. http://dx.doi.org/10.3855/jidc.10081
21. Aspland AM, Douagi I, Filby A, Jellison ER, Martinez L, Shinko D, et al. Biosafety during a pandemic: shared resource laboratories rise to the challenge. Cytometry Part A. 2021;99(1):68–80. http://dx.doi.org/10.1002/cyto.a.24280
22. Tang Q, Yan F, Yuan L, Tang Y, Chen H, Sun Y, et al. Enhancing laboratory biosafety management: a comprehensive strategy from theory to practice. Frontiers in Public Health. 2024;12:1439051. http://dx.doi.org/10.3389/fpubh.2024.1439051
23. Thi Ngoc Ha Bui, Trung Duc Nguyen, Joshi TTX, Thi Thu Ha Nguyen. Biosafety knowledge and perception among medical laboratory students: a cross-sectional study at a medical university in Vietnam. International Journal of Occupational Safety and Health. 2024;14(1):7–16. http://dx.doi.org/10.3126/ijosh.v14i1.56395
24. Kareem AJ, Kareem AO, Owoeye-Lawal OT, Aro AJ, Lawa OA, Ibekwe OC, et al. The use of safety practices to reduce occupational injury among solid mineral miners in Southwest, Nigeria: an examination of the health belief model. International Journal Of Community Medicine And Public Health. 2022;9(3):1492. http://dx.doi.org/10.18203/2394-6040.ijcmph20220718
25. Qin Q, Tseng C, Chen W, Tseng CL. Best practices for implementing biosafety inspections in a clinical laboratory: Evidence from a multi-site experimental study. Kamrani E, editor. PLOS ONE. 2023;18(10):e0292940. http://dx.doi.org/10.1371/journal.pone.0292940