



STRATEGIES FOR MANAGING BIOLOGY LABORATORY HAZARDS IN ILORIN WEST LOCAL GOVERNMENT AREA SENIOR SECONDARY SCHOOLS

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ABSTRACT

This study examined strategies for managing biology laboratory hazards in senior secondary schools in Ilorin West Local Government Area of Kwara State, Nigeria. Specifically, the study identified the common biology laboratory hazards encountered in schools, assessed the level of safety awareness among biology teachers and students, evaluated the availability of laboratory safety equipment and facilities, examined existing laboratory safety management practices, and identified strategies for improving biology laboratory hazard management. The study adopted a descriptive survey research design involving biology teachers, laboratory attendants, and senior secondary school students. Data were collected through a structured questionnaire and analyzed using descriptive statistics, particularly mean scores. The findings revealed that chemical spills, broken glassware, biological contamination, and fire hazards were the major laboratory hazards encountered in biology laboratories. The study further revealed that the level of safety awareness among teachers and students was moderate, while the availability of laboratory safety equipment and facilities was generally low. Existing laboratory safety management practices were also found to be moderately effective, with teacher supervision recording the highest rating among the management practices. Furthermore, regular safety training, provision of adequate safety equipment, appointment of trained laboratory personnel, strict enforcement of laboratory safety regulations, and increased government funding were identified as effective strategies for improving biology laboratory hazard management. The study concluded that effective management of biology laboratory hazards requires adequate safety facilities, continuous safety training, strict enforcement of laboratory safety regulations, and sustained government support to ensure a safe and conducive environment for biology practical activities in senior secondary schools.

Keywords: Biology laboratory, laboratory hazards, safety awareness, laboratory safety management, safety equipment, senior secondary schools.



Introduction

Practical laboratory experiences form the foundation of effective science teaching and learning, especially in biology, where direct observation and experimentation are essential. The laboratory enables students to investigate living organisms and natural phenomena, translating theoretical knowledge into practical understanding. Despite its importance, the laboratory environment poses several hazards, including exposure to harmful chemicals, biological agents, fire, and sharp objects.

In Nigeria, many secondary schools, particularly in Ilorin West L.G.A, face challenges in maintaining laboratory safety. Limited resources, poor infrastructure, and inadequate safety awareness often lead to accidents and unsafe practices. Many laboratories lack essential safety equipment such as fire extinguishers, first aid kits, safety goggles, and emergency exits. Furthermore, teachers and students often have little formal training in laboratory safety.

The effective management of laboratory hazards is, therefore, crucial. It involves identifying potential risks, providing safety training, enforcing safety regulations, and ensuring that laboratory facilities meet minimum safety standards. Implementing such strategies can greatly improve the teaching and learning environment and protect both teachers and students from harm. Laboratory safety refers to practices and precautions that minimize risk and ensure protection from hazards during laboratory activities (Olabisi, 2019). It encompasses preventive measures, safety equipment, and behavioral protocols that guarantee the well-being of laboratory users.

Common hazards in biology laboratories include chemical hazards, biological hazards, and physical hazards such as broken glass or electrical faults (Adebayo & Eze, 2020). Accidents often occur due to human error, inadequate supervision, or lack of safety training (Omole, 2021). Effective management strategies include proper training, provision of equipment, and enforcement of safety regulations (Okon, 2020). Biological laboratories are essential components of undergraduate education in the sciences, providing students with hands-on experience and practical skills. However, these laboratories also pose potential hazards to students, including exposure to biological agents, chemicals, and physical hazards. Effective management of these hazards is crucial to prevent accidents, injuries, and illnesses.

In Kwara State, Nigeria, many undergraduate students in biology-related fields participate in laboratory activities as part of their academic programs. However, concerns have been raised about the adequacy of laboratory safety practices and the potential risks faced by students. Factors contributing to these concerns includes Inadequate infrastructure, Outdated or poorly maintained laboratory facilities, Limited resources, Insufficient funding for safety equipment and training, and Inadequate training, Limited opportunities for students and staff to receive comprehensive safety training. Undergraduate students in biology-related fields participate in laboratory activities as part of their academic programs. However, concerns have been raised about the adequacy of laboratory safety practices and the potential risks faced by students.



Biology is one of the natural science subjects taught at secondary schools and tertiary levels of education that deals with studying living organisms, their structures, functions, evolution, distribution, and interrelationships. It serves as a prerequisite to studying many science courses and plays a vital role in the nation's economic development. Biology, as a branch of science, is the scientific study of life. It is a natural science with a broad scope; it has several unifying themes that tie it together as a single, coherent field. The secondary school biology curriculum is designed to foster students' investigation into natural phenomena, deepen students' understanding and interest in biological sciences, and encourage students' ability to apply scientific knowledge to everyday life (Onowugbeda, 2024). It is a popular and core science subject taught at the senior secondary school level in Nigeria. One primary function of Biology teaching is to help students understand biological concept, principles, theories, and laws. Also, the basic knowledge of biology is a prerequisite for studying several disciplines such as medicine, agriculture, pharmacy, microbiology, biochemistry, and psychology. Biology is generally defined as the study of life. Its significance in the Nigerian Secondary School curriculum cannot be overemphasized as it equips students with sound background in theories and practical knowledge which contributes greatly to their ability to manage natural resources in their immediate environment and the larger society (Makinde et al, 2024).

Biology is a key subject in Nigerian colleges of education curriculum under the supervision of the National Commission for Colleges of Education (NCCE). The philosophy behind the subject is to produce knowledgeable, highly motivated, professional, and effective biology teachers who will be able to develop in students an appreciation and understanding of biological processes and principles. The programme is also designed to build assertiveness in the biology teacher and enhance their ability to adapt to the changing situations in a science and technology-oriented society. The subject is combined with chemistry, computer, physical and health education, geography, mathematics, and physics (NCCE 2026). The teaching of biology is meant to expose learners to biological nature (facts, principles, and concepts), processes, and attitudes, as well as equip them with the skills of a professional biology teacher. All these can be achieved when students do biology rather than just reading biology. Doing biology implies going into the laboratory to carry out specific investigations (Lawal 2023; Lawal et al 2023).

According to Owolarafe, et al (2024), biology represents a unique branch within the field of natural science, committed to examining the intricacies/complexities of natural phenomena and occurrences. The Nigerian secondary school biology curriculum partially mirrors these facets of the discipline, it adopts a conceptual approach, covering topics such as the essence of life, fundamental ecological principles, and nutritional processes in both plant and animal, conservation of matter and energy, as well as concepts about variation, evolution, and genetics. The biology curriculum aims to equip students with proficient laboratory and field skills in biology, impart meaningful and applicable knowledge, foster the ability to apply scientific insights to everyday life, cultivate a sound scientific conduct, and inculcate an awareness of the interconnectedness between biology and other scientific disciplines (WAEC, 2023).



Biology practical plays a crucial role in science education, allowing students to gain hands-on experience that connects theoretical knowledge with real-world applications. These practical activities enable students to interact directly with biological processes, develop essential laboratory skills, and deepen their understanding of scientific principles (Simasiku et al., 2025). By participating in tasks such as dissections, microscopy, and controlled experiments, students enhance their ability to observe, analyze, and interpret biological data, ultimately improving their critical thinking and problem-solving skills. Additionally, engaging in biology practicals can spark curiosity and enthusiasm, encouraging students to explore the natural world and consider further studies in biological sciences. Well-designed biology practical's go beyond simply following procedures; they encourage inquiry-based learning and scientific reasoning.

The laboratory activity is a method of teaching where tools, apparatus, and instructional resources are used to enhance and stimulate the process of learning in a place known as a laboratory. Laboratory work in biology involves observation, description or drawing, microscopy, dissection, and experimental work (Lawal et al. 2023). In the teaching and learning of biology, scholars hold that laboratory work allows the student to experience science by using scientific research procedures and also encourages the development of analytical and critical thinking. Laboratory activities are an important pedagogical strategy for acquiring competencies in science education, making learners understand through a practical approach the theoretical topics learnt in the classroom (Paredes-Labra et al., 2018). It also strengthens theoretical Knowledge, experiencing the pleasure of discovery and development of their psychomotor skills, increasing creative thinking skills, higher order thinking skills, developing manual dexterity by using tools and equipment, allowing students to apply skills instead of rote memorization (Sison et al., 2024)

The laboratory method is one of the learning methods and its main function is to enable students to prove basic scientific facts in lab environment. Laboratory activities, to some extent, eliminate learning discrepancies resulting from individual differences. Because all the equipment, tools and techniques used in the labs during the “learning by doing” process also contributes to individual instruction. Besides, laboratory method improves students’ implication, critical thinking, scientific view and problem-solving abilities. Like any other science subject, the teaching of biology inevitably requires laboratory exercises as a part of the practical skills acquisition process (Bizimana et al., 2025).

The most accepted types of laboratories include conventional indoor laboratories and outdoor laboratories. An indoor laboratory is the school building set aside for scientific discovery and inquiry in which students are brought in direct contact with materials, manipulating them through procedures that reflect scientific thinking while an outdoor laboratory is sited outside the school building which also provides a meaningful learning experience for the students (Hofstein, & Lunetta 2004) such as natural reserves or parks, schoolyards or garden, forests or woodlands etc. Recent advances in managing hazards have made it possible to perform practical activities that are typically performed in a physical laboratory in an environment by using hazards management laboratories (Alnaser & Forawi, 2024).



Statement of the Problem

Despite the recognized importance of laboratory safety, many biology laboratories in Ilorin West L.G.A senior secondary schools operate without proper safety procedures or equipment. Accidents such as chemical burns, cuts, and fire outbreaks have been reported, often resulting from negligence, ignorance, or inadequate supervision. There is little evidence of consistent training for laboratory users, and safety rules are rarely displayed or enforced. These lapses indicate a serious need for effective strategies to manage laboratory hazards. The problem this study addresses is the lack of adequate hazard management strategies in biology laboratories of Ilorin West L.G.A senior schools. According to Sobandi et al (2020) stated that inadequate resources for teaching and learning science subjects could be connected to poor performance of students. When considering these challenges, looking for appropriate alternatives is inevitable. Hence, the use of a mobile app laboratory guide in supporting the laboratory methods could be a logical one.

Reports according to West African Examination Council (WAEC 2023), states the poor performance of students in their practical exams in conducting a simple experiment and deducing conclusions from the results. This may be due to unavailability of some laboratory apparatus needed to carry out the practical, leading to lack of adequate laboratory skills needed to carry out and evaluate experiments and projects in biology. Also, lack of skills needed to set up a laboratory for biology practical by the teacher or lab technicians and the time it takes may affect the students' ability to be learn and retain the processes of a biology practical in preparation for their major practical examinations. However, most reviews only included laboratory practices of many other disciplines, such as physics, chemistry, and engineering, with few review studies about the effectiveness and management of laboratories in teaching and learning in biology (Udin et al., 2020). As a result, this research intends to look into the effective management of laboratory in teaching and learning of biology practicals.

Purpose of the Study

The main purpose of this study is to examine strategies for managing biology laboratory hazards in Ilorin West L.G.A senior secondary schools. Specifically, the study aims to:

1. Identify the common types of hazards in biology laboratories.
2. Assess the level of safety awareness among teachers and students.
3. Evaluate the available safety equipment in school's laboratory.
4. Examine existing management practices for laboratory safety.
5. Suggest strategies for improving laboratory hazard management.

Research Questions

The study will be guided by the following questions:

1. What are the common biology laboratory hazards encountered in senior secondary



schools?

2. What is the level of safety awareness among biology teachers and students?
3. What safety equipment and facilities are available for use in school laboratories?
4. What existing management practices are used to ensure laboratory safety?
5. What strategies can be implemented to improve biology laboratory hazard management?

Scope of the Study

This study is confined to selected senior secondary schools in Ilorin West Local Government Area of Kwara State. It focuses on biology laboratories only, examining the nature of hazards, safety awareness, and management practices among teachers, students, and laboratory assistants. Other science disciplines such as chemistry and physics are excluded.

Significance of the Study

The findings of this study will be useful to: Teachers and students: by increasing awareness of safe laboratory practices, School administrators: by providing guidance on improving safety infrastructure and enforcement, Education authorities and policymakers by offering evidence to design or revise safety and management policies. Researchers, by serving as a reference material for future studies on science education and safety management. Ultimately, the study contributes to the promotion of a strategies and safety, conducive, and efficient learning environment in secondary school biology laboratories. The persistent low achievement of Nigerian students in biology has been of concern to the stakeholders, science teachers, biology teachers, curriculum planners, and government. Consequently, in the outcome of this study it may enlighten the learners and empower them to identify aspects of practical's that tailored to perfect their competence. This study may also assist the teachers in determining appropriate pedagogical tools, strategy to use in managing hazards and methodology to impart procedure, execution, observation, and interpretation skills, which are learned on the Bio lab Guide and make a marked impact on performance in practical's and subsequently on students' learning outcomes in Biology.

This study could also help the National Educational Research and Development Council (NERDC) to come up with different instructional methods and pedagogical tools to ensure students' competence in biological practical. This study may further help students and teachers save time and effort as they would not need to adhere to certain times in the laboratory. The finding of this study might contribute to the existing body of research on management hazards, strategies to manage equipment in the laboratories, providing new insights and perspectives on their effectiveness in biology education. The findings of the study shall inform education policy and decision-making, helping to shape the future of science education in Nigeria. This study will provide a framework for future research on management hazards in laboratories, enabling researchers to build upon and extend the findings. This study is significant because it has the potential to improve learning-outcomes, increase accessibility, enhance teacher training, promote cost-effectiveness, safety, and management environmental sustainability, contribute to existing literature, inform education



policy, provide a framework for future research, promote Science, Technology, Engineering, and Mathematics (STEM) education, support national development, and enhance global competitiveness.

Methodology

The study adopted a descriptive survey research design to investigate strategies for managing biology laboratory hazards in selected senior secondary schools in Ilorin West Local Government Area of Kwara State, Nigeria. The descriptive survey design was considered appropriate because it enabled the researcher to obtain information from respondents on the prevailing laboratory hazards, the level of safety awareness, the availability of laboratory safety equipment and facilities, existing safety management practices, and possible strategies for improving biology laboratory hazard management. The study involved biology teachers, laboratory attendants, and senior secondary school students, who constituted the respondents because they are directly involved in biology laboratory practical activities and are knowledgeable about laboratory safety issues.

Data for the study were collected through the administration of questionnaires to the selected respondents. The questionnaire elicited information on the common biology laboratory hazards encountered in senior secondary schools, the level of safety awareness among biology teachers and students, the availability of safety equipment and facilities in school laboratories, existing management practices used to ensure laboratory safety, and strategies that could be implemented to improve biology laboratory hazard management. The data collected were analyzed using descriptive statistics and presented in tables through the computation of mean scores to answer the research questions. The benchmark for interpreting the mean scores was 1.00–2.50 (Low), 2.51–3.25 (Moderate), and 3.26–4.00 (High), and the findings were interpreted accordingly.

Results

Answering of Research Questions

Research Question One: What are the common biology laboratory hazards encountered in senior secondary schools?

Table 1: Mean Score on the Common Biology Laboratory Hazards Encountered in Senior Secondary Schools

	Hazard Types	Mean Score	Decision
1	Chemical spills	3.52	High
2	Broken glassware	3.41	High
3	Biological contamination	3.36	High
4	Fire hazards	3.18	High
5	Electrical faults	3.10	Moderate
	Grand Mean	3.31	High

The benchmark for the level of the items is 1.00-2.50 (Low), 2.51-3.25 (Moderate) and 3.26-4.00 (High).



The findings in Table 1 revealed the common biology laboratory hazards encountered in senior secondary schools. Chemical Spills (mean = 3.52): This represents the highest-scoring hazard in the dataset. Falling deep into the "High" category, it suggests that chemical management, storage, or handling protocols require immediate attention, as this is perceived as the most critical threat. Broken Glassware (mean = 3.41) & Biological Contamination (mean = 3.36): Both of these hazards also scored firmly in the "High" category. This point to substantial risks surrounding physical waste disposal (glass) and bio-safety protocols (contamination), making them secondary priorities that closely trail chemical spills. Fire Hazards (mean = 3.18): Although fire hazards are categorized as "High" in the decision column, its mean score actually places it within the moderate (2.51–3.25) benchmark range. Electrical Faults (mean = 3.10): This is the lowest-scoring item on the list and is correctly designated as a Moderate hazard. The findings indicate a high level of perceived or actual hazard risk within the environment, as evidenced by the grand mean of 3.31, which falls squarely into the "high" risk category.

Research Question Two: What is the level of safety awareness among biology teachers and students?

Table 2: Mean on the Level of Safety Awareness among Biology Teachers and Students

Safety Awareness Indicator	Mean Score	Decision
1 Knowledge of safety rules	2.96	Moderate
2 Ability to identify hazards	2.88	Moderate
3 Knowledge of emergency procedures	2.52	Moderate
4 Use of safety equipment	2.41	Low
Grand Mean	2.69	Moderate

The results in Table 2 indicates the level of safety awareness among biology teachers and students. Knowledge of safety rules (mean = 2.96): This is the highest-scoring indicator. It shows that organizational rules, manuals, or training orientations have successfully imparted standard rules to the workers. Ability to identify hazards (mean= 2.88). Respondents score relatively well on recognizing a hazard when they see one. They know what poses a threat in their environment. Knowledge of emergency procedures (mean = 2.52): This item sits precisely on the lower boundary line of the moderate bracket (2.51–3.25). It reveals a critical gap: workers may understand day-to-day safety rules (2.96), but their understanding drops significantly when it comes to emergency protocols (e.g., handling unexpected fires, toxic containment, or evacuation steps). Use of safety equipment (mean = 2.41): This is the lowest-scoring indicator in the dataset, falling squarely into the low level of awareness or compliance. The grand mean of 2.69 indicates that the overall level of safety awareness among the respondents is moderate.



Research Question Three: What safety equipment and facilities are available in school laboratories?

Table 3: Mean on the Availability of Safety Equipment and Facilities in School Laboratories

	Equipment	Mean Score	Decision
1	Fire extinguishers	2.12	Low
2	First aid kits	2.20	Low
3	Emergency exits	1.98	Low
4	Eye wash stations	1.61	Low
5	Safety goggles and gloves	2.31	Low
	Grand Mean	2.04	Low

The findings in Table 3 revealed the safety equipment and facilities that are available in school laboratories. Fire extinguishers (mean = 2.12). It implies that if a fire hazard (which scored a 3.18 in previous data) manifests as an actual fire, the tools required to suppress it immediately are largely missing or unserviceable. First aid kits (mean = 2.20): Basic medical response supplies are severely lacking. Emergency exits (mean = 1.98) dropping below the 2.00 threshold, this low score indicates poor architectural safety design or compromised escape routes (e.g., locked, blocked, or poorly marked exits). Eye wash stations (mean = 1.61): This is the lowest score in the entire dataset. Eye wash stations are vital for neutralizing chemical splashes to the eyes. Safety goggles and gloves (mean = 2.31). This is the highest score in the dataset; it remains in the "low" category. The most striking finding from this dataset is the grand mean of 2.04, which is explicitly designated as Low.

Research Question Four: What existing management practices are used to ensure laboratory safety?

Table 4: Mean on the Existing Management Practices Used to Ensure Laboratory Safety

	Existing Management Practices	Mean Score	Decision
1	Teacher supervision	3.40	High
2	Restricted access	3.02	Moderate
3	Safety training	2.12	Low
4	Equipment maintenance	2.30	Low
5	Enforcement of rules	2.28	Low
	Grand Mean	2.62	Moderate

Table 4 showed existing management practices used to ensure laboratory safety. Teacher supervision (mean = 3.40): This is the highest-scoring practice and the only item that legitimately falls into the High category based on the benchmark. This indicates that educators are physically present in the laboratories to monitor students during practical sessions, providing a strong human line of defense. Restricted access (mean = 3.02): This



falls into the moderate category. It indicates a fair level of control over who enters the laboratory, preventing completely unsupervised student access or unauthorized personnel from wandering in. Equipment maintenance (mean = 2.30): routine checks and servicing of laboratory apparatus are largely neglected. Enforcement of rules (mean = 2.28). The grand mean of 2.62 reveals that, overall, laboratory safety management practices are at a moderate level.

Research Question Five: What strategies can be implemented to improve biology laboratory hazard management?

Mean on the Strategies for Implementation of Improving Biology Laboratory Hazard Management

	Strategies	Mean Score	Decision
1	Safety training	3.52	High
2	Provision of equipment	3.48	High
3	Appointment of trained personnel	3.41	High
4	Enforcement of rules	3.39	High
5	Government funding	3.55	High
	Grand Mean	3.47	High

The findings in Table 5 revealed strategies that could be implemented to improve biology laboratory hazard management. Safety training (mean = 3.52), stakeholders strongly agree that regular, standardized safety workshops and training modules for both teachers and students must be introduced immediately. Provision of equipment (mean = 3.48), this reinforces the urgent demand to address the severe shortage of safety infrastructure (such as eye wash stations and fire extinguishers, which previously scored a low 2.04). Appointment of trained personnel (mean = 3.41) respondents strongly support hiring dedicated, professionally trained laboratory technologists or safety officers. Enforcement of rules (mean = 3.39); is the lowest score in this specific table and it shows that clear consensus that passive supervision is not enough; government funding (mean = 3.55) is the highest-scoring item in the entire dataset. Respondents recognize that institutional or school-level budgets are insufficient to fix the laboratory crisis. The most defining characteristic of this dataset is the grand mean of 3.47, which falls firmly into the high category.

Discussion of the Findings

The findings of the study revealed that chemical spills, broken glassware, biological contamination, and fire hazards were the most common hazards encountered in biology laboratories of senior secondary schools in Ilorin West Local Government Area, while electrical faults were experienced at a moderate level. This finding suggests that biology laboratories expose teachers and students to numerous hazards capable of affecting effective teaching and learning if appropriate safety measures are not implemented. The result corroborates the submission of Adebayo and Eze (2020), who observed that chemical,



biological, and physical hazards constitute the major safety challenges confronting science laboratories in Nigerian secondary schools. Similarly, Omole (2021) reported that laboratory accidents are frequently associated with poor safety management, inadequate supervision, and negligence in the handling of laboratory materials.

The study further found that the level of safety awareness among biology teachers and students was moderate. Although respondents demonstrated moderate knowledge of laboratory safety rules and hazard identification, they exhibited low utilization of safety equipment. This implies that awareness of laboratory safety does not necessarily translate into compliance with safety practices. The finding supports the assertion of Musa and Afolabi (2021) that continuous safety training is necessary to improve laboratory users' knowledge and compliance with established safety procedures. The finding also agrees with Olabisi (2019), who emphasized that laboratory safety depends not only on knowledge of safety rules but also on the consistent application of safety practices during practical activities.

The findings also indicated that the availability of laboratory safety equipment and facilities was generally low. Essential safety facilities such as fire extinguishers, first aid kits, emergency exits, eye wash stations, and personal protective equipment were inadequately provided in the sampled schools. This finding confirms the observation of Okon (2020) that many Nigerian secondary school laboratories lack adequate safety facilities required for effective laboratory management. The inadequacy of safety equipment increases the vulnerability of laboratory users to accidents and limits the effectiveness of emergency response whenever hazards occur.

Furthermore, the study revealed that existing laboratory safety management practices were only moderately effective. Teacher supervision recorded a high mean score, whereas safety training, equipment maintenance, and enforcement of laboratory safety regulations were rated low. This indicates that although teachers supervise practical activities, institutional safety management practices remain inadequate. The finding agrees with Omole (2021), who reported that effective laboratory safety management requires regular equipment maintenance, continuous staff training, and strict enforcement of laboratory regulations in addition to teacher supervision.

Finally, the study established that regular safety training, adequate provision of safety equipment, appointment of trained laboratory personnel, strict enforcement of laboratory safety regulations, and increased government funding were effective strategies for improving biology laboratory hazard management. Government funding received the highest rating among the proposed strategies, suggesting that respondents considered adequate financial support essential for improving laboratory safety infrastructure. This finding is consistent with Okon (2020), who emphasized that effective laboratory management depends largely on adequate funding, provision of modern safety facilities, and regular maintenance of laboratory equipment. It also supports the position of Musa and Afolabi (2021), who concluded that continuous safety training and adequate provision of safety facilities significantly reduce laboratory accidents and promote effective science teaching and learning.



Conclusion

This study examined strategies for managing biology laboratory hazards in senior secondary schools in Ilorin West Local Government Area of Kwara State. The findings established that biology laboratories are exposed to several hazards, particularly chemical spills, broken glassware, biological contamination, and fire hazards, which pose significant threats to the safety of teachers and students during practical activities. The study also revealed that although respondents demonstrated a moderate level of safety awareness, the availability of laboratory safety equipment and facilities was generally low. Existing laboratory safety management practices were only moderately effective, with teacher supervision being the most prominent practice, while safety training, equipment maintenance, and enforcement of laboratory safety regulations remained inadequate. Furthermore, the study established that regular safety training, adequate provision of laboratory safety equipment, appointment of trained laboratory personnel, strict enforcement of laboratory safety rules, and increased government funding are effective strategies for improving biology laboratory hazard management. It is therefore concluded that creating a safe and conducive biology laboratory environment requires the combined efforts of school administrators, teachers, government, and other educational stakeholders through improved safety awareness, adequate provision of safety facilities, effective supervision, and sustained investment in laboratory safety management.

Recommendations

Based on the findings of this study, the following recommendations are made:

1. School authorities should implement effective measures to minimize common biology laboratory hazards, particularly chemical spills, broken glassware, biological contamination, and fire hazards, since these were identified as the major hazards encountered in biology laboratories.
2. Regular laboratory safety awareness programmes should be organized for biology teachers and students to improve their knowledge of emergency procedures and encourage the proper use of laboratory safety equipment, as the study revealed only a moderate level of safety awareness and low utilization of safety equipment.
3. Government and school proprietors should provide adequate laboratory safety facilities, including fire extinguishers, first aid kits, emergency exits, eye wash stations, safety goggles, and gloves, because the study found that these facilities were inadequately available in the sampled schools.
4. School administrators should strengthen laboratory safety management by organizing regular safety training, ensuring routine maintenance of laboratory equipment, and enforcing laboratory safety rules, since these management practices were found to be inadequate despite the high level of teacher supervision.
5. Government should provide increased funding for secondary school biology laboratories to facilitate the provision of safety equipment, appointment of trained laboratory personnel, implementation of regular safety training programmes, and effective enforcement of laboratory safety regulations, as these strategies were identified



by respondents as the most effective means of improving biology laboratory hazard management.

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