



## Overview of Quality Control and Safety in Public Health Pest Laboratory in Jeddah, Saudi Arabia

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### ABSTRACT

Quality and safety control at the Public Health Pests Laboratory (PHPL) in Jeddah, Saudi Arabia, has received great attention as part of the ongoing endeavors to protect workers and the surrounding environment, in line with the Kingdom's Vision 2030. This article aims to give an overview of the quality control and safety measures implemented within the PHPL in Jeddah, KSA. It reflects upon successful initiatives undertaken to strengthen the quality control and safety system while also proposing recommendations to sustain progress and enhance the overall quality control and safety framework within the PHPL in Jeddah, KSA. Broadly, an examination of quality and safety control documentation, as well as the regulatory systems within the KSA, has been conducted across various ministries and institutes related to quality and safety control. Specifically, this scrutiny has been applied to laboratory operations and their outcomes. The emphasis on quality control within the KSA is evident, aligning with regulations and laws set forth by entities such as Occupational Health in the labor system, Saudi Standards, Metrology (SASO), the Quality Organization, the National Strategic Program for Occupational Health, and the Technical Rules and Regulations of the Ministry of Natural Resources and Human Development. In addition, Quality control and safety were strengthened in the public health pests laboratory in Jeddah, Saudi Arabia, by issuing; a security and safety manual, an operational plan for safe evacuation during an emergency, and implementing as a practical experiment; a quality policy; and Safety tools and equipment provided within the laboratory.

**Keywords:** Quality control, Safety, Public health laboratory, Jeddah, Saudi Arabia.

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### INTRODUCTION

Quality management is defined as the part of the overall management function that determines and implements quality policy, gradually by doing the right things from the beginning (Ali et al., 2015). Public health laboratories serve as the first line of defense to protect people against diseases and other health risks. International and local public health laboratories often perform tests unavailable elsewhere. At the state level, public health laboratories assist in the formulation of public policies, the development of new methods for the detection and control of infectious diseases, environmental pollutants, and toxins, the organization of the work of medical and environmental

laboratories, and the provision of other necessary services to protect the health and well-being of the population (Prevention, 2013; WHO, 2017; Witt-Kushner et al., 2002). Implementing a quality management system, which depends on good management of the twelve quality basics, in order to achieve the highest level of accuracy and reliability in the quality of service provided. Quality fundamentals include: organization and management of information, documents and records, event management, equipment, purchasing, inventory and personnel, process monitoring and evaluation, process improvement, customer services, facilities and safety (Chaudhry et al., 2023; Mulleta et al., 2021) Public health laboratories focus on diseases and the health status of population groups.

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Moreover, provide emergency response support, perform applied research, and provide training for laboratory personnel (Prevention, 2013; WHO, 2017; Witt-Kushner et al., 2002). The goal of public health laboratories, in general, is to protect and improve public health by testing samples; providing high-quality equipment; expertise, and scientific information by applying research. The Association of Public Health Laboratories established and identify eleven core functions for public health laboratories, including providing a basis for assessing and improving the quality of laboratory activities being conducted, including disease prevention, control and surveillance; Integrated data management; Reference and specialized testing; Environmental health and protection; Food safety; Laboratory improvement and regulation; Policy development; Public health preparedness and response; Public health-related research; Training and education, and Partnerships and communication (WHO, 2017, 2020c; Witt-Kushner et al., 2002).

Although laboratory safety has long been considered of importance and priority in public health laboratories, multiple gaps remain between published best practices and the actual implementation of these practices in public health laboratories. This is because the implementation and development of work-related regulations and standards strategies are left to laboratories alone (Keckler et al., 2019).

### Quality Control and Safety Globally

Workers in laboratories are faced with many occupational risks at work and their health and safety may be severely jeopardized if adequate preventive protective measures are not taken (Alshalani and Salama 2019). International Organization for Standardization defined quality control as "coordinated activities to direct and control an organization with regard to quality". The main values for Quality and Safety control are dedication to work, transparency, honesty, mutual respect, adherence to organization policies, team spirit, and maintaining the confidentiality of information (WHO, 2020a). In general, the objectives of quality control and safety are to prioritize the quality program, provide health care to patients in record time characterized by high quality, cost-effectiveness, and safety with monitoring and evaluation, control quality-related activities, including policy development, pursue opportunities to improve healthcare, services, and safety, follow up on reports issued by various organization committees and make recommendations regarding issues of operation and quality of care, refer the facts to the competent authorities from committees, departments, clinical services, and work teams, solve the detected problems in a short time, and facilitate the understanding of administrative and clinical review data, including its distribution and management of discussions about it (WHO, 2020d). In the other hand different services can be provided by Quality and Safety Management which include: follow-up of multidisciplinary teams in their tasks and system by follow up the minutes and submit current recommendations to the concerned bodies; follow-up of the system of procedures and policies by follow-up

policies and keep pace with organization policies; providing consultations regarding the implementation of the requirements of the International Accreditation Organization by holding meetings and discussions with various departments of the organization and following up and updating the requirements, providing consultations related to the development of policies and regulations; coordination and follow-up with quality improvement teams in departments and units by ensuring the representation of all departments and benefiting from the teams for important improvements; coordination and overcoming quality improvement projects by recording all studies and collecting them with saving them in the quality and safety department for future benefit; coordination of clinical follow-up procedures by development of indicators and work of tables for the purpose of follow-up and periodic reports; education and training on organization policies and requirements of the International Commission for Accreditation; documentation and preparation coordination of risk management initiatives (fact reports - security - safety - spread of diseases - codes) and follow up on the implementation of international patient safety goals (Prevention, 2013; WHO, 2020a).

The complexity of the laboratory system requires that many factors must be addressed to assure quality in the laboratory. Some of these factors include the laboratory environment, quality control procedures, communications, record keeping, competent and knowledgeable staff, and good-quality reagents and equipment (Centrich et al., 2011; WHO, 2020b).

### International Organization for Standardization (ISO) 17025 Accreditation (Fig. 1)

ISO/IEC 17025 is a standard developed by the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC). It outlines the general requirements for the competence of testing and calibration laboratories. The accreditation process evaluates various aspects, including management systems, personnel competency, equipment calibration, traceability of measurements, quality assurance procedures, and more.

ISO 17025 accreditation ensures that a laboratory operates efficiently, produces accurate results, maintains proper documentation, manages risks effectively, and continuously improves its processes. By adhering to this standard, labs demonstrate their commitment to quality assurance and customer satisfaction.

ISO 17025 accreditation is of great importance to all national and regional laboratories. It is an internationally recognized standard that ensures the efficiency and reliability of laboratory operations (Centre, 2023; Staff writer, 2024).

### General Requirements for ISO 17025, 2017

- Laboratory activities should be undertaken impartially, structured and managed to safeguard impartiality.
- Risk to impartiality should be identified and prevented, e.g. possible conflicts of interest between personnel and activities performed.

- Confidentiality of results to the customer and of customer's information is guaranteed. However, findings of regulated pests or new pests and associated customer information should be reported to the National Plant Protection Organizations (NPPO) (including a requirement for customers from other countries to report such findings to the NPPO of their country). The customers will be notified of the information provided (Standard-Diagnostics, 2021).

#### **Benefits of Working with an ISO 17025 Accredited Lab**

Choosing to work with an ISO 17025 accredited lab provides numerous benefits.

Firstly, it assures clients that the lab operates at a high level of competence and follows international best practices. This reduces any uncertainties regarding the reliability of test results or calibration certificates.

Secondly, ISO 17025 enhances credibility in industries where accurate measurements are crucial. Whether it's pharmaceuticals, food safety testing, environmental analysis or automotive manufacturing – having test results from an accredited lab adds credibility to your products or services.

Thirdly, working with an accredited lab minimizes risks associated with faulty measurements or inaccurate data analysis. This is especially important in industries where safety, health, or compliance regulations are involved.

- Lastly, ISO 17025 accreditation fosters continuous improvement within the lab. Regular audits and assessments ensure that the lab maintains its competence and stays up-to-date with the latest technologies and methodologies (ISO, 2017; Standard-Diagnostics, 2021)

Due to the importance of quality in laboratories of public health pests and chemical and biological materials in general, there are many laboratories at the level of laboratories of international, regional and national organizations that have worked on applying and developing quality standards and systems (Ahmed et al., 2020; Alabbasy et al., 2021; Lau et al., 2021; López et al., 2021; Riana et al., 2021; Vreysen et al., 2021; Wulandari et al., 2023).

#### **Types of Quality Control in the Laboratories**

**Internal Quality Control:** It is concerned with daily and accurate follow-up of the validity of the results by measuring random samples. And compare them with the values to ensure the degree of operation of the laboratory equipment and its ability to produce the same results every day.

**External Quality Control:** This is concerned with long-term monitoring of the performance of the laboratory and comparing it with international laboratories. This is done through the participation of the laboratory in special programs through which samples of value that the laboratory does not know in advance are sent. Upon completion of the analyzes, the results are compared with the results of international laboratories to ensure the validity and accuracy of the laboratory results (Centrich et al., 2011; Hrsd.gov.sa, 2022; Saso.gov.sa, 2023).

Each laboratory must have key safety principles and procedures in place that minimize the risk of contamination and exposure to the pathogens being tested. In biological laboratories, one of four biosafety levels is assigned, with Level 1 being the lowest risk and Level 4 the highest.

The quality of the laboratory depends on accuracy, reliability, and timely reporting of test results. Laboratory results must be as accurate as possible, all aspects of laboratory operations must be relied upon, and timely reporting must be provided to be useful in clinical or public health settings. In a quality management system, all practical aspects of the laboratory, including organizational structure, processes and procedures, should be quality assurance-oriented (Hrsd.gov.sa, 2022; WHO, 2020b).

#### **Quality Control and Safety in Saudi Arabia**

Quality control and safety in the Kingdom are shared by several institutions and bodies working according to programs with specific responsibilities in which the roles of the various bodies and institutions are integrated to achieve the welfare and safety of community members and ensure the quality and safety of various products within the framework of the Kingdom's Vision 2030.

#### **Occupational Safety and Health in the labor system in Saudi Arabia**

In 1426, a royal decree was issued, dealt with several articles concerned with enhancing the attractiveness of the work environment, specifically occupational safety and health, distributed over several chapters. These articles are concerned with setting the main regulatory frameworks that the employer and the worker must adhere to, and give the Ministry more authority to detail occupational health and safety requirements in a way that contributes to protecting the health and safety of workers and maintaining property and preserving environment. Chapter eight stipulates specific concerns with the prevention of work risks and the prevention of major industrial injuries and accidents in social services and labor and health; these articles are the first part about the prevention of work risks in the Laboratory and the fourth part about the health and social services, further part nine include the women employment, part ten talked about child employment, and finally part twelve explain the requirements for work in mines and quarries (Saso.gov.sa, 2023).

#### **Saudi Standards, Metrology, and Quality Organization**

SASO is one of the institutions that carry out multiple tasks in the field of quality control and safety, as the vision of SASO is to be a globally reliable and enabler of quality of life and competitiveness of the national economy. Further, SASO mission is excellence in developing standards, conformity, and metrology and enhancing product safety in the KSA. The Authority has values of neutrality, perfection; integration with partners, creativity, and transparency.

**Objectives of the SASO:** Issuing Saudi standards, quality systems, and manuals, conformity assessments that comply with international standards and guides meet the

requirements of the World Trade Organization agreement in this field, and be compatible with Islamic law and achieve the interests of the Kingdom; providing health, environmental, and public safety protection, by ensuring that the products conform to the standard specifications approved by the authority; and ensuring the quality of national products by adopting appropriate Saudi standard specifications that enable national products to compete in local and international markets, and working to protect the Kingdom's markets from counterfeit and goods counterfeit (Saso.gov.sa, 2023).

As part of Saudi Standards, Metrology, and Quality Organization efforts in the fields of quality control and safety, Saudi Standards, Metrology, and Quality Organization designed the Saudi Product Safety Program (SALIM) as part of the vision of the Kingdom's National Transformation Program for the years 2020 and 2030, this program aims to ensure that quality and safety systems in the Kingdom of Saudi Arabia meet and that imported products comply with the standards and technical regulations set by the Saudi Organization for Standardization and Metrology. Thus, protecting the health and safety of consumers, as well as the environment, from the risk of substandard, counterfeit, and potentially dangerous goods (Hrsd.gov.sa, 2022).

### **National Strategic Program for Occupational Safety and Health of the Ministry of Natural Resources and Human Development (Aichouni et al., 2023; Prevention, 2013)**

**Program Description:** It is one of the programs of the Ministry of Human Resources and Social Development in the National Transformation 2020 (one of the programs of the Kingdom's Vision 2030) that contributes to achieving one of the strategic objectives entrusted to the Ministry. It is a program that contains several projects and outputs that seek to achieve two long-term goals, the first is the formulation of a national policy agreed upon by stakeholders, and the second is the development of a national system for occupational safety and health for private sector establishments in the Kingdom of Saudi Arabia. This program is based on the application of several standards of best practices offered by relevant international organizations and developed countries in the field of occupational safety and health (Saso.gov.sa, 2023).

**Strategic Objectives of the Program:** First Objective: Formulation of a national policy for occupational safety and health: The National Policy seeks to clarify the roles and responsibilities among all parties related to the development of occupational safety and health for private sector establishments. The practices of developed countries necessitate the existence of such a policy that clarifies to all stakeholders in occupational safety and health the roles and responsibilities, strategic directions and objectives, and how to integrate in general between the various bodies in order to achieve the development of the reality of occupational safety and health (Saso.gov.sa, 2023).

**Second Objective:** Developing a national system for occupational safety and health: To develop the reality of occupational safety and health practices, there must be a model followed for the methodology of developing occupational safety and health, and this model is a system (the system here means a model that has inputs and outputs and is not intended for legal expression) that contains strategic main pillars under which all initiatives and development directions fall (Saso.gov.sa, 2023).

### **Technical Rules and Regulations of the Ministry of Natural Resources and Human Development**

In the interest of the Ministry of Human Resources and Social Development to enhance the partners and institutes from public and private sectors to regulating the work environment, especially with regard to occupational safety and health, the Ministry issues technical regulations and regulations in order to promote practices that help employers and workers raise the level of occupational safety and health which are:

- Article 30 and their annexes explain the requirements and contents of the first aid cabinet.
- Equipping a first aid room and a paramedic (Ministerial Decree 400/1 dated 01/2/1428 AH).
- Occupational Safety and Health Inspection Mechanism - Appendix No. OSH1
- Guidance document for potential risks facing the work environment in private sector establishments - OSH2 Annex.
- Check List Occupational Safety and Health Regulation - Minimum Level - OSH3 Annex
- Check Occupational Safety and Health Regulation List - Intermediate Level - OSH4 Annex
- List of occupational safety and health violations

### **Public Health Pests Laboratory in Jeddah**

The vision of the public health pest laboratory in Jeddah is to create a work environment that encourages innovation and commitment in order to provide the necessary information to determine the best appropriate ways to reduce the spread of public health pests, ward off the seriousness of diseases that can transmit them, and participate in achieving the goals of the Kingdom 2030 aimed at building a vibrant society whose members enjoy a healthy lifestyle and creating a positive and attractive environment. The mission of the public health pest control laboratory in Jeddah is to reduce the densities of disease vectors and enhance the role of the laboratory in achieving the wheel of growth and providing a safe and disease-free healthy environment. Moreover, the public health pest control laboratory in Jeddah has many objectives, most notably: Providing specialized scientific and technical cadres; Providing advanced devices for use in the fields of definition and scientific classification of public health pests to develop scientific research and innovation capabilities in the field of insects of medical and veterinary importance and control them with a scientific methodology and with the least harm to humans and the environment; estimating the geographical distribution, densities and seasonal activity of disease vectors; measuring the sensitivity of

pests to pesticides and baits used to control public health pests; providing scientific consultations for the concerned authorities in the field of vector control; and providing scientific programs and high-quality training courses and developing research and capabilities in the laboratory. On the other hand, the public health pest control laboratory in Jeddah consists of seven units: the Environment and classification of public health pests unit; the biological evaluation unit for pesticides; the biochemistry and molecular biology unit; the microbiology and parasitology unit; the geographical information system unit; the data analysis and statistics unit and the quality and accreditation unit (Saso.gov.sa, 2023).

### Steps to Strengthen Quality Control and Safety

Public health pests laboratory in Jeddah follow the requirement of ISO 17025, 2017 which need the laboratory to establish, implement and maintain a

quality management system that is capable of supporting and demonstrating the consistent achievement of the requirements of this Standard and assuring the quality of the laboratory results (Standard-Diagnostics, 2021).

**First:** The Public Health Pests Laboratory in Jeddah was given the application of the highest quality standards in the Public Health Pests Laboratory and adhered to the principle of comprehensive application of quality and reliability of the laboratory's results, which led to the Public Health Pests Laboratory in the Jeddah Municipality obtaining accreditation for the standard specification ISO/IEC (2017): 17025 from the Saudi Accreditation Center. (SAC) for the pesticide biological evaluation laboratory, which confirms the continuity of work with the highest standards of quality requirements in the public health pest laboratory (Fig. 1).



**Fig. 1:** Accreditation Certificate for Insecticide Bioassay Lab in the Public Pest Laboratory, Jeddah Municipality.

**Second:** Issuing the Security and Safety Booklet: In August 2022, PHPL issued the security and safety booklet as the foundation of quality management. This booklet discussed many topics and clarified the requirements and procedures that must be followed to protect workers and the surrounding environment, most notably; "Write down what you do, do what you write." This means that everything done routinely must be documented in the laboratory. On the other hand, the purposes of this booklet are to document all the procedures and steps necessary to carry out the work and the precautions required to prevent damage to workers or the environment that may result from laboratory activities; besides that, train and explain this to all employees and provide copies across the laboratory site and inside the laboratory buildings.

The book includes seven main chapters first one gives an introduction to occupational safety and security; the second chapter explains primary sources of hazard within the PHPL in Jeddah; the third chapter explains the procedures to be followed to reduce chemical and biological hazards within the laboratory; the fourth chapter explains the precautions to be followed after completing the experiments and leaving the unit; the fifth chapter explains the activities related to occupational security and safety operations within the laboratory units; and last one explains the checklist for evaluating facilities in terms of occupational safety and security procedure.

**Third:** Operational Plan for safe evacuation during an emergency (Fig. 2): This plan aims to evacuate the workers

and visitors as soon as they hear the emergency or fire alarm bell by directing them to the predetermined assembly points and defining the responsibilities and tasks of the risk management team in the event of an emergency to serve as a general framework for the implementation of evacuation plans, firefighting, rescue and operation shelter, and a guide to protecting workers and the laboratory. Accordingly, the risk and crisis management team were established, and the responsibility of each member was determined, including the responsibilities of the unit's specialist. Besides that, the assembly point was established, and a trial was done to determine any challenges and constraints to be avoided. The report discussed in the meeting and recommendations were explained and approved by the laboratory staff.

**Fourth:** Quality policy (Fig. 3): In April 2022, the Pesticide Bio-Assessment Laboratory at the PHPL in Jeddah Municipality issued a quality policy that explains the PHPL in Jeddah is committed to achieving the highest safety requirements for the targeted people through continuous development processes and meeting the highest quality standards in accordance with international standards and systems. Moreover, this policy confirmed the laboratory's keenness to meet the requirements and desires of customers by understanding their needs and then meeting their requirements efficiently and without obstacles. This policy was discussed by all relevant staff and approved by the top manager and copies were fixed inside the laboratory and on the laboratory site.

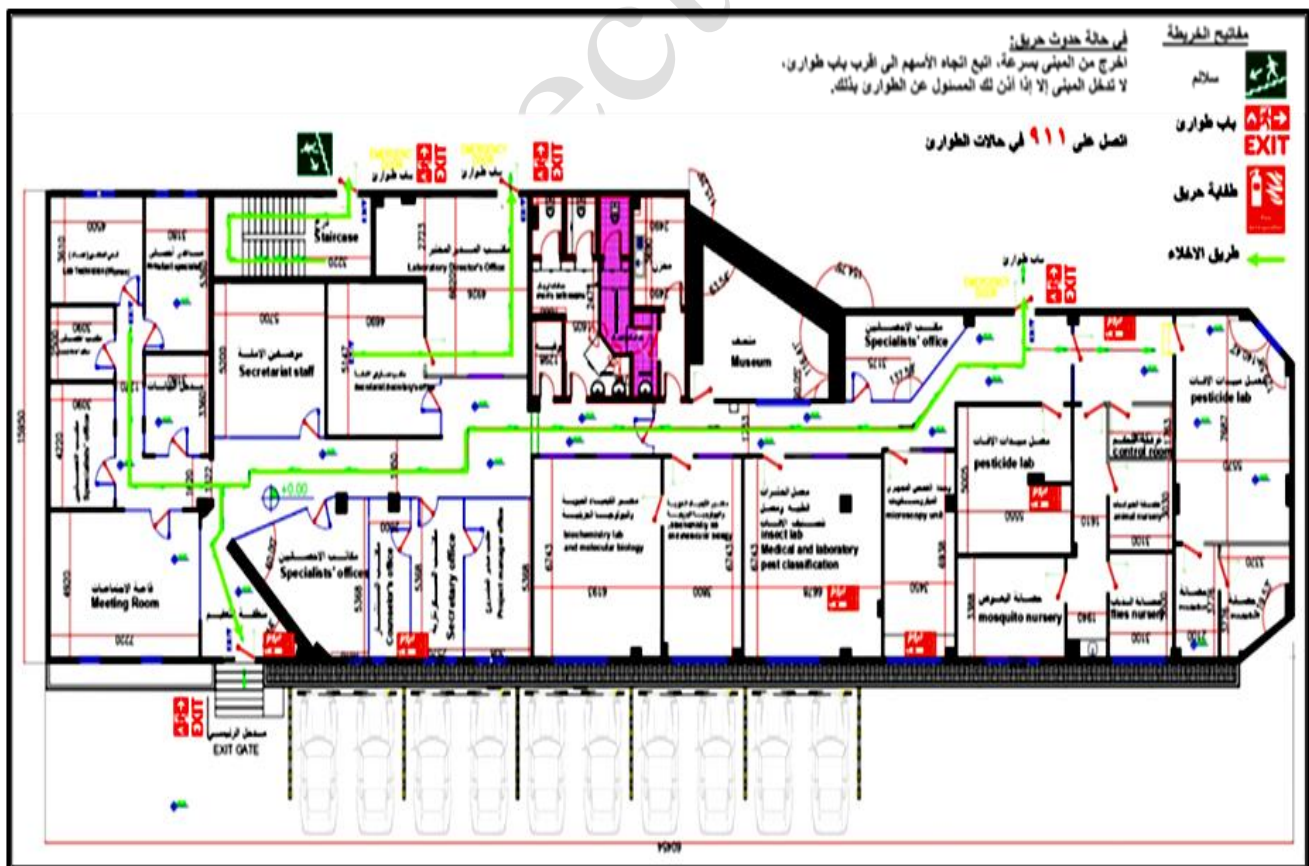


Fig. 2: Evacuation plan map.

**Insecticide Content of the quality policy document:**  
 Bioassay Lab at the Public Health Pests Laboratory, Jeddah Municipality

**Quality Policy**  
 Insecticide Bioassay Lab at the Public Health Pests Laboratory, Jeddah Municipality is committed to achieving ultimate safety of people through continuous improvement and providing quality standards that meets with the international, regulatory aspects. Customer satisfaction starts with understanding client's needs and meeting his requirements efficiently without hindrance.

**Laboratory Objective:**  
 Insecticide Bioassay Lab at the Public Health Pests Laboratory, Jeddah Municipality aims to:

- Ensure the effectiveness of pesticides and the sensitivity of pests to these specific pesticide concentrations, using the latest methods and applying the protocols recommended by the World Health Organization and the latest scientific research published in this field.
- Providing effective scientific and practical solutions to the client's problems.
- Ensuring timely delivery of testing results to meet clients' requirements.
- Providing high quality service and solutions to support client's with achieving their goals.

In providing services to clients, Insecticide Bioassay Lab at the Public Health Pests Laboratory, Jeddah Municipality conforms to legal and statutory safety practices and strictly adheres to specified standards with respect to ethical and professional business practices.

our greatest asset the human resources and it is committed to building a culture and working environment that fosters well-being whilst providing opportunities for on-going learning and advancement of its people. We are committed to quality and the continuous improvement of its systems and processes and understanding and fulfilling our client's expectations by providing expertise and high quality equipment to meet and exceed their requirements in accordance with contractual agreements.

We are responsible for the impartiality and transparency for its laboratory activities and not allow commercial, financial or other pressure to compromise impartiality.

We achieve this by strict adherence, by all employees, to the policies. and procedures of the Laboratory quality management system in accordance with ISO/IEC 17025, Standard, Test methods and other relevant legislative requirements.

Insecticide Bioassay Lab at the Public Health Pests Laboratory, Jeddah Municipality manager and employees ensure that the quality requirements of our customers are realized through:

- Implementation and maintaining a quality system compliance with ISO/IEC 17025 standard.
- Maintain the effectiveness of quality management system.
- Provide effective means of communication.
- Knowledge and its appropriate application.
- Retention and management of resources.
- Identification and management of quality objectives.
- Management review.
- Risk and opportunity Management.
- Metrics as measurements of success and opportunities for improvement.

Management's policy for Quality: ➢ Applying the principle of (safety first) by following national and international guidelines.

- Maintaining a quality management system that meets the requirements of ISO 17025:2017.
- Satisfy clients.
- Provide competitive solutions for clients.
- Operate within the of relevant national and international law and legislation.
- Improve continuously.
- Work with complete impartiality and maintain the confidentiality of the results of the analysis.

Laboratory Manager:  
 Date: 13/4/1444 H

**Fig. 3:** Quality policy.

**Fifth:** Safety tools and equipment provided by the laboratory and training was done for all staff (Fig. 4): The Public Health Pest Laboratory has made the safety of workers and the surrounding environment a priority with close follow-up from the Jeddah Municipality, and to achieve this, safety tools have been provided inside the laboratory buildings, including fire extinguishers of various kinds and installed in multiple locations, first aid boxes

fixed in a different location in the laboratory, complete protective clothing based on the nature of the work of each unit, hazardous waste bins, as well as training workers to use these tools if needed. Further, training was done for all staff to strengthen the knowledge and practice of staff as study Saudi Arabia, reported that training on occupational health and safety were a significant predictor of knowledge of the health workers in the labs, and there



**Fig. 4:** Safety tools and equipment.



**Fig. 5:** Proper disposal of hazardous waste.

findings showed that there is a great need to establish health and safety program for laboratory safety officer, as well as the need to organize a national training programs to increase awareness of the Laboratories health workers about proper laboratory techniques and self-hygienic principles (Alshalani and Salama 2019).

**Sixth:** Proper disposal of hazardous waste (Fig. 5): A private company has been contracted to collect, store and dispose of hazardous waste resulting from laboratory activities according to the correct scientific methods recommended by the World Health Authority, and the company has started its work since the beginning of the laboratory's activities.

**Seventh:** Establishing a Wheelchair ramp for people of determination: To ensure the evacuation of people of determination, workers, visitors, or workers who have accidents inside the laboratory, a wheelchair ramp has been constructed in front of the laboratory entrance and inside the main entrance to the laboratory to facilitate their evacuation procedures in emergency situations when they occur.

### Conclusion

The security and safety booklet was issued, and training courses were implemented for all employees as well as the operational plan for safe evacuation during emergencies was approved and implemented as a practical experiment, and the quality policy was adopted and presented to the workers and was installed in several sites within the laboratory and safety tools and equipment were provided as needed, and there is daily supervision and follow-up to ensure compliance with wearing it in the same time a private company has been contracted to collect, store and dispose of hazardous waste.

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### Authors' Contributions

SME did the conceptualization and wrote the original draft. NMA and FA did the conceptualization and supervised the data. HAG and TAD reviewed the manuscript. EOA did the conceptualization and reviewed and commented on all the drafts. All authors contributed to the article and approved the submitted version.

### Conflict of Interest

The authors declare no conflict of interest.

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