

**CHEMICAL HEALTH RISKS EXPOSURE TO
LABORATORY STAFF IN KENYA MARINE AND
FISHERIES RESEARCH INSTITUTE IN MOMBASA
COUNTY, KENYA**

ERIC OKENAGWA MAGARA

**MASTER OF SCIENCE IN
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Marine and Fisheries Research Institute in Mombasa County, Kenya**

Eric Okenagwa Magara

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the Degree of Master of Science in Occupational Safety and Health
of the Jomo Kenyatta University of Agriculture and Technology**

DECLARATION

This thesis is my original work and has not been presented for a degree in any other University

Signature.....Date.....

Eric Okenagwa Magara

This thesis has been submitted for examination with our approval as the University Supervisors

Signature.....Date.....

Dr. Benson Karanja, PhD

JKUAT, Kenya

Signature.....Date.....

Dr. Paul Njogu, PhD

JKUAT, Kenya

DEDICATION

I dedicate this thesis to my family, whose unwavering support and encouragement have been my greatest source of strength. To my friends, who have been my pillars of support, thank you for your patience and understanding. Special thanks to my supervisors, Dr. Benson Karanja and Dr. Paul Njogu, for their invaluable guidance and wisdom. Lastly, to all those who believed in me, your faith has been my motivation. This work is a testament to your love and support.

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ACRONYMS.AND ABBREVIATIONS

BCG	Bacillus Calmette–Guérin vaccine
CDC	Centers for Disease Prevention and Control
DOSHS	Directorate of Occupational Safety and Health Services
HAI	Health-care Associated Infections
HCW	Health Care Workers
HIRADC	Hazard Identification Risk Assessment Determination Control
HIV	Human Immunodeficiency Virus
IAEA	International Atomic Energy Agency
ILO	International Labor Organization
KMFRI	Kenya Marine and Fisheries Research Institute
KNRA	Kenya National Regulatory Authority
MOH	Ministry of Health
M and E	Monitoring and Evaluation
OSH	Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PEP	Post-Exposure Prophylaxis
PPE	Personal Protective Equipment
SOPs	Standard Operating Procedures
SPSS	Statistical Package for Social Sciences
UN	United Nations
UCLA	University of California and Los Angeles
USA	United States of America

ABSTRACT

To ensure a safe and healthy work environment for employees, the occupational Safety and Health Act 2007 was enacted in Kenya, and employers are required to comply with the Act. Owing to the global increase in the production and use of chemicals and other related reagents, chemical health risks have significantly risen. While necessary measures are in place to ensure safety in the labs, laboratory personnel are still vulnerable to exposure due to nature of work. Chemical hazards contribute to health risks resulting in significant fatalities and injuries to laboratory personnel, hence the need to protect them against such. This study evaluated chemical health risks exposure to laboratory staff in Kenya Marine and Fisheries Research Institute (KMFRI) in Mombasa County, Kenya. The objectives of the study were to assess Occupational Safety and Health Awareness, Effective PPE usage and exposure to radiations from unstable radioactive chemicals on laboratory staff, and how they contribute to chemical health risks. The study employed descriptive cross-sectional research design. Structured questionnaires, observation checklists and radiation measurements were used for data collection from a sample of 110 personnel from each of the KMFRI laboratories. The staff were selected based on specific inclusion, exclusion criteria. Only technical personnel who had worked in the laboratories for more than 5 years and who consistently worked for at-least five hours per day were considered eligible for participation in the study. Exposure to radiation was assessed using a calibrated radiation detector (dosimeter badges) meter to determine the extent of radiation exposure in the affected laboratory section. Data was analyzed using Statistical package for Social Sciences (SPSS) version 26.0. The study found a positive correlation between Occupational safety and Health awareness ($r=.945$ $N=97$ $p<.01$), PPE Usage ($r=.883$ $N=97$ $p<.01$), Exposure to radiation ($r=.955$ $N=97$ $p<.01$) and exposure to chemical health risks. The Analysis of Variance revealed a strong positive relationship between OSH awareness, PPE usage, exposure to radiation, and chemical health risks. The variables were found to be statistically significant and found to influence exposure to chemical health risks; OSH awareness, PPE usage and exposure to radiation largely contributed to exposure to chemical health risks among the laboratory staff. This study also revealed non-compliance to the set standards, leading staff to being exposed to potential chemical risks. The study findings further indicated that OSH awareness creation was not effectively done; hence a majority of the laboratory personnel were not privy to what was expected of them in terms of ensuring their occupational safety. Levels of exposure to radiation ranged between 0.018mSv/Month - 0.642mSv with a mean of 0.289mSv. The exposure to radiation was found to be within acceptable limits set by the Kenya nuclear regulatory authority in conjunction with the International Commission on Radiological Protection. The study recommends; mandatory OSH awareness creation and training for all laboratory staff; adequate provisions be made for quality PPE in compliance with standards for effective use; stringent measures be put in place to ensure controlled or eliminated exposure to radiation. The findings from this study will help laboratory management, policy makers, and occupational health practitioners to develop and implement effective safety measures, improve work place health standards, and enhance compliance with occupational safety regulations.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Chemical health risks are hazards from chemical substances, organic and inorganic in nature. These health risks have been classified by the Occupational Health and Safety Administration (OSHA) as physical, including corrosion, flammability and explosibility; and health risks, including sensitivity, irritation and carcinogenicity (OSHA, 2015). These chemical substances that we are interested with in this study may be toxic, mutagenic and carcinogenicity that present a threat to the health of people for example cancer from prolonged usage of formalin and other organics as preservative of lab samples, skin irritation, sensitization, respiratory tract, asthma, organ damage, flammability, corrosion, carcinogenicity and cell mutation usually caused by prolonged usage of organic and inorganic acids according to OSHA. Exposure to chemical health risks occurs when one comes into contact with chemicals (ATSDR, 2016). Laboratory personnel are potential candidates of laboratory incidents and accidents which could involve exposure to carcinogens, mutagenic and toxic chemical substances (WHO, 2020). These chemical health risks have been on the rise in the recent past, owing to the global increase in the production and use of chemicals and other related reagents. This report asserts that to ensure minimal exposure to health hazards, laboratories handling or processing chemical agents must be responsible to their personnel.

The International Labor Organization (ILO) reports that occupational illnesses and accidents claim the lives of over 2.78 million workers globally each year (Ais et al., 2019). According to the United Nations (UN) a worker dies every 30 seconds due to chemical exposure, resulting in occupational accidents of about 860,000 persons daily (Kisulu, 2020). WHO (2020) reports that about 3 million laboratory personnel are exposed to blood pathogens, of which 90% occur in developing countries, as cited in Mohamed (2020). Over 500, 000 medical injuries have been reported to occur in Germany annually, whereas in the United Kingdom at least 100,000 needle stick injuries occur in the laboratories (Weldasamuel et al., 2019). While laboratories are

designed to be safe workplaces by default, some hazards are inevitable. According to Ais *et al.* (2019), Indonesia experienced massive occupational accidents with up to 86.35% deaths. In Kenya, laboratory injuries have happened to at least 58% of laboratory workers (Mohamed, 2020).

The risks that laboratory workers are exposed to are detrimental to their health and well-being. The risks listed in this study include toxicity, carcinogenic and mutagenic effects, usually due to personal contact with the chemicals. According to Macharia (2018), over 71% of medical waste handlers across Kenya lack appropriate PPE like respirators and gloves, exposing them to health risks. These infections and potential health risks are preventable if stringent measures are put in place. Handling of radioactive substances or working in radiation laboratories can also pose a great health risk to laboratory personnel. A radiation safety course is recommended and laboratory induction is recommended to all persons working in radiation laboratories, according to International Atomic Energy Agency (IAEA)'s radiation protection Safety standards (IAEA, 2014). The level of exposure to any chemical health hazard and an evaluation of involved risks should therefore be a subject of concern to all lab-oriented institutions. Macharia (2018), alluded that all potentially contagious materials should be handled as infectious hazardous at all times, in order to control infections.

1.2 Statement of the Problem

Chemical hazards contribute to health risks resulting in fatalities and injuries in workplaces. Centers for Disease Control (CDC) advocates for the protection of patients and health care workers against injuries and infections (CDC, 2022). Research laboratories provide a unique environment where workers interact and use chemicals, radioactive substances and infectious materials. According to OSHA, 2007 chemicals are classified as being: toxic, mutagenic, teratogenic, irritants, explosives and carcinogenic. Protecting workers from work environment-related injuries is the central aim of OSH (OSHA, 2022). Inappropriate and ineffective Personal Protective Equipment (PPE) usage, lack of OSH awareness and non-compliance with set out measures and standards greatly contribute to the increased number of chemical incidents and accidents. Several studies have reported that laboratory workers are

more prone to suffering occupational injuries than employees in other sectors (Njogu, 2019; Bankole, 2020; Tait, 2019). Macharia (2018) reported that exposure to chemicals was the cause of most health effects reported in laboratories in non-medical laboratory set-ups, like KMFRI Laboratories, which have a focus on marine and blue economy research; hazards and risks in such laboratories have not been documented, though workers are exposed to hazardous chemicals in their work. This study evaluates and assesses the chemical health hazards and risks faced by laboratory staff in KMFRI- the study examined the role of OSH awareness, PPE Usage and exposure to radiation from radioactive chemicals.

1.3 Justification

This study carries out an evaluation of chemical health risks faced by laboratory staff in KMFRI laboratories in Mombasa County, Kenya. The study was limited to KMFRI because there are adequate and differently specialized laboratories to inform the research. As a research Centre that oversees numerous laboratory operations including use of chemicals and biological reagents, hazards and ergonomic issues common to laboratory staff and researchers are most likely to be the norm. While KMFRI laboratory regulations require that all personnel be in full PPE during working hours, the level of compliance and adherence to OSH guidelines was a matter of concern. There was also need to investigate the exposure of laboratory personnel to radiations, and whether the doses were within acceptable limits. The findings of this study will inform KMFRI management on the possible shortcomings and areas of improvement. The results of the study will further educate the laboratory personnel on their exposure to chemical health risks, and also add to the body of knowledge on the existing research gaps regarding exposure to such risks.

1.4 Objectives of the Study

1.4.1 Main Objective

The main objective of the study was to evaluate chemical health risks exposures among staff working in KMFRI Laboratories in Mombasa County, Kenya

1.4.2 Specific Objectives

- 1 To assess Occupational Health and Safety awareness on chemical safety of workers in Kenya Marine research laboratories in Mombasa County, Kenya.
- 2 To determine the levels of exposure to ionizing radiations to workers in Kenya Marine and fisheries research laboratory in Mombasa County, Kenya.
- 3 To determine the effectiveness and appropriateness of personal protective equipment in use in Kenya Marine research laboratory Mombasa, Kenya.

1.5 Research Questions

The research questions were as follows;

- 1 What is the level of occupational safety and health awareness regarding chemical safety among staff working in the Kenya Marine and Fisheries Research institute laboratories in Mombasa County, Kenya?
- 2 What are the levels of occupational exposure to ionizing radiation among workers in the Kenya marine and fisheries research institute laboratories in Mombasa County, Kenya?
- 3 How effective and appropriate is the use of personal protective equipment in the prevention of chemical health risks among laboratory staff in KMFRI research laboratories in Mombasa County, Kenya?

1.6 Research Scope

The study conducted an evaluation and identification of chemical health risks faced by laboratory staff in KMFRI laboratories in Mombasa County. The respondents were limited to the laboratory personnel at KMFRI. An assessment of OSH awareness, PPE usage and exposure to radiation was done to ascertain their influence on chemical health risks faced by the laboratory staff. The laboratory staff were interviewed and observed to inform the study.

1.7 Limitation of Study

Some of the respondents were not willing to share some of the information relating to personal behavior and likely to influence on chemical health risks. Similar observation was made on accidents reporting as was shown in the general register book where few accidents were recorded or missing despite observation during walk through showed a different picture altogether.

1.8 Conceptual Framework

The conceptual framework outlines the association between independent and dependent variables, where a variable is an observable function with various values. The element affecting or controlling a dependent variable is known as an independent variable (Jabareen, 2009). In this case, Figure 1.1 demonstrates the relationship between (OSH awareness, PPE usage, and exposure to radiation) and chemical health risks faced by laboratory staff in KMFRI laboratories. In this instance exposure to chemical health risks (carcinogenicity, mutagenicity and toxicity) is the dependent variable which is being controlled or affected by independent variables (OSH awareness, personal protective equipment usage and exposure to radiation). The moderating variables were OSH standards and MOH policies which can alter the association between independent variable and the dependent variables.

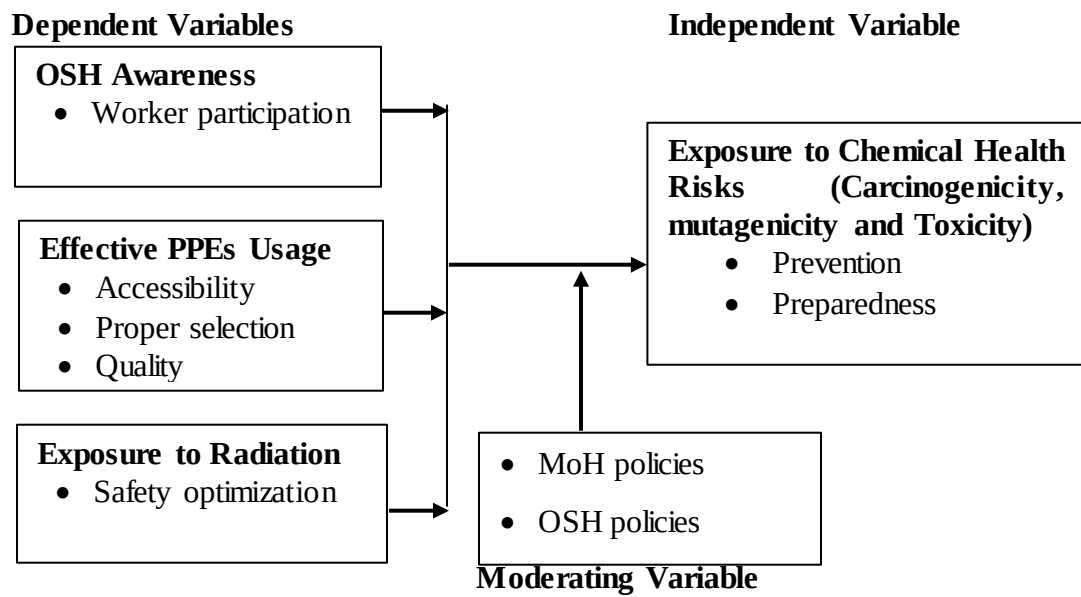


Figure 1.1: Conceptual Framework

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Theoretical and empirical literature related to this study are reviewed here. The study was guided by Danger factor theory, behavioral change theory and sociological theory. Further, discussions on previous works on OSH awareness, PPE usage and exposure to radiation are also highlighted in this chapter.

2.2 Theoretical Review

The theories relating to exposure to chemical health risks among laboratory personnel were reviewed here. According to Kisulu (2020), occupational accidents and health risks can be prevented through understanding their determining factors. The researcher alludes to the development of theories that influence the occurrence of occupational accidents and some of the theories are discussed below.

2.2.1 Danger Factor Theory

The danger factor theory postulates that accidents happen at the meeting point of a worker and the danger factor itself, causing injury to the worker. Mostly based on practical experience, the theory was proposed by Skiba (1973) who stated that the probability of accidents is determined by the danger factors. This theory aided the study in the identification of the danger factors present at the KMFRI laboratories and how they contributed to the chemical health risks of the laboratory staff. A danger factor that came out during the study was congestion in the laboratories and storage that did not conform to the set standards at KMFRI. This increased the chances of exposing the laboratory staff to accidents or incidents that could translate to health risks. The likelihood of putting the staff in danger in the event of a small mishap, such as a spill, was extremely high.

2.2.2 Behavioural Change Theory

This theory has been used to enhance OSH in relation to health care workers, according to Guerin and Sleet (2021). The researchers suggest that behavioural theory can be applied to design interventions that prevent or minimize workplace injuries and illnesses. The theory helps explain why workers engage in certain behaviours or avoid others. When workers are made to understand and believe the benefits of their behaviour in safety and health promotion, they are more likely to re-adjust their attitudes and behaviour accordingly. This study assessed the extent to which this theory is true in the case of KMFRI laboratory staff and revealed that while there were necessary standard operating procedures in place for the laboratory personnel, some behavioral factors like lack of accountability for self and others exposed the staff to health risks to a great extent. This according to the findings, could be enhanced by holding each staff and the management accountable for their behavior as far as safety is concerned, in order to minimize the exposure to chemical health risks among themselves. The majority of lab employees who took part in the study said they understood that it was their duty to ensure their own safety while working in the lab.

2.2.3 Sociological Theory

This theory reiterates that social relations at workplaces generate errors that eventually lead to occupational injuries. For safety management and prevention of occupational injuries, this theory can be used to put worker behavior under control. Employee's acts should be put in check in order to eliminate or reduce occupational accidents (Bankole, 2020). This study unveiled how the interrelationships among laboratory workers at KMFRI contributed to their exposure to chemical health risks. The findings further revealed that social interactions inside the laboratories could lead to errors in handling of the chemicals, posing potential risks to the laboratory workers.

2.3 Exposure to Chemical Health Risks

Despite the guidelines on control and prevention of occupational accidents, laboratory personnel still risk being exposed to hazards that are detrimental to their health. Associated with consequential exposures to health hazards, laboratories happen to be

very dangerous places to work in (Tait, 2019). Biological and chemical hazards are bound to happen in any laboratory facility. Macharia (2018) adds that laboratory work environments are demanding, complex and pose significant safety risks. According to OSHA (2022) guidelines, risks to workers' safety and general hazards should be assessed and identified on an ongoing basis. Even in countries with high levels of compliance with OSH regulations, Mong'are (2019) indicates that occupational accidents still occur. Elimination of risks and hazards, control or minimizing risks and provision of appropriate PPE are recommended as preventive and protective measures.

An evaluation of occupational safety and health management systems was conducted by Njeru (2015) seeking to evaluate the state of OSH management in Egerton university in Nakuru Kenya. The study determined the types and sources of hazards at the university, the level of implementation of OSH policy and influencing factors. Cross-sectional descriptive survey research design was employed in the study. Collection of data was done using structured questionnaires, interview schedules and observation lists. The study identified numerous sources of hazards with chemical hazards accounting for the majority 32% of the identified types, mechanical (23%), ergonomics (16%), physical (13%), biological (11%) and psycho social (5%). The study further revealed that there was no OSH policy in place, and that implementation was majorly influenced by lack of training, inadequate resources and failure to carry out medical examinations. The creation of an OSH policy document, frequent medical examinations of employees, and OSH training for workers were among the recommendations made. In contrast to this study, the KMFRI laboratories followed policy guidelines, with non-compliance being the only issue.

Occupational hazards and their impacts were assessed by Langat (2020) using a case study of metal workers in Nakuru town. Survey research design was used and Yamane 1967 formula employed in determining a sample size of 288 respondents. Data was collected using a combination of observation guides, measurements and questionnaires. Descriptive and inferential statistics was used in data analysis. The main chemical hazards in the *jua kali* establishments were found to be solvents and paints, accounting to 35% of the occupational hazards in the sector. The study revealed that most of the hazards were related to the workplace activities, like use of uninsulated

electrical cables and worn-out insulations. The study found that the workers' awareness of OSH was low and that they had received little training on the subject. Enhancing hand tool safety, enhancing ergonomics and hygiene, and providing OSH awareness training were among the suggested interventions. The findings relate to this study, as it was observed that a considerable number of the laboratory staff had not participated in any awareness campaign or training in handling of the chemical health risks in case of exposure.

Mohamed (2020) sought to determine the outcomes of control measures against occupational hazards resulting from needle stick injuries and medical sharps in sub county hospitals in Mombasa County. The researcher was specific to determining the available control measures, knowledge and training on control measures and adherence to safety guidelines by laboratory workers (HCW). The study revealed that safety features in the medical facilities significantly reduced exposure to injuries. Lack of safety training was found to be a leading contributor to experienced injuries and incidents. The study further found out that PPE usage had a positive impact on reducing exposure by up to 35%. The study recommended training on safety guidelines, sustainable supply of required PPE and surveillance or potential injury causes.

A similar study conducted by Kisulu (2020) investigated the factors affecting the occurrence of laboratory accidents in food laboratories in Mombasa County. The study indicated that lack of awareness on occupational, health and safety practices resulted in the exposure of most laboratory staff to accidents and incidents. The study also revealed that substance abuse was also a key contributing factor and recommended screening of workers before reporting to their work areas to minimize such accidents. It was further recommended that all laboratory workers undergo a mandatory safety training program prior to employment. Laboratory staff in the laboratories at KMFRI are candidates of exposure to health associated risks and hazards. Appropriate enforcement of OSH guidelines, risk prevention, preparedness and response will ensure containment of the occupational health hazards that may occur. This research sought to ascertain whether there was awareness, compliance and adherence to the set guidelines by the KMFRI staff. The study revealed an existing gap on prevention,

preparedness and response to hazards and chemical health risks among the laboratory staff. The assessment of human health risks requires identification, compilation and integration of information on chemical health hazards according to WHO (2010). These elements were found to be missing in the KMFRI laboratories, as there was lack of compilation on the available communication methods as far as the indicators were concerned.

The Occupational Safety and Health Act (OSHA) was enacted in the United States (US) to reduce everyday accident at work places by overseeing the health and safety of workers (Occupational Safety and Health Administration [OSHA], 2023). According to Bankole (2020) everyone interacts with or is exposed to at least one hazard on a daily basis. It is therefore no exception that laboratory just like healthcare workers will interact with hazards in their line of duty. While OSHA (2023) is committed to ensuring that employers provide safe working environments (OSHA, 2022), employees also have a responsibility to protect themselves from potential hazards. Workers who lack awareness of hazards in their work environment are at a greater risk of injury.

An emphasis on the need for risk awareness and frequent hazard identification was made by Kemsley (2010). The researcher reported on a laboratory incident that led to the death of a research assistant who sustained injuries from a chemical fire. A study on factors affecting occupational safety and health performance in public dispensaries and health centers was conducted by Njogu (2019) in Machakos County, Kenya. The research assessed the adequacy of OSH awareness in the health management and workforce, and workers' participation in OSH practices. A strong positive relationship was found to exist between OSH performance and worker awareness. It was concluded that OSH awareness among laboratory workers, management commitment and worker's participation influenced performance of OSH in public health facilities. The study recommended training of workers in OSH, workers taking the initiative to improve OSH performance.

An assessment of the effects of geothermal well drilling occupation on the safety and health status of workers in Kenya was conducted by Kachila (2019) in order to check

the adequacy of the onsite safety program. The study employed descriptive and inferential statistics to assess the components of OSH management in place at GDC. The OSH management system was found to be 60% effective, made possible by effective communication and reviewing. Findings of a study on determinants of effective control of occupational accidents unveiled training gaps on OSH awareness and hazard prevention (Kiogora, 2023). To find ways to improve efficient control and management of incidents in Mombasa port areas, the study used structured questionnaires for data collection. Out of the 650 workers in the population, 248 respondents were arrived at via random sampling. An underlying poor safety culture was identified, and chemical spillages found to be among the reported occupational accidents.

Safer workplace practices can be brought about by familiarity with potential health risks and hazards. To eliminate the risks and hazards employers should ensure appropriate training on safety and health aspects of daily operations (OSHA, 2022). The OSH act outlines that clear communication must be laid out across different organizational levels while ensuring that workers' ideas and concerns are addressed effectively. Poor communication across the divide negatively affects appreciation of safety practices. Bankole (2020) highlights that employees who are well communicated to tend to be more satisfied in their work environment and thus significantly drive organization's success. Other workers including laboratory personnel should thus be made aware of OSH by training, involvement and proper communication. The encouragement of health practitioner's involvement in health and safety procedures improves the employee acceptance of OSH policies. Additionally, if OSH policies and Ministry of health guidelines are properly adhered to the likelihood of exposure to chemical health risks is reduced drastically.



Figure 0.1: Main Elements of the OSH Management System

Source: (ILO-OSH, 2001)

2.4 PPE Usage and Chemical Health Risks among Laboratory Staff

Personal protective equipment is required by laboratory personnel and researchers for protection against exposure to potential hazards, lack of which puts them at the risk of infections and health risks. According to WHO (2021) PPE usage is vital to protection from and interruption of the exposure occupational hazards that result in injuries or illnesses. PPE minimizes the likelihood of exposure to hazards by providing a barrier between a hazard and worker (Mohamed, 2020). According to WHO (2020) PPE could include and is not limited to masks, goggles, respirators, safety glasses, gowns, lab coats, body-suits and protective footwear.

An investigation on occupational safety and health status in medical laboratories was conducted in Kajiado County by Tait (2019). The research aimed at establishing physical, chemical and biological hazards encountered in the laboratories and reviewing the set control measures in the laboratories the study revealed that biological hazards made up to 80% of the hazards that happened in the labs, while chemical and physical hazards followed closely. Handling of unlabeled and unmarked chemicals contributed to 38.2% of laboratory hazards and 49.5% of the hazards were

as a result of poor laboratory equipment storage. The study also revealed that the following control measures were used by laboratory staff; PPE usage, PEP provision, BCG and hepatitis B vaccination and HIV screening. Lack of awareness and training on OSH, lack of OSH policies in the laboratories, inadequate laboratory infrastructure and negative OSH attitudes were found to hinder the implementation of good OSH practices. The study recommended training on PPE usage and provision of the same among other measures in controlling laboratory hazards.

Appropriateness of PPE against bio-hazards exposure in public primary care laboratory facilities in Mombasa Kenya was investigated by Macharia (2018). The study's main objective was to investigate the efficacy of personal protective against exposure to bio- hazards. The study found a significant relationship between PPE usage and availability and recommended training on usage and availability.

PPE must be made accessible to all workers to enhance safety. According to OSHA (2022), the type of PPE to be used varies depending on the exposure risks involved, thus effective PPE usage and compliance to all other OSH regulations. It is recommended that PPE be selected based on the worker's specific duties and reflect the identified risk of exposure. While PPE can be effective if properly used, it does not eliminate the hazard and only protects the person wearing it (WHO, 2020). It is therefore key that PPE be appropriately used for maximum protection. Centers for disease control and prevention (CDC) recommends a PPE program that addresses; employee training on PPE selection and use, workplace hazard assessment, replacement of worn out PPE and continuous monitoring for effectiveness (CDC, 2022).

According to Kemsley, (2010), a research assistant working in the University of California, Los Angeles (UCLA) laboratory was handling large quantity of tert-butyl lithium where the pyrophoric chemical spilled and ignited her clothing leading to death. At the time of the accident, it was reported that the victim was not wearing personal protective equipment e.g. Lab coat, safety goggles, and was not following the manufactures safety and health protocols for handling large quantities of pyrophoric chemicals (for example the reagent bottle was not clamped and a plastic syringe was

used instead of glass. Additionally, the use of personal protective equipment was not officially mandated by the university policy on safety and health practices. It's on the above grounds that this study focused on personal protective equipment usage as the second line of defense against exposure to hazardous chemical risks.

Personal protective equipment usage was found to play a critical role in exposure to chemical health risks among KMFRI laboratory staff. While PPE was relatively available for use, not all laboratory staff wore them appropriately and for the intended purpose. It was proposed that enough resources be employed to ensure proper PPE selection, quality provision and compliance with standards. According to Kachila et al., (2019), employers must implement an appropriate system for PPE selection with regard to hazards, correct usage and protection level provided.

2.5 Exposure to Radiation as a Chemical Health Risks

Exposure to radiation or radioactive substances is a major risk that laboratory personnel are likely to face in their line of duty. According to a WHO (2000) hazard datasheet on occupation, laboratory workers are exposed to different hazards ranging from accident hazards, chemical, biological, ergonomic and physical hazards (International Hazard Datasheets on Occupation, 2000). Depending on equipment types and laboratory processes, laboratory personnel are exposed to various radiation types which could be ionizing (x-rays, gamma rays, alpha or beta particles) or non-ionizing (ultra-violet light, infrared, visible light or laser radiation). WHO (2022) indicates that depending on amount of received radiation, excessive exposure to radiation has a damaging effect to organs and living tissues. Adverse effects of radiation are likely to be caused by exposure to higher doses beyond acceptable limits. In order to identify and evaluate any hazard in the laboratory, an integration of the scientific method and basic hazard identification method is proposed by the (American Chemical Society, 2015), which could also be borrowed in the case of radiation hazards.

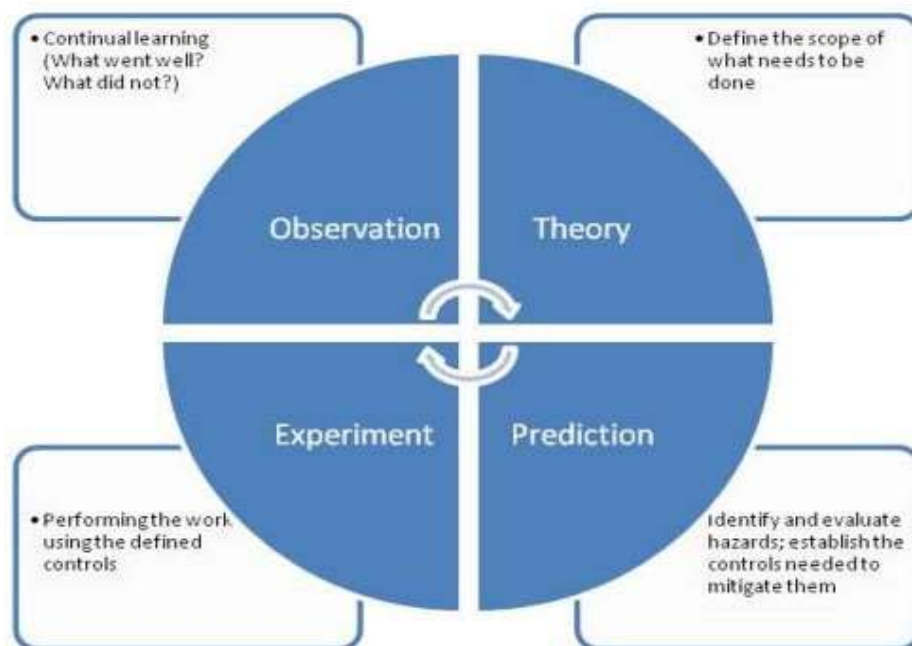


Figure 2.2: Integration of Hazard Identification

Source: (America Chemical Society, 2015)

The likelihood of exposure and the number of people exposed to radiations in the laboratories should be kept low as reasonably achievable, taking societal and economic factor into account. The International Atomic Energy Agency (IAEA), safety standard for protecting people and the environment on occupational radiation protection recommends the optimization for safety and protections in all exposure cases (IAEA, 2018). According to Janzekovic and Krizman (2007) laboratory personnel could be unintentionally exposed to radiation due to lack of understanding of involved compounds and thus an underestimation of potential risks. The researchers investigated radioactive sources in chemical laboratories in Slovenia. They sought to assess the awareness of laboratory personnel on precautions and implementation of safety measures. The study found out that most laboratory users were not aware of chemicals that were radioactive and thus in case of spills the persons and equipment in use could easily be contaminated leading to exposure. In order to optimize the implementation of safety measures in the laboratories, the researchers recommended that the establishment of a laboratory's organizational structure should engage qualified experts including a competent radiation officer. They further stressed that

contaminated equipment must be handled with special precaution, and the safety guidelines be adhered to strictly.

The risk of exposure to radiation by laboratory personnel was studied by Schwartz, Philips, Shriver and Okorodudu (2016). They aimed at heightening awareness of potential radiation hazards and the measures that can be implemented to reduce the likelihood of exposure to laboratory personnel. The researchers made use of radiation badges and rings to monitor hospital laboratory personnel. These rings and badges were worn by the laboratory personnel whenever they entered radioactive sections or the blood bank. Quarterly analysis of the badges and rings was done for a period of 2 years. Dosimeter readings were used to tabulate the risks of external exposure to radiation for different occupants. The results of the dosimeter indicated that the technologists who worked in radioimmunoassay laboratories received more external radiation than those who worked in the general laboratories, but less than the nurses who were involved with radioactive cervical cancer implants in the gynecology ward. The study presented that there was a risk of cancer from ionizing radiation, they however reiterated that it was not yet possible to distinguish radiation induced cancers from cancers of the unexposed. While the study focused on hospital laboratory personnel, this study was limited to KMFRI laboratories. From the recorded dosimeter results, it was worth noting that the staff were exposed to radiation within the acceptable dose limits. There's however, a suggested area for further study on how much radiation in a lifetime can be hazardous, in order to keep the relevant personnel abreast.

OSL Body Badge (Optically Simulated Luminescent Dosimetry)



Figure 0.2: Radiation Dosimeter Badge

Source: (University of Wisconsin, 2017)

2.4 Knowledge Gaps

Table 2.1: Research Gaps in the Reviewed Literature

Author	Study	Methodology	Key variables	Findings	Knowledge Gap
Ais et al., 2019	Hazard Identification, Risk Assessment, and Determining Controls in Laboratories	Observational approach Cross-sectional	Hazard, Risk assessment, control	Laboratories had potential hazards Risk control essential in preventing occupational accidents	Research performed in nutrition laboratories and recommended continuous implementation of risk controls to mitigate possible hazards

Author	Study	Methodology	Key variables	Findings	Knowledge Gap
Kachila et al, 2019	Assessment of the Effects of Geothermal Well Drilling Occupation on the Safety and Health Status of Workers in Kenya-A case study of Menengai Geothermal Project	Descriptive survey research design,	Occupation, Safety and Health	OSH management was moderately effective	Carried out in Geothermal Well drilling project and recommended a review of occupational and safety strategy
Macharia, 2018	Appropriateness of Personal Protective Equipment Against Bio-Hazards Exposure in Public Primary Healthcare Facilities in Mombasa County, Kenya	Descriptive cross-sectional research design, random sampling, observation guides and questionnaires	PPE provision and usage Safety Appropriateness	Significant association between PPE availability and utilization	Study recommended facilitation of regular training and safety guidelines availability
Mohamed, 2020	Outcomes of Preventive and Control Measures of Medical Sharp Injuries Among Healthcare Workers at Sub-County Facilities in Mombasa, Kenya	Descriptive cross-sectional research design	Prevention and control Awareness Adherence Prevalence	Training significantly reduced chances of exposure to injuries PPE reduced chances of exposure	Focused on needle-stick injuries among healthcare workers and recommended sustainable provision of PPES reporting and surveillance of injuries.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study Area

Study Area The study was conducted at the Kenya Marine and Fisheries Research Institute (KMFRI) laboratories in Mombasa County, Kenya, because the institution provides an appropriate setting for evaluating chemical health risks within laboratory environments. KMFRI has several well-equipped laboratories that routinely handle a wide range of chemicals and laboratory reagents used in marine and fisheries research activities. The presence of diverse laboratory operations, chemical storage facilities, and laboratory personnel exposed to chemical substances made the institution suitable for this study. Additionally, the availability of relevant infrastructure, technical personnel, and laboratory safety management systems provided adequate information and data necessary for assessing chemical health risks and generating reliable findings for the study. Mombasa County, Kenya.

3.2 Study Design

Descriptive cross-sectional survey research design was used in this study. This entails the description of attributes to aid in data collection, analysis and interpretation. Questionnaires, observation checklists and radiation badges aided the researcher in data collection. The study collected data on OSH awareness, PPE usage, and exposure to radiation as chemical health risks faced by laboratory staff in KMFRI.

3.3 Study Population

The target populations were laboratory staff and those who have been exposed to chemical health risks for a period of five years and consistently exposed for at least five hours every day. The study targeted respondents from each of the existing laboratories in KMFRI which had a total of 10 laboratories manned by at least 8 personnel including technicians, technologists and analysts. 10 laboratory managers and their two assistants in each lab were also candidates for this study informing a total of 110 targeted laboratory staff. The response rate was 97% due to the cooperation

between the researcher and the managers who ensured that everybody is brought on board to participate. Those who were not present were emailed the questionnaire after having a talk on phone and accepted to participate willingly.

A purposive sampling approach was employed in this study whereby all laboratory personnel who meet specific inclusion criteria were included in this study because it ensured that only individuals with adequate exposure and experience related to chemical health risks were included in the study.

KMFRI comprises ten laboratories, namely: the Organic Chemistry Laboratory, which conducts analyses of pesticides, hydrocarbons, and other organic compounds; the Inorganic Chemistry Laboratory, which focuses on the analysis of nutrients in water and sediments as well as trace metal analysis; the Environmental Pollution Laboratory, which specializes in microplastic analysis and persistent organic pollutants; the Microbiology Laboratory, which examines microbial agents in water, feeds, and food samples; the Fisheries Laboratory, which deals with fish production and management; the Post-Harvest Laboratory, which focuses on post-harvest losses; the Radioisotope Laboratory, which handles unstable radioisotopes; the Biological Samples Laboratory, which analyzes biological samples such as phytoplankton and zooplankton; the Molecular Laboratory; and the Chemistry Preparation Laboratory.

From each laboratory, the laboratory manager and two deputy personnel were purposely selected to participate in the study because of their supervisory responsibilities and extensive knowledge of laboratory operations, chemical handling procedures, and safety practices, given their supervisory roles and in-depth knowledge of laboratory operations and safety practices.

The inclusion of all laboratory units, alongside key personnel in leadership positions, ensured that relevant and diverse perspectives on occupational health and safety practices were adequately captured.

3.3.1 Inclusion Criteria

Only technical staff who had worked for more than five years and were consistently exposed to laboratory chemicals for more than five hours a day were eligible to participate in this study.

3.3.2 Exclusion Criteria

Researchers, interns and attaches were not involved in the study because they did not meet the minimum criteria set to participate in this study.

3.4 Sample Size Determination

There were 8 laboratory technologists/technicians/analysts in each one of the laboratories. All the laboratory staff were eligible to take part in the study as they were directly involved in the laboratories, the laboratory managers with their two deputies in each lab were also interviewed. The target population therefore consisted of 80 laboratory technicians 10 laboratory managers and their two assistants drawn from each lab; a total target population of 110 laboratory personnel. Stratified random sampling was employed to determine the lab technician's sample size using Yamane's (1967) formula:

$$Sample\ size = \frac{N}{1+(e^2)}$$

This formula was preferred because of its simplicity and ease to understand and apply in determining reasonable sample presentation. The formula's interpretation is; n = Sample size; N = Population under study; e = 5% error; 1 = Constant

The sample size for laboratory technicians was found to therefore be;

$$n = \frac{80}{1 + 80(0.052)}$$
$$=66.67 \sim 67 \sim 70$$

The total sample size therefore was made up of 70 laboratory staff, 10 laboratory managers and 20 assistant managers, a calculated sample size of 100, from the targeted 110.

Table 3.1 shows the distribution of laboratory staff across the KMFRI Laboratories, indicating the name of each laboratory, the number of Laboratory Technicians and the number of Laboratory managers together with their deputies. These categories collectively constitute the total target population for the study. The table, therefore, provides a clear overview of the staffing structure within the laboratories and forms the basis for determining the study sample and subsequent analysis

Table 3.1: Distribution of Lab Staff at KMFRI

	Laboratory	No. of Lab technicians	Lab managers and deputies	Total target population
1	Organic Chemistry	8	3	11
2	Inorganic chemistry	8	3	11
3	Environmental Pollution	8	3	11
4	Microbiology	8	3	11
5	Fisheries	8	3	11
6	Natural/Postharvest	8	3	11
7	Radioisotope	8	3	11
8	Molecular Biology	8	3	11
9	Biological	8	3	11
10	Chemistry Preparation	8	3	11
	Total	80	30	110

3.5 Data Collection Procedures

3.5.1 Assess Occupational Safety and Health Awareness on Chemical Safety

Data collection was done using questionnaires, observation checklists and dosimeter badges for radiation exposure level measurements. Self-administered questionnaires were administered to the laboratory personnel. A 5-point Likert scale type of questionnaire was employed as follows: - 1- Strongly disagrees, 2- Disagree, 3- Neutral (Neither agree nor disagree) 4-Agree, 5- Strongly agree. This was manageable and time-saving, owing to the nature of the work of the laboratory staff who were interviewed.

The level of awareness of the laboratory personnel on Occupational Safety and Health practices and guidelines was assessed using self-administered questionnaires. Descriptive statistics from the opinion Likert scale statements were utilized to determine the level of awareness on OSH practices. The data was further analyzed on the basis of percentage frequencies and the results presented in a summary table as presented in chapter 4. Observation guides by help of a checklist were used in monitoring the usage of PPE by the laboratory staff during their operations, to ascertain the effect of compliance or non-compliance on exposure to chemical health risks.

3.5.2 Levels of Exposure to Ionizing Radiations to Workers

Measurement of ionizing radiation exposure among laboratory workers was carried out using personal dosimeter badges. The dosimeter badges were issued to staff working in areas with potential radiation exposure and were worn throughout the working period. The badges were normally placed on the chest area, outside the laboratory coat, to provide an estimate of the whole-body radiation dose received by the worker. Radiation exposure measurements were conducted on a monthly basis. At the end of each month, the dosimeter badges were collected and analyzed to determine the cumulative radiation dose received by each worker. A control dosimeter badge was used and kept in a radiation free environment to account for background radiation and environmental influences during the monitoring period. The recorded readings were then compared with recommended occupational exposure limits to assess radiation safety compliance within the laboratory setting.

3.5.3 Effectiveness and Appropriateness of Personal Protective Equipment

The effectiveness and appropriateness of personal protective equipment (PPE) among KMFRI laboratory workers were evaluated using a combination of observation and structured questionnaires. The assessment focused on the availability, suitability, condition, and proper use of PPE in relation to the specific chemical hazards present in each laboratory. PPE assessed included laboratory coats, gloves, safety goggles, face shields, respirators, and safety footwear.

An observational checklist was used to determine whether laboratory personnel

consistently wore the recommended PPE while handling chemicals, conducting experiments, and managing laboratory samples. The checklist also assessed the condition of the PPE, including signs of damage, contamination, or improper fit that could compromise worker protection.

In addition, structured questionnaires were administered to laboratory personnel to collect information on the frequency of PPE use, adequacy of the provided equipment, level of comfort, ease of use, and workers' awareness of PPE requirements for different chemical hazards. Respondents were also asked about challenges associated with PPE use, including availability, maintenance, and replacement.

The appropriateness of PPE was determined by comparing the type of PPE used in each laboratory with the nature of chemical hazards and laboratory activities being undertaken. The effectiveness of PPE was further evaluated based on compliance with laboratory safety guidelines and the extent to which the equipment minimized potential exposure to chemical hazards among laboratory workers.

3.6 Data Processing and Analysis

Collected data was cleaned and coded for analysis. According to Mugenda and Mugenda (2003) qualitative data is converted to quantifiable form through conversion to numerical code for statistical analysis. Statistical Package for Social Sciences (SPSS) Version 26.0 was used due to its user-friendly features (Ong and .3, 2017) and availability for all three major computer platforms, i.e., Windows, MacOS, and LINUX (URI,2019) to analyze the gathered data. No prior knowledge was required to use this statistical program hence applicable in any kind of quantitative analysis (Arkkelin, 2024). This analytical approach facilitated comprehensive exploration of the underlying factors and connections among the key elements affecting the exposure to chemical health risks. In addition, the study utilized a diverse set of analytical tools; including descriptive analysis, mean, standard deviations, and percentages the formulated regression model.

3.7 Data Validation

The research instruments were tested for validity with the help of two experts in the area of study, where questions were reviewed and revised before use in data collection. A pilot study was conducted on 10 laboratory personnel in order to improve the quality and efficiency of the main study (Junyong, 2017).

3.8 Ethical Considerations

Permission was sought by the researcher from the Institute of Energy and Environmental Technology (IEET) of Jomo Kenyatta University of Agriculture and Technology (JKUAT) before commencement of the data collection exercise. Upon proposal approval, further permission was sought from KMFRI management to conduct the study in KMFRI laboratories. Consent was sought from all respondents before interviewing them. Data was collected using semi-structured questionnaires, walk-through, observation guides/checklists, and dosimeter measurements.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

The study's findings are presented in this chapter. The first section of the chapter includes data on the response rate, the demographics of the participants in the study, and the analysis and interpretation of the field data collected on the evaluation of chemical health risks among laboratory staff in KMFRI. The primary objective of a descriptive statistical research design is to provide a comprehensive portrayal of the conditions of the issues under investigation, capturing their existing state (Kothari, 2013). The computed statistic for every variable was tabulated using a frequency distribution table. To evaluate the importance of the chosen model, the researcher employed regression and correlation analysis to find out the relationship between variables. A 95% confidence level and a 5% significance level were used to test the study. The following was the regression equation that was chosen:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \varepsilon$$

Where:

Y = Exposure to chemical health risks

β_0 = Constant term $\beta_1, \beta_2, \beta_3$ and β_4 , = Beta coefficients X_1 = OSH awareness

X_2 = PPE Usage

X_3 = Exposure to radiation

ε = Stochastic disturbance error term. It accounts for the uncertainty in a statistical model.

It captures errors in measuring Y and the effect of any missing variable that would contribute to explaining variations in Y.

4.2 Response Rate

Out of the 100 administered questionnaires, 97 responses were received, translating to a return rate of 97% as tabulated below. This return rate is an excellent response rate for analysis, reporting and making inferences (Mugenda & Mugenda, 2003).

The table below illustrates the distribution of staff who responded to the research instrument. It highlights the number of respondents included in the study and serves as a foundation for the analysis and interpretation of the findings.

Table 4.1: Response Rates

	Lab staff	Sample	Response Rate (%)
1	Technicians	70	96
2	Managers	10	96
3	Deputies	20	99
1	Technicians	70	96
	Aggregate	100	97

4.2.1 Reliability Test

The reliability of all the items was calculated as shown in Table 4.2. According to Kothari and Garg (2014) reliability is the extent to which the estimating tools can produce accurate and dependable results. The findings indicate that the research items were excellent for data collection and, as a result, assessed the constructs they were intended to assess. A strong positive correlation among items is indicated by a high Cronbach's alpha coefficient (above 0.7), which also indicates consistency among the items (Mugenda & Mugenda, 2003).

Reliability statistics were used in this study to assess the consistency and stability of the research instrument. Specifically, Cronbach's alpha was applied to evaluate the internal consistency of the Likert-scale questionnaire, ensuring that the items reliably measured the intended constructs and enhanced the credibility of the study findings.

Table 4.2: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No of Items
0.981	0.982	3

4.3 Demographics of the Study Population

Personnel involved in KMFRI laboratories informed the target population, including technicians, managers and deputy managers as shown in Table 4.0.

4.3.1 Distribution of the Respondents by Gender

In order to determine whether the study was gender sensitive, the researcher sought to find out the respondents' gender. The results were presented in Table 4.3.

Table 0.1: Respondents' Gender

Gender	Frequency (n=97)	Percentage
Male	78	80.4
Female	19	19.6
Trans-gender	0	0
Total	97	100.0

ONLY 19.6% of the laboratory staff were women, compared to 80.4% of men. These results concur with Giakoumi et al. (2021), who reported that women are underrepresented in marine sciences. Again, the institutional policies may have a bearing on this area where the absence of supportive institutional policies, such as family-friendly policies and flexible work arrangements, can create barriers for women in marine sciences.

The ratio of female: male was 1:5, indicating gender bias, and the Constitution of Kenya 2010 provides for 2/3 representation of either gender. Initiatives promoting diversity, equity, and inclusion, as well as policies that support work-life balance and equal opportunities, are crucial for creating a more inclusive environment especially at the study area.

4.3.2 Distribution of the Respondents by Age

The laboratory personnel working in KMFRI were asked to state their age bracket and the results are as tabulated below.

Table 4.4: Age of Respondents

Valid	Frequency n=97	Percent (%)	Valid Percent (%)	Cumulative Percent (%)
26- 30 Years	26	26.8	26.8	26.8
31- 34 Years	12	12.4	12.4	39.2
35-40 Years	30	30.9	30.9	70.1
41-44 Years	9	9.3	9.3	79.4
45-50 Years	10	10.3	10.3	89.7
51-55 Years	6	6.2	6.2	95.9
>55 Years	4	4.1	4.1	100.0
Total	97	100.0	100.0	

The results indicated that the majority of the respondents were in the 35-40 years' age bracket, followed by those in 26-30 years bracket. Only 4 respondents were above 50 years and those between 51 to 55 years of age accounted for only 6.2%. It is evident that most of the KMFRI laboratory personnel were of productive age and therefore were more involved in laboratory operations, and could provide sufficient information for the study.

4.3.3 Distribution of the Respondents by Years of Work Experience

The respondents were asked to state their years of work experience. The results are as follows:

Table 4.5: Work Experience

Valid	Frequency (n=97)	Percent	Valid Percent	Cumulative Percent
5-9 Years	15	15.5	15.5	15.5
10-14 Years	15	15.5	15.5	30.9
15-19 Years	20	20.6	20.6	51.5
20-24 Years	25	25.8	25.8	77.3
20-24 Years	9	9.3	9.3	86.6
25-29 Years	11	11.3	11.3	97.9
30-34 Years	2	2.1	2.1	100.0
Total	97	100.0	100.0	

The Table above shows that 25.8% of the respondents had worked in KMFRI for a period of 20-24 years, 2.1% of the respondents reported to have worked for 30-34 years. 69% of the respondents had worked with KMFRI for a period of more than 15 years which indicates that the majority of the respondents were well experienced to give informed feedback on the chemical health risks among laboratory workers.

4.3.4 Levels of Education of Respondents

The researcher sought to establish the respondent's levels of education to determine their qualification. The results were presented in Table 4.6

Table 4.6: Level of Education

Valid	Frequency (N=97)	Percent	Valid Percent	Cumulative Percent
KCSE	4	4.1	4.1	4.1
Craft Certificate	20	20.6	20.6	24.7
Diploma	47	48.5	48.5	73.2
First Degree	20	20.6	20.6	93.8
Master's Degree	6	6.2	6.2	100.0
Total	97	100.0	100.0	

Table 4.6 shows that more than half 75.3% of the respondents had a diploma and above, Respondents with certificate qualifications accounted for 20.6% while those with only KCSE certificates accounted for only 4.1%.

4.4 Exposure to Chemical Health Risks

The chemical health risks faced by the laboratory staff in KMFRI are presented in Table 4.7.

Table 4.7: Responses on Exposure to Chemical Health Risks

STATEMENTS	5	4	3	2	1
Cleaning and decontamination of work surfaces after use	28.8%	19.6%	11.3%	17.5%	25.8%
Laboratory has appropriate ventilation for the work being performed (chemical fume hood, snorkel, canopy hood, biosafety cabinet, etc.).	41.2%	28.9%	10.3%	12.4%	7.2%
A current chemical inventory listing the chemicals used in the laboratory especially the toxic, mutagens and carcinogens is available	43.3%	37.1%	3.1%	10.3%	6.2%
Knowledge on worker safety	27.8%	21.7%	3.1%	22.7%	24.7%
Laboratories are well equipped to attend to exposed staff	28.8%	19.6%	5.2%	25.8%	20.6%
Adequate plans are in place to handle exposure cases	26.8%	20.6%	5.2%	21.6%	25.8%
Lab personnel know what to do in case of a chemical emergency e.g. if chemicals are accidentally spilt	34%	22.7%	10.3%	13.4%	19.6%
There's adequate clinical support for staff who get exposed	8%	10%	20%	28%	34%
Clear warnings and communication are passed across to staff in case of exposure	28.9%	23.7%	3.1%	5%	27.8%

Table 4.6 makes it clear that the KMFRI laboratories had an inventory of the chemicals they used, and that the rooms were reasonably ventilated, as reported by over 60% of the respondents. More than 50% of respondents disagreed that the laboratories were well- equipped, and a majority of 52.6% reported insufficient staff support in the event of exposure, indicating lack of adequate laboratory control measures. Less than 30% of laboratory staff members were aware of what to do in the event of an exposure, according to nearly 50% of respondents who reported inadequate communication regarding chemical health risks. The OSHA laboratory standards state that workers in the lab must follow the right procedures to guarantee that chemical exposures are kept below permissible limits and as low as practically possible (OSHA, 2022). Employees

must be shielded from chemical exposure that exceeds permissible limits and given additional information about the risks associated with chemicals in the workplace. The study's results made it clear that more work needs to be done to ensure that established OSH standards are followed. A study by Tait (2019) also showed how disregarding safety regulations and guidelines can lead to exposure to chemical hazards.

4.4.1 Descriptive Statistics for Exposure to Chemical Health Risks

To evaluate the exposure to chemical health risks among laboratory staff in KMFRI, respondents were presented with three constructs as indicators of chemical health risks. A five-point Likert scale was used to collect views from the respondents, where they responded to the statements as strongly agree (5) to strongly disagree (1). The data was analyzed in terms of percentage frequencies and summarized on Table 4.7 above.

4.5 Occupational Safety and Health Awareness and Chemical Health Risks

This study sought to assess occupational safety and health awareness and exposure to chemical health risks among laboratory staff in KMFRI research laboratories in Mombasa County. Exposure to chemical health risks was the dependent variable. The responses thus rated the extent to which the stated statements on OSH awareness contributed to exposure to chemical health risks.

4.5.1 Descriptive Statistics for OSH Awareness

The table below presents descriptive statistics on occupational safety and health (OSH) awareness among laboratory personnel. The table summarizes key variables related to knowledge, understanding, and perception of OSH practices, including awareness of hazards, safety procedures, use of personal protective equipment, and training exposure. These statistics provide an overview of the level of awareness among respondents and help address the research question on how well laboratory personnel are informed about OSH in their work environment.

Table 4.8: OSH Awareness

Statements	5	4	3	2	1
Laboratory staff participate in OSH awareness campaigns	30.9%	27.8%	32%	7.2%	2.1%
Employers are held accountable for their safety and that of staff	27.8%	32%	28.9%	8.2%	3.1%
Staff are encouraged to report safety and health concerns	41.2%	23.7%	21.6%	10.3%	3.1%
There is a mandatory OSH training for laboratory staff	8.2%	7.2%	20.6%	28.9%	35.1%
Laboratory staff are trained to check and spot incidents of safety and health concern	11.3%	8.2%	15.5%	25.8%	39.2%
Follow-up is done after training to assess implementation	15.5%	7.2%	13.4%	29.9%	34%
Storage areas (rooms, refrigerators, freezers, cupboards) where infectious and/or toxic Materials are kept are labeled accordingly.	26.8%	29.9%	33%	8.2%	2.1%
Chemicals and hazardous materials are clearly labeled	34%	27.8%	30.9%	5.2%	2.1%
Laboratory equipment are covered by safety instructions	7.2%	8.2%	25.8%	30.9%	27.8%

N=97

Table 4.8 reveals that staff education regarding occupational health and safety (OSH) was found to be lacking, as only 15.4% of respondents agreed to have participated in training; even among those who did, implementation was not guaranteed, with a significant 77.3% majority reporting no follow-up after training. This contrasts with the majority of KMFRI laboratory personnel (58.7%) who participated in OSH awareness campaigns, at least 9.3% of whom were left out. More than half of the respondents strongly agreed (27.8%) and agreed (32%) that employers were responsible for their safety and that of the laboratory staff. While many of the respondents agreed that they were encouraged to report health and safety concerns, there were no laid-out procedures on how the reporting ought to be done. The above findings agree with the study of Kiogora (2023) who identified training gaps in various contexts as a majority of respondents had not undergone any training or awareness on occupational hazard prevention or handling.

The storage areas in the laboratories where toxic materials were kept were labelled, as agreed by 56.7% of the respondents. This however was not the case in all laboratories as evidenced by the observation guides during the walkthrough. While the chemical and hazardous materials were labelled as indicated by at half of the respondents, it was evident that laboratory equipment were not covered by safety instructions. This was also supported by nearly 60% of the respondents.

4.5.2 Correlation for OSH Awareness

The Pearson Moment Correlation Coefficient, a statistic that indicates the strength of a relationship between two variables, was used to investigate the relationship between OSH awareness and exposure to chemical health risks among KMFRI laboratory personnel. OSH scores were used as the independent variable and chemical health risks as the dependent variable in order to calculate this correlation. The analysis was done as shown in Table 4.9 shows.

Table 4.9: Correlation for OSH Awareness

		Chemical Health Risks
OSH Awareness	Pearson Correlation	.945**
	Sig. (2-tailed)	.000
	N	97

**Correlation is significant at 0.01 level (2 tailed) $r = 0.945$, $N = 97$, $P < .01$

The findings from Table 4.8 demonstrate a significant positive correlation ($r = .945$, $N = 97$, $p < .01$) between OSH awareness and exposure to chemical health risks. The findings agree with those of Mong'are (2019), who discovered a substantial, positive, and strong correlation between occupational safety and health awareness and exposure to workplace accidents.

4.6 PPE Usage and Chemical Health Risks among Laboratory Staff

Table 4.10 presents the descriptive statistics on the use of personal protective equipment (PPE) among laboratory personnel. The analysis covers key variables, including accessibility, usage, suitability, quality, compliance with standards, adequacy of resources, and policy on usage.

Table 4.10: PPE Usage

Statements	5	4	3	2	1
PPE is readily accessible to all laboratory staff.	17.5%	20.6%	21.6%	23.7%	16.5%
All laboratory personnel appropriately wear personal protective equipment.	19.6%	18.6%	23.7%	25.8%	12.4%
Replacements for worn-out PPE are available	8.2%	9.3%	13.4%	30.9%	38.1%
Selected PPE is adequate for infection control	9.3%	9.3%	11.3%	34%	36.1%
PPE is used appropriately (for intended use)	5.2%	11.3%	13.4%	29.9%	40.2%
Chosen PPEs are not affected by the laboratory chemicals	7.2%	10.3%	19.6%	29.9%	33%
High quality PPE is provided to the laboratory staff	13.4%	11.3%	25.8%	21.6%	27.8%
PPE is purchased in compliance with standards	14.4%	10.3%	23.7%	22.7%	28.9%
There are adequate resources for quality PPE					

N=97

Most respondents indicated poor PPE usage at the KMFRI laboratories, as shown in Table 4.10. For example, over 80% of respondents do not agree that PPE was used appropriately for the intended purpose in the fifth construct. Conversely, fewer than 18% of staff members had their worn-out personal protective equipment (PPE) replaced. This suggested that a significant portion of the staff used worn-out PPE, which raised the possibility of exposure to chemical health risks. Only 25% of the participants concurred that PPE was acquired in accordance with established guidelines, an indicator that PPE usage was not effectively implemented. The observation checklists also demonstrated the ineffectiveness of the PPE administration. While the PPE procurement procedure was not clearly laid out during the study, the researcher counter checked the quality of the administered PPE and found out that they met acceptable KEBs quality standards, but availability was an area of concern due to inadequate resources for provision of adequate quality PPE, leading to lack of enough quality PPE that sometimes did not comply with the required standards. A similar study on PPE usage was conducted by Macharia (2018)

and found a significant association between utilization of available gear and PPE range.

4.6.1 Correlation for PPE Usage

To ascertain the association between PPE usage and exposure to chemical health risks, Pearson Moment Correlation Coefficient was used to calculate the scores for PPE usage as an independent variable and chemical health risks as a dependent variable. These results were analyzed and summarized as shown in Table 4.11.

Table 0.2: Correlation for PPE Usage

		Chemical Health Risks
PPE Usage	Pearson Correlation	.883**
	Sig. (2-tailed)	.000
	N	97

**Correlation is significant at the 0.01 level (2-tailed), $r = 0.883$, $N = 97$, $P < .01$

The results showed that there was a strong positive association ($r=.883$ $N=97$ $p<.01$) between PPE usage and exposure to chemical health risks as in Table 4.10. These findings relate with a study by Njeru (2015) who found a significant correlation between use of PPE and occupational illness of workers. These findings further resonate with the results of Mohamed (2020) who found out that that use of personal protective equipment contributed positively towards the reduction of exposure to laboratory hazards.

4.7 Exposure to Radiation and Chemical Health Risks

4.7.1 Descriptive Statistics for Exposure to Radiation

The table below presents the descriptive statistics on laboratory personnel's exposure to radiation. The analysis summarizes key aspects such as frequency of exposure, duration, use of protective measures, monitoring practices, and adherence to safety protocols.

Table 4.12: Exposure to Radiation

Statements	5	4	3	2	1
Hazard symbols and warnings are posted as required for radiation, biohazard, high voltage, laser, unattended operations, and other hazards.	40.7%	29.9%	8.2%	10.3%	11.3%
There is an inclusion of written Standard Operating Procedures (SOPs) for chemical procedures in the laboratory	11.3%	24.7%	9.3%	20.6%	34%
Screening for exposure is continuously done	34%	20.6%	6.2%	20.6%	18.6%
Emergency showers/iodine/chelating agents are available when required	9.3%	13.4%	11.3%	29.9%	36.1%
A trained fast-aider is available on standby	9.3%	5.2%	13.4%	30.9%	41.2%
Emergency procedures and emergency contacts are accessible to all staff	13.4%	15.5%	16.5%	23.7%	30.9%
Risk assessments are conducted to identify potential risks associated with laboratory chemicals, equipment, materials, and procedures.	23.7%	20.6%	13.4%	21.6%	20.6%
There are hazard assessment tools in place to keep track of identified risks	22.7%	16.5%	42.3%	10.3%	8.2%
Material Safety Data Sheets are available for all hazardous substances used in the lab	41.2%	34%	9.3%	6.2%	9.3%

N=97

Table 4.12 makes it clear that the KMFRI laboratories had warning signs and hazard symbols, as most respondents agreed to the first construct and strongly agreed with it. For every hazardous material used in the lab, material safety data sheets were in place, according to more than 75% of respondents. However, almost half of the respondents stated that no hazard assessment tools were in place to monitor the risks that were identified, and 13.4% of respondents were unsure about whether risk assessments were carried out or not. The survey also showed that, with over 70% of respondents' indications, there was no trained fast aider available to handle emergencies.

The dosimeter readings obtained during the study period revealed that radiation levels were within permissible bounds, which was determined to be consistent with earlier

measurements considered standard at KMFRI. Personnel entering high dose rate areas, such as the radioisotope laboratory, were wearing personal dosimeters, which was a great indication that standard operating procedures were being followed.

4.7.2 Correlation for Exposure to Radiation

Pearson Moment Correlation Coefficient was used to calculate the scores for PPE usage as an independent variable and chemical health risks as a dependent variable. These results were analyzed and summarized as shown in Table 4.13

Table 0.3: Correlation for Exposure to Radiation

		Chemical Health Risks
Exposure to Radiation	Pearson Correlation	.955**
	Sig. (2-tailed)	.000
	N	97

**Correlation is significant at the 0.01 level (2-tailed). $r = 0.955$, $N = 97$, $P < .01$

The results showed that there was a strong positive association ($r=.955$ $N=97$ $p<.01$) between exposure to radiation and chemical health risks among laboratory staff as in Table 4.13

4.8 The Regression Model

A multivariate regression model was employed in this study to determine the significance of the independent variables to the dependent variable which is exposure to chemical health risks among laboratory staff in KMFRI. This was helpful in determining the statistical significance of the predictor variables used in this study. The study investigated how well the predictor variables would predict exposure to chemical health risks. The regression model used was as follows;

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \epsilon$$

Where:

Y = Exposure to chemical health risks;

β_0 = Y intercept; β

1, β_2 , β_3 = the slope of the regression line for each independent variable;

X1 = OSH awareness;

X2= PPE usage,

X3 = exposure to radiation and

ϵ = Error term.

Table 4.14 presents the summary of the regression model used to examine the relationship between [independent variable(s)] and [dependent variable]. The table includes key statistics such as R, R^2 , adjusted R^2 , and the standard error of the estimate, providing an overview of the model's explanatory power and overall fit.

Table 4.14: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.989 ^a	0.977	0.975	0.24831

a. Predictors: (Constant), OSH awareness, PPE usage, Exposure to radiation

b. Dependent variable: Exposure to chemical health risks

From Table 4.14, R value which is the correlation between the predictors and the dependent variable was .989. The findings suggested that there was a strong positive influence of OSH awareness, PPE Usage and exposure to radiation on exposure to chemical health risks among KMFRI staff in Mombasa County. The coefficient of determination (R^2) which indicates the proportion of variance in the dependent variable that was accounted for by the predictor(s) in our sample data was .977 which is 97.7% proportion of variance of chemical health risks because of the independent variables. Since R^2 is always between 0 and 100%, a level of 0 showing none of the variability of the response data while 100% showing that the model explains all the variability of the response data around its mean, 97.7% is therefore, a higher value signifying that the model fits well the data. An analysis of variance (ANOVA) was also done to ascertain whether the independent variables were a significant predictor of chemical health risks among laboratory staff. The results were summarized as

shown in Table 4.15.

Table 4.15: Analysis of Variance

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	230.553	9	25.617	415.486	0.000b
Residual	5.364	87	0.062		
Total	235.918	96			

Dependent Variable: Chemical Health Risks

Predictors: (Constant), OSH awareness, PPE Usage, Exposure to Radiation
 Table 4.15 the ANOVA findings [F (9, 87) =415.486, P<.05)] where the significance value of 0.00 depicts that there exists a significant influence of the predictor variables (OSH awareness, PPE Usage and Exposure to radiation) on the response variable (Exposure to Chemical Health risks).

Multiple regressions were also performed to ascertain the influence of predictor variables on the response variable; these results were summarized and presented as shown in Table 4.15.

Table 4.16: Coefficients of Regression Equation

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	0.135	0.110		1.237	0.219
OSH awareness	0.475	0.125	0.425	3.796	0.000
PPE Usage	-0.307	0.102	-0.267	-3.014	0.003
Exposure to radiation	0.829	0.126	0.796	6.592	0.000

a. Dependent Variable: Chemical Health Risks

The multiple regressions were used in order to determine the relationship between exposure to chemical health risks and the other variables which were OSH awareness, PPE Usage and Exposure to radiation. From Table 4.16, the multiple linear regression equation models that was fit for this study is,

$$Y = 0.425X_1 - 2.67X_2 + 0.796X_3 + 0.110$$

From the linear regression equation, the coefficients indicate how much the independent variables vary with exposure to chemical health risks when all other variables are kept constant. $\beta_0 = 0.135$ shows that even with OSH awareness, PPE usage and exposure to radiation were all to be rated at zero, exposure to chemical health risks would be at 0.135. The constant was statistically insignificant and was thus excluded from the model equation. $\beta_1 = 0.425$ shows that an increase in a unit of OSH awareness results in 0.425 increase in exposure to chemical health risks. From the model, this predictor is statistically significant and was used in fitting the model. $\beta_2 = -0.267$ depicts that an increase in a unit of PPE usage results in a decrease of 0.267 in exposure to chemical health risks. From this model this variable was statistically significant hence it was fitted in the model. $\beta_3 = 0.796$ shows that an increase in a unit of exposure to radiation results in 0.796 increase on chemical health risks. From the model, this predictor was statistically significant hence it was used in model fitting. From Table 4.16, it is evident that the independent variables were statistically significant and would highly influence exposure to chemical health risks.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the study's summary of findings, conclusions, and recommendations. It focuses on the assessment of chemical health risks among laboratory staff at the Kenya Marine and Fisheries Research Institute (KMFRI).

The study concludes that Occupational Safety and Health (OSH) awareness, exposure to radiation, and the proper and consistent use of Personal Protective Equipment (PPE) are significant determinants of chemical health risks among KMFRI laboratory staff.

5.1.1 OSH Awareness

The first objective of the study sought to assess Occupational Safety and Health awareness and exposure to chemical health risks among laboratory staff in KMFRI research laboratories in Mombasa County. Most of the respondents agreed that laboratory personnel participated in OSH awareness campaigns. There were, however, several staff who reported not having participated, hence a disparity in the level of awareness of staff. More than half of the respondents strongly disagreed that mandatory Occupational Safety and Health (OSH) training was provided for laboratory staff. Similarly, more than half of the respondents disagreed that laboratory equipment was accompanied by adequate safety instructions. More than half of the respondents disagreed that there was a follow-up after training to ascertain implementation of the safety guidelines. The correlation indicated that there was a strong positive association ($r=.945$, $N=97$ $p<.01$) between OSH awareness and exposure to chemical health risks. It was also revealed by the multivariate regression that OSH awareness is statistically significant in predicting exposure to chemical health risks. OSH awareness therefore influences the exposure to chemical health risks among laboratory staff. Several studies agree that OSH awareness plays a critical role through training and communication (Njeru, 2015; Mongare, 2019)

The findings of the study established a strong positive relationship between OSH awareness and exposure to chemical health risks among laboratory staff. The variable was found to be statistically significant to chemical health risks, hence would highly influence the exposure to chemical health risks.

5.1.2 Exposure to Radiation

The second objective sought to investigate the extent to which exposure to radiation resulted in chemical health risks among laboratory staff in KMFRI. From the findings, many of the respondents strongly agreed that hazard symbols and warnings were appropriately indicated for safety optimization. There were however divided responses on whether standard operating procedures were included in laboratory chemical procedures. Another majority of the respondents agreed that screening for exposure was continuously done for staff that accessed high risk areas. Nearly 20% of the respondents were neutral to the statement that risk assessments are conducted to identify potential risks associated with laboratory chemicals, equipment, materials, and procedures. On the other hand, more than half of the respondents agreed that there were hazard assessment tools in place, with material safety data sheets for all hazardous substances used in the laboratories. The Pearson moment correlation established that exposure to radiation had a strong positive correlation with exposure chemical health risks. The multiple regressions also deemed exposure to radiation as statistically significant in relation to chemical health risks.

The findings indicated a positive relationship between exposure to radiation and chemical health risks. Additionally, there was high statistical significance between exposure to radiation and chemical health risks.

5.1.3 Personal Protective Equipment

The third objective of the study was to determine the effectiveness of PPE usage on exposure to chemical health risks among laboratory staff in KMFRI. According to the descriptive statistics, many of the respondents disagreed that the laboratory staff appropriately wore PPE, while only less than half agreed that PPE was readily accessible to all staff. The results also revealed that there were hardly any replacements

for worn out PPE, as indicated by over 80% of the respondents. More than 50% of the respondents agreed that the chosen PPE were likely to be affected by the laboratory chemicals in case of exposure. Regarding quality of PPE used, the study found out that there were inadequate resources for provision of quality PPE sometimes leading to purchase of low- quality PPE that didn't comply with the required standards. The Pearson moment correlation coefficient indicated a strong positive association between PPE usage and exposure to chemical health risks. PPE usage was found to be statistically significant in the exposure to chemical health risks among laboratory staff. Mohamed (2020) records similar findings where he recorded a positive impact of PPE in reduction of exposure to chemical hazards, as the percentage of those who were exposed was higher for those who didn't have protective equipment.

A strong positive correlation existed between PPE Usage and exposure to chemical health risks. An increase in PPE usage resulted in a decrease in exposure to chemical health risks. PPE usage therefore is a significant determinant of exposure to chemical health risks.

5.2 Recommendations

The researcher recommends the following owing to the findings of this study;

1. Strengthen OSH Training and Awareness Program

KMFRI should implement mandatory, regular, and comprehensive OSH training for all laboratory staff, including induction and refresher courses. These programs should incorporate clear safety guidelines for equipment use and be supported by structured follow-up mechanisms to monitor compliance and reinforce safe practices.

2. Enhance Radiation Safety Management and Risk Assessment:

The institution should standardize and enforce radiation safety procedures by ensuring consistent application of standard operating procedures (SOPs), regular risk assessments, and continuous monitoring of exposure levels. Additionally, periodic audits and updates of hazard communication systems (For example., signage and

warning labels) should be conducted to maintain high safety standards

3. Improve Provision, Quality, and Utilization of PPE:

KMFRI should ensure adequate supply, accessibility, and timely replacement of high-quality PPE that meets required safety standards. Policies should be established to enforce proper and consistent use of PPE, alongside routine inspections and training to promote correct usage and minimize exposure to chemical health risks.

5.3 Area for Further Study

The regression analysis in this study indicated a statistically significant relationship between exposure to radiation and chemical health risks among laboratory personnel. Although dosimeter readings showed that staff were exposed to radiation doses within acceptable limits, further investigation is warranted. Future research should focus on determining the threshold levels of radiation exposure or frequency of exposure that may lead to significant chemical health risks. Additionally, the effects of prolonged exposure on laboratory personnel should be examined to provide a more comprehensive understanding of occupational hazards in laboratory settings.

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APPENDICES

Appendix I: Introduction Letter for Data Collection

Dear Sir/Madam,

RE: DATA COLLECTION

My name is Eric Magara, a post-graduate student pursuing a Master of Science in Occupational Safety and Health at Jomo Kenyatta University of Agriculture and Technology. As a requirement for the course, I am carrying out a study on **CHEMICAL HEALTH RISKS AMONG LABORATORY STAFF IN KENYA MARINE AND FISHERIES RESEARCH INSTITUTE IN MOMBASA COUNTY, KENYA**. This study is strictly for research purposes only, and your responses will be treated confidentially and anonymously. Do not append any personal details to the questionnaire. Please complete all the required items.

Your honest responses will be highly appreciated.

Thank you.

Yours Faithfully,

Eric Magara

Appendix II: Questionnaire

SECTION A: DEMOGRAPHICS

Please tick appropriately

1. Gender: Male () Female () Trans-gender ()

2. Age:

15-20 () 21-25 () 26-30 () 31-34 () 35-40 () 41-44 () 45-50 () 51-55 () 56+ ()

3. Working experience:

0-4 () 5-9 () 10-14 () 15-20 () 20-24 () 25-30 () 31-34 () 35+ ()

4. Highest Educational qualifications attained:

KCSE () Certificate () Diploma () Degree () Masters () Doctorate ()

5. Tick appropriately using a scale of 1-5 as:

5-Strongly agree 4- Agree 3-Neutral 2- Disagree 1-Strongly disagree

SECTION B:

Occupational Safety and Health Awareness and chemical Health risks among Laboratory Staff

Please indicate your level of agreement or disagreement with the following statements about Occupational Safety and Health (OSH) Awareness and chemical Health risks among Laboratory Staff.

Please tick (✓) the space corresponding to the correct answer in each question below.

Scale: Strongly Disagree = 1: Disagree= 2: Neutral = 3: Agree = 4: Strongly Agree = 5

CODE		5	4	3	2	1
Worker participation						
OSH 1	Laboratory staff participate in OSH awareness campaigns					
OSH 2	Personnel are held accountable for their safety and that of other staff					
OSH 3	Staff are encouraged to report safety and health concerns					
Training						
OSH 4	There is a mandatory OSH training for laboratory staff					
OSH 5	Laboratory staff are trained to check and spot incidents of safety and health concern					
OSH 6	Follow-up is done after training to assess implementation					
Communication						
OSH 7	Storage areas (rooms, refrigerators, freezers, cupboards) where infectious and/or toxic materials are kept are labelled accordingly.					
CODE		5	4	3	2	1
OSH 8	Chemicals and hazardous materials are clearly labelled					
OSH 9	Laboratory equipment is covered by safety instructions					

What is your view on OSH Awareness and chemical Health risks among Laboratory Staff at KMFRI?

SECTION C:

PPE Usage and Biochemical Health Risks among Laboratory Staff

Please indicate your level of agreement or disagreement with the following statements about PPE Usage and Biochemical Health Risks among Laboratory Staff. Please tick (✓) appropriately in each question below. Scale: **Strongly Disagree = 1: Disagree= 2:**

Neutral = 3: Agree = 4: Strongly Agree = 5

S/No.		5	4	3	2	1
Accessibility						
PPE 1	PPE is readily accessible to all laboratory staff					
PPE 2	All laboratory personnel appropriately wear					

What role do you think PPE Usage plays on chemical Health Risks among Laboratory Staff at KMFRI?

.....

SECTION D:

Exposure to radiation and chemical Health Risks among Laboratory Staff

Please indicate your level of agreement or disagreement with the following statements about Exposure to radiation and chemical Health Risks among Laboratory Staff. Please tick (✓) appropriately.

Scale: Strongly Disagree = 1: Disagree= 2: Neutral = 3: Agree = 4: Strongly Agree = 5

S/No.		5	4	3	2	1
Safety optimization						
ETR 1	Hazard symbols and warnings are posted as required for radiation, biohazard, high voltage, laser, unattended Operations, and other hazards.					
ETR 2	There is an inclusion of written Standard Operating Procedures (SOPs) for chemical procedures in the laboratory					
ETR 3	Screening for exposure is continuously done					
Emergency response						
ETR 4	Emergency showers/iodine/chelating agents are available when required					
ETR 5	A trained fast-aider is available on standby					

ETR 6	Emergency procedures and emergency contacts are					
S/No.		5	4	3	2	1
	accessible to all staff					
Risk assessments						
ETR 7	Risk assessments are conducted to identify potential risks associated with laboratory chemicals, equipment, Materials, and procedures.					
ETR 8	There are hazard assessment tools in place to keep track of identified risks					
ETR 9	Material Safety Data Sheets are available for all hazardous substances used in the lab					

In your own opinion how has Exposure to radiation contributed to chemical Health Risks among Laboratory Staff at KMFRI?

.....

SECTION E:

Exposure to chemical Health Risks among Laboratory Staff

Please indicate your level of agreement or disagreement with the following statements about Exposure to Biochemical Health Risks among Laboratory Staff. Please tick (✓) appropriately.

Scale: Strongly Disagree = 1: Disagree= 2: Neutral = 3: Agree = 4: Strongly Agree = 5

S/No.		5	4	3	2	1
Prevention						
BHR 1	Work surfaces are cleaned and decontaminated after use					
BHR 2	Laboratory has appropriate ventilation for the work being performed (chemical fume hood, Snorkel, canopy hood, biosafety cabinet, etc.).					

BHR 3	A current chemical inventory listing the chemicals used in the laboratory, especially the toxic, mutagens and carcinogens are available					
Preparedness						
BHR 4	Laboratory staff know what they have to do to keep themselves and others safe					
BHR 5	Laboratories are well equipped to attend to exposed staff					
BHR 6	Adequate plans are in place to handle exposure cases					
Response						
BHR 7	Lab personnel know what to do in case of a chemical emergency e.g. if chemicals are accidentally spilt					
BHR 8	There's adequate clinical support for staff who get exposed					
BHR 9	Clear warnings and communication are passed across all staff in case of exposure					

What is your say on chemical Health Risks prevention, preparedness, and response among Laboratory Staff at KMFRI?

.....

Thank you. The End.

Appendix III: Observation Guide

S/No.	OBSERVATION	YES	NO
OSH AWARENESS			
1.	Safety rules are clearly displayed		
2.	Hazardous waste is clearly labelled		
3.	There is a written chemical hygiene plan detailing the policies and procedures Using chemicals in the laboratory.		
4.	Chemicals are stored and segregated by chemical compatibility		
5.	Infectious waste materials are decontaminated before disposal		
6.	There is a hand-washing sink available with liquid soap and paper towels in each working area		
7.	Hand-washing instructions are illustrated		
8.	Smoking, eating, drinking and the application of cosmetics are prohibited in the lab		
9.	There are appropriate spill kits available to deal with spills/leaks of hazardous substances		
10.	Fire-fighting equipment in place and unobstructed		
PERSONAL PROTECTIVE EQUIPMENT (PPE)			
11.	Are laboratory personnel protected by lab coats or overalls?		
12.	Safety goggles and/or face shields are available and worn appropriately		
13.	Laboratory personnel wear effective and appropriate shoes while in the lab		
14.	Appropriate respiratory protection is available		
15.	Appropriate personal protective equipment is worn in the laboratory. Gloves, lab coats,		
16.	Potentially contaminated PPE are removed before leaving the laboratory		
17.	All reusable PPE that is exposed to skin is disinfected before being used by another person		
18.	Laboratory personnel confine long hair and avoid loose clothing		
EXPOSURE TO RADIATION			
19.	Doors controlling access to the laboratory are always closed and locked when the Laboratory is not occupied.		
20.	Access is limited to individuals authorized to work in the laboratory		
21.	Radiation-prone areas are well labelled		

Appendix IV: Observation Photos



Unlabeled storage area. Picture taken on 08/12/23



Chemicals stored above eye level. 08/12/24



Potential hazards

Image courtesy of KEMFRI taken on 08/12/2023



Unsafe storage.

Image taken 08/12/2023

Appendix V: Chemical Inventory in KMFRI Laboratory Dispensing Store

No	Chemical name	Quantity	Expiry Date	Remarks
1	Potassium phosphate monobasic Solution(1m)	1lt		Used
2	Methyl red	100g		Used
3	Griess reagent			Used
4	Kjeldahl catalyst (free of hg and se)	100tabs		Used
5	Tashiro's indicator solution	0.5l		Used
6	Potassium hydroxide	2kg		Used
7	Ethanol 96%	131lt		Used
8	Buffer solution ph4	18lt	July, 2025	Used
9	N-(1-naphthyl) ethylenediamine Dihydrochloride	450g		Used
10	Absolute ethanol 99.94%	2.5l		Used
11	Buffer solution ph7	18l	June, 2025	Used
12	Hydrofluoric acid 48%	9l	April, 2025	Used
13	Silica gel self-indicator	100g	June, 2026	Used
14	Nitric acid	2.5 l		Used
15	Iodine crystals	700g	October, 2026	Used
16	Trypan blue	10g		Used
17	Brilliant blue	25g		Used
18	2,2,4-trimethylpentane	1l		Used
19	Perchloric acid	500ml		Used
20	Rose bengal	25g		Used
21	Carbon tetrachloride	2.5l		Used
22	Potassium iodide	300g		Used
23	Hydrogen peroxide	1l		Used
24	Acetic acid	2l		Used
25	Hydrochloric acid	1l		Used
26	Benzene	2.5l		Used
27	All classes of organic and inorganic Acids	12.5l		Used
28	Ammonia	1l		Used
29	Methylated spirit	4l		Used
30	Acetic acid	200ml		Used
31	Potassium permanganate	500g		Used
32	Lithium bromide	500g		Used

Appendix VI: Radiation Report

Facility: Kenya Marine and Fisheries Research Institute

Location: Nyali, Mombasa **No. of badges:** 10 **Radiation source:** X-rays **MONTH:**
SEPTEMBER 2023

Personnel name	Gender	TLD serial No	DOSE (mSv/month)		Comments
			Body	Skin	
A	M	000185	0.578	0.422	Dose Within Limit
B	F	000186	0.419	0.159	Dose Within Limit
C	M	000187	0.459	0.234	Dose Within Limit
D	M	000188	0.192	0.086	Dose Within Limit
E	F	000189	0.458	0.179	Dose Within Limit
F	M	000190	0.369	0.018	Dose Within Limit
G	F	000191	0.456		Dose Within Limit
H	F	000192	0.369		Dose Within Limit
I	M	000193	0.295		Dose Within Limit
Background radiation	-	00094	0360		Dose Within Limit

NB: Maximum Dose Limit:

- a) 20 mSv/yr
- b) 0.96 mSv/yr (for expectant mother)

Facility: Kenya Marine and Fisheries Research Institute

Location: Nyali, Mombasa **No. of badges:** 10 **Radiation source:** X-rays **MONTH:**
OCTOBER 2023

Personnel name	Gender	TLD serial No	DOSE (mSv/month)		Comments
			Body	Skin	
A	M	000185	0.382	0.402	Dose Within Limit
B	F	000186	0.384	0.098	Dose Within Limit
C	M	000187	0.351	0.045	Dose Within Limit

D	M	000188	0.424	0.047	Dose Within Limit
E	F	000189	0.301	0.131	Dose Within Limit
F	M	000390	0.176	0.238	Dose Within Limit
G	F	000191	0.453	0.241	Dose Within Limit
H	F	000192	0.276	0.541	Dose Within Limit
I	M	000193	0.387	0.327	Dose Within Limit
Background radiation	-	000194	0.176	0.0094	Dose Within Limit

NB: Maximum Dose Limit:

a) 20 mSv/yr

b) 0.96 mSv/yr (for expectant mother)

Facility: Kenya Marine and Fisheries Research Institute

Location: Nyali, Mombasa **No. of badges:** 10 **Radiation source:** X-rays **MONTH:** NOVEMBER 2023

Personnel name	Gender	TLD serial No	DOSE (mSv/month)		Comments
			Body	Skin	
A	M	000185	0.591	0.191	Dose Within Limit
B	F	000186	0.413	0.106	Dose Within Limit
C	M	000187	0.263	0.047	Dose Within Limit
D	M	000188	0.642	0.119	Dose Within Limit
E	F	000189	0.488	0.144	Dose Within Limit
F	M	000190	0.302	0.305	Dose Within Limit
G	F	000191	0.342	0.287	Dose Within Limit
H	F	000192	0.345	0.198	Dose Within Limit
I	M	000193	0.378	0.241	Dose Within Limit
Background Radiation	-	000194	0.202	0.105	Dose Within Limit

NB: Maximum Dose Limit:

a) 20 mSv/yr

b) 0.96 mSv/yr (for expectant mother)

Facility: Kenya Marine and Fisheries Research Institute

Location: Nyali, Mombasa **No. of badges:** 10 **Radiation source:** X-rays **MONTH:**
DECEMBER 2023

Personnel name	Gender	TLD serial No	DOSE mSv/month)		Comments
			Body	Skin	
A	M	000185	0.269	0.327	Dose Within Limit
B	F	000186	0.527	0.202	Dose Within Limit
C	M	000187	0.446	0.073	Dose Within Limit
D	M	000188	0.375	0.057	Dose Within Limit
E	F	000189	0.421	0.096	Dose Within Limit
F	M	000190	0.321	0.098	Dose Within Limit
G	F	000191	0.361	0.101	Dose Within Limit
H	F	000192	0.367	0.198	Dose Within Limit
I	M	000193	0.401	0.210	Dose Within Limit
Background Radiation	-	000194	0.121	0.041	Dose Within Limit

NB: Maximum Dose Limit:

- a) 20 mSv/yr
- b) 0.96 mSv/yr (for expectant mother)