ASSESSMENT OF PESTICIDES HANDLERS' KNOWLEDGE, PRACTICES AND SELF-REPORTED TOXICITY SYMPTOMS: A SURVEY OF KISUMU COUNTY, KENYA

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Assessment of Pesticides Handlers' Knowledge, Practices and Self-Reported Toxicity Symptoms: A Survey of Kisumu County, Kenya

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DECLARATION

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

Signature……………………………………… Date ………………………………..

Adams Nyamongo Obonyo

This thesis has been submitted for examination with our approval as University supervisors.

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DEDICATION

I wish to dedicate this thesis to God for helping me through my research. This thesis is also dedicated to my family; my mother Rael Bochaberi Obonyo, my father Huron Obonyo, my wife Diana Buyaki, my children Loice Bochaberi, Llyod Obonyo and Ivan Obonyo. Finally, I dedicate this thesis to my employer Pest Control Products Board (PCPB) for according me a conducive environment to do this research work.

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LIST OF ABBREVIATIONS

AR	Attributable risk
DDT	Dichlorodiphenyltrichloroethane
DOSHS	Directorate of Occupational Safety and Health Services
EPA	Environmental Protection Agency
FAO	Food and Agricultural Organization
IPM	Integrated Pest Management
KIRA	Kenya Interagency Rapid Assessment
OCs	Organochlorines
OPs	Organophosphates
OSHA	Occupational Safety and Health Act
PCPB	Pest Control Products Board
PPE	Personal Protective Equipment
RR	Relative Risk
SPSS	Statistical Package for Social Scientists
WHO	World Health Organization

OPERATIONAL DEFINITION OF TERMS

Accidental poisoning	Unintentional ingestion of potentially toxic pesticides.
Acute symptoms	Illnesses or injuries that may appear immediately after a single exposure to a pesticide (usually within 24 hours).
Attributable risk	It is the incidence of a disease in the exposed that would be eliminated if exposure were eliminated.
Carbamate	Esters of N-methyl carbamic acids. Eg. Carbaryl and Carbofuran.
Chronic symptoms	Illnesses or injuries that appear after a long time, usually several years, after exposure to low doses of pesticide.
Exposure	The risk of a pesticide entering the body.
Exposure levels	Concentration of hazardous substance to which pesticides handlers are exposed during a specific period.
Odds ratio	A measure of an association between an exposure and an outcome.
Oil based	Formulations that contain liquid

pesticides	active ingredient, one or more petroleum based solvents and emulsifying agent.
Organochlorine	Contain organo-chlorides e.g. DDT, Dieldrin, Aldrin, endosulfan, heptachlor etc.
Organophosphate	Made of organic compounds onto which phosphate group is attached e.g. Dimethoates, Primiphos methyl, Chlorpyrifos
Personal protective equipment	Equipment worn to minimize exposure of handlers to pesticides.
Pesticide	Any substance used to kill, repel, attract, to deter or influence pest for control
Relative risk	A measure of the relationship between the incidence in the exposed and that in the unexposed.
Risk	The ability of a pesticide to cause harm to handlers.
Toxicity	A measure of the ability of a chemical to cause harmful effects.
Water based pesticides	Formulations that contain water based solvents and dissolve freely in water.

ABSTRACT

Pesticide use in modern agriculture have not only increased productivity, but also brought negative health effects on human and the environment due to mishandling. This study assessed the knowledge, practices and self-reported toxicity symptoms among 464 pesticides handlers in Kisumu County, Kenya. Data were collected by use of questionnaires and observational checklists. Chi-square test ($\chi2$-test) was used to test the associations between independent and dependent variables. The study found that 97% of the participants knew pesticides have negative effects on human health while 96% could read and understand instructions on pesticides labels. There was significant association between the age and awareness on pesticides exposure level ($p< 0.001$), knowledge on exposure through contact ($p< 0.02$) and dust mask use (p<value 0.03). A Majority (82%) of handlers changed clothing before and after pesticide exposure whereas 92% never ate or drank while handling pesticides. A majority, 66% and 61 % of stockists lacked firefighting equipment and first aid kits respectively. Itching eyes (79%), skin itching (74%) and coughing (68%) were the most reported acute symptoms. Handlers' degree of knowledge was associated with safety practices and acute symptoms. Their safety practices were also associated with toxicity symptoms. In conclusion, the null hypotheses were rejected because education and experience influenced gloves and dust masks wearing. Skin itching, itching eyes and excessive sweating were associated with skin disease. Respiratory disease was associated with sore throat, stuffy nose, nose bleeding, chest tightness and shortness of breath. Age, gender and type of workplace were the main predictors of the odds of an increase in high degree of knowledge. Education, experience, and hours of working per day were significant to the prediction of the odds of an increase in good practices. Shortness of breath was significant to the prediction of the odds of an increase in developing Asthma. It is recommended that special trainings on Integrated Pest Management (IPM) and pesticide safety be introduced to help minimize exposure to pesticides risks.

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Pesticides are chemical compounds, devices or organisms that are used to control, destroy, attract or repel pests, pathogens and parasites. These include organochlorines, organophosphates, carbamates, formamidines, thiocyanates, organotins, denitrophenols, pyrethroids and antibiotics (Bhandari, 2014).

Use of pesticides in modern agriculture has not only significantly increased productivity and quality of yield but has also brought negative effects on human health and the environment (Andersson *et al.,* 2014). Their use in developing countries has increased, accounting for about 20% of the world's expenditure on pesticides (Oesterlund *et al.,* 2014). For example, approximately 28,286 metric tons of pesticides valued at Ksh. 20 billion were imported into the country in the 2012/2013 financial year (PCPB, 2014).

Once in the country pesticides are repacked into small approved containers and distributed directly to farmers or retailed in Agro-vets. The Pest Control Products Board (PCPB) is mandated to ensure that retailers distribute only registered pesticides and also maintain safe handling and disposal in order to safeguard human health, animals and the environment (PCPB, 2014). In addition, pesticides handlers are required to have adequate knowledge of efficacy, uses and handling precautions of pesticides (RoK, 2012).

Other requirements for licensing of retail outlets include the presence of safety equipment, well ventilated premises, fire extinguisher, first aid kit that is stocked with antidotes, personal protective equipment, sufficient running water, sufficient space for stocking chemicals, availability of dust bin, saw dust or sand for cleaning pesticides spills, smooth floor, shelves and properly packaged and labeled products (RoK, 2012).

1.1.1 Environmental exposure to pesticides

The effects of pesticides to humans are documented all over the world (Raksanam *et al.,* 2012; Bhattacharjee *et al.,* 2013; Njogu *et al.,* 2013; Andersson *et al.,* 2014). The mishandling of these chemicals poses a serious health problem to the handlers in developing countries who are at significant risk of illness due to frequent unintentional exposure to pesticides when not handled safely (Stadlinger *et al.,* 2012).

According to Mohsen *et al.* (2016) there has been an increase in pesticides poisoning in the world with 99% of the 300000 cases reported annually in low and middle income countries. Pesticide exposures occur through inhalation of vapour, ingestion/oral and dermal/contact (Oesterlund *et al.,* 2014). Duration of an exposure could take seconds, minutes, hours, days, weeks, months, years or even a generation. Its frequency could be continuous, intermittent, cyclic and random or may be rare (Dzobo, 2016).

Although the effects differ depending on the degree and duration of exposure, they are classified based on short-term or long-term effects (Andersson *et al.,* 2014). Short term pesticides effects include; coughing, fatigue, burning/stinging/itching eyes, excessive sweating, dizziness, burning nose, headaches, nausea, diarrhoea, abdominal pain, vomiting, impaired lung functions, skin and nose irritation.

Long term effects include; Asthma, cancer, reproductive disorders, skin diseases, neurological disorders, respiratory diseases, depression, diabetes, genetic disorders and death (Raksanam et *al.,* 2012; Bhattacharjee *et al.,* 2013; Njogu *et al.,* 2013; Andersson *et al.,* 2014; Mohsen *et al.,* 2016)

Low schooling level, lack of knowledge, lack of information, inadequate Personal Protection Equipment (PPE) and unsafe work practices worsens the risk of exposure to pesticides (Khan, 2012; Tofolo *et al.,* 2014). Other factors such as temperature, decanting/repacking, shop/store construction material; design and ventilation also contribute to exposure to pesticides (Stadlinger *et al.,* 2012). Indeed it is critical to look at the knowledge, practice and attitude towards pesticide among the handlers (Oesterlund *et al.,* 2014).

Khan (2012) in his study noted that despite farm workers being knowledgeable about health effects of pesticide use, some were still using very toxic pesticide without personal safety measures. In addition to this, in Tanzania it was reported that pesticides retail workers had low knowledge of pesticides exposure routes and only a few were aware of pesticides poisoning symptoms (Stadlinger *et al.,* 2012).

Though this was studied by Khan (2012) and Stadlinger *et al.* (2012), it is not known whether lack of Knowledge could cause exposure of handlers to pesticides in Kisumu. Therefore, this study will seek to observe the level of knowledge amongst handlers who store and handle pesticides within Kisumu County, Kenya with respect to PPE, exposure routes and self- reported pesticides toxicity symptoms.

1.1.2 Risk factors for pesticides exposure

In Tanzania retail workers had problems while selling pesticides in metal containers because the fumes became too strong with the increasing temperature and lack of ventilation (Stadlinger *et al.,* 2012). Other problems were due to decanting or repacking of pesticides into smaller quantities without proper PPE which led to exposure of the handlers to pesticides risks (Stadlinger *et al.,* 2012).

Though Stadlinger *et al. (*2012) noted the problems related with their practices, he did not associate them with exposure and self-reported symptoms which may result from poor ventilation, high temperatures, fumes and spillages from decanted and repacked pesticides hence the need for this study. In another study by Lekei *et al.* (2014), products which were repackaged or decanted into secondary containers showed signs of spills due to lack of proper seals and damaged containers.

A small percentage (9.3%) of the outlets had PPE, first aid kits, fire-fighting equipment, well ventilated premises, displayed warning signs and had washing facilities (Lekei *et al.,* 2014). Elsewhere, Oesterlund *et al.* (2014) observed that farm workers used their home clothes and a small number used gloves, overalls, masks or hats during application and handling of pesticides which exposed them, their families and the environment to pesticide risks.

Since large quantities of pesticides are sold at retail stores and because there is currently no documented information regarding the risk of pesticide poisoning among the handlers in Kisumu County, this study sought to address this topic by relating the exposures due to the said practices with self- reported symptoms among handlers in Kisumu County.

1.2 Problem statement

Use of chemicals in agriculture has significantly increased productivity but has resulted in various negative health, environmental and economic effects (Andersson *et al.,* 2014). In Kenya, Pesticides handlers use highly hazardous pesticides (Nyakundi *et al.,* 2012). Majority (86%) of them who are in Nyando catchment do not use safety information and do not read instructions on pesticides labels. They also lack knowledge on safe use of pesticides, environmental and health risks and alternative pest management methods (Abong'o *et al.,* 2014).

Lack of knowledge on handling and routes of exposure, failure to utilize personal protective equipment, lack of safety measures and poor practices with regard to handling contributes to pesticides related health effects (Ugwu *et al.,* 2015). Pesticides handlers come into contact with these potentially hazardous chemicals when they are involved in high- risk practices such as; opening the original containers of pesticides and decanting or reweighing them into small unlabeled containers (Abong'o *et al.,* 2014) and also when mixing or applying pesticides without personal protective equipment (Dzobo, 2016).

In addition, poor design insufficient space and lack of enough ventilation within the pesticides stores could contribute to increased room temperature and poor air circulation. Without sufficient ventilation and without adequate PPE, pesticides fumes could be inhaled into the human body (Osterlund *et al*., 2014).

Most handlers are ignorant of the safe use and handling of the pesticides, which results to their exposure through nose, mouth and skin. This is the case because some lack clean running water for washing hands and body after handling pesticides which leads to accidental poisoning and eventually cause acute and chronic effects among handlers (Bhattacharjee, 2013). The number of exposed and unexposed groups among pesticides handlers due to their knowledge and practices when handling pesticides in Kisumu County is not known. This study sought to assess pesticides handlers' knowledge, practices and their relationship with self-reported toxicity symptoms.

1.3 Justification of the study

Pesticides exposure is common in the World and in Africa at large. Although Africa accounts for a small fraction of pesticides used globally, lack of pesticides knowledge on storage, handling, routes of exposure, use of PPE together with bad practices and negative attitude towards pesticides has led to increased rate of morbidity and mortality in developing countries (Al-Haddad & Al-Sayyad, 2013; Oesterlund *et al.,* 2014; Tofolo *et al.,* 2014).

In Kenya over 29.2 kg of illegal pesticides impounded by Pest Control Products Board inspectors were decanted or reweighed by retailers in Kisumu County (PCPB, 2014) and 59 out of 130 retailers in Kisumu County did not meet the requirements for licensing of premises (PCPB, 2015). Nyakundi *et al.* (2012) also reported cases of decanting and reweighing among farm workers in Rift valley and Central Kenya. In addition, there is scarcity of information on diagnosed and suspected cases of pesticide poisoning in the country (PCPB, 2014).

Extensive studies on safe use and handling of pesticides have been conducted in parts of Kenya such as; Central, Coast, Rift valley and Eastern provinces (Nyakundi *et al.,* 2012; Njogu *et al.,* 2013; Kurui *et al.,* 2014; Tsimbiri *et al.,* 2015) but none has been conducted in Nyanza province and specifically Kisumu County, Kenya which has many agricultural activities such as sugar cane, rice, ground nuts and horticultural crops farming and small scale livestock keeping.

In order to promote safe storage, handling and use of pesticides among handlers in Kisumu County; it is critical to assess their degree of knowledge and safety practices with regard to pesticides storage, handling, exposure routes, personal protective equipment and self-reported toxicity symptoms of pesticides among this group of workers, who are part of the Kenyan workforce.

Therefore, documentation of pesticides handlers' knowledge, practices and toxicity symptoms in Kisumu County, Kenya is very urgent. This will eventually minimize the risk of exposure to pesticides and reduce absenteeism, mortality rate and labour turnovers in pesticides and agricultural industry.

The findings will also confirm the various studies carried out and hence the results can be used to make a general inference on pesticides handlers in Kenya. This will add to academic knowledge and foster a good basis of policies for bodies that control matters pertaining to pesticides in Kenya**.**

1.4 Hypotheses (H_o)

1. Pesticides handlers' high degree of knowledge and good practices is not associated with age, gender, level of education, experience, position at work, type of work, hours of working and
2. There is no association between self- reported acute pesticides toxicity symptoms and chronic medical conditions reported by pesticides handlers

1.5 Objectives

1.5.1 Main Objective

The main objective of the study was to assess knowledge and practice on pesticides, and self- reported toxicity symptoms related to pesticide exposure among handlers in Kisumu County, Kenya.

1.5.2 Specific Objectives

- To assess the knowledge of pesticide handlers regarding handling, exposure routes and personal protective equipment.
- To evaluate handlers' practices with pesticides and activities with potential for exposure to pesticides.
- To determine the prevalence of self- reported toxicity symptoms associated with pesticide exposure in the work.
- To determine the relationship between handlers knowledge, practices and self-reported toxicity symptoms.

1.6 Scope of the study

The scope of the study was to assess the knowledge, practices and self-reported toxicity symptoms of pesticides handlers in Kisumu County, Kenya. The study engaged participants in filling questionnaires in the period of one month. It did not schedule unstructured interviews, but structured survey method with closed ended questionnaire.

The researcher stayed with the participants for an hour. An observational checklist was also used to collect the stores suitability over the same period of time. The participants included workers in 80 retail outlets and 384 farmers located in Kisumu County. The study did not focus on class U pesticides handlers, but class I, II and III. Owners of farms and retail outlets who were not handling pesticides were excluded from the study.

Lastly, the study recorded only self-reported symptoms and there was no biological testing of participants conducted.

1.7 Study limitations

The researcher could not have been able to control the attitude of the respondents as they respond to the questions. However, the purpose and importance of the study was explained to the interviewees so that they could freely participate and minimize biasness. The study relied heavily on information given by the pesticides handlers with the exemption of information from shop and farm owners who did not handle pesticides and without taking into consideration the situation in other towns outside Kisumu County.

1.8 Conceptual framework

For the purpose of this study two types of variable were used. Dependent variables included participants' degree of knowledge, safety practices and chronic toxicity symptoms. Independent variables consisted of demographic characteristic of pesticides handlers and acute toxicity symptoms.

Through the proposed framework the influence of demographic characteristics of pesticides handlers on knowledge and practices was examined.

The influence of acute toxicity symptoms experienced immediately after handling pesticides on chronic toxicity symptoms was also examined. Furthermore, the proposed framework also provided an opportunity to determine whether participants' degree of knowledge could influence safety practices. Finally, the influence of the degree of knowledge and safety practices on acute and chronic toxicity symptoms was also examined (Figure 1.1).

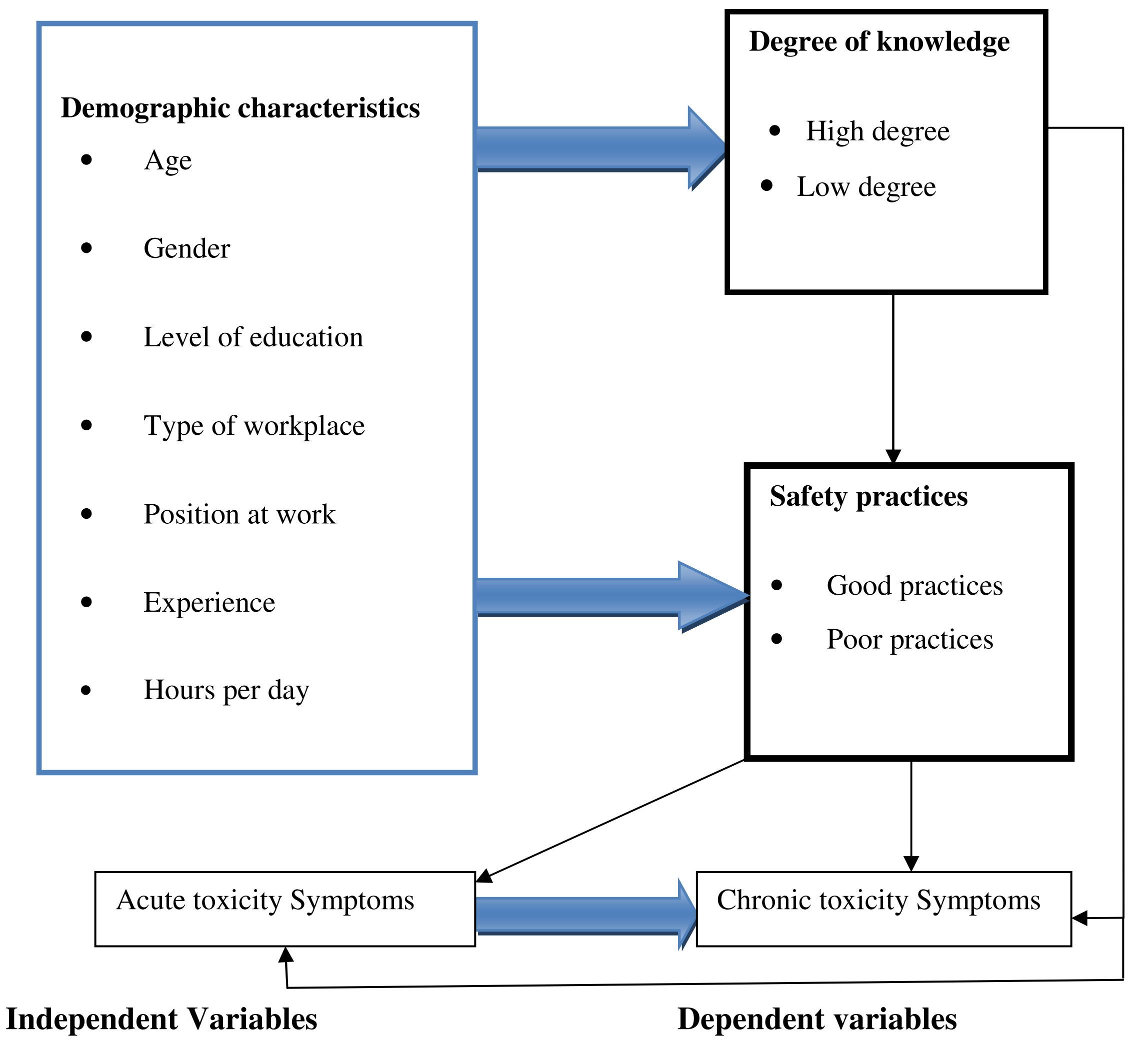

Figure 1.1: Conceptual framework of demographic characteristics, acute symptoms and knowledge, practices of pesticide use and chronic symptoms of pesticide exposure among farmers

Age, gender, level of education, type of workplace, experience, position at work, and hours of per day of handling pesticides could impact one's degree of knowledge and safety of practices. Consequently the degree of knowledge could also affect practices related to pesticide use. In addition, self-reported acute toxicity symptoms may influence development of chronic toxicity symptoms such as asthma, skin disease and respiratory disease among other reported chronic symptoms in the study. Degree of knowledge and safety practices may also be associated with self-reported acute and chronic toxicity symptoms.

CHAPTER TWO

LITERATURE REVIEW

2.1 Theoretical principles

2.1.1 Pesticides classification

Pesticides may be classified into different groups based on their chemical composition which include; organochlorines (OCs), organophosphates (OPs), carbamates, formamidines, thiocyanates, organotins, denitrophenols, pyrethroids and antibiotics (Bhandari, 2014). These chemicals may also be classified based on their target pest such as insecticides, fungicides and herbicides (Dey *et al.,* 2013).

Further, World Health Organization (WHO) has classified pesticides by hazard which include; Ia (extremely hazardous), Ib (highly hazardous), II (moderately hazardous), III (slightly hazardous) and U (unlikely hazardous) (WHO, 2010). Pesticides can also be classified by their mode of action such as stomach, systemic, contact. Organochlorines such as Dichlorodiphenyl Trichloroethane (DDT), Dibromochloropropane, Endrin and Aldrin have since been banned in Kenya because of their persistent nature (PCPB, 2014).

2.1.2 Pesticides toxicity

Most pesticides sampled by PCPB from the agrochemical outlets in 2013 included; organophosphates, pyrethroids, carbamates and pyrethrins (PCPB, 2014). These chemicals, especially Organophosphates and Carbamates are known to cause immediate and short-term neurological signs and symptoms ranging from less severe (headache, dizziness and nausea) to more severe (muscle weakness, bronchospasm and change in heart rate) (Khan *et al.,* 2014).

Other studies conducted on acute and chronic pesticide exposure suggest fatigue, burning/itching eyes, excessive sweating, dizziness and burning nose, headaches, nausea, breathlessness, chest tightness, diarrhea, abdominal pain, vomiting, impaired lung functions, skin and nose irritation and long term effects such as asthma, cancer, reproductive disorders skin diseases, depression, neurological deficits, diabetes, genetic disorders, respiratory diseases, neurological disorders and death may be linked to occupational exposure to pesticides (Raksanam *et al.,* 2012; Bhattacharjee *et al.,* 2013; Njogu *et al.,* 2013; Senthilselvan *et al.,* 2013; Andersson *et al.,* 2014; Lekei *et al.,* 2014; Eldoom *et al.,* 2016). In Kisumu County, it is not known whether handlers are aware of the health effects of pesticides and whether they experience toxicity symptoms associated with pesticides exposure.

2.1.3 Occupational Safety and Health Act and regulations on hazardous substances

The Occupational Safety and Health Act (OSHA) imposes general obligations on employers, those self-employed, suppliers and employees which are intended to ensure the health and safety of all those in workplaces including students, visitors and the neighbours (OSHA, 2007). In Kenya, OSHA is administered by the Directorate of Occupational Safety and Health Services (DOSHS).

This Act makes it compulsory for every workplace to be kept clean, with sufficient space for work to avoid overcrowding which may cause risk of injury to an employee (OSHA, 2007). In addition, an occupier must ensure circulation of fresh air in each workroom and the adequate ventilation of the room (OSHA, 2007).

It is also the responsibility of the occupier to contract designated medical practitioners to conduct medical surveillance in order to safeguard the health of workers and recommend for job rotation where necessary (OSHA, 2007).

According to the Factory and Other Places of Work (Hazardous Substances) Rules (2007), the employer must prevent his employees from being exposed to hazardous substance or if it is not reasonably practical, to ensure that the exposure of an employee is adequately controlled.

This can be done through providing PPE such as respiratory protective equipment and protective clothing for air born hazards and impermeable protective equipment for hazardous substances that can get into the body through the skin. The employers can also inform the workers of the hazards associated with exposure to chemicals used at the workplace (Ministry of Labour, 2007).

These rules also requires the manufacturers or suppliers to ensure proper labeling of hazardous substances, indicating the nature of their contents, health hazards and instructions for safe handling of the substance (Ministry of Labour, 2007). He/she must provide Personal Protective Equipment and safe means of transportation and handling of Hazardous substances to employees and on the other hand employees are supposed to ensure they do not injure themselves or fellow workers (OSHA, 2007).

Premises that meet the OSH standards and use of personal protective equipment protect workers from exposure to hazardous materials but in Kisumu County it is not known whether the retail stores and agricultural farms meet these standards and whether handlers use PPE to protect themselves from the adverse effect of pesticides.

2.1.4 Pest Control Products Act and regulations on pesticides

The Pest Control Products Act and its regulations are administered by the Pest Control Products Board (PCPB). Therefore, risk assessment of pesticides before registration is important in order to safe guard human health, animals and the environment from pesticides risks (PCPB, 2014). Awareness creation of handlers on all aspects of safety, storage, handling, disposal and use of pesticides has also been given priority by the Board (PCPB, 2014). In addition, suitability of premises used for manufacture/formulation, re-packing, storage and distribution of pesticides are assessed for purposes of licensing them for those functions (PCPB, 2014). This is ensured through inspection and checking for availability of sufficient space, enough ventilation, PPE, availability of clean running water, fire-fighting equipment, first aid measures among other requirements stated in the pest control products Act chapter 346 of 1982 (RoK, 2012).

Through this Act, assessment and approval of pesticide labels by PCPB is compulsory for every importer and manufacture in Kenya. These pesticides must be properly labeled in accordance with Pest Control Products ACT and international guidelines (WHO/FAO guidelines), meet requirements for commercial labeling and they must not bear any statement, design, or graphic representation that is false, misleading or deceptive (PCPB, 2014).

There is no documented information that pesticides retail outlets in Kisumu County meet all the inspections requirement set by PCPB and whether all pesticides in the market are labelled as required by the pest control products act. There is also no available information on safe handling of pesticides among handlers in Kisumu County.

2.2 Previous works relevant to the study

2.2.1 Pesticides handling, routes of exposure and PPE knowledge

Illiteracy, poverty, lower sanitation, inadequate knowledge about the pesticide handling and poor medical care standards have been associated with higher health risks during occupational, accidental, and long-term exposure to pesticides (Yang *et al.,* 2014; Bhattacharjee *et al.,* 2013). In a study conducted in china it was observed that handlers considered pesticides as toxic products, most of them (92%) had information of the harmful effects of pesticides (Yang *et al.,* 2014). Despite have knowledge of the harmful effects of pesticides 40% did not know how to protect themselves from pesticides risks (Yang *et al.,* 2014).

In Kenya, Njogu *et al.* (2013) found out that 83.3% of the respondents could read pesticide labels before use, 50% of the respondents always wear apron when applying pesticides, 45.8% never wore nose mask and 61.1 % never wore gloves when applying pesticides which caused exposure of handlers to pesticides hence poor human health.

Lack of the necessary knowledge about safe handling of pesticides put human health and the environment at risk (Stadlinger *et al.,* 2012). In India and Ethiopia, a few people knew pesticide enters the body through nose and affects lungs but they were not aware of the other key routes of exposure (Kumari & Reddy, 2013; Woldemichael *et al.,* 2014). In addition, more educated and adult respondents had good knowledge on handling pesticides than younger and illiterate (Kumari & Reddy, 2013).

Elsewhere, in Sudan some participants knew inhalation, ingestion and skin as routes of exposure to pesticides (Eldoom *et al.,* 2016). According to Damalas and Koutroubas (2016), liquid and gas formulations of pesticides can get into the body through all the three routes of entry whereas powders and dust formulations are not easily absorbed through the skin as compared to liquid. They also indicated that oil based pesticides are more quickly absorbed into the body than water based or dry pesticides (Damalas & Koutroubas, 2016).

It is not only farm workers who are exposed, retail workers are also at significant risk of illness due to frequent exposure to pesticides when not handled properly (Stadlinger *et al.,* 2012). Concerning the knowledge on use of PPE, 58.2% of participants had used at least one PPE, and 9.8% of those had experienced at least one short-term health problem following pesticide exposure (Woldemichael *et al.,* 2014).

Finally, problems in reading and interpreting labels can also contribute to exposure of the handlers to pesticides (Tofolo *et al.,* 2014). The level of knowledge and practices with pesticides in Kisumu is not known hence the need for the study to assess the Knowledge of pesticides handlers in this area.

2.2.2 Pesticides handlers' practices

The attitude of farm workers towards pesticide handling has become wanting because some farmers mix water with pesticides using bare hands, do not wash their hand with soap after pesticides spraying and some smoke during the time of spraying (Bhattacharjee *et al.,* 2013). In addition many of the handlers talked about inappropriate protective measures such as use of tissue or a paper and rags as face mask which increased pesticides absorption rate (Bhattacharjee *et al.,* 2013).

Kurui *et al.* (2014) reported that farm workers who were not wearing PPE during handling of pesticides were exposed to pesticides related risks, while those who used few PPE were also exposed and showed toxicity symptoms. The dangers of not using PPE among workers to prevent exposure to pesticides is reported in many studies (Raksanam *et al.,* 2012; Dey *et al.,* 2013; Khan *et al.,* 2014).

It is recommended that pesticides handlers should wash hands before eating, smoking, or using the restroom, wearing protective clothing to minimize occupational pesticide exposure (Al-Haddad & Al-Sayyad, 2013; Oesterlund *et al.,* 2014). In addition, showering and changing clothes immediately after work, and washing work clothes separately from household laundry and after use reduce occupational pesticides exposure (Oesterlund et al., 2014).

Elsewhere, studies conducted in Brazil and Bahrain indicated that farm workers stored pesticides far from food, avoided to eat during spraying, took a shower after work shift, did not smoke during spraying, wore hats and special shoes, a few used special gloves, clothing, and face and eye masks when handling pesticides, this lowered the cumulative exposure duration of the farmers (Bhandari, 2014; Tofolo *et al.,* 2014).

A study in Zanzibar reported that, retail workers, opened the original containers of pesticides and decanted or reweighed them into small containers which were preferred by farmers because they were cheaper, but led to exposure of retailers to pesticides

(Stadlinger *et al.,* 2012). This was also reported in Sudan by Eldoom *et al.* (2016) where cases of accidental oral exposure was associated with transferring of pesticides from their original containers to unlabeled bottle or food containers.

In Tanzania it was observed that attendant lacked appropriate qualification (57.3%), 38.6% lacked first aid kit, 25.3% repacked pesticides, 22.6% lacked fire-fighting equipment, 14.7% were using unsuitable PPE or no PPE at all (14.6%), handled pesticide containers without proper label (14.6%), sold unregistered pesticides (9.3%), lacked hand-washing facilities (9.3%), and 8% sold expired pesticides (Lekei *et al.*, 2014).

This generates potential for workers' exposure to pesticides through contact, inhalation of fumes or dust and accidental ingestion from the opened containers or spills, damaged or dropped pesticide containers, inhalation within the premises, direct contact while stocking shelves (Stadlinger *et al.,* 2012). These exposures due to poor practices are not documented in Kenya and specifically in Kisumu.

2.2.3 Prevalence of self-reported acute and chronic toxicity symptoms of pesticides

Occupational exposure to pesticides occurs during spraying, mixing or loading, transporting and storing pesticides in the field or within premises. Headache, burning itching eyes, weakness, fever, skin itching and skin irritation, dizziness, chest pain, vomiting and diarrhoea were high among pesticides handlers in Tanzania (Manyilizu *et al.,* 2017). Andersson *et al.* (2014) also reported diarrhoea, abdominal pain, headaches, nausea, vomiting as the most reported symptoms. The most frequent self-reported toxicity symptoms reported in a study in Ghana were headache, dizziness, nausea, restlessness, excessive sweating, skin irritations, stomach poisoning and eye irritations (Dzobo, 2016).

Elsewhere, in Bangladesh the exposure to pesticides was significantly associated with fatigue, burning/stinging/itching eyes, excessive sweating, nausea/vomiting, skin redness/white patches on skin/ skin scaling, dizziness and burning nose with relative risk values above 1 (1.85, 1.61, 1.58, 1.46, 1.42, 1.31 and 1.11, respectively) (Bhattacharjee *et al.,* 2013). In addition, diabetes, asthma and hypertension were reported as the chronic symptoms in the same study (Bhattacharjee *et al.,* 2013).

Similarly, a study in Egypt reported that participants experienced headache, dizziness, blurred vision, nausea, cough, chest tightness, and rash after exposure to pesticides (Mohsen *et al.*, 2016). In Uganda, Skin irritation, headache, extreme tiredness, excessive sweating, blurred vision and dizziness were reported as the most common symptoms (Oesterlund *et al.,* 2014).

Chronic toxicity symptoms of pesticides include; respiratory disease, reproductive disorders, skin disease, asthma, neurological disorders, blindness and diabetes (Andersson *et al.,* 2014; Tofolo *et al.,* 2014).

In Elgeyo Marakwet County, Kenya, it was reported that 85% of pesticides handlers, experienced runny nose, coughing, skin irritation, chest pain, dizziness and high fever (Kurui *et al.,* 2014). It is not clear if pesticides handlers in Kisumu County could be experiencing these toxicity symptoms.

2.2.4 Summary of gap in knowledge

Although studies have indicated that handlers had knowledge on harmful effects of pesticides but lacked knowledge on exposure routes and PPE use (Yang *et al.,* 2014; Kumari & Reddy, 2013; Woldemichael *et al.,* 2014; Eldoom *et al.,* 2016), little is known about the factors influencing their level of knowledge. Therefore, the goal of this study was to establish whether handlers in Kisumu County had knowledge on pesticides handling, exposure routes, PPE use and whether their level of knowledge was influenced by their demographic characteristics.

In as much as recent studies have reported low level of knowledge (Kumari & Reddy, 2013; Woldemichael *et al.,* 2014) and poor practices (Kurui *et al.*, 2014; Bhattacharjee *et al.,* 2013), little is known about the relationship between pesticides handlers' degree of knowledge and safety practices. Therefore, the aim of this study was to assess handlers' practices and determine whether they were associated with their degree of knowledge. Elsewhere, previous studies have not established the relationship between knowledge, practices and toxicity symptoms hence the need for the study.

Previous studies have associated exposure to pesticides with acute symptoms (Bhattacharjee *et al.,* 2013; Mohsen *et al.*, 2016) but the relationship between self-reported chronic and acute symptoms have not been clarified, which this study sought to address. The literature reviewed has left a relative gap on this subject, particularly in the context of Kisumu County. This study will provide empirical evidence on factors influencing knowledge and practices among pesticides handlers and the relationship between knowledge, practices and toxicity symptoms.

CHAPTER THREE

MATERIAL AND METHODS

3.1 Study design

The study was a descriptive cross-sectional survey in nature and employed qualitative methods of data collection. The researcher used cross-sectional survey because it allows researchers to compare many different variables at the same time. With cross- sectional survey, we could for example, look at age, gender, experience and educational level in relation to knowledge and practices, with little or no additional cost.

However, cross-sectional studies may not provide definite information about cause-and-effect relationships. This is because such studies offer a snapshot of a single moment in time; they do not consider what happens before or after the snapshot is taken.

Structured questionnaires and observational check lists were used for data collection. The study population consisted of 100 pesticides retail workers and 280,000 farmers located in Kisumu County. The number of retail workers and farmers in Kisumu County was obtained from the Pest Control Products Board and Kisumu County agricultural extension offices respectively.

The purpose of the study was explained to all the respondents, and their consent obtained before questionnaires were administered. The questionnaire was divided into four sections to record the demographics of the target population and to assess the knowledge; practices and self- reported toxicity symptoms with regard to storage and handling of pesticides among retail shop workers and farm workers based on the proposed objectives.

This questionnaire was pre-tested among 20 stockists and 50 farmers from the County who were not involved in the final study. Another method of data collection was by checklist which was used to record the retail premises suitability such as availability of clean running water, sufficient space, PPE, ventilation, first aid kit, fire extinguisher among other health and safety issues.

3.2 Study area and population

The study was conducted in Kisumu County. Kisumu County neighbours Siaya County to the West, Vihiga County to the North, Nandi County to the North East and Kericho County to the East. Its neighbour to the South is Nyamira County and Homa Bay County is to the South West. The economic activities are farming, livestock keeping, fishing and small scale trading (KIRA, 2014).

The county has 7 Sub- Counties namely Kisumu East which is popularly known for horticulture, Kisumu West known for dairy cow keeping and fishing, Kisumu Central for fishing, pig and poultry keeping, Seme known for sorghum, Nyando known for paddy rice production, Muhoroni known for sugarcane farming and Nyakach which is known for cotton production as illustrated in (Figure 3.1).

The county has a shoreline on Lake Victoria, occupying northern, western and a part of the southern shores of the Winam Gulf. Kisumu County is situated at 0.1° South latitude, 34.75° East longitude and 1132 meters elevation above the sea level.

The mean temperatures of the county ranges from a minimum of 20.0°C to a maximum of 35.0°C, with an annual average of 23.0°C and Annual Rainfall ranges between 1200 mm and 1,300 mm per annum (KIRA, 2014).

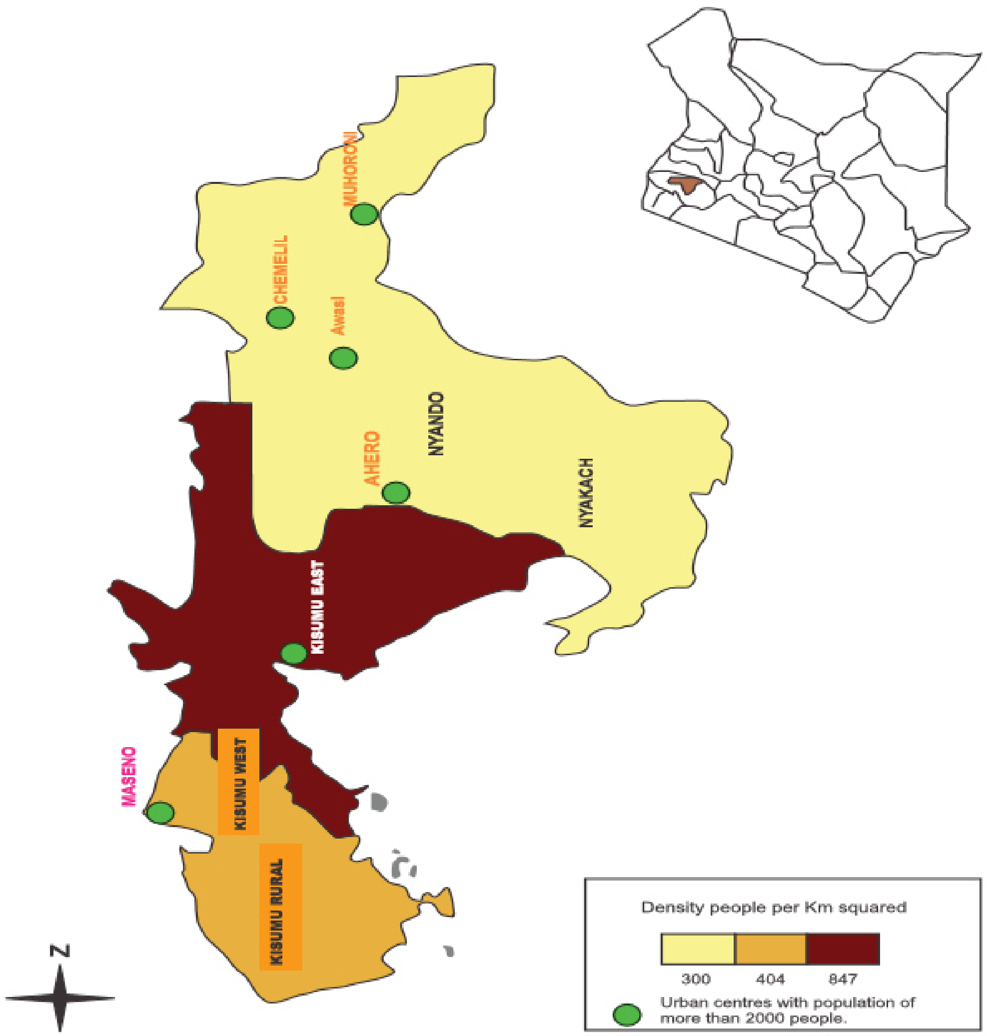

Figure 3.1: Map of Kisumu County, Kenya (KIRA, 2014)

This study targeted sellers and users of pesticides within the Kisumu County. The sellers included 80 employees and self-employed people working in Chemists, Agro vets and Agro-Hardware shops while the users included 384 large scale and small scale farm workers. Selection of the study group was based on the proportion of full-time and daily operation of the worker, cooperation from the owners, and the willingness of the handlers to participate.

3.2.1 Inclusion criteria

The study included retail shop workers who were involved in selling pesticides as their way of making a living. Retail shops workers who were self-employed and worked on daily basis were also included in the study. This study targeted retail shops workers involved in the sale of WHO class Ia, 1b, II, III and class U pesticides. These included Chemists, Agrovets and Agro-Hardware shops**.** Farm workers who were working within the study area and who handled class Ia, Ib, II, and III pesticides were also included in the study and interviewed.

3.2.2 Exclusion criteria

The retail shop and farm owners who were not involved in handling and dispensing of pesticides were not interviewed since they were not at risk of exposure to pesticides. Retail shops that were dealing with only domestic class pesticides (WHO class U) and included general shops, supermarkets and general distributors were excluded from the study.

3.3 Sampling method

Stratified and convenience sampling techniques were employed for the purpose of selecting the sample size of the study. For the pesticides stockists the County was sub-divided into 7 strata namely Kisumu central (50), Kisumu East (11), Nyakach (9), Muhoroni (8), Nyando (8), Kisumu West (7) and Seme (7) Sub- Counties. The stratification was based on the unique farming activities conducted in each sub- County in Kisumu County. This is because retailers in each sub- County could always stock specific pesticides for control of pests in the crops grown within their locality.

Kothari (2004) method of proportional allocation under which the size of the sample from the different strata are kept proportional to the size of the strata was followed for pesticides outlets. Kothari (2004) method of determining the sample size for a finite population was used to determine the sample size from the target population of 100 pesticides stockists and 280,000 farmers. Convenience sampling was then used to select the handlers for interview from each stratum.

3.4 Sample size determination

Kothari (2004) method of determining the sample size for a finite population was used to determine the sample size as follows:

$$n = (Z^2pqN)/ (e^2 (N-1) +z^2pq)$$

Where n = the desired sample size

Z = Confidence level at 95% (1.96),

p = Acceptance error of 0.5,

q = 1- p,

e = Statistical significance set at 0.05,

N = the target population size

Sample size of stockists was calculated as follows:

$n = (1.96^2 \times 0.5(1-0.5) \times 100/0.05^2 (100-1) + 1.96^2 \times 0.5 (1-0.5) = 79.50 = 80$

Sample size of farmers was also calculated as follows:

$n = (1.96^2 \times 0.5(1-0.5) \times 280000/0.05^2 (280000-1) + 1.96^2 \times 0.5 (1-0.5) = 384$

Kothari (2004), method for stratified sampling was then used to determine the stockists sample size from each of the seven strata as follows: Nyakach ($N_1 = 9$), Muhoroni ($N_2 = 8$), Kisumu East ($N_3 = 11$), Kisumu West ($N_4 = 7$), Kisumu Central ($N_5 = 50$), Nyando ($N_6 = 8$), Seme ($N_7 = 7$).

$n_1 = n \times P_1$. From stratum $N_1 = 11$, we have $P_1 = 9/100$

$n_1 = n \times P_1 = 80(9/100) = 7.2$

$n_2 = n \times P_2 = 80(8/100) = 6.4$

$n_3 = n \times P_3 = 80(11/100) = 8.8$

$n_4 = n \times P_4 = 80(7/100) = 5.6$

$n_5 = n \times P_5 = 80(50/100) = 40$

$n_6 = n \times P_6 = 80(8/100) = 6.4$

$n_7 = n \times P_7 = 80(7/100) = 5.6$

Therefore, the sample size of stockists consisted of Muhoroni (6), Kisumu west (6), Nyando (6), Seme (6), Nyakach (7), Kisumu East (9) and Kisumu Central (40). Convenience sampling technique was then applied and stockists from each stratum were selected for inclusion in the sample based on the ease of access to their shops.

3.5 Research Instruments

A structured survey was used in the study and a questionnaire was administered to the respondents to collect primary data. The other source of primary data was observational checklist. Research assistants were trained and hired to obtain informed consent and administer questionnaires in-person to pesticides handlers in the month of October, 2015.

The selected stockists and farmers were visited and the questionnaires administered to them. This questionnaire was developed based on questions asked in similar studies by (Al-Haddad & Al-Sayyad 2013; Dey *et al*., 2013; Kumari & Reddy, 2013; Wongwichit *et al*., 2012). The questionnaire contained four sections which included;

(i) Demographics of participants

(ii) Knowledge on safe storage and handling of pesticides, exposure routes, and PPE

(iii) Practices with pesticides and

(iv) Self-reported toxicity symptoms (Appendix 3).

The first part of questions was the demographic section, which contained questions regarding age, gender, marital status, education level, type of workplace (pesticide shop or farm) and experience as pesticides handlers.

The second section was designed to assess participants' knowledge on safe storage and handling of pesticides, exposure routes, and Personal Protective Equipment. Participants were asked questions that were answered by either yes' or no'.

The third section of the questionnaire consisted of questions related to their practice when handling pesticides. The participants were also asked questions that were answered by either never, sometimes or always.

The last section was designed to record self-reported toxicity symptoms of the handlers due to pesticide exposure. In this section the subjects were asked to tick (√) against the acute and chronic symptoms they had experienced immediately after handling pesticides and in the duration they handled pesticides.

The researcher also used an observational checklist to assess the working conditions and risk factors in the pesticides premises such as; layout, design, sufficient space, pesticides stacking, availability of running water, general cleanliness, enough ventilation, condition of pesticides containers, availability of first aid equipment, availability of PPE, sumps or sawdust for handling pesticides spills, fire fitting equipment, products labels and package, mixing of pesticides with food stuff and other exposure risk factors in the premises. This check list was ticked Yes' or No' and was used by the researcher to record the availability or lack of safety items in the retail outlets in Kisumu county.

3.6 Data processing and statistical analysis

All data collected via the questionnaire and observational checklist were coded, keyed into the Statistical Package for Social Sciences Program (SPSS) and then analyzed. Descriptive results were expressed as frequencies and percentages. Chi-square test ($\chi 2$-test) was used appropriately to test the significant differences or associations between independent and dependent variables and the important findings were revealed.

SPSS was also used to calculate the knowledge and practices scores for all participants based on the previously published methods by Lorenz *et al.* (2012). The researcher calculated the knowledge and practices score that measured the number of questions answered correctly. The median for knowledge and practices scores were calculated and knowledge scores greater than the median were categorized as a high degree of knowledge, and those below the median as a low degree of knowledge. Further, practices scores greater than the median were categorized as good practices, and those below as poor practices (Lorenz *et al.*, 2012).

These knowledge and practices scores were used for testing the hypothesis of the study. The scores were also used for testing the relationship between knowledge, practices and self-reported toxicity symptoms. After data collection a contingency two by two table was used to cross tabulate acute (exposure) and chronic (disease) toxicity symptoms in the present study (Table 3.1).

Kaelin and Bayona (2004) formula ($RR= a(c + d)/c (a + b)$) for calculating relative risk was used to calculate the risk of occurrence of a disease in those with acute symptoms (exposed) to that among those without acute symptoms (unexposed) and (AR% = (Ie - Iu)/Ie) x100) was used to calculate the percentage by which the risk of developing a chronic symptom can be reduced by elimination or control of a particular acute symptom (AR).

Table 3.1: An example of a contingency two by two table commonly used in epidemiology

	Skin Disease	**No disease**	**Total**
Exposed (skin itching)	a (exposed and diseased)	b (exposed not diseased)	a + b
Unexposed(no skin itching)	c (unexposed but diseased)	d (unexposed not diseased)	c + d
Total	a + c	b + d	a + b + c + d

Logistic regression was used to test the hypotheses of the study and the odds ratio for different variables was revealed.

3.7 Data validation

The data collected by questionnaires and checklists were keyed into SPSS cleaned and validated before finding frequencies of descriptive results and before association of independent variables (age, gender, level of education, type of work place and experiences with pesticides) with dependent variables (Knowledge and practices with pesticides of the handlers in Kisumu). Participant in Agro vets, chemists and Agro-hardware were combined and labelled as stockists. Certificate holders, diploma, and degrees were combined and labelled as holders of certificate and above.

3.8 Ethical consideration

Informed consent was sought from pesticide handlers before questionnaires were administered to them and before collections of data by the observational checklist in the pesticides retail shop (Appendix 1). The risks and benefits of the study were explained in the consent form which was signed between the interviewers and participants.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Demographic characteristics of the participants

The study involved 464 respondents, where 80 (17%) were stockists while 384 (83%) were farm workers (Figure 4.1). These findings were similar to what was observed in China where farmworkers were the majority compared to retailers (Yang *et al.,* 2014).

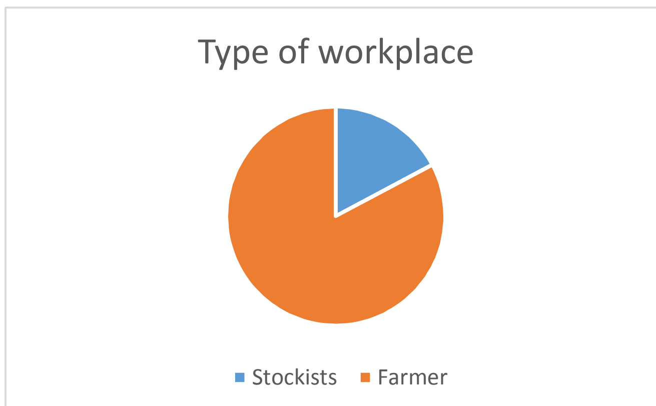

Figure 4.1: Frequency distribution of pesticides handlers' by workplace

Most of them (86%) were self-employed whereas the rest (14%) were employees. These findings were contrary to the findings in Thailand where majority were employees (49.1%) while 24.1% and 13% were farm owners and business owners respectively (Saowanee *et al.,* 2012). The majority of respondents 223 (48%) were aged between 21 and 30 (Figure 4.2).

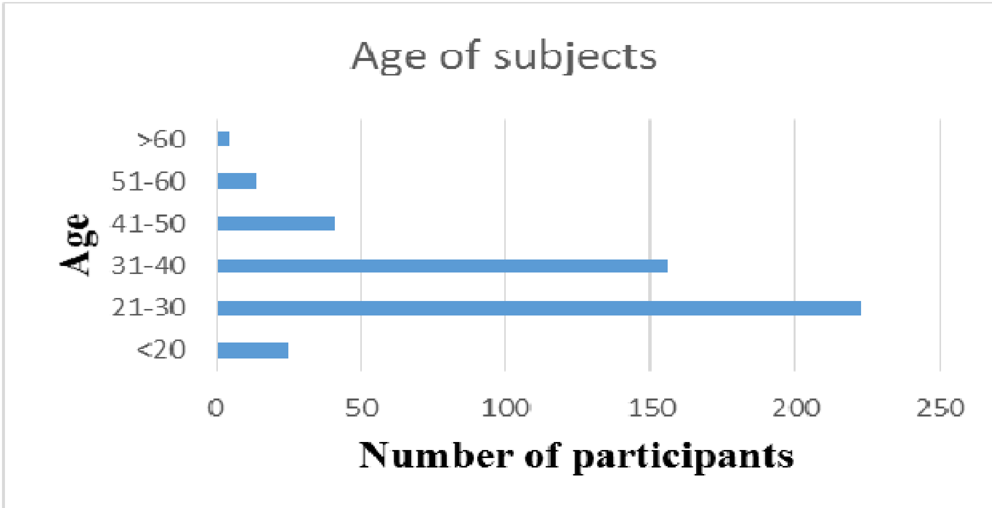

Figure 4.2: Frequency distribution of participants' age groups

This implies that young people were more engaged in pesticides handlers than older people. In the present study, most of the respondents 385 (83%) were male and 79 (17%) were female. This means that the probability, therefore that a pesticides handlers is female is much lower than the probability that such a handler is male. This showed that men were more engaged in pesticides handling than women. These results were similar to what was reported in Kenya by Njogu *et al.* (2013) where the majority of the respondents (62.5%) were male whereas 37.5% were females (Figure 4.3). Contrary to the present study, Saowanee *et al.* (2012) in their research reported that most respondents were female (52.8%) compared to male who were 47.2%. Most participants 199 (42.9%) were literate and had college certificate and above.

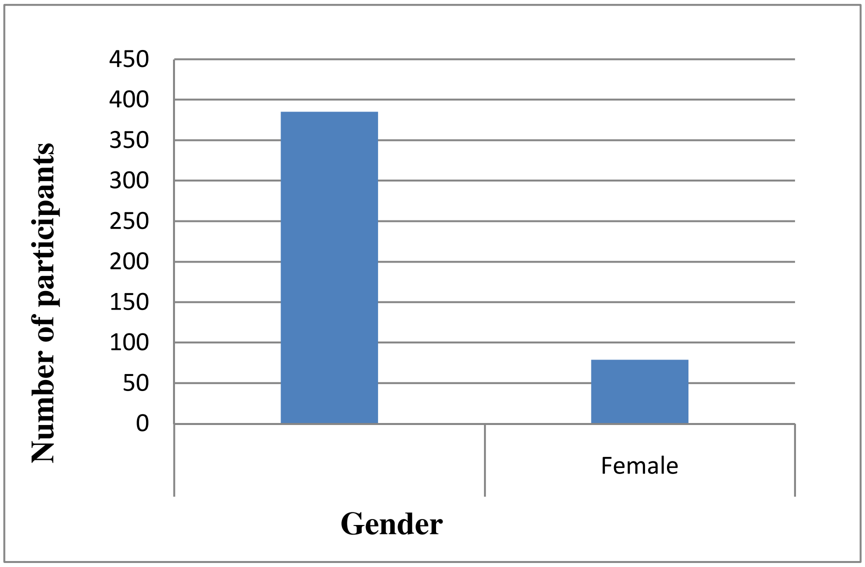

Figure 4.3: Frequency distribution of participants' gender

The rest 175 (37.7%) and 90 (19.4%) were secondary and primary school educated respectively (Figure 4.4). The present study's results were inconsistent with what was reported in Kenya, Sudan, Thailand and Pakistan. These studies reported that the majority of participants had primary education (Raksanam *et al.,* 2012; Saowanee *et al.,* 2012; Njogu *et al.,*2013; Tofolo *et al.,* 2014; Eldoom *et al.,* 2016).

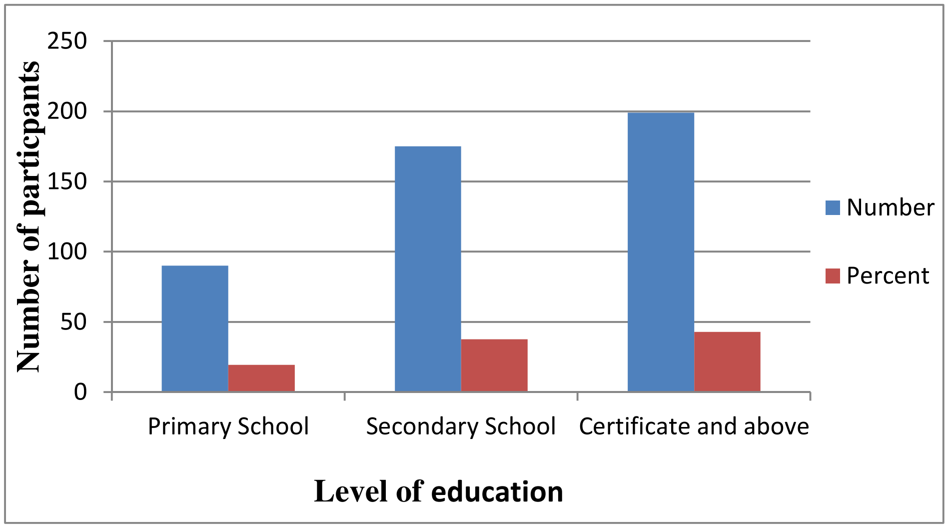

Figure 4.4: Frequency distribution of level of education of pesticides handlers.

In this study, the highest proportion of pesticides handlers 255 (55%) reported handling pesticides for over 24 months and 54 (12%) handled for 18 to 24 months. Seventy three (16%) of the participants reported working for a period of 12 to 18 months with pesticide whereas 82 (18%) stated that they had worked with pesticides for less than one year (Table 4.1).

Table 4.1: Demographic features of the pesticide handlers in Kisumu County

Characteristics		N	Percent %
Age groups	<20	25	5.4
	21-30	223	48.1
	31-40	156	33.6
	41-50	41	8.8
	51-60	14	3.0
	>60	5	1.1
Gender	Male	385	83
	Female	79	17
Level of education	Primary School	90	19.4
	Secondary School	175	37.7
	Certificate and above	199	42.9
Type of workplace	Stockists	80	17
	Farmer	384	83
Position at work	Self employed	399	86
	Employee	65	14
Experience with pesticides	<12 Months	82	17.7
	12-18 Months	73	15.7
	18-24 Months	54	11.6
	> 24 Months	255	55
Hours handling pesticides in a day	< 8 hours	364	78.4
	8 hours	48	10.3
	>8 hours	52	11.2

The majority 364 (78.4%) handled pesticides for less than 8 hours in a day. Forty eight (10.3%) and 52 (11.2%) handled pesticides for 8 hours and over 8 hours respectively.

This could be as a result of many farm workers involved in the study who are known to handle pesticides for less than 8 hours during application on their farm compared to stockists who open their shops very early in the morning and close them late in the evening.

4.2 Knowledge on pesticides handling, routes of exposure and PPE use

The health effects of pesticides have long been known and the undesired effects of these chemicals have been recognized as a serious public health concern during the past decades (Dey *et al.,* 2013). Knowledge of the health effects of pesticides could reduce the chances of exposure to pesticides risks among handlers.

In the present study, a majority 451 (97%) of the participants knew pesticides had negative effects on human health. This finding concur with Njogu *et al.* (2013) who reported that the majority (97.2%) of pesticides handlers knew pesticides have negative impact on human. A similar study in Uganda reported that 92% of farmers knew pesticides have negative effect on their health (Oesterlund *et al.,* 2014). These findings also concur with a study in Sudan where the majority 85% knew pesticides have negative effect on humans (Eldoom *et al.*, 2016). In addition, these results were consistent with what was reported by Raksanam *et al.* (2012).

Two hundred and seventy nine (60%) reported red color code as the sign for most dangerous pesticide whereas 36 (8%) stated blue colour code, 50 (11%) yellow colour code, 23 (5%) green colour code and 76 (16%) reported skull and cross bones. The present study's results show that 40% of handlers did not know the sign for the most dangerous pesticides. A similar percentage (40%) was also noted in Uganda (Oesterlund *et al.,* 2014).

Lack of knowledge on whether pesticides have negative effect to human health and the sign for most dangerous pesticides could lead to a problem of not differentiating the most toxic pesticides from the least toxic. This could result in poor handling of pesticides hence exposure to pesticides (Oesterlund *et al.,* 2014).

Four Hundred and forty seven (96%) handlers could read and understand instructions on pesticides labels and 352 (76%) were aware of pesticides exposure level. These findings concur with what was reported in Sudan where the majority, (84%) were able to read and understand pesticides labels (Eldoom *et al.,* 2016). This could be due to the high level of literacy witnessed among handlers in the present study.

Contrary to the present study, in Bahrain it was reported that handlers could not read or understand the pesticide information because of different language comprehension and because they were written in English (Al-haddad & Al- Sayyad, 2013). A total of 322 (69%) knew that pesticides in dry form can be absorbed through the skin. Also 413 (89%) knew pesticides in liquid form penetrates the skin.

Surprisingly 255 (55%) pesticides handlers did not know whether pesticides in oil (oil based) are more likely to penetrate skin than pesticides in water (water based). Formulations of pesticides differ in absorption ability e.g. emulsifiers are more readily absorbed than the other formulations (Dzobo, 2016).

Lack of clear knowledge on which pesticide formulation penetrates the skin faster than the other could contribute to workers not using the right personal protective equipment. In addition, without use of appropriate PPE, handlers may be exposed to pesticides (Henry & Feola, 2013).

Concerning hygiene, 360 (78%) indicated that washing of hands does not promote movement of pesticides to the body and 447 (96%) indicated that the food they eat can be contaminated by pesticides if no washing of hands (Table 4.2).

Table 4.2: Knowledge on pesticides handling and routes of exposure of handlers in Kisumu County

Knowledge on pesticides		N	Percent %
Sign for most dangerous pesticide	Blue Colour Coding	36	8
	Red Colour Coding	279	60
	Yellow Colour Coding	50	11
	Green Colour Coding	23	5
	Skull and cross bones	76	16
Whether pesticides have negative effects on health	Yes	451	97
	No	13	3
Reading and understanding instructions on pesticides labels	Yes	447	96
	No	17	4
Awareness on pesticides exposure levels	Yes	352	76
	No	112	24
Whether pesticides in dry form can be absorbed through the skin	Yes	322	69
	No	142	31
Whether pesticides in liquid form can be absorbed through the skin	Yes	413	89
	No	51	11
Whether pesticides in oil are more likely to penetrate skin than pesticides in water	Yes	209	45
	No	255	55
Washing of hands promote movement of pesticides into the body	Yes	104	22
	No	360	78
Whether food that you eat can be tainted by pesticides if no washing of hands after pesticides handling	Yes	447	96
	No	17	4
Instructed about safe pesticides handling methods	Yes	303	65
	No	161	35
All gloves provide same level of protection	Yes	89	19
	No	375	81
Exposure can be through inhalation	Yes	451	97
	No	13	3
Exposure can be through contact	Yes	430	93
	No	34	7
Exposure can be through ingestion	Yes	433	93
	No	31	7
Exposure can be through injection	Yes	310	67
	No	154	33

The present study's results show that most (96%) handlers knew that food can be tainted by pesticides if they do not wash their hands after handling pesticides. According to Oesterlund *et al.* (2014), washing of hands and body lowered handlers' exposure to pesticides. Thus having knowledge of washing hands after pesticides handling could prevent most handlers in Kisumu County from consuming food stuff that are contaminated with pesticides.

Most of them had knowledge of pesticides exposure routes with 451 (97%) reported inhalation, 433 (93%) ingestion, 430 (92.7%) contact and 310 (69%) injection. Similar findings in Thailand showed ingestion and skin as potential pathways (Raksanam *et al.,* 2012). Lack of knowledge on pesticides routes of entry into the body could lead to exposure of handlers to pesticides risks. This was emphasized in Jamaica where it was observed that knowledge on routes of exposure was associated farmers use of personal protective equipment to prevent exposure (Henry & Feola, 2013).

Regarding whether all gloves provide same level of protection, result show that a high percentage (81%) were against the statement. The majority of handlers had knowledge of using gloves 394 (85%), dust coat/apron 319 (69%) and dust mask 298 (64%). The least known PPE were 151 (33%) respirator and 134 (29%) hat/helmet (Table 4.3).

Table 4.3: Knowledge on Personal Protective Equipment usage among pesticides handlers in Kisumu County

PPE		N	Percent
Knowledge on gloves use	Yes	394	85
	No	70	15
Knowledge on dust mask use	Yes	298	64
	No	166	36
Knowledge on dust coat/apron use	Yes	319	69
	No	145	31
Knowledge on respirator	Yes	151	33
	No	313	67
Knowledge on hat/Helmet use	Yes	134	29
	No	330	71

The higher percentage of handlers with knowledge on PPE use could be as a result of high level of education and information among handlers in Kisumu County. This is so because in Pakistan it was also reported that the decision to use safety measures was determined by the level of awareness on safety measures and quality of information about the risks of pesticides (Khan *et al.,* 2013).

A similar study in Jamaica reported that training of farmers on health effects of pesticides and PPE use improved their safety practices. He further and reported that training in PPE use was associated with wearing some PPE when applying pesticides (Henry & Feola, 2013).

The present study indicates that 33% of pesticides handlers had knowledge on respirator use. This contradicted the findings in a similarly study in Jamaica where it was observed that none of the handlers had knowledge of respirators which led to their exposure to pesticides (Henry & Feola, 2013).

4.2.1 Association between age and knowledge

Majority (86%) of the handlers who were aged between 51 to 60 years were aware of pesticides exposure levels. There was significant association between the age and awareness on pesticides exposure level ($\chi 2 = 24.611$; $p < 0.001$). Pesticides handlers who are aware of the health consequences of pesticide use would choose to use more safety clothing while using pesticides (Khan *et al.,* 2013). The present study indicates that older handlers were more aware of pesticides exposure levels than younger ones. Hence it can be concluded that awareness of exposure level is improving as long as their age is enhancing. A Similar study in India also reported that age was associated with awareness on exposure levels (Kumari *et al.,* 2015).

Regarding exposure routes, 100% of age group 51 to 60 years and 100% of above sixty years knew exposure through contact. On the other hand, 100 % who were above sixty and 99% of age group 31 to 40 knew exposure to pesticides could be through ingestion. There was significant association between age and exposure through contact ($\chi2$ = 13.757; $p < 0.02$) and exposure through ingestion ($\chi2$ = 15.497; $p < 0.01$) respectively.

Concerning knowledge on PPE use, the majority 100% of those who were over sixty years knew how to use dust masks and 80% of the same age group had knowledge of dust coat/apron use. There was significant association between age and knowledge of dust mask use ($\chi2$ = 12.122; $p < 0.03$) and dust coat/apron use (12.789; $p < 0.03$) respectively.

Younger handlers are less likely to have knowledge of using PPE than older handlers (Aryal, *et al.,* (2014). Older pesticides handlers could lower their exposure to pesticides significantly by knowing how to use PPE because proper wearing of PPE is widely assumed to protect workers from pesticide exposure and lowers exposure levels (Macharia *et al.,* 2013). These results show that older pesticides handlers had high degree of knowledge on pesticides handling, routes of exposure and PPE use than younger ones (Table 4.4).

Table 4.4: Association between age and knowledge on safe handling of pesticides among handlers

	Age of subjects						Pearson Chi-Square	
	<20 n=25	21-30 n=223	31-40 n=156	41-50 n=41	51-60 n=14	>60 n=5	Chi-Square value	p-value <0.05
Awareness on pesticides exposure levels	20 (80%)	186 (83%)	109 (70%)	21 (51%)	12 (86%)	4 (80%)	24.611	0.001
Exposure can be through contact	20 (80%)	201 (90%)	150 (96%)	40 (98%)	14 (100%)	5 (100%)	13.757	0.020
Exposure can be through ingestion	24 (96%)	198 (89%)	154 (99%)	39 (95%)	13 (93%)	5 (100%)	15.497	0.010
Knowledge of dust mask use	12 (48%)	132 (59%)	111 (71%)	29 (70%)	9 (64%)	5 (100%)	12.122	0.030
Knowledge of dust coat/apron use	10 (50%)	153 (69%)	116 (74%)	26 (63%)	10 (71%)	4 (80%)	12.789	0.030

4.2.2 Association between gender and knowledge

A total of 374 (97%) of men and 73 (92%) of women could read and understand the instructions. On whether pesticides in oil are likely to penetrate skin than in water, 44 (56%) of women were aware compared to 165 (43%) of men. There was significant association between gender and reading and understanding instruction ($\chi 2 = 4.169$; $p < 0.04$). Participants gender and penetration of pesticides in oil than in water was also significantly associated ($\chi 2 = 4.365$; $p < 0.04$) (Table 4.5). These results show that more men could read and understand instruction on pesticides label than women.

Table 4.5: Association between gender and knowledge on safe handling of pesticides among handlers

	Gender of subjects				Pearson Chi-Square	
	Male (n= 385)		Female (n = 79)		Chi-Square value	p. value < 0.05
	N	%	N	%		
Reading and understanding instructions on pesticides labels	374	97%	73	92%	4.169	0.04
Pesticides in oil are more likely to penetrate skin than pesticides in water	165	43%	44	56%	4.365	0.04

A similar study in Nepal, also reported that female handlers had lower levels of education than male, making females less likely to read and understand labels on pesticides. Likewise a majority of women knew that emulsifiable concentrates are more likely to penetrate the skin than soluble liquids pesticides. Nevertheless, the finding contradicts the Nepal study where women lacked a strong notion of the dangers caused by pesticides because they had lower education level (Bhandari, 2014).

This is not the case in Kisumu County, Kenya because the level of education among women is high since they are given equal opportunity as men for education through introduction of affirmative actions, free primary education and subsidized day secondary schools (IEA, 2008).

4.2.3 Association between education and knowledge

One hundred and ninety four (99%) participants with certificate and above and 174 (99%) with secondary school education could read and understand instruction on pesticides labels. The difference was significant ($\chi2 = 47.786$; $p < 0.001$). The lower the educational level the lesser one could read and understood instruction on pesticides labels (Tofolo *et al.,* 2014). High level of education was associated with reading and better understanding of instruction on pesticides labels in Brazil (Tofolo *et al.,* 2014). The findings of this study are in line with what was observed in Brazil because majority of the participants in the present study were well educated. Brazil handlers had low schooling level hence their exposure to pesticides (Tofolo *et al.,* 2014).

This was also consistent with what was reported by Khan *et al.* (2013) where they held that education enhances awareness regarding health and in that study the more educated farmers reported wearing more safety clothing than farmers with less education. Therefore, lack of education can be associated with failure to understand instruction and poor safety measures among handlers.

Further, Eldoom *et al.* (2016) reported that almost half (49%) of participants in Sudan had primary education which led to poor understanding of the health impacts of pesticides. Participants with secondary school education who represented the majority (92%) responded that pesticides in liquid can be absorbed through skin. Poor understanding of pesticides instruction on the label can be associated with primary education (Zbobo, 2016)

Certificate and above (72%) respondents were instructed on pesticides safe handling method compared to 64% who had secondary and 52% with primary education. There was significant association between the levels of education and knowledge of absorption of liquid pesticides through the skin ($\chi 2 = 5.877$; $p = 0.05$) and instructed safe handling method ($\chi 2 = 11.304$; $p = 0.001$) respectively.

Lack of education among handlers could result to higher risk when using pesticides since they are not well instructed about pesticides safe handling methods. The findings were consistent with what was reported by Kumari and Reddy (2013) where high level of education was associated with good handling of pesticides. Similar findings were also reported in other studies (Raksanam *et al.,* 2012; Tofolo *et al.,* 2014).

Regarding knowledge on PPE use, 72% who had certificate and above knew how to use dust masks. On knowledge of dust coat/apron use, 79% of participants with certificate and above knew how to use dust coat/apron when handling pesticides compared 62% with secondary and 59% with primary level of education. The difference were significantly associated ($\chi 2 = 17.009$; $p< 0.001$) (Table 4.6).

Table 4.6: Association between education and knowledge on safe handling of pesticides among handlers

	Level of education			Pearson Chi-Square	
	Primary n=90	Secondary n=175	Certificate > n=199	Chi-Square value	p. value < 0.05
Can read and understand instructions on labels	76 (84%)	174 (99%)	197 (99%)	44.786[a]	0.001
Pesticides in liquid can be absorbed through skin	74 (82%)	161 (92%)	178 (89%)	5.877a	0.050
Instructed about safe pesticides handling methods	47 (52%)	112 (64%)	144 (72%)	11.304a	0.001
Knowledge of dust mask use	51 (57%)	104 (59%)	143 (72%)	9.038a	0.010
Knowledge of dust coat/apron use	53 (59%)	109 (62%)	157 (79%)	17.009a	0.001

In a similar study, high level education was associated with knowledge on PPE use (Henry & Feola, 2013). This concurs with the findings of the present study where handlers with certificate and above and secondary school education had knowledge on PPE use than those with primary school education. These show that a good number of handlers in Kisumu were not at risk of pesticides exposure because most of them were educated (secondary and certificate and above) and had knowledge on pesticides handling, routes of exposure and PPE use. These findings were inconsistent with what was reported in Brazil by Tofolo *et al.* (2014), that most handlers were illiterate which made it difficult for them to read and understand instruction written in English on pesticides labels. The less educated were also unaware of pesticides effect which placed them at risk of exposure to pesticides and they complained of headache, dizziness, vomiting, cloudy vision (Tofolo *et al.*, 2014).

Indeed low level of education contributes to pesticides exposure among the handlers. According to Bhandari (2014), less educated farmers lack awareness of pesticide residues and they rarely pay attention to the toxic side effects of chemicals on human health. Another similar study conducted in Kenya reported that education and training had a positive influence on the level of awareness (Kurui *et al.,* 2014). The present study's results show that participants with certificate and above and secondary education were more knowledgeable which translated into more knowledge on safe handling of pesticides.

4.2.4 Association between type of workplace and knowledge

Results reveal that the knowledge of stockist is more than that of farmers. In this study, 80 stockists and 384 farmers we interviewed. The majority 76% and 86% who were stockists reported red as the sign for the most dangerous pesticides and were aware of pesticides exposure level respectively. The type of work place and sign for most dangerous pesticides ($\chi 2$ = 12.688; $p< 0.01$) and awareness on exposure levels ($\chi 2$ = 5.697; $p< 0.02$) were significantly associated respectively.

The findings concurred with a similarly study from china where retailers were more aware of exposure levels and understood the relationship between pesticides and illness than farmers (Yang *et al.,* 2014). Stockists who were the majority (80%) knew pesticides in dry form can be absorbed through the skin. The difference were significant ($\chi2$ = 5.118; $p < 0.02$).

Regarding knowledge on PPE use, 81% of stockists had knowledge of using dust mask and 31% of farmers on hat/helmet when applying pesticides. Knowledge on dust mask use ($\chi2$ = 12.19; $p < 0.001$) and hats/helmet use ($\chi2$ = 6.094; $p < 0.01$) were associated with the type of workplace. Concerning whether washing of hands promotes movement of pesticides to the body, the majority (86%) who were stockists disagreed. The difference was significant ($\chi2$ = 4.172; $p < 0.04$).

Majority (79%) who were stockists knew injection as a route of exposure to pesticides compared with 64% of farmers. The difference was significant ($\chi2$ = 6.215; $p < 0.01$) (Table 4.7).

Table 4.7: Association between the type of workplace and knowledge on safe handling of pesticides among handlers

	Type of work place		Pearson Chi-Square	
	Stockists	Farmer	Chi-Square Value	p. value
	N	N		
Sign for most dangerous pesticide	61 (76%)	218 (57%)	12.688	0.010
Awareness on pesticides exposure levels	69 (86%)	283 (74%)	5.697	0.020
Whether pesticides in dry form can be absorbed through the skin	64 (80%)	258 (67%)	5.118	0.020
Washing of hands promote movement of pesticides into the body	69 (86%)	291(75%)	4.172	0.040
Exposure can be through injection	63 (79%)	247 (64%)	6.215	0.010
Knowledge of dust mask use	65 (81%)	233 (61%)	12.19	0.001
Knowledge of hat/Helmet use	14 (18%)	120 (31%)	6.094	0.010

Lack of knowledge and poor practices with pesticides could lead to exposure of both handlers to pesticides risks because pesticides containers could leak or release fumes in retail outlets and farmers may fail to protect themselves in their farms due to lack of PPE on pesticides. In addition some stockists decanted/repacked pesticides in these closed environment without sufficient ventilation hence the high risk to pesticides exposure. In India it was reported that the knowledge of workers in closed workplaces was more than that of workers in open workplaces because the nature of closed workplaces favoured the occurrence of hazards, and therefore the extensive handling of pesticides in closed areas exposes the workers to a higher risk (Kumar & Reddy, 2013).

4.2.5 Association between experience and knowledge

The majority (70%) who had worked with pesticides for 18 to 24 months knew sign for most dangerous pesticide compared to those with above 24 months experience (63%), < 12 months (54%) and 12 to 18 months (49%). These differences were significant ($\chi2 = 20.729$; $p< 0.05$). These results reveal that participants with more experience were more aware of sign for most dangerous pesticides than those with less experience. This could be as a result of them working with pesticides for a long time.

Participants with less than 12 months (90%) experience were aware of pesticides exposure level whereas 78% with 12 to 18 months, 73% with above 24 months and 63% with 18 to 24 months were aware. These differences were significant ($\chi2 = 15.256$; $p< 0.001$). These findings show that less experienced participants were more aware of pesticides exposure levels. Elsewhere awareness of exposure level was associated with experience (Dzobo, 2016), but these is not the case in the present study because the less experienced are the ones who are more aware of pesticides exposure level than the more experience.

The majority (96%) who had experience of more than 24 months knew ingestions as a route of exposure to pesticides. These difference statistically significant ($\chi2 = 11.914$; $p< 0.01$). Participants (73%) with 18 to 24 months and 69% with over 24 months of experience had knowledge on dust mask use. The majority (74%) with 18 to 24 knew how to use dust coats.

There was significant association between experience and knowledge on dust mask use ($\chi2 = 13.561$; $p< 0.00$) and dust coat use ($\chi2 = 10.434$; $p< 0.02$) respectively (Table 4.8). Knowledge of PPE use can majorly be attributed to experience. This is confirmed by previous studies which indicated that experience influences knowledge on PPE use (Henry and Feola, 2013).

Table 4.8: Association between experience and knowledge on safe handling of pesticides

	Duration of handling pesticides in months				**Pearson Chi-Square**	
	<12	12-18	18-24	> 24	Chi-value	p. value
Sign for most dangerous pesticide	44 (54%)	36 (49%)	38 (70%)	161 (63%)	20.729	0.05
Awareness on pesticides exposure levels	74 (90%)	57 (78%)	34 (63%)	187 (73%)	15.256	0.00
All gloves provide same level of protection	58 (71%)	56 (77%)	48 (89%)	42 (84%)	9.654	0.02
Exposure can be through ingestion	75 (91%)	62 (85%)	51 (94%)	245 (96%)	11.914	0.01
Knowledge of dust mask use	39 (48%)	45 (62%)	38 (73%)	176 (69%)	13.561	0.00
Knowledge dust coat/apron use	46 (56%)	46 (63%)	40 (74%)	187 (73%)	10.434	0.02

4.2.6 Association between position at work and knowledge

The majority (82%) who were employed were instructed about safe pesticides handling methods compared to the self-employed (63%) A total of 391 (98%) of the self-employed knew pesticides exposure through inhalation compared to 92% of the employees. Employees (79%) knew exposure through injection with farm needles. There was statistical significant association between position at work and instruction about safe handling methods ($\chi2 = 8.795$; $p< 0.001$), exposure through inhalation ($\chi2 = 6.639$; $p< 0.01$) and exposure through injection ($\chi2 = 4.628$; $p< 0.03$) respectively.

With regard to knowledge on PPE use, employees who were the majority knew how to use dust mask (79%) and dust coat/apron (88%). Knowledge of dust mask use ($\chi2 = 6.669^a$ $p< 0.01$) and dust coat use ($\chi2 = 12.624$; $p< 0.001$) were significantly associated with position at work (Table 4.9)

Table 4.9: Association between position at work and knowledge on safe handling of pesticides

	Self-employed	Employee	Pearson Chi-Square	
			Chi-Square Value	p. value
	n = 399	n = 65		p< 0.05
Instructed about safe pesticides handling methods	250 (63%)	53 (82%)	8.795^a	0.001
Exposure can be through inhalation	391 (98%)	60 (92%)	6.639^a	0.010
Exposure can be through injection	259 (65%)	51 (79%)	4.628^a	0.030
Knowledge of dust mask use	247 (62%)	51 (79%)	6.669^a	0.010
Knowledge of dust coat/apron use	262 (66%)	57 (88%)	12.624^a	0.001

4.2.7 Association between hours of working per day and knowledge

The majority (92%) who worked with pesticides for over 8 hours in a day were instructed on safe pesticides handling methods compared to 73% and 60% of 8 hours and below 8 hours respectively. The difference were significant ($\chi 2 = 21.764$; $p < 0.001$). These results were contrary to what was reported in West Bank, Palestine by Zyoud *et al.* (2010), who reported that farm worker with less hours at the farm were more aware on safe handling than those with more hours.

The majority of respondents (95%) of those who worked for less than 8 hours knew exposure to pesticides through ingestion. The difference was significant ($\chi 2 = 6.156$; $p < 0.05$). Results show that there was association between knowledge on PPE use and hours of working per day, where the majority (81%) of over 8 hours knew how use dust mask ($\chi 2 = 9.725$; $p < 0.01$) and (90%) dust coat/ apron ($\chi 2 = 14.798$; $p < 0.001$) (Table 4.10).

Table 4.10: Association between hours of working with pesticides and knowledge on safe handling

	< 8 Hours n= 364	8 Hours n = 48	> 8 Hours n = 52	Chi square value	P. value p< 0.05
Instructed on safe pesticides handling methods	220 (60%)	35 (73%)	48 (92%)	21.764a	0.001
Exposure can be through ingestion	345 (95%)	43 (90%)	45 (87%)	6.156a	0.050
Knowledge of dust mask use	221 (61%)	35 (73%)	42 (81%)	9.725a	0.010
Knowledge of dust coat/apron use	236 (65%)	36 (75%)	47 (90%)	14.798a	0.001

4.3 Practices of safety measures on pesticides handling

Majority 378 (82%) handlers changed clothing before and after pesticide exposure, 67 (14%) changed occasionally while 19 (4%) never changed their clothes. Change of clothing before and after pesticides handling reduce occupational exposure to pesticides (Senthilselvan *et al.,* 2013). These results concurred Dzobo (2016) who found out that most workers always changed clothing after pesticides application but were inconsistent with a study in Bahrain whereby majority (95.8%) never changed their clothes (Al-Haddad & Al- Sayyad, 2013). Elsewhere, in a contrary study Jamaica also reported that the majority of the handlers never changed their clothes and never separated work clothes from home clothes which led to their exposure to pesticides (Henry & Feola, 2013). Four hundred nine (88%) handlers always had a place to wash hands next to where they store or handle pesticides. Washing of hands prevents poisoning after pesticides handling (Yang *et al.,* 2014).

The huge percentage with washing facility was also observed in Philippines where it was observed that over 70% of the farmers washed their hands after pesticides handling this prevented poisoning (Yang *et al.,* 2014). A total of 25 (5%) never had showers after handling pesticides while 68 (15%) showered sometimes and the remaining majority 371 (80%) always took showers after pesticide handling (Table 4.11).

Table 4.11: Pesticides handlers' responses on practices with pesticides in Kisumu County

Practices with pesticides Percent %	Response	N	
Change clothing before and after pesticides exposure	Never	19	4
	Sometimes	67	14
	Always	378	82
Have a place to wash hands next to where you store or handle pesticides	Never	27	6
	Sometimes	28	6
	Always	409	88
Shower after handling pesticides	Never	25	5
	Sometimes	68	15
	Always	371	80
Eat or drink while handling pesticides	Never	428	92
	Sometimes	22	5
	Always	14	3
Wash hands after pesticides exposure before eating or drinking	Never	5	1
	Sometimes	11	2
	Always	448	97
Wear PPE when handling pesticides	Never	42	9
	Sometimes	183	39
	Always	239	52
Wear Gloves when cleaning pesticides spills	Never	117	25
	Sometimes	117	25
	Always	230	50
Wear Respirator when handling liquid formulations	Never	286	61.6
	Sometimes	58	12.5
	Always	120	25.9
Wear dust mask when handling dust and powder formulations	Never	160	34.5
	Sometimes	96	20.7
	Always	208	44.8
Chew or smoke tobacco while handling pesticides	Never	448	97
	Sometimes	10	2
	Always	6	1

Showering after handling pesticides prevents exposure through the skin and accidental ingestion during eating. A similar study by Tofolo *et al.* (2014) reported that a similar percentage (80%) always took showers after pesticides handling and those who did not shower experienced acute toxicity symptoms. Contrary to the findings in the present study, only 17.9% showered after handling pesticides in China and poisoning was reported (Yang *et al.,* 2014).

Fortunately 428 (92%) never ate or drank while handling pesticides, 22 (5%) did it occasionally and 14 (3%) always ate or drank. A contrary practice was reported in Bahrain by Al- Haddad and Al- Sayyad (2013), who observed that the majority ate and drank while handling pesticides and did not shower after handling pesticides. Eating and drinking while handling pesticides could result to accidental ingestion of pesticides into the body.

A study in Tanzania disclosed that, eating or drinking when handling pesticides increased hand to mouth exposure (Manyilizu *et al.,* 2017). In this study 448 (97%) washed their hands before eating or drinking, 11(2%) washed occasionally and 5(1%) never (Table 4.4). These results showed similarity with what was reported in Bahrain by Al- Haddad and Al-Sayyad (2013) who established that 87.9% washed their hands after pesticides handling.

Contrary to the findings in the present study Bhattacharjee *et al.* (2013) reported that 87.5% of pesticides handlers never washed their hands with soap after pesticides application. These led to exposure of the handlers to pesticides.

The present study's findings clearly indicated that hygiene practices with pesticides among handlers was excellent (> 90%) but those who eat or drink and do not wash their hands after pesticides exposure can end up ingesting some traces of pesticides which could cause acute symptoms and depending on their toxicity and dosage can lead to death of the handler. In addition those who do not shower after pesticides handling increase chances of pesticides being absorbed into their body through their skin which could result to skin related diseases.

Concerning safe pesticides handling, 239 (52%) always wore PPE when handling pesticides and 117 (50%) wore gloves when cleaning pesticides spills. Handling of pesticide formulation requires wearing of appropriate personal protection equipment as a precaution against pesticide exposure. Workers who do not wear PPE are often exposed to pesticides (Kumari *et al.,* 2015). None wearing of gloves by the handlers causes skin injury which can cause skin damage and eventually more exposure to pesticides through the exposed body tissues which could lead to serious dermatological diseases.

A considerable number did not wear PPE regularly. Most of them 286 (62%) never wore respirators when handling liquid formulations, 160 (34%) never wore dust masks when handling dust and powder formulations. None wearing of respirators and dust masks could lead to the increase of respiratory diseases resulting from inhalation of fumes and dust when handling liquid and dust formulations of pesticides respectively.

Similar studies have indicated that wearing PPE, such as a respirator, goggles and dust masks, is an effective way to reduce risk of developing pesticide-induced respiratory diseases when handling pesticides (Senthilselvan *et al.,* 2013; Yang et *al.,* 2014).Only 6 (1%) reported chewing or smoking tobacco (Table 4.4). Chewing or smoking when applying pesticides requires one to remove the respirator/dust mask which may expose the handlers to inhalation of fumes and dust particles. Henry and Feola (2013) in their study found that only 1 out of 81 farmers smoked during pesticides handling in Jamaica.

In Bangladesh, contrary findings by Bhattacharjee *et al.* (2013) indicated that a higher proportion of (21%) participants smoked tobacco while handling pesticides which led to some of them experiencing symptoms associated with pesticides exposure.

4.3.1 Risk factors for pesticides exposure and practices in retail outlets

A checklist was used to assess the premises suitability of pesticides retail outlets in Kisumu County. The majority (89%) of premises were constructed with good material (concrete wall), 86% well-constructed shelves and easily accessible, 89% had smooth floors made of concrete and 82% sufficient space as required by OSHA (2007).

Only 14% of the premises had poorly constructed overstocked and inaccessible shelves (Plate 4.1). Thirty seven (46%) workers lacked dust coat, gloves (42%), dust masks (41%) and (73%) safety boot/closed shoes. In addition 34% lacked clean running water and 58% lacked sawdust or sand for cleaning pesticides spills.

Lack of PPE and clean running water for washing was also noted in a similar study conducted in Tanzania where it was reported that retailers lacked suitable PPE (14.7%) or had no PPE (14.6%) and (52%) lacked hand washing facility which contributed to exposure (Lekei *et al.,* 2014).

Plate 4.1: Over stocked shelves and not easily accessible observed in one of the shops in Kisumu

The majority 66% of premises were dirty and with a lot of dust and fumes (Plate 4. 2).

Plate 4.2: A dirty floor with pesticides granules on the floor of one of the retail outlest in kisumu

Some stockists (22%) mixed their pesticides with medicine and food stuff in the shelves (Plate 4.3).

Plate 4.3: Pesticides mixed together with medicine and food stuff on the shelves of a shop in Kisumu

Twenty nine (36%) premises that were visited lacked dust bins for pesticides waste disposal. Others 12 (15%) lacked sufficient ventilation and the temperature inside was not conducive. Regarding products safety, 69 (86%) had their product package intact and no single one was opened while only 14% opened pesticides containers for decanting or reweighing (Plate 4.4). Opening of original pesticides containers and decanting into bottles or food containers causes accidental ingestion of pesticides by the handlers (Eldoom *et al.*, 2016). Similar findings were reported in studies conducted in Tanzania and Zanzibar (Stadlinger *et al.,* 2012; Lekei *et al.,* 2014).

Plate 4.4: Pesticides decanted from their original container into a portable water bottle in a shop in Kisumu County.

Majority of the stockists (88%) had products that were within the stipulated shelf life but 12% had some expired products in their shelves. These were products that stayed in the shelves longer than the stipulated duration on the label. This was also noted in Tanzania (Lekei *et al.*, 2014).

A majority of 66% and 61 % lacked firefighting equipment and first aid kits respectively. This showed similarities with what was reported in Tanzania by Lekei *et al.* (2014), whereby retailers lacked first aid kit and fire-fighting equipment. Lack of these items could lead to adverse health effects in pesticides industry because many sellers could be exposed to fumes and dust in some of the poorly ventilated premises.

They also lacked running water for cleaning the premises and washing or showering (34%). In addition they lacked suitable PPE for safe handling of pesticides. According to

OSHA (2007) workers are supposed to use PPE to protect themselves against pesticides risk. Lack of this equipment could lead to exposure of the retailers to pesticides. Lastly, a majority 54 (68%) lacked inventory of pesticides and their toxicity. The inventory could make it easier for the handlers to identify highly hazardous pesticides from less hazardous and lack of it made separation of highly toxic pesticides from less toxic and prevention of contamination difficult (Table 4.12)

Table 4.12: Absence or presence of safety items recorded in observational checklists at retail outlets

Available items	**Yes**	**No**
Good construction material and design (concrete floor and wall)	71 (89%)	9 (11%)
Shelves are well constructed and easily accessible by attendant	69 (86%)	11 (14%)
The shop/store has smooth floor made of concrete	71 (89%)	9 (11%)
Space is sufficient for storing and for easy movement of attendant (as per OSHA, 2007)	66 (83%)	14 (17%)
The store is clean: free from dirt, dust and or fumes	27 (34%)	53 (66%)
Workers are provide with dust coats	43 (54%)	37 (46%)
Workers are provided with gloves	46 (57%)	34 (43%)
Workers are provided with dust mask	47 (59%)	33 (41%)
Workers are provided with safety shoes/ closed shoes	22 (28%)	58 (72%)
There is availability of clean running water inside the premises	53 (66%)	27 (34%)
Products are not put on top of the others to reduce breakage of containers	62 (78%)	18 (22%)
There is an inventory of pesticides and their classification based on toxicity	25 (31%)	55 (69%)
Products are not stored under high temperature inside an iron sheet/metal containers shop	68 (85%)	12 (15%)
Windows are available and opened for ventilation and fresh air circulation	68 (85%)	12 (15%)
The shop has sawdust or sand for cleaning pesticides spills	34 (43%)	46 (57%)
The shop has a dustbin for pesticide waste disposal	70 (88%)	10 (12%)
All products are intact in their containers (no decanting or reweighing)	69 (86%)	11 (14%)
All products are within the stipulated shelf life (not expired)	70 (88%)	10 (12%)
Availability of firefighting equipment in the shop	27 (34%)	53 (66%)
Availability of first aid measures	31 (39%)	49 (61%)

These problems can be controlled through the provision of first aid kits, training of sales personnel, provision of PPE, introductions of pesticides inventories, preventing sale of expired pesticides and prevention of decanting/reweighing of pesticides.

Repackaging was associated with spillage of pesticides (Plate 4.4). This was conducted by some handlers without use PPE, without sawdust or sand for controlling, containing and cleaning spills and without washing facilities. These practices could generate potential for a high risk of exposure for the sellers. The exposures can occur as a result of fumes and dust that were observed in most of the shops (66%) due to opening of containers and repacking or decanting of pesticides. This was also considered as a serious problem in a similar study conducted in Zanzibar (Stadlinger *et al.,* 2012).

4.3.2 Association between age and practices

On practices with pesticides, 100% who were over sixty years had a place to wash their hands after handling pesticides. A similar proportion (100%) of the same age group (over 60) also never ate or drank while handling pesticides. There was significant association between age and availability of a washing area ($\chi2 = 37.325$; $p < 0.001$) and not eating or drinking while handling pesticides ($\chi2 = 18.315$; $p < 0.05$) (Table 4.13).

Table 4.13: Association between age and practices with pesticides among handlers

	Age of subjects						**Pearson Chi-Square**	
	<20	21-30	31-40	41-50	51-60	>60	Chi-Square value	p-value
	n=25	n=223	n=156	n=41	n=14	n=5		<0.05
Have a place to wash hands next to where they store or handle pesticides	15 (60%)	195 (87%)	141 (90%)	40 (98%)	13 (93%)	5 (100%)	37.325	0.001
Never eat or drink while handling pesticides	23 (92%)	199 (89%)	151 (97%)	39 (95%)	11 (79%)	5 (100%)	18.315	0.050

Older handlers' practices with pesticides were good compared to the younger ones. This variation elicits that older handlers who have worked with pesticides for longer period tend to have good practices with pesticides than younger ones. This means that pesticides handlers' practices improve with increase in age. In addition, a similar study in India reported that the majority (32%) who were above 50 years had good practices compared to 20% and 26% of the younger and middle age groups respectively (Kumari *et al.,* 2013).

4.3.3 Association between gender and practices

Men (82%) and women (81%) changed clothing after pesticides exposure. This difference was significant ($p < 0.04$) (Table 4.14).

Table 4.14: Association between gender and practices with pesticides among handlers

	Gender of subjects				Pearson Chi-Square	
	Male (n= 385)	%	Female (n = 79)	%	Chi-Square value	p. value < 0.05
Change clothing always before and after pesticide exposure	314	82%	64	81%		0.04

The present findings were contrary to what was reported in Kenya where by women were observed to be having good practices with pesticides than men (Kurui *et al.,* 2014).

4.3.4 Association between level of education and practices

The respondents (89%) with secondary level of education changed their clothing always before and after pesticides handling. There was significant association between changing of clothing and level of education ($\chi 2 = 14.682$; $p< 0.01$).

Regarding PPE wearing, 58% wore dust mask always when handling dust and powder formulations of pesticides. Education and use of dust mask ($\chi 2 = 9.038$; $p< 0.01$) and wearing of dust mask ($p< 0.001$) were significantly associated. The majority 58% with certificate and above always wore gloves when cleaning pesticides spill compared to 44% with secondary and 42% primary education. The difference were significant ($\chi 2 = 23.180$; $p<0.001$). A similar study showed that non-use of gloves led to exposure of handlers to pesticides (Kurui *et al.,* 2014).

Majority (32%) with certificate and above wore respirators always when handling liquid formulations. The finding was also significantly associated with the level of education ($p< 0.001$). These results show that 68% of those with certificate and above never wore respirators but a huge percentage of participants with secondary education (81%) and primary education (74%) also did not wear respirators when handling liquid formulation of pesticides. (Table 4.15)

These led to exposure of the handlers to pesticides through inhalations of fumes. These results agree with a similar study in India where it was reported that handlers did not use PPE when handling pesticides and they had direct contact with pesticides which exposed them to harmful effects of pesticides (Khane and Arora, 2015).

Table 4.15: Association between education and practices of pesticides among handlers

	Level of education			Pearson Chi-Square value	Chi-Square p. value < 0.05
	Primary n=90	Secondary n=175	Certificate > n=199		
Always change clothing before and after pesticides exposure	76 (84%)	155 (89%)	147 (74%)	14.682a	0.010
Always wear gloves when cleaning pesticides spills	38 (42%)	77 (44%)	115 (58%)	23.180a	0.001
Always wear respirator when handling liquid formulations	23 (26%)	34 (19%)	63 (32%)		0.001
Always wear dust mask when handling dust and powder formulations	27 (30%)	73 (42%)	108 (54%)		0.001

The present study's results show that participants with certificate and above and secondary education had good practices than participants with primary education. In this study, majority of the handlers in Kisumu County had certificate and above and secondary school education which translated into more knowledge and good practices with pesticides. Most handlers who were more educated were not at risk of exposure compared to those with primary school education. This was also reported in another study whereby education and training appeared as an important determinant of safety practices (Khan *et al.,* 2013).

4.3.5 Association between the type of workplace and practices

Result show that level of knowledge among stockists was higher than of farmers but some practices among farmers was safer than those of stockists. Farmers (85%) reported changing of clothing before and after pesticides exposure compared to 66% of stockists which showed significant association ($p < 0.001$).

The majority (94%) of farmers did not eat or drink while handling pesticides compared to 85% of stockists. The difference was significant ($p < 0.02$). A total of 48 (60%) of stockists reported wearing PPE ($p < 0.05$), 68% wore gloves when cleaning pesticides spills ($p < 0.001$), and 66% reported wearing dust mask when handling dust and powder formulations of pesticides ($p < 0.001$) (Table 4.16).

Table 4.16: Association between the type of workplace and practice with pesticides among handlers

	Type of work place		Pearson Chi-Square	
	Stockists	Farmer	Chi-Square Value	p. value
	N	N		
Always change clothing before and after pesticide exposure	53 (66%)	325 (85%)		0.001
Never eat or drink while handling pesticides	68 (85%)	360 (94%)		0.020
Always wear PPE when handling pesticides	48 (60%)	191 (50%)		0.050
Always wear gloves when cleaning pesticides spills	54 (68%)	176 (46%)		0.001
Always wear dust mask when handling dusts and powders	53 (66%)	155 (40%)		0.001

The present study's results indicate that most stockists wore PPE as opposed to farmers. Despite the fact that the great majority of handlers in this study knew that pesticides have negative effect on their health, the use of personal protective equipment during pesticide handling was not a common practice among farmers and some practices with pesticides among stockists was not good in Kisumu County.

4.3.6 Association between experience and practices.

Most participants (70%) with 12 to 18 months experience wore PPE when handling pesticides compared with 60% of participants with less than 12 months, 46% with above 24 months and 43% with 18 to 24 and experience.

The majority 37% with 12 to 18 months always wore gloves when cleaning pesticides spills. Thirty five (48%) of those with 12 to 18 months also wore dust mask when handling dust and powder formulations of pesticides compared to 47% with above 24 months, 46% with 18 to 24 months and 34% with less than 12 months experience. Wearing PPE when handling pesticides ($p < 0.001$), gloves when cleaning spills ($p < 0.01$) and dust mask ($p < 0.02$) when handling dust and powder formulations were significantly associated with experience (Table 4.17).

Table 4.17: Association between experience and practice with pesticides among handlers

	Duration of handling pesticides in months				**Pearson Chi-Square**	
	<12	12-18	18-24	> 24	Chi-value	p. value
Always wear PPE when handling pesticides	49 (60%)	51 (70%)	23 (43%)	116 (46%)		0.001
Always wear gloves when cleaning pesticides spills	39 (48%)	47 (70%)	20 (37%)	124 (49%)		0.010
Always wear dust mask when handling dust and powder formulations	28 (34%)	35 (48%)	25 (46%)	120 (47%)		0.020

The present study's findings show that participants with less than 12 months and more than 24 months of experience had poor practices than participants with 12 months of experience. These findings were consistent with what was reported in India by Kumari and Reddy (2013) who found out that; agricultural workers who had less than a year experience and the most experienced in pesticide application were more likely to have poor practices despite their good knowledge.

4.3.7 Association between position at work and practices

The majority (83%) who were self- employed changed their clothing before and after pesticides exposure ($\chi2$ = 9.168; p< 0.01), 94% never ate or drank while handling pesticides ($\chi2$ = 12.207; p< 0.001) compared to 82% of the employees. Regarding wearing of PPE, the majority (62%) of employees wore them always when handling pesticides ($\chi2$ = 6.312; p< 0.04). In addition, 31% of employees wore respirator always when handling liquid formulation compared to 25% of the self- employed ($\chi2$ = 10.409; p< 0.01) (Table 4.18)

Table 4.18: Association between position at work and practices with pesticides among handlers

	Self-employedn = 399	Employeen = 65	Pearson Chi-Square	p. valuep< 0.05
Change clothing always before and after pesticide exposure	331 (83%)	47 (72%)	9.168a	0.010
Never eat or drink while handling pesticides	375 (94%)	53 (82%)	12.207a	0.001
Wear PPE always when handling pesticides	199 (50%)	40 (62%)	6.312a	0.040
Wear respirator always when handling liquid formulations	100 (25%)	20 (31%)	10.409a	0.010

The results show that the self-employed had good hygiene practices such as changing clothing and avoiding eating and drinking while handling pesticides than employees. On the other hand employees had good protective measures such as wearing PPE when handling pesticides. Changing clothing always prevents exposure to pesticides through the skin. Avoiding eating and drinking when handling pesticides prevents exposure through the mouth. Studies have shown association between poor hygiene practices and exposure to pesticides. A similar study in Tanzania indicated that eating while handling pesticides was associated with diarrhea and non-wearing of PPE was associated with increased risk of exposure (Manyilizu *et al.,* 2017).

4.3.8 Association between hours of working per day and practices

Three hundred and seven (84%) who handled pesticides for less than 8 hours changed their clothing always before and after pesticides exposure compared to 73% and 69% of those of 8 hours and over 8 hours respectively ($\chi2 = 10.311$; $p< 0.03$), 95% of less than 8 hours never ate or drank while handling pesticides ($\chi2 = 18.366$; $p< 0.001$).

Regarding wearing of PPE, 75% of those who handled pesticides for 8 hours a day wore PPE always when handling pesticides compared to 49% and 48% of less than 8 hours and over 8 hours respectively ($\chi2 = 14.673$; $p< 0.01$) and 67% who handled pesticides for 8 hours wore gloves always when cleaning pesticides spills compared to 65% of 8 hours and 45% of less than 8 hours ($\chi2 = 14.752$; $p< 0.01$). The Majority (42%) who handled pesticides for 8 hours wore respirator always when handling liquid formulations of pesticides compared to 33% of over 8 hours and 23% of less than 8 hours ($\chi2 = 21.301$; $p< 0.001$) and 64% who worked for over 8 hours wore dust mask always when handling powder and dust formulations of pesticides compared to 60% and 40% of 8 hours and less than 8 hours ($\chi2 = 16.944$; $p< 0.001$). Finally, 98% of those who worked for less than 8 hours never chewed or smoked tobacco when handling pesticides ($\chi2 = 10.871$; $p< 0.03$) (Table 4.19).

Table 4.19: Association between hours of working with pesticides per day and practices with pesticides

	< 8 Hours n= 364	8 Hours n = 48	> 8 Hours n = 52	Chi square value	P. value P< 0.05
Change clothing always before and after pesticide exposure	307 (84%)	35 (73%)	36 (69%)	10.311a	0.030
Never eat or drink while handling pesticides	344 (95%)	37 (77%)	47 (90%)	18.366a	0.001
Wear PPE always when handling pesticides	178 (49%)	36 (75%)	25 (48%)	14.673a	0.010
Wear gloves always when cleaning pesticides spills	164 (45%)	31 (65%)	35 (67%)	14.752a	0.010
Wear respirator always when handling liquid formulations	83 (23%)	20 (42%)	17 (33%)	21.301a	0.001
Wear dust mask always when handling dust and powder formulations	146 (40%)	29 (60%)	33 (64%)	16.944a	0.001
Never chew or smoke tobacco while handling pesticides	355 (98%)	46 (96%)	47 (90%)	10.871a	0.030

These findings indicate that handlers who worked with pesticides for 8 hour and below had good safety practices than those who handled them for more than 8 hours. In addition, majority of those who handled pesticides for less than 8 hours also did not chew or smoke tobacco while applying pesticides. More working hours in a day was associated with poor practices.

This was emphasized by a similar study where it was reported that wearing of PPE for long hours especially during hot hours of the day caused discomfort which made handlers ignore them sometimes (Wongwichit *et al.,* 2012).

4.4 Prevalence of self- reported acute and chronic pesticides toxicity symptoms

The prevalence of self- reported toxicity symptoms were included in the study questionnaire. The handlers were asked whether they had experienced these signs and symptoms during or immediately after pesticides handling and in the duration they have handled pesticides. Short term and long term toxicity symptoms were reported by some handlers.

Acute self- reported symptoms with higher prevalence were burning/stinging/itching eyes 368 (79%), skin itching 341 (74%), coughing 313 (68%), headache (58%) and sore throat 245 (52%). These results were consistent with observations in other studies (Karunamoorthi and Yirgalem, 2012; Raksanam *et al.,* 2012; Stadlinger *et al.,* 2012; Dey *et al.,* 2013; Oesterlund *et al.,* 2014; Tofolo *et al.,* 2014; Manyilizu et al., 2017).

The least recorded acute symptoms in the present study were nose bleeding 32 (7%), Diarrhea 53 (11%), 85 (18%) reported blurred vision and sudden loss of appetite each (Table 4.20). A study in Uganda also pointed out blurred vision as one of the symptoms (Oesterlund *et al.,* (2014).

Table 4.20: Self- reported acute symptoms experienced immediately after handling of pesticides

Symptoms	N	Percent%
Headache	271	58
Burning/stinging/itching eyes	368	79
Blurred vision	85	18
Sore Throat/throat irritation	245	53
Burning, runny or stuffy nose	233	50
Nose Bleeding	32	7
Shortness of breath	192	41
Chest tightness	204	44
Coughing	313	68
Excessive sweating	94	20
Skin Itching	341	74
Dizziness	202	44
Sudden loss of appetite	85	18
Stomach Pain	99	21
Diarrhea	53	11

In relation to chronic self- reported symptoms, skin disease 34 (7%) and respiratory disease 25 (5%) prevalence were high. The least were Asthma 15 (3%), neurological disease 8 (2%), reproductive disorder 8 (2%) and 7 (1.5%) blindness (Table 4.21).

Table 4.21: Self- reported chronic symptoms among pesticide handlers in Kisumu County

Chronic symptoms	N	Percent %
Asthma	15	3.2
Skin Disease	34	7.3
Reproductive disorder	8	1.7
Neurological Disorder	8	1.7
Respiratory Disease	25	5.4
Blindness	7	1.5

In the present study, majority of the handlers were literate, were using appropriate PPE and had experience, knowledge of pesticides and had good OSH practices hence the reason for low prevalence of pesticides related self-reported diseases. These diseases were as a result of long-term exposure to pesticides. Similar chronic symptoms were also reported in other studies (Dey *et al.,* 2013). The researchers tested the association between the exposures and diseases using a contingency two by two tables that is mostly applied in epidemiological studies.

4.4.1 Relative and attributable risks of chronic toxicity symptoms

A total of 4 participants with skin disease had not experienced skin itching (non-exposed but diseased), 30 who had the disease experienced skin itching when handling pesticides (exposed and diseased). 311 experienced skin itching but did not develop skin disease (exposed but not diseased) while 119 had not experienced skin itching and did not report skin disease (non- exposed and not diseased) (Table 4.22).

Table 4.22: Relationship between skin itching after handling pesticides and skin disease

	Skin disease	**No skin disease**	**Total**
Exposed (skin itching)	30 (a)	311 (b)	341 (a + b)
Unexposed (no skin itching)	4 (c)	119 (d)	123 (c + d)
Total	34 (a + c)	430 (b + d)	464 (a+ b + c + d)

Kaelin and Bayona (2004) formula (RR= a(c + d)/c (a + b)) for calculating relative risk was used to calculate the risk of occurrence of a disease in exposed group to that among non-exposed (control group) and (AR% = (Ie - Iu)/Ie) x100) was used to calculate the percentage by which the risk of developing a disease can be reduced by elimination or control of a particular exposure (AR).

In this study, the risk of occurrence of a skin disease among people who experienced skin itching to that among those non-exposed is 2.7. This shows that skin itching was significantly associated with skin disease (RR>1). This meant that the exposed group was 2.7 times at a higher risk than the non-exposed. The rate (proportion) of a skin disease in exposed individuals that can be attributed to the exposure (AR %) is 63%. Results show that skin disease can be reduced by 63% if exposure can be prevented through proper use of skin protective equipment such as; gloves, dust coats and hat/ helmets when handling pesticides. Similar study in Tanzania also indicated that wearing of PPE reduced the risk of developing skin disease by 80% (Manyilizu *et al.,* 2017)

Four (4) participants with respiratory disease had not experienced coughing (non-exposed but diseased), 21 experienced coughing and had developed respiratory disease (exposed and diseased), 292 experienced coughing but had no respiratory disease (exposed but not diseased) and 147 had not experience coughing and never had respiratory disease (non- exposed and not diseased) (Table 4.23).

Table 4.23: Relationship between coughing after handling pesticides and respiratory disease

	Respiratory disease	No respiratory disease	Total
Exposed (coughing)	21	292	313
Unexposed (no coughing)	4	147	151
Total	25	439	464

The relative risk of a respiratory disease among those who experienced coughing to that among non-exposed is 2.5. The Attributable risk is 61%. These results reveal that coughing is significantly associated with respiratory disease (RR> 1). In addition, the exposed group is 2.5 times at a higher risk than the unexposed. Respiratory disease can be reduced by 61% if the handlers use dust masks and respirators properly.

These could minimize exposure to dusts and fumes originating from solid and liquid formulations of pesticides. These will eventually reduce coughing as a result of pesticides exposure among pesticides handlers in Kisumu County.

Four (4) of those with respiratory disease had not experienced sore throat/throat irritation, 21 experienced and had respiratory disease, 224 handlers experienced sore throat but did not report the disease while 215 had not experienced sore throat and did not report respiratory disease (Table 4.24).

Table 4.24: Relationship between sore throat/irritation and respiratory disease

	Respiratory disease	No respiratory disease	Total
Exposed (throat irritation)	21	224	245
Unexposed (no irritation)	4	215	219
Total	25	439	464

The relative risk of respiratory disease among those who experienced sore throat/throat irritation to that among non- exposed is 4.7. The Attributable risk is 79%. Sore throat/throat irritation is strongly associated with respiratory disease (RR>3). Exposed groups are 4.7 times at a higher risk of developing respiratory disease compared to the non- exposed group. Respiratory disease among handlers who experienced sore throat/throat irritation can be reduced by 79% if they handle liquid, aerosol and dust formulation of pesticides in a well-ventilated area and with respirators and or dust masks. These mean that the use of PPE when handling pesticides helps in reducing exposure of handlers' to pesticides. This was also emphasized in a study conducted in Nepal. In that study it was reported that the use of personal protective equipment could reduce pesticides exposure through inhalation, thereby potentially reducing the acute and chronic health hazards to the handlers (Bhandari, 2014).

4.4.2 Association between acute and chronic pesticides symptoms

There was statistically significant association between asthma and 12 out of 15 self-reported acute symptoms ($p<0.05$). Only itching eyes ($p= 0.173$), coughing ($p= 0.106$) and skin itching ($p=0.240$) were insignificant. There is also statistically significant difference between skin disease and 11 out of 15 self-reported acute toxicity symptoms ($p< 0.05$). There was insignificant difference between skin disease and headache, chest tightness, coughing and dizziness ($p>0.05$).

Thirteen out of 15 acute symptoms were significantly associated to respiratory disease ($p<0.05$). The rest, headache and coughing were statistically insignificant ($p> 0.05$) (Table 4.25).

Table 4.25: Association between self-reported acute and chronic pesticides toxicity symptoms

	Headache		Itching eyes		Blurred vision		Sore throat	
	Chi value	**p-value**	**Chi value**	**p-value**	**Chi value**	**p-value**	**Chi value**	**p-value**
Asthma	5.096[a]	0.024	1.858[a]	0.173	31.354[a]	0.001	7.133[a]	0.008
Skin disease	3.454[a]	0.063	9.571[a]	0.002	9.726[a]	0.002	12.856[a]	0.001
Respiratory disease	3.367[a]	0.067	4.485[a]	0.034	15.557[a]	0.001	10.320[a]	0.001
	Stuffy nose		**Nose bleeding**		**Shortness of breath**		**Chest tightness**	
	Chi value	**p-value**	**Chi value**	**p-value**	**Chi value**	**p-value**	**Chi value**	**p-value**
Asthma	8.239[a]	0.004	38.184[a]	0.001	17.249[a]	0.001	11.473[a]	0.001
Skin disease	12.510[a]	0.001	21.892[a]	0.001	4.603[a]	0.032	2.115[a]	0.146
Respiratory disease	18.454[a]	0.001	12.038[a]	0.001	13.057[a]	0.001	11.007[a]	0.001
	Coughing		**Excessive sweating**		**Skin itching**		**Dizziness**	
	Chi value	**p-value**	**Chi value**	**p-value**	**Chi value**	**p-value**	**Chi value**	**p-value**
Asthma	2.606[a]	0.106	34.247[a]	0.001	1.381[a]	0.240	5.599[a]	0.018
Skin disease	3.708[a]	0.054	16.312[a]	0.001	4.094[a]	0.043	2.276[a]	0.131
Respiratory disease	3.294[a]	0.070	25.834[a]	0.001	2.855[a]	0.091	17.601[a]	0.001
	loss of appetite		**Stomach pain**		**Diarrhoea**			
	Chi value	**p-value**	**Chi value**	**p-value**	**Chi value**	**p-value**		
Asthma	31.354[a]	0.001	18.978[a]	0.001	26.911[a]	0.001		
Skin disease	9.726[a]	0.002	21.835[a]	0.001	20.664[a]	0.001		
Respiratory disease	20.033[a]	0.001	28.656[a]	0.001	27.717[a]	0.001		

The present findings indicate that asthma was significantly associated with sore throat, stuffy nose, nose bleeding, chest tightness and shortness of breath. These acute symptoms occur as a result of inhaling pesticide fumes and dust during mixing/spraying of pesticides at the workplace (Khane &Arora, 2015). Inhalation of pesticides over a long period of time could lead to chronic medical condition such as asthma. A similar study among pesticides handlers in India associated inhalation of pesticides with asthma (Senthilselvan *et al.,* 2013).

Skin disease was associated with itching eyes, excessive sweating, and skin itching. Skin related acute toxicity symptoms occur when pesticides come into contact with the skin during mixing and spraying without coveralls. This was also emphasized in India where it was reported that dermal exposure to pesticides occurs as a result skin contact with pesticides (Senthilselvan *et al.,* 2013). Skin exposure to pesticide over a long period of time has been associated with skin diseases by other researchers (Anjali *et al.,* 2014).

Finally a respiratory disease was associated with sore throat, stuffy nose, nose bleeding, chest tightness and shortness of breath. Handlers experience these symptoms immediately after inhaling pesticides dust and fume. Exposure to pesticides is linked to acute and chronic respiratory symptoms. Similar studies have shown significant association between occupational exposure to pesticides and respiratory disease (Nigatu, 2017).

4.5 Relationship between knowledge, practices and self- reported toxicity symptoms

A majority (69%) of handlers' with high degree of knowledge had good practices compared to 33% of those with low degree of knowledge. Knowledge level was significantly associated with practice ($\chi2 = 54.121$; $p < 0.001$), chest tightness ($\chi2 = 5.260$; $p < 0.022$) and coughing ($\chi2 = 4.286$; $p < 0.038$). These findings concur with what was observed in Thailand by Wongwichit *et al.* (2012) where they was reported that knowledge was significantly associated with practice.

Though a contrary study in India reported insignificant association between high degree of knowledge and good practices (Kumari and Reddy, 2013), pesticides handlers with high degree of knowledge might have good practice in pesticide use (Dzobo, 2016). Low degree of knowledge was also associated with exposure to pesticides in India (Kumari and Reddy, 2013).

Similarly, 80% of those with poor practices experienced skin itching immediately after handling pesticides compared to 69% of those with good practices. There was statistical significant association between safety practices and skin itching ($\chi2 = 7.085$; $p< 0.008$).

Handlers with poor practice (52%) also experienced chest tightness immediately after exposure to pesticides compared to 38% of those with good practices. The difference was statistically significant (($\chi2 = 7.085$; $p< 0.002$) (Table 4.26).

Table 4.26: Relationship between pesticides handlers' knowledge, practices and self-reported toxicity

Safety practices					
Degree of knowledge		Poor practices	Good practices	Chi-Square	p value
	Low degree of Knowledge	107 (67%)	53 (33%)	54.121a	0.001
	High degree of knowledge	95 (31%)	209 (69%)		
Chest tightness					
Degree of knowledge		Yes	No	5.260a	0.022
	Low degree of Knowledge	78 (49%)	82 (51%)		
	High degree of knowledge	182 (60%)	122 (40%)		
Safety practices	Poor practices	97 (48%)	105 (52%)	9.328a	0.002
	Good practices	163 (62%)	99 (38%)		
Coughing					
Degree of knowledge		Yes	No	4.286a	0.038
	Low degree of Knowledge	62 (39%)	98 (61%)		
	High degree of knowledge	89 (29%)	215 (71%)		
Skin itching					
Safety practices		Yes	No	7.085a	0.008
	Poor practices	41 (20%)	161 (80%)		
	Good practices	82 (31%)	180 (69%)		
Skin disease					
Safety practices	Poor practices	194 (96%)	8 (4%)	5.973a	0.015
	Good practices	236 (90%)	26 (10%)		

The present study indicates that poor practices lead to exposure of handlers to pesticides risks. The findings concurred with a similar study in Tanzania where association between practices and self-reported toxicity symptoms was reported (Manyilizu *et al.,* 2017). In addition, a study in Ghana also reported that almost all the farmers who engaged in poor practices confirmed typical symptoms of poisoning after each spraying task (Dzobo, 2016). This is also supported by Kumari *et al.* (2015) where they reported that high level of knowledge was significantly associated with good practices among handlers and due to good practices they minimized exposure to pesticides.

4.6 Hypotheses testing using binary logistic regression (backward conditional method)

4.6.1 Variables associated with changes in the degree of knowledge and practices

The stepwise backward selection method starts with a model with all the variables and eliminates them one by one depending on the significance of their coefficients. Regarding the degree of knowledge, the model chi-square value which is the difference between the null model and the current (full) model chi-square value was 26.664.

The null hypothesis is rejected since the p-value is less than 0.05. In the case of safety practices, the model chi square value was 33.01586. The null hypothesis is also rejected since the p-value is less than 0.05, implying that the addition of the independent variables improved the predictive power of the models. (Table 4.27).

Table 4.27: Omnibus test of coefficients for degree of knowledge and safety practices

Omnibus Tests of Model Coefficients					
			Chi-square	**df**	**Sig.**
Degree of Knowledge	Step 5[a]	Step	-2.980	2	0.225
		Block	26.664	7	0.001
		Model	26.664	7	0.001
Safety practices	Step 5a	Step	-1.29108	1	0.256
		Block	33.01586	7	0.001
		Model	33.01586	7	0.001
a. A negative Chi-squares value indicates that the Chi-squares value has decreased from the previous step.					

The Hosmer-Lemeshow test explores whether the predicted probabilities are the same as the observed probabilities. An overall goodness of fit of the model is indicated by insignificant p-values ($p > 0.05$). This model produced an insignificant differences between the observed and predicted probabilities indicating a good model fit ($p>0.05$) (Table 4.28).

Table 4.28: Hosmer and Lemeshow test for degree of knowledge and practices

Hosmer and Lemeshow Test				
		Chi-square	**df**	**Sig.**
Degree of knowledge	Step5	0.277	4	0.991
Safety practices	Step5	5.745	8	0.676

The coefficient of age 2 (21-30 years) was 1.031483, this implies that exp (B) = exp (1.031483) ≈ 2.805222. Thus, when age group 21-30 is increased by one unit (one person) the odds ratio is 2.8 times as large and therefore participants with age group 21-30 are 2.8 times likely to have high degree of knowledge. Thus age group 21-30 is associated with high degree of knowledge.

The coefficient of gender 1 (male) was 0.652257, this implies that exp (B) = exp (0.652257) ≈ 1.919868. Thus, when male gender is increased by one unit the odds ratio is 1.9 time as large. This means that men are 1.9 times more likely to be high knowledgeable. Thus, male gender is associated with high degree of knowledge. The coefficient of workplace 1 (stockist) was -0.74782 which implies that exp (B) = exp (-0.74782) ≈ 0.473397. Since Exp (B) is less than one (0.5), a unit increase in stockist leads to a drop in the odds of having high degree of knowledge.

The coefficient of secondary education was 0.81187, the Exp (B) was 2.252, and thus when participants with secondary level of education are increased by one unit (one person) the odds ratio is 2.2 times as large. This implies that participants with secondary school education are 2.2 times more likely to have good practices.

Regarding experience, the coefficient of less than 12 months, 12-18 months and 18-24 months were 0.912662, 0.964433, and 0.54251respectively. Their odds ratio were 2.491, 2.623 and 1.720 respectively. This means that participants with 12-18 months of experience were 2.6 times more likely to have good practices.

The coefficient of less than 8 hours was 0.857065, this implies that exp (B) = exp (0.857065) ≈ 2.356. Thus when participants with less than 8 hours of handling pesticides are increased by one unit (one persons), the odds ratio is 2.4 times as large and therefore handlers with less than 8 hours per day of handling pesticides were 2.4 times more likely to have good practices.

The Wald statistics and the significance level shows that 3 out of the 7 independent variables namely; age, gender and type of workplace were significant to the prediction of the odds of an increase in participants' high degree of knowledge. This is because they had p-values of less than 0.05. Elsewhere, the Wald statistics and the significance level also shows that 3 out of the 7 independent variables which included; education, experience and hours of handling pesticides in day were significant to the prediction of the odds of an increase in good practices with pesticides. This is because they had p-values of less than 0.05 (Table 4.29).

Table 4.29: Variable in the equation for degree of knowledge and safety practices

Variables in the equation								
			B	**S.E.**	**Wald**	**df**	**Sig.**	**Exp (B)**
Degree of Knowledge	**Step 5a**	Age1 (<20)	0.526891	0.428847	1.509507	1	0.219	1.694
		Age2 (21-30)	1.031483	0.443447	5.410545	1	0.020	2.805
		Age3 (31-40)	0.188071	0.517132	0.132264	1	0.716	1.207
		Age4 (41-50	0.671249	0.692378	0.939898	1	0.332	1.957
		Gender1 (Male)	0.652257	0.298341	4.779825	1	0.03	1.920
		Workplace1 (stockist)	-0.74782	0.299537	6.232956	1	0.013	0.473
		Constant	0.530825	0.492049	1.163823	1	0.281	1.700
Safety practices	**Step 5a**	Education(primary)	0.279611	0.265325	1.110589	1	0.292	1.323
		Education(secondary)	0.81187	0.272079	8.903958	1	0.002	2.252
		Experience(<12 months)	0.912662	0.343955	7.040727	1	0.008	2.491
		Experience(12-18 months)	0.964433	0.37353	6.666433	1	0.010	2.623
		Experience(18-24 months)	0.54251	0.263599	4.235716	1	0.040	1.720
		Hours per day(<8 hours)	0.857065	0.363017	5.574084	1	0.018	2.356
		Hours per day(8 hours)	0.284896	0.328295	0.753088	1	0.386	1.330
		Constant	-0.84275	0.297313	8.034703	1	0.005	0.431

4.6.2 Variables associated with self-reported chronic toxicity symptoms

Regarding the Asthma, the model chi-square value which is the difference between the null model and the current (full) model chi-square value was 48.62754. In the case of skin disease, the model chi square value was 43.67623. Finally, the model chi square value for respiratory disease was 47.62126. The null hypothesis is rejected since the p-values are less than 0.05, implying that the addition of the independent variables improved the predictive power of the models. (Table 4.30).

Table 4.30: Omnibus tests of model coefficients for self-reported chronic toxicity symptoms

Omnibus Tests of Model Coefficients					
			Chi-square	df	Sig.
Asthma	Step 12a	Step	-1.378111	1	0.240
		Block	48.62754	4	0.001
		Model	48.62754	4	0.001
Skin disease	Step 11a	Step	-1.828672	1	0.176
		Block	43.67623	5	0.001
		Model	43.67623	5	0.001
Respiratory disease	Step 13a	Step	-1.244987	1	0.265
		Block	47.62126	3	0.001
		Model	47.62126	3	0.001

The models produced an insignificant difference between the observed and predicted probabilities indicating a good model fit ($p>0.05$) (Table 4.31).

Table 4.31: Hosmer and Lemeshow test for chronic toxicity symptoms

Hosmer and Lemeshow Test				
	Step	Chi-square	df	Sig.
Asthma	12	4.620388	3	0.2018
Skin disease	11	2.170	7	0.950
Respiratory disease	13	0.818	5	0.976

The coefficient of blurred vision was 1.45485494, this implies that exp (B) = exp (1.45485494) ≈ 2.284. Thus, when respondents who experience blurred vision are increased by one unit the odds ratio is 4 times as large. This means that pesticides handlers with blurred vision are 4 times more likely to develop asthma. Thus, blurred vision is associated with asthma. The results also show that participants with shortness of breath and excessive sweating are 9 and 5 times respectively more likely to develop asthma.

The coefficient of stomach pain was 0.9073149, the Exp (B) value was 2.478. This implies that respondents who experienced stomach pain are 2.5 time more likely to develop skin disease. Hence stomach pain was associated with skin disease.

In relation to respiratory disease, the coefficient of stuffy nose was 2.19862801, which implies that (B) = exp (2.19862801) ≈ 9.013. Thus when participants stuffy nose are increased by one unit (one person), the odds ratio is 9.013 times as large and therefore handlers who experienced stuffy nose were 9 times more likely to develop respiratory disease. Participants who experience dizziness and stomach pain were 5 time and 4 times respectively more likely to develop respiratory disease (Table 4.32).

Table 4.32: Variable in the equation for self-reported chronic toxicity symptoms

Variables in the equation								
			B	S.E.	Wald	df	Sig.	Exp(B)
Asthma	Step 12a	Blurred vision	1.45485494	0.66483028	4.78870191	1	0.029	4.284
		Shortness of breath	2.21053192	1.07037914	4.2649928	1	0.039	9.121
		Excessive sweating	1.65640742	0.7366421	5.05616528	1	0.025	5.240
		Sudden loss of appetite	1.1498267	0.67155988	2.93153642	1	0.087	3.158
		Constant	-6.9347286	1.13783268	37.1451516	1	0.001	0.001
Skin disease	Step 11a	Stuffy nose	0.77916673	0.45810784	2.89284623	1	0.089	2.180
		Nose bleeding	0.95466959	0.49488233	3.72136514	1	0.054	2.599
		Stomach pain	0.9073149	0.40962996	4.90605774	1	0.027	2.478
		Constant	-21.928882	3988.09773	0.001	1	1.000	0.001
Respiratory disease	Step 13a	Stuffy nose	2.19862801	0.75558883	8.46705656	1	0.004	9.013
		Dizziness	1.52019018	0.58301966	6.79875579	1	0.009	4.573
		Stomach pain	1.41205093	0.46552333	9.20063538	1	0.002	4.104
		Constant	-6.0296112	0.83911488	51.6340006	1	0.001	0.002

The Wald statistics and the significance level shows that blurred vision, shortness of breath and excessive sweating were significant to the prediction of the odds of an increase in developing Asthma. This is because there p- values were less than 0.05. Elsewhere, stomach pain was significant to the prediction of developing skin disease ($p<0.05$). Finally, stuffy nose, dizziness and stomach pain were also significant to the prediction of the odds of increase in developing respiratory disease ($p<0.05$).

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Generally, handlers' degree of knowledge was significantly associated with safety practices. Degree of knowledge of pesticides handling exposure routes and PPE use was also significantly associated with self-reported acute symptoms. Their safety practices were also significantly associated with acute and chronic symptoms.

Knowledge on pesticide exposure routes was associated age, experience, level of education, type of workplace, position at work and hours of working with pesticides in a day. Knowledge on dust mask and dust coat use was also associated with participants' age, level of education, type of workplace, experience, position at work and hours of working with pesticides per day.

This study also shows that employees were more instructed on safe pesticides handling method than the self-employed. The self-employed had knowledge of exposure through inhalation but some never used respirators and dust masks when handling liquids and dust formulations. The employees on the other side knew exposure through ingestion but many of them ate and drank while handling pesticides compared to the self- employed.

There is evidence that experience has influence on knowledge on pesticides handling, routes of exposure and PPE use but practices with pesticides was poor among the experienced. Stockists were more knowledgeable on pesticides handling, routes of exposure and PPE use compared to farmers but some of their practices with pesticides were poor than of farmers. Participants with high level and lower level of education showed knowledge on pesticides handling but participants with high level of education had good practices than those with low level.

Some of them did not wear respirator when handling liquid pesticides and a good number did not wear dust masks when handling dust formulation of pesticides. Wearing of gloves when cleaning pesticides spills and dust mask when handling powder formulations was influenced by level of education, type of workplace, experience and hours of working with pesticides per day. Avoiding eating or drinking and changing clothing after pesticide exposure was significantly associated with pesticides handlers' age, gender, level of education, type of workplace, position at work and hours of working with pesticides.

It can be concluded that majority did not wear gloves when cleaning pesticides spills. Some never took a shower after handling pesticides, ate and drank while handling pesticides. Due to the poor practices, majority of handlers experienced acute toxicity symptoms such as; headache, itching/stinging eyes, skin itching and coughing.

This resulted to some handlers developing asthma, reproductive disorders, skin diseases, respiratory diseases and neurological diseases. There was significant association between skin itching, itching eyes, excessive sweating and skin disease. Respiratory disease was associated with sore throat, stuffy nose, nose bleeding, chest tightness and shortness of breath. There was also significant association between asthma and sore throat, stuffy nose, nose bleeding, chest tightness and shortness of breath.

Participants' age, gender and type of workplace were the main predictors of the odds of increase in high degree of knowledge. Level of education, experience, and hours of working with pesticide per day were significant to the prediction of the odds of an increase in good practices. The first null hypothesis was rejected since there was association between demographic characteristics of participants' and degree of knowledge and safety practices. Blurred vision, shortness of breath and excessive sweating were significant to the prediction of the odds of an increase in developing Asthma. Stuffy nose, dizziness and stomach pain were significant to the prediction of the odds of an increase in developing respiratory disease. The second null hypothesis is also rejected since there was association between acute and chronic toxicity symptoms. These findings call for interventions that involve pesticides stakeholders aimed at increasing the adoption of safe handling of pesticides and reducing pesticide exposure among handlers.

5.2 Recommendations

It is recommended that special pesticide safety and health trainings be introduced to help minimize pesticides risks. Development of legislation to impart knowledge and promote good practices with pesticides is also important.

It is also recommended that small scale farm workers and stockists be trained on effective PPE use and their provision by employers made mandatory; such approaches are necessary to decrease exposure of handlers to pesticide in Kisumu County. This will eventually reduce the prevalence of acute and chronic toxicity symptoms reported among handlers in Kisumu County.

Regulators such as PCPB and DOSHS should ensure strict adherence to regulations on hazardous substance among these group of workers by ensuring provision of clean, well ventilated workplaces with enough firefighting, first aid and personal protective equipment since from the study it was noted that some of the pesticides premises lacked these items.

In addition, handlers should be trained on alternative pest control methods such as Integrated Pest Management (IPM) which will encourage handlers to use pesticides as their last option after exhausting other methods of pest control. This will minimize pesticide overuse and eventually minimize exposure of handlers to pesticides.

5.2.1 Recommendation for further studies

There is also need for another study in the area to conduct biological testing among the exposed and diseased with the aim of preventing disabilities or deaths among the pesticides handlers in Kisumu County. In addition, a study can be conducted to establish the level of exposure among individuals who apply public health pesticides in their houses and also among commercial pest control operators in Kisumu County. These groups were not included in the present study.

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APPENDICES

Appendix 1: Consent explanation and consent form

Introduction

This research study is being conducted by Adams Obonyo, a postgraduate student at Jomo Kenyatta University of Agriculture and Technology pursuing Master's Degree in Occupational Safety and Health. His study entails the assessment of how handlers knowledge, practices with pesticides is related with their self-reported toxicity symptoms.

Procedures

You will be asked to complete a questionnaire. The questionnaire consists of 36 questions and will take you approximately 30 minutes. Questions will include details about your demographics, Knowledge about pesticides, work practices with pesticides and self- reported toxicity symptoms.

Risks/Discomforts

There are minimal risks for participation in this study. However, you may feel emotional discomfort when answering some few questions on toxicity symptoms.

Benefits

There are no direct benefits to subjects. However, it is hoped that your participation will help the researcher to come up with recommendations on how safely one should handle pesticides in retail shop and at farm level and how to minimize pesticides toxicity symptoms among pesticides retailers.

Confidentiality

All information provided will remain confidential and will only be reported as group data with no identifying information. All data, including questionnaires will be kept in a secure location and only those directly involved with the research will have access to them. After the research is completed, the questionnaires will be destroyed.

Questions about the Research

If you have questions regarding this study, you may contact Adams Obonyo at Mobile 0717-602-992, email adamsobonyo@yahoo.com , Dr. Njogu, P.M., Mobile 0723538887, email njogupl@yahoo.com and Dr. Gitu Leonard, Mobile 0724495493 email gitumleo@gmail.com of Jomo Kenyatta University of Agriculture and Technology- Main campus.

Consent

I Mr./ Miss………………………………………….consent to serve as a subject in the study
entitled:……………………………………………………………………………………

I have read, understood, and received a copy of the above consent and desire of my own free will and volition to participate in this study. I believe that reasonable safeguards have been taken to minimize both known and the potentially unknown risks.

Participant's signature ……………………………………………Date …………………

Name of person obtaining the consent ....
Signature …………………………….. Date…………………………….
Witness………………………………. Date…………………………….

Appendix 2: Questionnaire for knowledge, practices and self- reported symptoms

Subject Name………………………………………………………. (Optional)

Sub County………………………..

Mobile……………….…………….…

Section 1: Demographics (Please tick where appropriate)

1. What is your age group?

<20 [ ] 21-30 [ ] 31-40 [ ] 41-50 [ ] 51-60 [ ] >60 [ ]

2. Gender Male [ ] Female [ ]

3. What is you level of Education? 1. No education [ ] 2. Primary School [ ]

3. Secondary school [ ] 4. Certificate 5. Diploma [ ] 6. Degree [ ] 7. Post Graduate [ ]

4. What is your marital status? 1. Married [ ] 2. Single [ ] 4. Divorced [ ] 5. Widowed [ ]

5. Which type of workplace do you work in?

1. Agro vet [ ] 2. Agro Hardware [ ] 3. Chemist [ ] 4. Farmer [ ]

6. What is your position in the workplace? 1. Self-employed [ ] 2. Employee [ ]

7. How long have you been handling pesticides?

<12 months [ ] 12- 18 months [ ] 18- 24 months [ ] > 24 months [ ]

8. How many hours of the day do you handles pesticides?

1. Below 8 hours [ ] 2. 8 hours [ ] 3. Over 8 hours [ ]

Section 2: Pesticides knowledge on handling, exposure routes and PPE use (please tick where appropriate)

9. Which sign marks the most dangerous pesticide? 1. Blue colour coding [ ] 2. Red colour coding [ ] 3. Yellow colour coding [ ] 4. Green colour coding [ ] 5. Skull and cross bones [ ]

No.	Questions	Yes(√)	No(√)
10.	Do you think pesticides can have a negative effect on your health?		
11.	Can you read and understand instructions on the pesticide labels?		
12.	Are you aware of pesticide exposure level?		
13.	Can pesticides in dry form be absorbed through skin?		
14.	Can pesticides in liquid form be absorbed through the skin?		
15.	Can pesticides in oil more likely to penetrate skin then pesticides in water?		
16.	Can washing of hands promote the movement of pesticides into the body?		
17.	If you do not wash your hands after pesticide handling, can the food that you eat be tainted with pesticides?		
18.	Have you been instructed about safe pesticide handling methods?		
19.	Can all types of gloves provide same level of protection?		
20.	Handlers can be exposed to pesticides through inhalation		
21.	Handlers can be exposed to pesticides through contact		
22.	Handlers can be exposed to pesticides through ingestion		
23.	Handlers can be exposed to pesticides through injection		

24. Do you know how to use the following Personal protective equipment?

Gloves? Yes [ ] No [ ]

Dust Mask? Yes [ ] No [ ]

Dust Coat/Apron? Yes [ ] No [ ]

Respirator? Yes [ ] No [ ]

Hat/helmet? Yes [ ] No [ ]

Section 3: Practices with pesticides (Please tick where appropriate)

No.	Questions	Never(√)	Sometimes(√)	Always(√)
25.	Do you change clothing before and after pesticide exposure?			
26.	Do you have a place to wash hands next to where you store or handle your pesticides?			
27.	Do you shower after handling pesticide?			
28.	Do you eat or drink while handling pesticides?			
29.	Do you wash your hand after pesticides exposure before you eat or drink?			
30.	Do you wear personal protective equipment when handling pesticides?			
31.	Do you wear gloves when cleaning pesticides spills?			
32.	Do you wear respirator when handling liquid formulations of pesticides?			
33.	Do you wear dust mask when handling dust and powder formulations of pesticides?			
34.	Do you chew or smoke tobacco while inside the store or when handling chemicals			

Section 4: Self- reported toxicity symptoms (please tick where appropriate)

35. Please indicate the acute symptoms you have/had experienced after handling or applying pesticides in the shop or farm. (*Please record only symptoms that occurred soon after exposure [handling, mixing and applying] to pesticides in the questions that follow.*)

No.	Signs and symptoms associated with pesticides	Tick (√) below where appropriate
1.	Headache	
2.	Burning/stinging/itching eyes	
3	Blurred vision or problem seeing at night	
4	Sore throat/ throat irritation	
5	Burning, runny or stuffy nose	
6	Nose bleeding	
7	Shortness of breath	
8	Chest tightness and pain	
9	Coughing	
10	Excessive sweating	
11	Skin itching	
12	Dizziness	
13	Sudden loss of appetite	
14	Stomach pain	
15	Diarrhea	

36. Please indicate any of the following long-term medical condition you have/had in the duration you have handled pesticides.

No.	Medical condition	Tick (√)below where appropriate
1.	Asthma	
2.	Skin disease	
3.	Reproductive disorder	
4.	Neurological disease	
5.	Respiratory diseases	
6.	Blindness	

Appendix 3: Observation checklist

NO	ITEM	PRESENCE OR ABSENCE OF THE ITEM	
	OBSERVATION	**YES(√)**	**NO(√)**
1.	Good construction material and design (concrete floor and wall)		
2.	Shelves are well constructed and easily accessible by attendant		
3.	The shop/store has smooth floor made of concrete		
4.	Space is sufficient for storing and for easy movement of attendant (as per OSHA, 2007)		
5.	The store is clean: free from dirt, dust and or fumes		
6.	Workers are provide with dust coats		
7.	Workers are provided with gloves		
8.	Workers are provided with dust mask		
9.	Workers are provided with safety shoes/ closed shoes		
10.	There is availability of clean running water inside the premises		
11.	Products are not put on top of the others to reduce breakage of containers		
12.	There is an inventory of pesticides and their classification based on toxicity		
13.	Products are not stored under high temperature inside an iron sheet/metal containers shop		
14.	Windows are available and opened for ventilation and fresh air circulation		
15.	The shop has sawdust or sand for cleaning pesticides spills		
16.	The shop has a dustbin for pesticide waste disposal		
17.	All products are intact in their containers (no decanting or reweighing)		
18.	All products are within the stipulated shelf life (not expired)		
19.	Availability of fire fighting equipment are available in the shop		
20.	Availability of first aid measures are put in place		