SOCIO-ECONOMIC FACTORS AND CULTURAL PRACTICES INFLUENCING THE RESURGENCE OF BED BUGS (*Cimex hemipterus);* NAKURU TOWN, KENYA.

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DECLARATION AND APPROVAL

Declaration by the student

This thesis is my original work and has not been presented for a degree in any other university or for any other award.

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Approval by the supervisors

We confirm that the work reported in this thesis was carried out by the candidate under our supervision.

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DEDICATION

This study is whole heartedly dedicated to my parents Faith Muriithi, the Late Peter Muriithi and to my mentor, Steve Kiunga.

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The single greatest cause of happiness is gratitude. Gratitude turns disappointments into lessons learned, discoveries made, explorations made and new plans set in motion.

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ABSTRACT

Bed bugs are parasitic insects that feed mostly on blood (human) .The most occurring bed bug, *Cimex lactularius* is found in almost all continents. *Cimex hemipterus* commonly known as the Tropical bed bugs resurge in warmer climates like Africa, Asia and America. The objectives of this study was to identify and determine socioeconomic factors, cultural practices that led to resurgence of bed bugs, reasons for residents to deny public health officials access to their homes and to identify methods been used to eradicate the bed bugs in Nakuru County. The study adopted Analytic epidemiological study design using cross-sectional descriptive survey approaches for data collection and used the formula (Mugenda and Mugenda, 1999) in determining the sample size of 422 households. Data collection tools used included questionnaires, KII and FGD. Data gathered from the study was entered into Microsoft Excel spreadsheet and then exported into SPSS software version 24 for data cleaning and analysis. This study sought approval from Mount Kenya University Ethical Review Board (Ref No. MKU/ERC/0890) and the Kenya National Commission for Science, Technology and Innovation–NACOSTI (NACOSTI/P/1821614/23855). Consent to participate in this study was sought from all the heads of households and confidentiality was observed. The results of this study indicates that low income communities are more susceptible to the burden of bed bugs resurgence due to financial constraints and there was a statistical significance between income and presence of bed bugs in the homesteads **($\chi 2$ =12, p=0.001)**. This study found that residents still believe that bed bugs are brought by curses and witch craft and this lack of awareness lead to resurgence of bed bugs and that Public health officials are least sought after to curb bed bugs resurgence in Nakuru County. Majority of the residents who experienced the bed bugs sprayed the bed bugs by themselves in spite availability of professional control and MOH officials. This study in its totality concludes that, current socioeconomic status among the respondents is limiting the fight against bed bugs resurgence, cultural beliefs are limiting the eradication of bed bugs and leads to the resurgence, respondents were not readily open to the idea of Ministry of Health officials eradicating bed bugs in their homesteads and that respondents were not well sensitized to modern control methods which can lead to resurgence of bed bugs. This study further recommends that, County Government should organize communal spraying so to reach each and every household as is highlighted by the FGD with the CHVs, private spraying firms and the Nakuru County Health Department to come up with more affordable methods, enhance surveillance of bed bugs and research as is highlighted in KII with the chief Public health Officer in charge of vector control and motivation of CHVs training and empowerment with equipment in bed bugs prevention and control methods.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

FGD	**:**	Focus Group Discussion
KII	**:**	Key Informant Interview
CHVs	**:**	Community Health Volunteers
SPSS	**:**	Statistical Package for the Social Sciences
HoH	**:**	Head of Household
NACOSTI	**:**	National Commission for Science, Technology and Innovation
MoH	**:**	Ministry of Health
USEPs	**:**	Usability Elicitation Patterns
USNPMA	**:**	United States National Pest Management Association
IGRS	**:**	Insect Growth Regulators
USEPA	**:**	United States Environmental Protection Agency.
PPS	**:**	Probability proportion to size

CHAPTER ONE

INTRODUCTION

1.0 Background of the study

Bed bugs are insects of parasitic origin in the genus *Cimex* and human blood is their meal of preference (Sutton & Thomas, 2008). The most common bed bugs that is found in almost all continents is the *Cimex lactularius* which exclusively feeds on human blood (Boase, 2001). The *Cimex hemipterus* is likely to be found in warm regions like Africa and Asia. The life cycle and feeding behavior determines the size and color of bed bugs (Sutton & Thomas, 2008). Cases of bed bugs resurgence have been reported in worldwide countries such as USA, Canada, Australia, Europe and some Asian Countries (STEPHEN L. Doggett & Russell, 2008, MICHAEL F. Potter et al., 2008, (Hwang et al., 2005), R. Cooper, 2006, L. Wang et al., 2013). In 1998, first cases of bed bugs infestation were recorded in USA (Michael F. Potter, 2006). Bed bugs prevalence in New Jersey a state in USA was found to be 12.3% in 2016 (C. Wang et al., 2016). Resurgence of bed bugs in United Kingdom begun in 2000 (Boase, 2001), followed by Australia in 2001 (STEPHEN L. Doggett & Russell, 2008) and China in 2007 (L. Wang et al., 2013). Bed bugs resurgence remains unclear but various factors are known to contribute to it. the factors which work in combination include poor sanitation and hygiene, lack of awareness, resistance of insecticides, increased international travel and finally lack of effective monitoring and management tools (Stephen L. Doggett et al., 2004, (Alvaro Romero et al., 2007).

Bed bugs causes ill health and lack of wellbeing making them a public health nuisance considering they are environmentally communicable (Aultman, 2013). People who are exposed to bed bugs bites manifest symptoms like; pain, itching, sleep loss and psychological distress (Goddard & deshazo, 2009, Rieder et al., 2012). Reaction from

bed bugs bite differ from one individual to the other, some individuals experience bite symptoms while others suffer from systemic reactions like difficulty in breathing, dysphagia, lethargy and chest tightness (Goddard & deshazo, 2009, Stephen L. Doggett & Russell, 2009). Bed bug infested residents are sometimes denied health care service or public services by service providers for the phobia of bed bugs (Aultman, 2013). It is an expensive affair controlling bed bugs infestation (Y. Wang, 2009) (MICHAEL F. Potter et al., 2008). Residents throw away their furniture and other household items trying to curb bed bugs infestations.

Previous studies have shown that bed bugs migrate and spread via exchange of infested furniture among the residents, home visits, social interactions between residents and are dispersed actively (C. Wang, Cooper, et al., 2011) (R. Cooper et al., 2015). Bed bugs are most common in multi-unit homes compared to single unit dwellings due to the closeness to each other within a building structure. In addition, distribution of bed bugs in apartments tends to be clustered with one unit having multiple bed bugs infestations and the other free from bed bugs infestation (Stephen L. Doggett & Russell, 2009, C. Wang, Tsai, et al., 2011).

Bed bugs infestations prevalence is highly associated with socioeconomic status of the residents. Past surveys have indicated that communities with low in-come in the United States are more burdened with bed bugs infestation issues than middle income as well as upper income communities (C. Wang, Tsai, et al., 2011, R. Cooper et al., 2015). Limited or low income has contributed to infective pest management plans and lack of resident cooperation in management of bed bugs infestations (C. Wang, Cooper, et al., 2011, R. Cooper et al., 2015).

In the recent past, there has been resurgence of bed bugs infestation in Kenya. On the other hand, bed bug infestation is a public health nuisance; their bites causes itching

and skin breaks which can lead to secondary infections. Bed bugs infestation can also lead to sleep loss and stigmatization leading to loss of respect among peers. In Kenya, Nakuru County has been hit by quite a number of bed bugs resurgence which has been in the public domain. This study aimed to establish socioeconomic factors and cultural practices influencing to the resurgence of bed bugs in Nakuru Town.

1.1 Statement of the Problem

Study of bed bugs in Kenya is not widely researched and this study looks to fill in that research gap by addressing fundamental issues in the resurgence of bed bugs. Officials from Ministry of Health and other stakeholders have attempted to curb bed bugs infestation in affected estates of Nakuru by fumigating and spraying within the homesteads and in the houses but bed bugs resurgence is still on the rise.

Health officials have expressed challenges of residents denying their access to the estates for fumigation and spraying purposes worldwide (Lyons, 2010). This can be attributed because of low self-esteem and fear insecurities. This resistance by residents could aid bed bugs movement from one area to the other and also increase resurgence in estates where there is compliance with health workers. Been a metropolitan city, Nakuru hosts people of all socio economic blocks. Low income communities hinder the eradication of bed bugs and some residents (Bennett et al., 2016). People living in Nakuru town estates are under very impoverish conditions which could in turn lead to resurgence of bed bugs as most people cannot even afford the basic insecticides to kill and eradicate bed bugs in their households.

Reason for resurgence of bed bugs includes resistance of insecticides (Alvaro Romero et al., 2007) and lack of best practice in bed bug management (Bennett et al., 2016, p. 201)

Culture is very vibrant in Nakuru County as it hosts nearly all the tribes of Kenya. Cultural practices like rearing of pet animals and migration from one place to the other in case of the pastoralist communities can lead to bed bugs resurgence and this research study aimed at establishing some of this practices that may cause the same. This study sought to establish the socioeconomic factors and cultural practices that influence the resurgence of bed bugs in Nakuru town considering the county itself is ranked 2 out 47 counties in the republic in compliance to water and sanitation indexes.

1.2 Purpose of the study

The purpose of this study was to determine the socioeconomic factors and cultural practices that influence the resurgence of bed bugs in Nakuru town and make necessary recommendations to stakeholders.

1.3 Broad Objective

To determine socioeconomic factors and cultural practices influencing the resurgence of bed bugs in Nakuru Town.

1.4 Specific Objectives

1. To identify socioeconomic factors influencing the resurgence of bed bugs infestation in Nakuru Town.
2. To identify cultural practices influencing the resurgence of bed bugs infestation in Nakuru Town.
3. To establish reasons for residents' resistance to public health officials to access their homes to spray and eradicate the bed bugs.
4. To examine and identify methods currently being used by residents to control and prevent the spread of bed bugs in Nakuru, Town.

1.5 Research Questions

1. What were the households' socioeconomic factors influencing the resurgence of bed bugs infestation in Nakuru Town?
2. What were the households' practices influencing the resurgence of bed bugs infestation in Nakuru Town?
3. What were the reasons for the residents not allowing the public health officials to access their homes to control and eradicate bed bugs?
4. What were the methods used by the residents to control and prevent spread of bed bugs?

1.6 Justification of the Study

Globally the issue of bed bugs infestation is a major concern because of their high burden on socioeconomic status and public health importance according to the USEPA (United States Environmental Protection Agency). Various reports have indicated that bed bugs can act as vectors for pathogens such as *Bartonella quintanna* and *Trypanosoma cruzi* that causes trench fever and chagas disease (Lai et al., 2016)

Infestation of bed bugs can cause public health inconvenience and the painful bites can make one to rub the skin continuously which exposes them to opportunistic infections in case of skin breakages. The invasion of bed bugs can be in schools, hotels, homes, hospitals, public transport vessels and offices (Boulanger, 2018).

The resurgence of bed bugs has been rising over the past few 10 years (Parola & Izri, 2020). Factors contributing to this rise remain unclear. However, some reports have noted that minimal use of insecticides could lead to bed bugs resurgence (Fourie & Crafford, 2018). It becomes hard to eradicate the bed bugs once they invade households because of mobility and migration. Control methods sometimes can be very expensive and risky when used round susceptible people (A. Romero et al., 2017).

It was important that this study in its totality investigated the resurgence of bed bugs in Nakuru Town and also seek to understand some of the factors within the communities that are leading to the resurgence in general.

1.7 Scope of the Study

The study was carried out within the seven estates of Nakuru Town in an estimated period of seven months. The estates included, Kivumbini, Flamingo, Lake view, Rhoda, Kaptembwa, Bondeni and Mwariki.

1.8 Study Limitations

The study limitations included; academic limitations, financial limitations and time constraints.

1.9 Study Delimitations

The study was carried out only in Nakuru Town estates targeting heads of the households.

1.10 Assumptions of the Study

The assumption of this study was that everything would go as planned and that none of the study goals had been covered in the study area.

1.11 Definition of Key Terms

The following terms are used in the study and defined as follows:

Resurgence: This is an increase or revival (of bed bugs) after a period of little activity or occurrence.

Re-emergence: The process of bed bugs coming into sight or prominence once more after the initial outbreak.

Cultural practices: Cultural practice is the exhibition of a customs, in relation to traditions and customary presentations of a specific ethnic or a sub cultural group.

CHAPTER TWO

LITERATURE REVIEW

2.0 History of bed bugs

Bed bugs are known to have undergone development from cave-dwelling ectoparasites of mammals such as bats. Movement of humans from caves to tents and later houses may have facilitated transmission of bats to their homes (Usinger, 1966). The first report of bed bugs in England was in 1583 according to Kemper 1936. Bed bugs were rare in North America and Western Europe bed bugs were rare during earlier 20th century (Ryan et al., 2002). Bed bugs have been of global concern in recent years. They belongs to family Cimicidae in the insect order Hemiptera or true bugs (Bell et al., 2009). They are nocturnal bloodsucking ectoparasites with piercing and sucking mouthparts to feed on plant juices, other insects, or the blood of vertebrate animals as well as humans (Tawatsin et al., 2011). Bed bugs can be distinguished from other hemipterans, by the reduction of their wings to short transverse scale which renders them flightless (Weeks et al., 2011).

Bed bugs fall under family Cimicidae which comprises of more than hundred 100 species. Only two species are known to feed on humans. They include; common bed bugs *Cimex lectularius* and the tropical bed bugs *Cimex hemipterus* (Goddard & deshazo, 2009). *Cimex lectularius*, widely spread in North America and Europe while *C. hemipterus* is found exclusively in tropical areas and widespread in West Africa (Eddy & Jones, 2011). Bat bugs *Leptocimex boueti* may feed on humans if their host is absent. Bed bugs mature to 7 mm in length and may live from 4 months up to a year, depending on the species and feeding habits (D. M. Elston & Stockwell, 2000). Both sexes of bed bugs are can live for 12 months without feeding and therefore they are hematophagous. They can survive for up to 18 - 24 months without feeding in cold

environment (Delaunay, 2012). In a study by (Quarles, 2007) it's evident that, bed bugs can survive wide range of temperatures and atmospheric compositions below 16.1°C. At -10 °C, adult bed bugs enter semi hibernation and can survive for at least five days. At a temperatures of −32°C they can live for 15 minutes (J. B. Benoit et al., 2009). Common commercial and residential freezers can reach temperatures low enough to exterminate most life stages of bed bugs, with about 95 per cent of them dying after 3 days at −12°C (Olson et al., 2013). Bed bugs show high dehydration tolerance, surviving low humidity as low as 35–40°C range even with loss of one-third of body weight; earlier life stages are more subject to drying out than later ones (Joshua B. Benoit et al., 2007). The thermal death point for *C. lectularius* is 45°C and it happens within 7 minutes after exposure (Quarles, 2007). Bed bugs cannot survive high levels of carbon dioxide concentrations for a long time. However, exposure to pure nitrogen atmospheres appears to have little effect even after 72 hours (Herrmann et al., 2007). Bed bugs are often found in large numbers therefore they are social insects (J. B. Benoit et al., 2009). They live under congested and jam-packed living conditions; they are often in army barracks, labour and prison camps and similar situations where they may readily contact a variety of hosts (METCALF & FLINT, 1973). Bed bugs hide in beds, wooden furniture, floors, walls and cracks during daytime and appear at night to feed on their preferred host (MICHAEL F. Potter et al., 2008).

Insecticides such as dichlorodiphenyltrichloroethane (DDT) were used during the Second World War, which worked effectively by reducing the population of insects including bed bugs (Robson et al., 2010). The effectiveness of insecticides lasted for a period of time. In the late 1990's, the bed bugs developed resistance to the available insecticides making it challenge for management and elimination of them (Hwang et al., 2005). Due to increased international travels, transmission of bed bugs became

eminent thought the world. Factors such tourism and migration have contributed to spread and increase of bed bugs population. This may have contributed to the spread and uncontrollable increase of bed bugs' prevalence as travelers carry with them either adult bugs, nymphs or eggs of bed bugs (Alvaro Romero et al., 2007). Bed bugs carried on clothes and in luggage by travelers to other places hence facilitating the spread (Delaunay, 2012). Bed bugs infestation has increased beyond the expectations leading to closure of many institutions such as McDonalds restaurant in Elyria United States of America on June 16 2015 (MICHAEL F. Potter et al., 2008). Bed bugs infestation has also led to burning of furniture in homes to control them since the use of pesticide could not yield the desired result. The presence of bed bugs has been experienced in hospitals. Patients in these hospitals reported the presence of bed bugs, which called for immediate health and medical attention

2.1 Biology of Bed bugs

Bed bugs are generally known as insects from the Cimicidae family, small in size and parasitic in nature that feed on blood from the vertebrates (Reinhardt & Siva-Jothy, 2007). The attention on this parasitic insects had disappeared until the past ten years or so, not only in science literature but also in the press (Kilpinen, 2008). Bed bugs have been suspected to transmit more than 40 infectious diseases but this transmission has not been proven to our knowledge (Delaunay, 2012). However, they can bring about psychological distress because of their incorrect association with poor hygiene and poverty.

Figure 1: Bed bugs photograph

Source: Google photos, 2018

2.2 Appearance

Bed bugs are of the order Hemiptera and mostly have wings which are half sclerotic and half membranous and part of the Cimicidae family that are commonly referred to as Cimicids (Delaunay, 2012) They not only infest human households but can also infest the bird environment like chicken, bats, and certain assorted animals (Huntley, 1999). Cimicids do not stay on the host to complete their life cycle making the unique parasites among the obligate blood feeders (MICHAEL F. Potter et al., 2008). *C. lectularius* and *C. hemipterus* are the two species of bed bugs that commonly affect human beings (Delaunay, 2012). They are identified only through the help of a specialist and both male and female are hematophagous and can live for as long as twelve months without feeding on blood (Delaunay, 2012, Levy Bencheton et al., 2011)

C. lectularius are found in temperate climates like in the United States while in tropical climates *C. hemipterus* are found. (Gbakima et al., 2002). However, recently they can both be found in any climate due to easy movement by travelers. It is difficult to differentiate these species and more than one species can be found in an infestation. *C. lectularius* ranges in size between 5&7 mm while the *C. hemipterus* is elongated in size. They can both inter-breed and overlap in sizes (Fountain et al., 2014). Bed bugs have flat, oval bodies in shape and reddish brown in color before feeding on their host. The bed bugs flat body becomes elongated after feeding and becomes more reddish than brown. Juvenile bed bugs are as small as 1.5mm and are yellow to translucent in color before a meal and after a meal they turn to bright red (Reinhardt & Siva-Jothy, 2007).

In accordance to the Pest World Organization, the biology of bed bugs generally aids infestation. The female bed bugs can lay from 1-5 eggs per day and approximately 540 eggs in a lifetime. Bed bugs have the habit of laying their eggs in cracks or rough surfaces. The nymphs grow into full adulthood within 21 days and before they can reach maturity they go through 5 developmental stages (Ridley, 1988). A blood meal is required for a bed bugs to molt and an adult bed bugs can survive for several months without a blood meal (Joshua B. Benoit et al., 2007). Adult bed bugs are attracted by carbon dioxide emitted by their hosts for this reason they tend to feed during the night on bare skin. However, in highly infested areas, bed bugs can be opportunistic and feed on a host during the day (Fogain, 2013). The preference of bed bugs being a human blood meal, they can also feed on other warm blooded animals. It takes about 5-10 minutes for a bed bugs to gorge a blood meal. They insert 2 hollow feeding tubes which look like beaks into their host (Rivnay, 1930). The first tube inoculates the host with bug saliva to numb the area where they feeding while the second tube sucks blood from

the host. They move to hidden places in the households to digest, mate and lay eggs without feeding and this takes around 5-10 days (Lavoipierre, 1965).

2.3 Life Cycle

Bed bugs infestation is a global phenomenon. Over time these bugs have been referenced with poor economic regions; however, they are frequently found in areas to which people travel or in public buildings like hotels and conference centers which are frequented by many people (Kells, 2006).

Multi-unit homes and institutional facilities are more likely to be infested because bed bugs move from one local area to another affecting many residents. Bed bugs do not hide on visible areas of the furniture but they move to cracks and crevices. They come out of their hiding places every 5-10 days to feed (Bryks, 2010).

They are commonly found in crevices of mud houses and also in thatched roofs in developing countries. Refugee camps are more susceptible to bed bugs infestation. A previous study found that 98% of the rooms investigated in a refugee camp in Sierra Leone had infestation with bed bugs bites been evident in 86% of the residents (Gbakima et al., 2002).

Bed bugs are attracted to carbon dioxide production and can locate warmth (A. Romero et al., 2017) aiding them in their movement towards humans (Bryks, 2010). Bed bugs walk at the same rate as ladybugs do. Due to the constant movement of humans, bed bugs can also be found inside household items and their presence in homes is due to human dispersal (Goddard & deshazo, 2009). Bed bugs feed for about 5 minutes in one night and marks of the bed bugs bite are found on the arms of the host, face, hands and neck of the host depending on what parts were exposed during the host sleep period (Stephen L. Doggett & Russell, 2009). Individuals who toss and turn at night exposes more skin to bed bugs bites hence the bites can be found on various parts of the body.

Bite marks are not felt by people until several days later and in some cases a reaction to the bite can occur (Bryks, 2010).

After feeding, bed bugs deliver proteolytic enzymes through their saliva, leading to hypersensitivity and anticoagulant factors and vasodilatory compounds including nitric oxide carrying protein (Valenzuela et al., 1995, Huntley, 1999). Bed bugs use two separate elongated tubes at their time of feeding, one for withdrawing blood without clotting and the other for injecting saliva to numb the feeding area making it pain free (Wilson, 2011). A female that has recently fed undergoes about 5 traumatic inseminations after each feeding by the male bed bugs (Reinhardt & Siva-Jothy, 2007). The sperm of the male bed bugs is passed by the intermittent organ, by passing through the female genital tract, and the cuticle pierced (Delaunay, 2012). The migration of the sperm is directed by a female organ (mesospermagele) where the sperm is injected. The mortality of female bed bugs is common during mating; however, each fertilized female adult bed bugs can lay up to 500 eggs in her lifetime (Reinhardt & Siva-Jothy, 2007).

Bed bugs emit a strong odor from the oils secreted by the dorsal abdominal glands and are very active during the dark (Feldlaufer et al., 2014).

2.4 Resurgence of Bed bugs

In the past 15 years, bed bugs resurgence has been recognized widely but there remains many queries about the current bed bugs resurgence (Stephen L. Doggett & Russell, 2009). Questions on how prevalent the infestation has been in the communities, the main bed bugs dispersal mechanisms in the communities, how socio-economic factors are influencing bed bugs resurgence, what materials and methods have been used by locals to control and prevent bed bugs. Answers to these questions present an

opportunity to identify challenges and ways for better bed bugs infestation management.

Since the 1980's bed bugs resurgence has been there but for reasons not well established by scientists but various factors influencing this surge could be socio-economic, resident practices, resistance to insecticides and non-compliance (Naylor et al., 2018). In the years between 2000 and 2005 the USNPMA (United States National Pest Management Association) indicated a 71% rise in bed bugs infestation. Bed bugs are known to hide and yield their eggs where their hosts rest such as beddings, furniture like beds and sofas, wall cracks, behind photo frames and in crevices (STEPHEN L. Doggett & Russell, 2008).

The baffling thing about the resurgence is that it is involving two species: the tropical bed bugs Cimex *Hemipterus* and the obvious bed bugs Cimex *lectularius.* The involvement of these species makes it more difficult to ascertain the reasons for the resurgence (Tyagi, 2003).

The most common factor identified to be influencing the resurgence is bed bugs resisting the pyrethroid insecticides and carbamate (Alvaro Romero et al., 2007). The main difference between now and the past is that the present day bed bugs are resistant to pyrethroid (A. Romero et al., 2017) and most of the insecticides been used to prevent and control bed bugs today are of the pyrethroid group. Insecticide resistance is thought to be the key cause for the bed bugs resurgence and bed bugs that resist these insecticides have been spread globally via increased global travel (Tawatsin et al., 2011).

As a result of been exposed to the bed bugs, humans are continuously been exposed to various health risks as a consequence of the huge resurgence of bed bugs infestations. The resistance of current pesticides and ineffective monitoring practices; public health

entities have acknowledged that there is lack of public awareness both in private and government organizations in matters infestation, treatment and control of the infestations (Gostin & Wiley, 2016).

A bed bugs infestation is not a reportable disease despite its communicable characteristic (Abejuela-Matt, 2014). In this manner, not only is it challenging to prevent its spread, but validating and tracking it can be hard to comprehend. This lack of reporting may have added to the past perceptions of complete bed bugs eradication (Borth et al., 2019). More so the limited resources of public health organizations are delaying the eradication since bed bugs eradication is not prioritized. It is unclear who is solely responsible for the bed bugs eradication as it cannot lie squarely on public health departments. Some residents may reduce the course of pro longed insecticide application based on the expensive prices or limited public education on the duration of exposure (Borth et al., 2019). Someone could conclude that those not very aware of the effective principles of treatment and control may have these misconceptions and allow infestations to spread without early or thorough eradication.

Variation in eradication techniques and resistance, as well as lack of reporting from both patients and public entities has complicated control (KOGANEMARU). The ever increasing movement of goods and people has aided further the bed bugs spread. While present literature thoroughly explains the clinical manifestation of bed bugs and the spreading effects on society, there is little that is discussed about its etiology (Abejuela-Matt, 2014).

In 2017, the ministry of health reported that the occupants of 7 Nakuru estates no longer at peace as they had been invaded by bed bugs. These estates included Mwariki, Rhonda, Bondeni, Flamingo, Lake View, Kaptembwa and Kivumbini estates. The infestations in Nakuru has been blamed on the multi-unit housing structures and

densely populated estates insecticide resistance and ineffective pest control but the residents had their reasons circulating around cultural practices and second hand items.

Reports have indicated that bed bugs are a public health concern since their bites can bring about insomnia and cause itching but there is little evidence establishing if bed bugs can transmit any diseases (Hwang et al., 2005). The itching can lead to prolonged scratching of the human skin leading to breakage which in turn exposes the victim to secondary infections. In addition, the cosi-economic and public health burden makes the bed bugs spread a global concern as reported by the USEPA (United States Environmental Protection Agency).(Anderson & Leffler, 2008) Various reviews have indicated that bed bugs could act as vectors for pathogens such as *Trypanasoma cruzi* and *Bartonellla quintanna* that causes chagas disease and trench fever (Lai et al., 2016)

2.5 Effects of Bed bugs infestation

Bed bugs can bring more than physical harm to their hosts who in turn may develop distress from bed bugs infestations. These infestations can lead to psychological stress affecting daily life and can lead to constant self-isolation, worrying, interrupt daily life and management tactics (Stephen L. Doggett & Russell, 2009).

Physical marks left on the neck or face by bed bugs bites can make the human victim feel insecure and lowered self-esteem because bites on exposed body surfaces are very visible and can even affect the employment performance at work (Hwang et al., 2005, Stephen L. Doggett & Russell, 2009). Some individuals may develop constant fear of bed bugs even when they have been completely eradicated and also develop delusions that they feel the insects moving on their skin. Self-isolation is common in the communities as those with bed bugs bites avoid their neighbors and some community members can isolate themselves from them for the fear of acquiring the insects (Goddard & deshazo, 2009)

Having bed bugs in one's house has been seen as a sign of poor hygiene and such is the main reason for stigmatization in many communities globally (Stephen L. Doggett & Russell, 2009). Individuals develop distress and even mental trauma from the expenses that comes with bed bugs eradication as they are forced to pay hundreds and thousands of dollars to thoroughly eliminate these insects and this may be hard to accept in some individuals (Stephen L. Doggett & Russell, 2009). As a consequence, hosts may experience anxiety, mild to severe levels of stress and depression all of which may require to be attended to via treatment (Aultman, 2013).

2.6 Clinical Manifestations

By feeding with its proboscis, a cimicid pierces the skin and this behavior is mostly confused with biting, it may cause skin reactions as individuals respond to its saliva. In this case, not all people experience it as the reaction is allergic in nature, some may not react at all. Mostly, there are minor reactions to a bite. The common skin lesion is a pruritic 5 to 20mm in diameter with a hemorrhagic crust at the point where proboscis enters (Delaunay et al., 2011). The skin reactions may be confused with spider or mosquito bites and mostly in developed countries in which bed bugs are not commonly seen. Many individuals with bed bugs bites have been misdiagnosed by their clinicians with scabies or hives (Joshua B. Benoit et al., 2007).

Some situational cues establish that the proper diagnosis include presence of bed bugs blood flecks and fecal smears on bed linen and on patients skin and waking up with new skin lesions. These may call for inspection of the household items, furniture and laundry to expose any hidden bed bugs in the house. In addition, the consistent odor of the oils released by bed bugs may be identified throughout the household or apartment locally. The microscopic anatomy of a bed bugs bite involves a per vascular within the

upper dermis and looks like those of various insect and arthropod hypersensitivity reactions (Kolb et al., 2009).

Every individual does not no react to the saliva inoculated by the bed bugs, but if an allergic reaction occurs (itchy, red) which can be infected through scratching, treatment should be prompted. Histamine causes the itchiness individuals feel after been bitten by an insect and the mast cells release this histamine and other substances during a reaction (allergic). In common cases, bed bugs bites should heal within one week. If the allergic reaction to the bite is severe, antihistamines are given to suppress itching and an antibiotic is only given if a secondary or opportunistic infection develops from the prolonged scratching of the skin (Goddard & deshazo, 2009, Harv Women's Health Watch. 2011. Antihistamines can put the victim at risk of reduced ability to detect an ongoing infection but they are very effective at reducing itching on bitten are by the bed bugs.

2.7 Factors influencing Resurgence of bed bugs

This is not a vastly researched area and there are no clear indicators of factors influencing the resurgence of bed bugs and recent reports show that bed bugs have become resistant to insecticides as is reported by (Goddard & deshazo, 2009). Resident practices like pet rearing, working in game parks, migration and acquiring second hand furniture could be a possible way of aiding bed bugs movement to their residences.

2.8 Bed bugs Treatment & Control Methods

Controlling bed bugs is a process. It includes; positively identifying the bed bugs, inspecting the site to establish which areas or parts that treatment is required, non-chemical controlling options, applying insecticides, evaluating the effectiveness of the treatment process and procedures involving risk management. In estates, multi-unit dwellings, school-dormitories, hotels and apartments the control process involves

inspecting and examining all the rooms next to the room that has been infested and preferably risk management should be a continuous process and implementation of the same should be done even before bed bugs infestation occur.

In an aim to reduce the biomass of the bed bugs infestation in a residence, non-chemical control can be established and this can even achieve full control of an infestation. Non-chemical methods are likely to have a more an effective effect in numbers reduction and have a key advantage in that they are less hazardous to the environment and residents than chemical control methods (MICHAEL F. Potter et al., 2008, Alvaro Romero et al., 2007).

Normally, at some point in the process insecticide application will be required to achieve complete effectiveness in controlling the bed bugs but integrating the non-chemical methods reduces the amount of insecticides used and also lowers the cost of buying a lot of chemicals on the resident.

The easiest and simple method of non-chemical control is disposing off the infested house-hold items. To reduce the chances of counter contamination, this items need to be sealed off before disposal. Consequently, furniture marked for disposal should be disfigured completely or burned to avoid others using the same furniture thus reducing chances of resurgence. Disposal of household items is not always the last option in bed bugs control as some can be treated, however, in heavily infested residences; disposal is the only economically friendly method in bed bugs control

Globally, the main insecticide groups currently are the insect growth regulators (IGRS), pyrethroids and silicates. In some parts, some organophosphates and carbamates are still in use and more recent, arylpyroles and neonicatinoids are been used.

Due to the bed bugs infesting the sleeping areas in residences, treatment methods other than application of insecticides are on demand by residents. Some of these methods can

be expensive, exhausting, shameful, time consuming and pose a great risk to the health status of the residents. Heat treatment is one popular method among residents. Recent reports from University of Minnesota Department of entomology, insecticide application is important and to achieve effectiveness it is recommended that residents high professional pest management individuals.

2.9 Treatment.

Identification of infestations can be done by small pieces of bed bugs remnants, including blood from their host and fecal matter and skin parts left on the beddings when the bed bugs molt (Cleary & Buchanan, 2004). However, it is very difficult to locate bed bugs. In the past for easier identification of bed bugs via smell, trained detector dogs have been used commercially and have a 97.5% positive identification rate (Pfiester et al., 2008). Once bed bugs are positively identified, residents should launder all their beddings and vacuum clean all their furniture to reduce the biomass of bed bugs within a residence (Leininger-Hogan, 2011).

Professional pest management personnel should be contracted with an understanding that not only the sleeping area is treated but also the adjacent rooms and apartments are treated to reduce chances of resurgence. Implementation of chemical and non-chemical methods should be done to make sure these chemicals are gotten rid of. The chemical method may pose challenges as some bed bugs have proven resistant to insecticides recently (Delaunay et al., 2011).

In the 1970s, Dichlorodiphenyltrichloroethane (DDT) was used to treat bed bugs infestation as other less toxic methods used at the time were as effective. Eucalyptus oils and mosquito repellents have been proposed but their use in bed bugs treatment has not been successful (Goddard & deshazo, 2009). Fumigants used on bed bugs hiding places do not penetrate fully and their application cam harm susceptible humans.

Normal bug sprayers can kill roaches and kill bed bugs instantly but it is advised that these chemicals are applied directly on the infested areas for good results (Delaunay et al., 2011). But in spite of these measures, bed bugs resurgence can occur.

Non-chemical application methods such as laundering infested beddings, vacuuming, heat treatment and freezing (Dirk M. Elston et al., n.d., Kells, 2006) have given some of the best bed bugs-eradication results. When the infested area is vacuumed with a gadget that contains air-filter which are efficient, bed bugs debris and allergens are removed. However, there are always chances that bed bugs eggs remain on the surface as they glued on the surface by glue-like substance produced by the female egg-laying bed bugs (Kolb et al., 2009). Heat treatments are used as alternate bed bugs treatment methods to insecticide application but should be applied by a professional to avoid burn accidents. With the right gadgets, there are high chances of heating the rooms to temperatures that are deadly to the bed bugs: at all its developmental stages, the bed bugs dies when exposed to temperatures exceeding 50°C (122°F) for 90 minutes minimum. Laundering of infested clothing's or beddings should be done on the hottest available washer and dryer settings and the highest possible temperature that the fabrics can sustain. This process ca easily kill bed bugs compared to disposing the fabrics; however, it doesn't prevent further resurgence. Freezing is only effective in less infested items and it should be done for at least four days (Kolb et al., 2009). The freezing and heating gadgets are used by trained professionals; however, many residents cannot afford the $500 to $1500 to hire such professionals (Manuel, 2010a). The alternative way due to the cost is disposing of the infested items to avoid re-occurrence of the infestation.

2.10 Prevention of Further Bed bugs Infestations

With growing evidence that traveling is one of the main ways in which people are exposed to bed bugs, some proposals to help humans avoid been in these unattended vessels for the bed bugs are warranted. Bed bugs cling on clothing during traveling and can be found in public transport vessels and hotels including key conference rooms aiding their movement to the individuals' residence (Emmanuel et al., 2014). It is proposed that people should inspect their hotel rooms before unpacking and they should place their luggage in the bathrooms as the bed bugs do not frequent that place.

Inspecting the head board and the mattress may help determine bed bugs presence in the hotel room and also turning the bed sheets upside down to check for any bed bugs markings. Wardrobes should be inspected with a flash light before storing any clothes there. Luggage should never be placed on the floor instead should be placed on tables away from the walls. On leaving the hotel residence, any clothes to be laundered should be placed in an air tight plastic to seal off the bed bugs. On returning to their residences, individuals should inspect their luggage for any bed bugs remnants and if any is found, those items should be treated thoroughly (Chalupka, 2010).

In public transport vessels, bed bugs remnants can be seen in buses, planes, cars and taxis. Bags should remain on an individual's lap where possible and should avoid trunk storage where necessary. For individuals who travel frequently, bed bugs proof luggage covers and laundry liners may be used. It always advised to check one's skin and luggage for bed bugs after exiting the vessel.

To prevent bed bugs consuming further blood meals, individuals can cover their skin to prevent bites. Sleeping wear that covers as much skin as possible can prevent the bed bugs from piercing the skin which cannot penetrate any form of clothing (Kolb et al., 2009). A tight woven material or tape can be used to cover crevices known to harbor

bed bugs and this can prevent the bed bugs mobility (Kolb et al., 2009). Bed bugs find it difficult to move on smooth or less-friction surfaces, so covering the bed surfaces with paraffin oil or petroleum jelly has been proposed (Thomas et al., 2004).

2.11 Conceptual Framework

In this study, the dependent variable was the resurgence of bed bugs which with the independent variables been the socio-economic status of the residents, cultural practices among the residents, behavior towards Public health officials and public awareness towards the control methods.

Poor socio economic status, resistance towards health officials to spray the residences and lack of public awareness has accelerated the resurgence of bed bugs in various parts of the world.

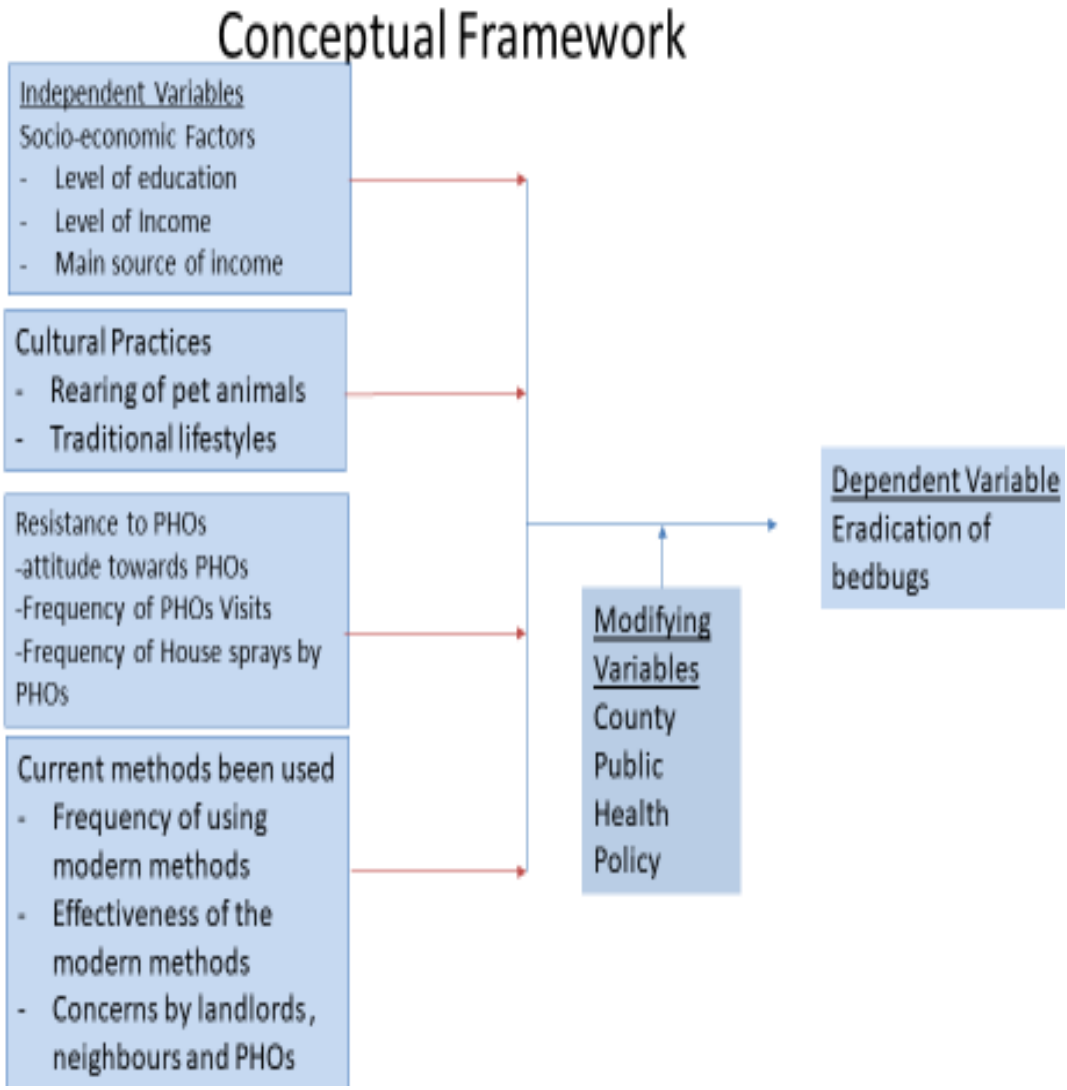

Figure 2: Conceptual Framework

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Location of the study

The study was conducted in seven estates in Nakuru town both in Nakuru East sub-county and Nakuru west sub-county. Nakuru East has four estates which are Kivumbini, Bondeni, Lake View and Flamingo while Nakuru west has three estates Rhoda, Kaptembwa and Mwariki. Living conditions in this estates match those of a 2002 UN conference definition of a slum household as number of people living under one room missing one or more of these conditions; sanitation services and adequate living area or good housing, access to better quality and quantity of water and access to education (Reis et al., 2008).

Nakuru is the fourth-largest urban area in Kenya after the cities of Nairobi, Mombasa and Kisumu. Like most rift valley cities, Nakuru enjoys a temperate climate throughout the year but temperatures fall significantly at night and during the cold season of June to August. The city has a warm-summer (Mediterranean climate Köppen climate classification). Agriculture, manufacturing and tourism are the backbones of the economy of Nakuru.

Most of the houses in the estates are mud and earth houses, Semi-permanent and plaster houses which most of them had electricity and tapped water. By the time of the data collection, most of the residents depended on casual work by the either working in small business such as riding motorbike and working in flower farms.

https://www.google.com/maps/d/edit?mid=1LvBfRr7NKTa3dqsd96ItHTHjmPDM52I m&usp=sharing

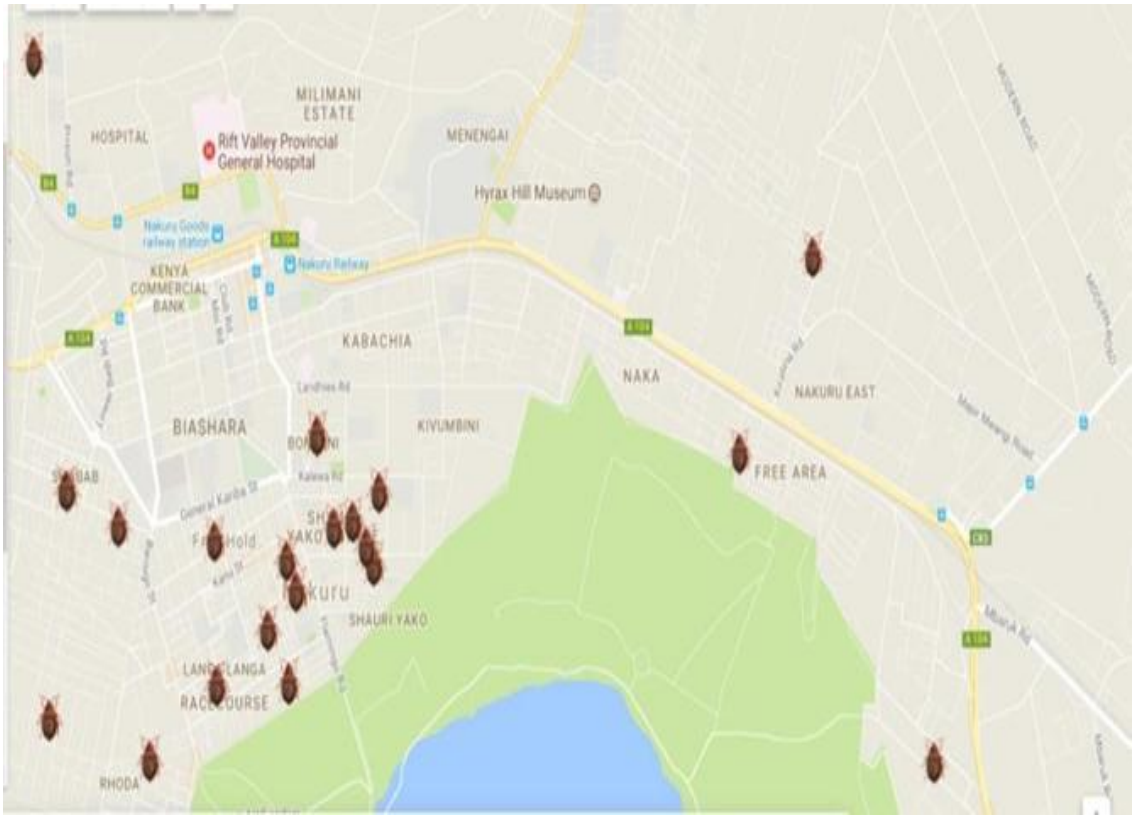

Figure 3: Nakuru Town Bed bugs infestation GIS map

3.1 Study design

Cross sectional descriptive study design technique was used for data for collection. The methods included questionnaire administration, observations, quantitative data collection and statistical text assessment. Questionnaires were used to assess the presence of bed bugs in a locality, home and institution, it was also used to seek permission to carry out inspection and collection. During collection, careful observation were made. These were compared with existing data and tested. The multi-method design was used also to investigate the knowledge people have on bed bugs, and the measures they take in the control of bed bugs.

3.2 Target Population

The target population of this study was heads of households. Population is the total number of items from which an inference in made (D. R. Cooper & Schindler, 2006),

target population of study was 422 heads of households who had experienced sleepless and itchy due to bed bugs infestation.

3.3 Sampling Techniques

In the affected estates in Nakuru town cluster sampling was used. Clusters were purposively selected due to similar characteristics. Probability proportion to size (PPS): was used to get the household number that was enlisted per cluster based on the size of the population. In this sampling procedure, the selection probability of a household was proportional to the population size allowing the bigger clusters a higher probability and smaller clusters a lower probability of selection respectively. Snow balling helped in identifying the households affected to be interviewed and requested to interview the next household until the sample size desired is achieved.

3.4 Sample Population size

The study used the formula (Mugenda, 1999) in determining the sample size. $n=z^2pq/d^2$;

n= Population desired sample >10000

z=standard normal deviate

p=target population proportion as per characteristics

q=1-p

d=statistical significance level

Therefore;

n= $(1.96)^2(.50)(.50/(.50)^2=384$

384 + 10% for non-respondents (Manuel, 2010a) (38) = **422 households**

3.5 Validity

To ensure that the research tools accurately measured what they were supposed to measure the standard data collection tools and methods were used. Well-structured key

informant interviews, questionnaires and focus group discussions were used to collect data and pretesting of these tools was carried out to ensure the validity was maintained.

3.6 Reliability

The study instruments were used in such manner that the results were consistent and stable. Data was thoroughly cleaned throughout the data collection period and research assistants were trained effectively and supervised to make sure consistent results were collected.

3.7 Description of the study site

This study will be conducted in 7 estates in Nakuru Town with an estimation of the total population 32,856. Nakuru Town is the capital city of Nakuru Town and the fourth largest city in Kenya. It is in North-West of Nairobi in the Rift Valley.

3.8 Description of study area

Table 1: Description of study area

Area	Estates	Population	P.P.S.S
Nakuru East	Kivumbini	1231	14
	Flamingo	2426	28
	Bondeni	1072	13
	Lake View	1280	15
Nakuru West	Rhoda	11,181	131
	Kaptembwa	10,748	126
	Mwariki	4918	57
Total Population		**32,856**	**384**

Source: Researcher, (2018)

3.9 Data Collection Methods

The study used primary data, and to achieve this, questionnaires, interviews and Focus Group Discussion were used. Questionnaires were administered to 422 heads of

households. The questionnaire guide consisted of five sections: Section A consisted of the characteristics of type of houses, section B was social economic and demographic factors. Section C and D consisted of resident practices and resistance to public Health officials spraying bed bugs respectively. And finally section E consisted of current prevention and control method used. Community health Volunteers and heads of households were involved in Focus Group Discussions. Public health officer in charge of vector Control, lands house officer, private spraying forms were involved in Key Informant Interviews. Data collection for this study was done between 9th of September to 15 of September 2018.

3.10 Data Analysis Techniques

The study used SPSS Statistical social science package version 22 for analyzing data and generation of themes for the FGDs. SPSS is a software platform that offers advanced statistical analysis, a vast library of machine-learning algorithms, text analysis, open source extensibility, integration with big data and seamless deployment into applications. Data was collected from the filed via hard copies then entered in to a computer to ensure consistency and accuracy of data. In analysis data used themes and statistical package for social science (SPSS) version 23.Then analysis was interpreted and concluded tables, graphs and pie charts.

3.10.1 Quantitative data analysis

Data was coded, cleaned, checked and entered into Statistical package for social science (SPSS) software for analysis. All quantitative data was analyzed by using SPSS version 23. Descriptive summary statistics such as percentage and frequencies and cross-tabulations were used to define bed bugs prevalence (Time and place) and perception of heads of households (psychological distress and social isolation). T-test was used to compare social economic factors that influence bed bugs resurgence (No.

of rooms occupied. Type of home, level of education, main source of income and monthly income) and increase of bed bugs infestation. Chi-square test was used to establish significant association between bed bug infestations and number of people who are living in one or more rooms.

3.10.2 Qualitative data analysis

The data from two focus group discussion was documented; answers were organized in general categories identified in the discussion guide the coded. Common theses were identified, inferences were made from each themes and conclusion were made then triangulated with the data from questionnaires. SPSS Statistical social science package version 22 was used for analyzing data and generation of themes for the FGDs. The study instruments were used in such manner that the results were consistent and stable. Data was thoroughly cleaned throughout the data collection period and research assistants were trained effectively and supervised to make sure consistent results were collected. Descriptive analysis was done and data represented inform of graphs, figures and pie charts.

3.11 Ethical Clearance

This study sought approval from Mount Kenya University Ethical Review Board (Ref. No. MKU/ERC/0890) and the Kenya National Commission for Science, and Technology and Innovation –NACOSTI (NACOSTI/P/1821614/23855) and consent to participate in this study was sought from all the households and confidentiality was observed.

Consent was sought from all households' heads who were selected to participate in the study. It was voluntarily and gave a room for freedom of withdrawal at any time. All respondents were guaranteed that the information they gave would only be used for purpose of the study and the findings will be communicated to them. Also the study

guaranteed the participants that study would not use any form of names or any other identification

CHAPTER FOUR

RESEARCH FINDINGS AND DISCUSSIONS

4.1 Introduction

This chapter comprises of the research findings on all the four objectives; Socioeconomic factors influencing the resurgence of bed bugs infestation, Cultural practices influencing the resurgence of bed bugs, establishing reasons for residents' resistance to public health officials to access their homes to spray and eradicate bed bugs and to methods currently being used by residents to control and prevent the spread of bed bugs in Nakuru Town, Kenya. Data was collected from 422 respondents in all the seven estates (Kivumbini Estate, Flamingo Estate, Lake View Estate, Rhoda Estate, Kaptembwa Estate, Bondeni Estate & Mwariki Estate) in Nakuru Town. The data was presented in this chapter was analyzed using SPSS (Statistical Social Science Package, Version 22).

The majority of respondents in this study were heads of households at 55% of the total count. Other respondents in relation to the head of the household were the spouses at 41% and the relatives to the head of the household were 4% of the total number of the respondents. Mainly the respondents' interaction with the activities surrounding bed bugs resurgence in the Estates depended on their responsibilities in the family setting. This was evident as some of the respondents referred the interview question to either the head of the household or the relative based on who had more information on the issues raised in the question. In this study, the heads of households were better placed to answer the questions.

4.2 Demographic Analysis

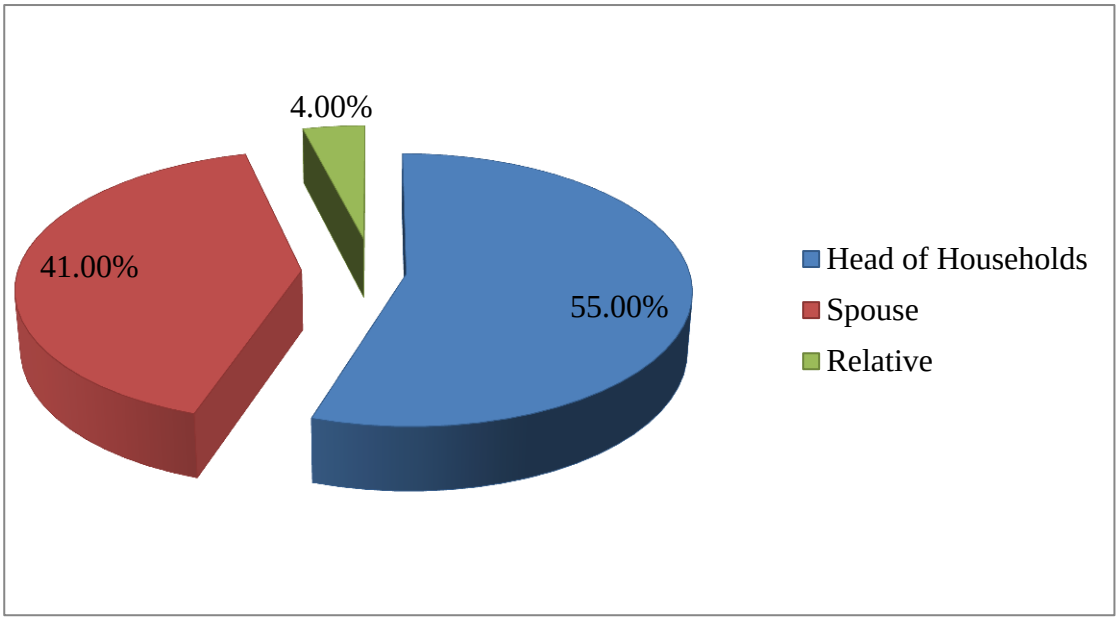

Figure 4: Respondent's relation to the Head of Household

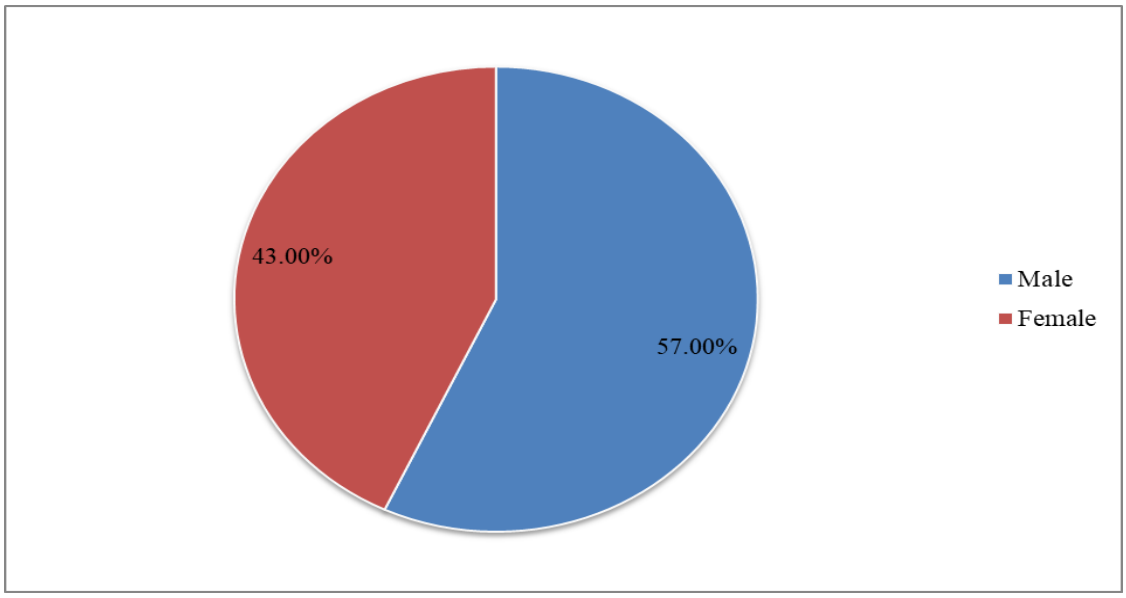

Figure 5: Respondent's Gender

This study focused on all genders. The majority of the study participants were male respondents at 57% and female respondents were at 43%. In the respondents' relation to the head of the households, majority were head of households. This shows that majority of the heads of the households were male respondents.

The female respondents accounted for the spouses with a close relation in the findings in which 44% were spouses and in this specific outcome the female respondents were 43%. The relatives to the head of the households could fall under any gender but also a small portion of the head of households was females.

Respondents age Distribution

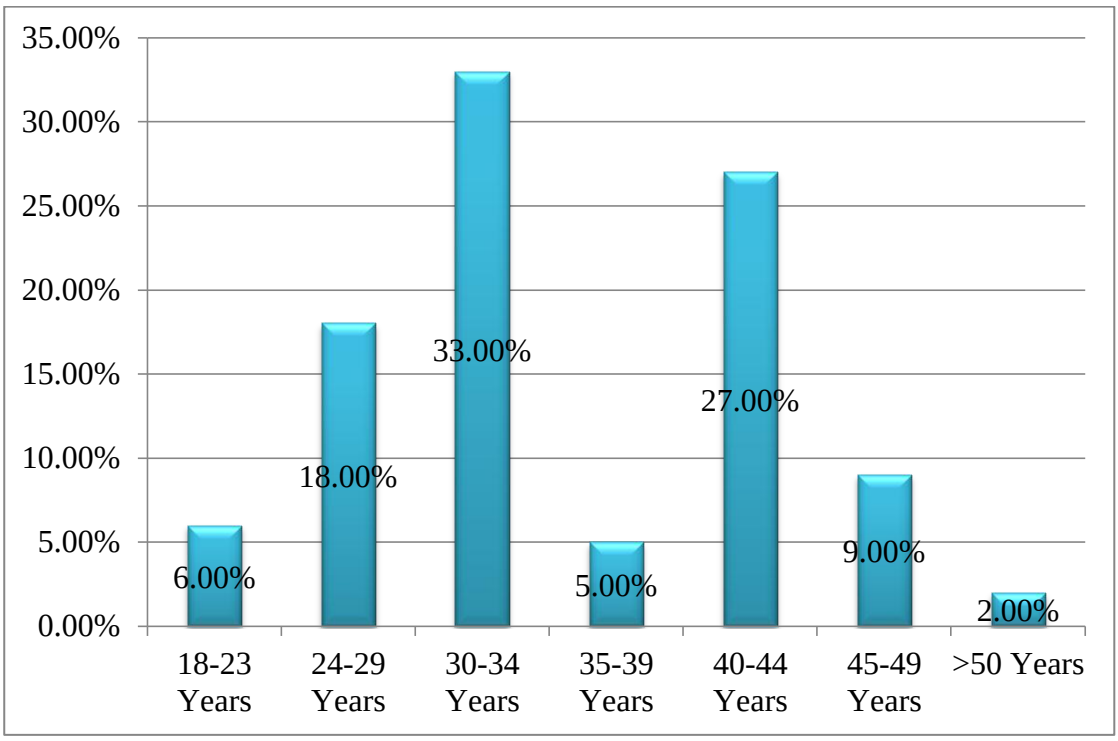

Figure 6: Respondent's Age Distribution

All the study participants were of 18 years and above. Majority of the respondents were between the ages of 30 years to 34 years old at 33%. Respondents in the age range of 40 to 44 years old were 27% of the total respondents. The least number of participants were above 50 years at 2% of the total respondents.

This study found out that among the respondents most were in their youth years. The number of respondents in the range of 18 to 29 years catered for about 24% of the total respondents while there was a slight decline in the respondents aged 35 to 39 years.

Respondents Distribution in the estates of Nakuru Town

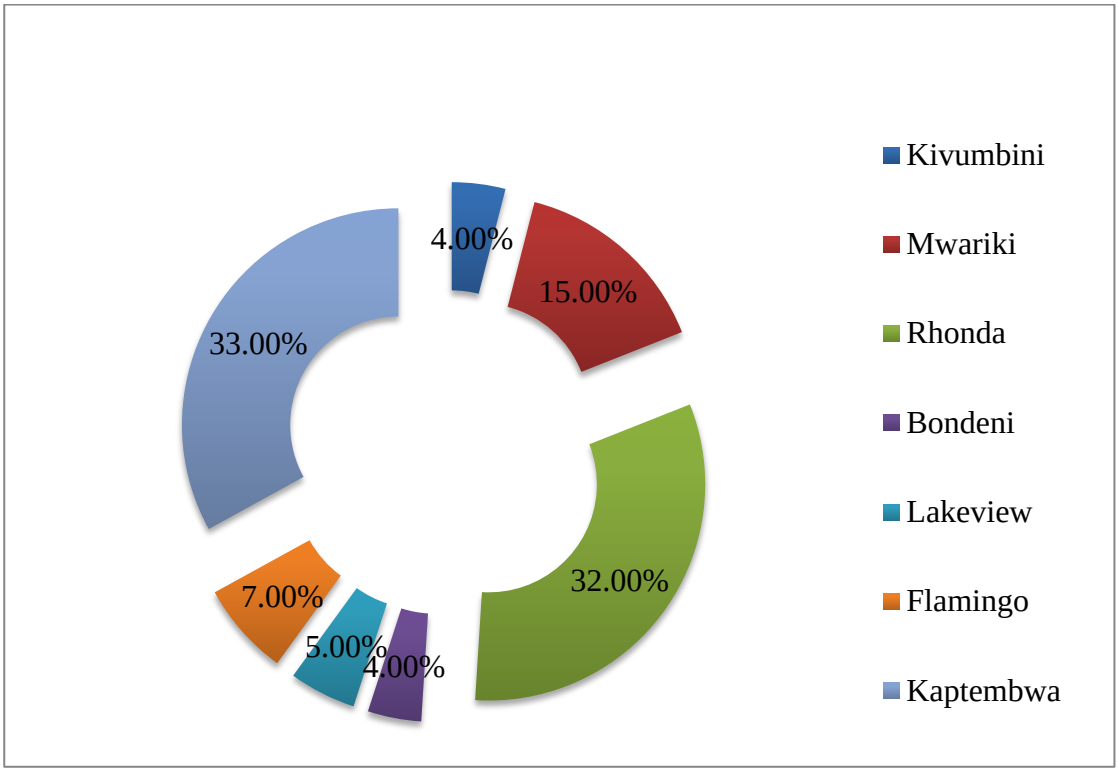

Figure 7: Estates Distribution

This study was conducted in seven estates in Nakuru town. The distribution of the study respondents was based on the population proportion to size sampling. Kaptembwa and Rhonda estates had majority of the respondents with 33% and 32% of the total respondents coming from this two estates.

The least number of respondents came from Kivumbini and Bondeni Estates with 4% each coming from these estates. Other estates including Mwariki, Lakeview and Flamingo were evenly distributed based on their population.

4.3 Demographic Analysis Summary

Majority of the respondents in this study were the heads of households at 55% and their spouses at 41%. The relatives to the heads of the households that included their children were at 4% who were present in the homesteads at the time of this study.

The majority residents that participated in this study were male at 57% of the total respondents and female respondents at 43%. Most respondents that were interviewed were between the age of 30-34 years and the least number of respondents were above 50 years old at 2%. Kaptembwa estate produced the highest number of respondents that participated in this study at 33% while Bondeni and Kivumbini were 4% each of the total respondents that participated in this study.

4.4 OBJECTIVE ONE: Socio-economic factors affecting resurgence of bed bugs in Nakuru town.

Number of rooms Occupied in the House

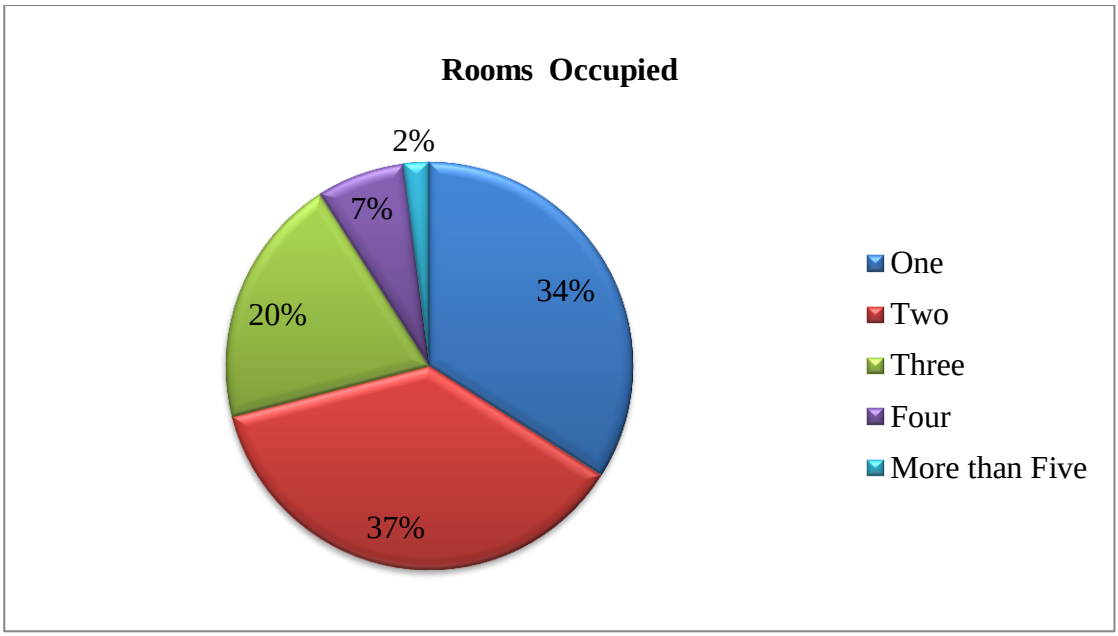

Figure 8: Number of Rooms Occupied

In Nakuru Town, this study found out that the houses that were available in the estates were not spacious enough for the families therein. Majority of the study participants

lived in two roomed houses which was 37% of the total respondents. Also, 34% of the respondents lived in one roomed houses. Only about 20% and 7% live in three and four roomed houses respectively.

This in relation to the number of people living in this houses shows there is congestion in the houses which makes it easy to harbor and ease movement of bed bugs. There has been an outcry in the estates for the county government to improve on the housing but that is yet to be realized as of when the study was taking place in Nakuru Town.

Type of home owned

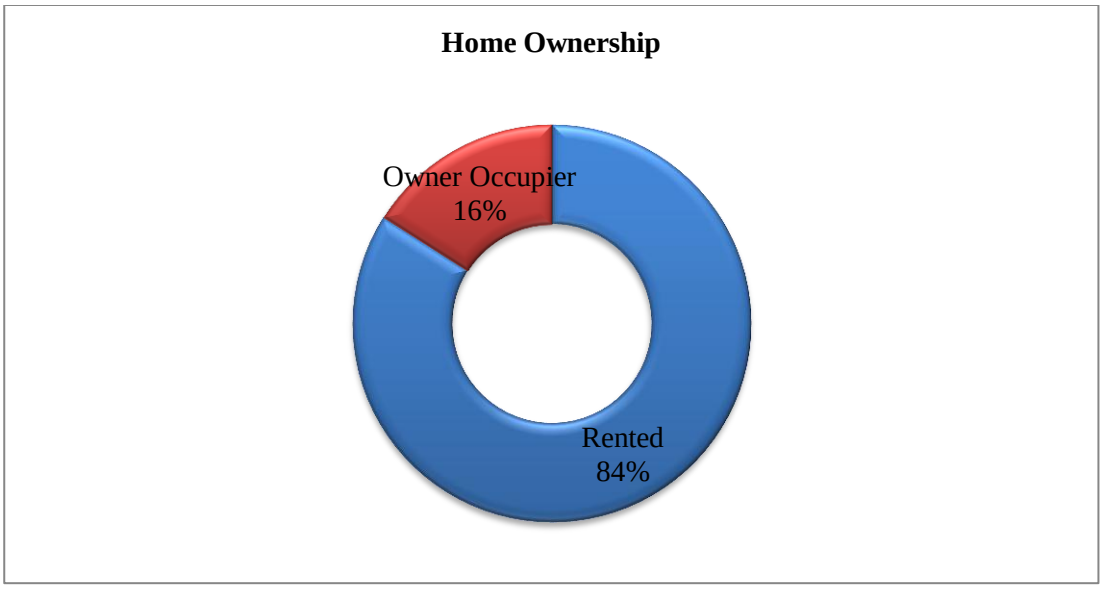

Figure 9: Type of Home Owned

This study found that majority of the study respondents were living in rented houses with about 84% of the total count. This is a major concern as people who rented houses were more prone to movement from one house to the other or moving from one estate to the other. This is a major concern as this makes it easier to move bed bugs from one place to the other as they are moving houses and thus the resurgence in most areas in Nakuru Town. On the other hand, the number of people living in their own houses was relatively low as was their movement from one estate to the other. It also makes it easy for them to control bed bugs in their own houses as they did not to consult a third party.

Level of Education among the respondents

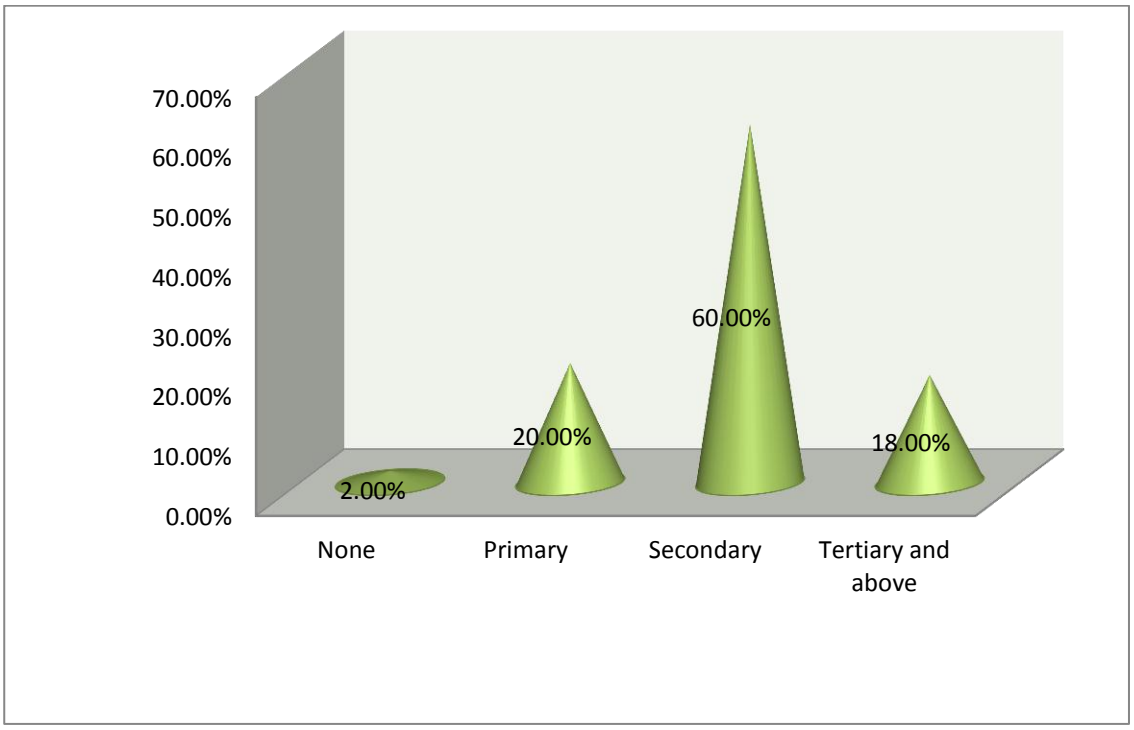

Figure 10: Level of Education

Among the residents of Nakuru Town, Kenya, about 2% of the study participants had not attained any education in their lifetime by the time this study was carried out in the estates. 60% of them had reached up to secondary level while only 18% of the respondents had attained tertiary education and above. According to the study outcome, this would later affect the comprehensive awareness of modern methods of eradicating bed bugs.

The level of education also dictates the chances among the study participants in the study area to seek employment and have some income and also improve their chances of economic empowerment in terms of eradicating bed bugs.

Main Source of Income

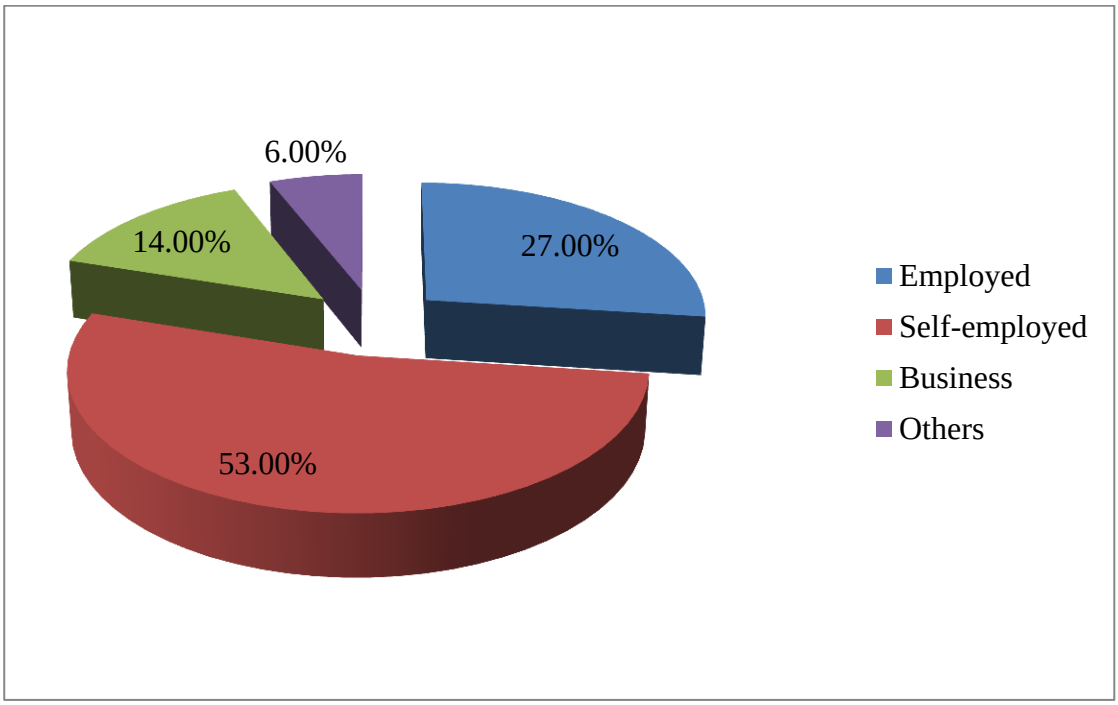

Figure 11: Main Source of Income

The sources of income among the study participants were based on their level of income as was evident in about only 27% of the respondents having formal employment. Majority of the respondents at the time of this study were self-employed with about 53% of the total population. A notable number is the 6% of the respondents which is significant who depended on others for their sources of income. These included the elderly parents who benefited from stipends from their children and also those who depended on well-wishers for their source of income. This poses a major problem in terms of empowering the residents economically to fight the resurgence of bed bugs among themselves.

Monthly Income

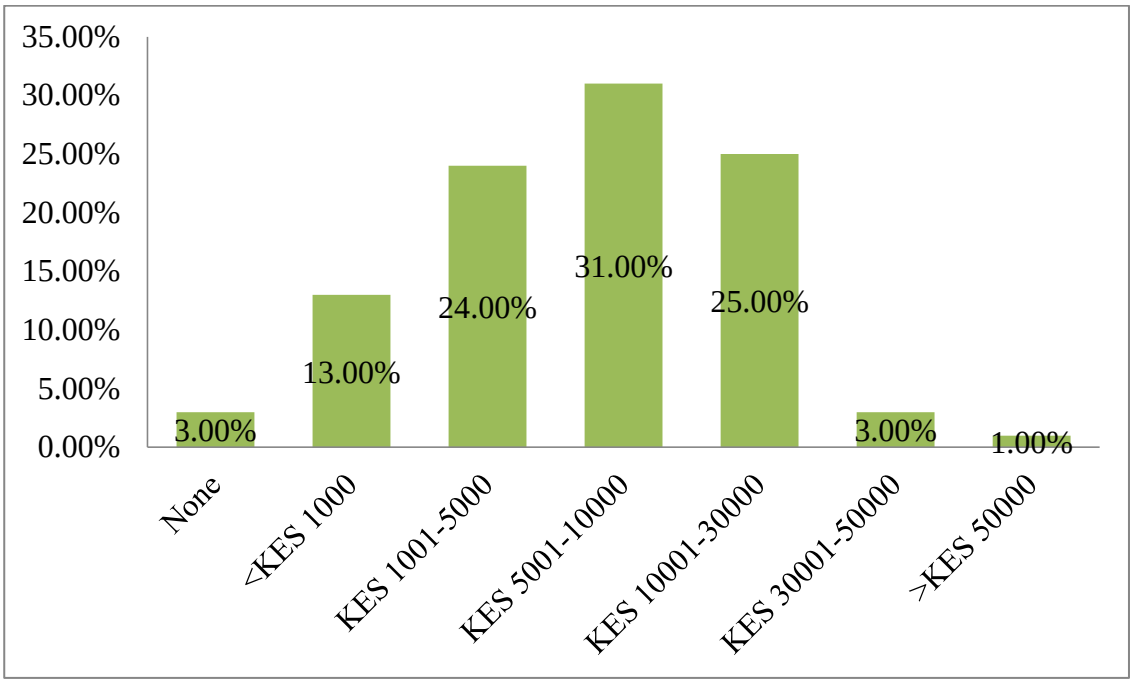

Figure 12: Monthly Income

The level of income among the study participants highly depended on the socioeconomic activities been undertaken by the respondents. This study finds that a significant number of respondents totaling to 3% of the total count did not have any income. Also, 13% of the study participants were earning less than KES 1000 per month which makes it really difficult for survival in such tough economic times.

24% of the respondents were earning between KES 1001-5000 at the time of this study and the majority of the residents interviewed at 31% of the total count were earning between KES 5001-10000. This means that 71% of the residents interviewed, were earning below the minimum wage of KES 13,500 in Kenya (Kenya Revenue Authority).

This is a major challenge especially in prioritizing for bed bugs eradication activities as is seen in the next figure which eventually leads to resurgence. It was also noted in this

study outcome that 29% of the respondents in this study were earning above the minimum wage at the time of this study.

Main Monthly Expenditure

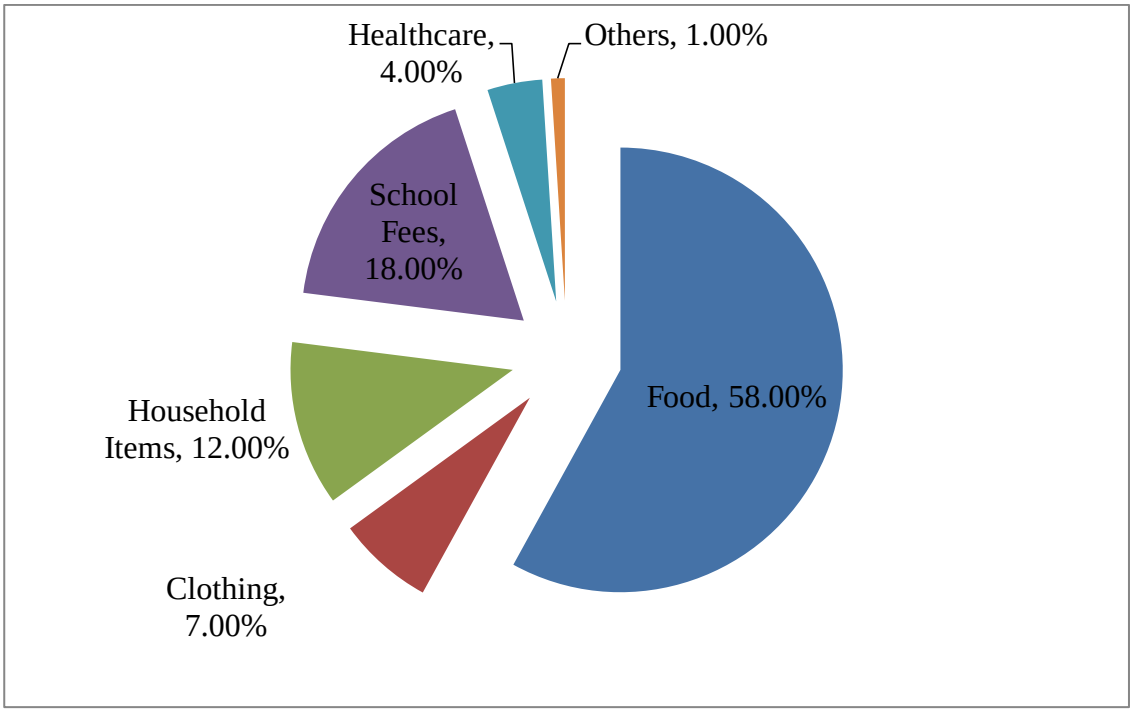

Figure 13: Main Monthly Expenditure

The main monthly expenditure of the residents mainly depended on the socio economic activities at the time and the level of monthly income. The biggest priority as this study finds is food, where 58% of the study respondents considered it as their main monthly expenditure. Bed bugs eradication falls under healthcare where on 4% of the study respondents considered it their main monthly expenditure.

When bed bugs eradication is giving such a small amount of budgetary attention, resurgence of the bed bugs is bound to occur among the residents. This shows that socioeconomic factors play a big role in cubing the resurgence of bed bugs in an area. This is highly dependent on the monthly income considering 71% of the respondents did not attain the minimum wage in Kenya.

4.5 Summary Interpretation

The level of education among the respondents was in relation to the Kenya 8-4-4 system of education. 60% of the respondents had attained education up to secondary level which was the majority. 18% of the respondents had attained tertiary and above and 2% of the respondents participating in this study had not attained any education.

The main source of income of the respondents was self-employment and a relative number of respondents were employed compared to the number of respondents with secondary education and above. Majority of the respondents were earning between 5,000-10,000 Kenya shillings at the time of this study. A notable group of respondents at 13% earned at least 1000 per month which is relatively low. In relation to their monthly incomes, majority of the respondents at 58% prioritized food as their main monthly expenditure. Health care was at 4% under which bed bugs eradication fall which explains that due to their limited incomes, the respondents were at difficulty in prioritizing health care.

This findings are supported by a Key Informant Interview with the Chief Public Health officer – Vector Control in Nakuru County, he noted that "due to high cost of chemicals very few benefit as most people cannot afford due to low socio-economic status." Another KII with a Private Pest Control officer confirmed the same. He noted that "Not all people are able to afford the charge fee of two rooms at KES 800{66% of the respondents lived in houses with more than two rooms} and only about 30% can afford to buy the chemicals individually." He also highlighted that " most residents prefer to spray by themselves to reduce cost but since they are not trained and well informed they are not effective hence the resurgence in some areas."

A KII with the officer in charge of Lands and Housing he noted that "Permanent houses are common in Flamingo and Kivumbini estates, Single Unit houses are common in

Nakuru East and west, Semi permanent houses are common in Bondeni and Lakeview estates, and semi-permanent houses are likely to harbor more bed bugs while single unit houses lead to more movement of bed bugs due to over population"

4.6 Discussion

This study finds that low socio economic status among the residents interviewed has led to the resurgence of bed bugs in Nakuru Town, over the years. Estate wide inspections of this study revealed a number of interesting socio economic characteristics among the residents of Nakuru Town, Kenya. Many residents were living in multi-unit houses and Bed bugs are most common in multi-unit homes compared to single unit dwellings due to the closeness to each other within a building structure. In addition to that, distribution of bed bugs in apartments tends to be clustered with one unit having multiple bed bugs infestations and the other free from bed bugs infestation (Stephen L. Doggett & Russell, 2009) (C. Wang et al., 2010).

Bed bugs infestations prevalence is highly associated with socioeconomic status of the residents. Past surveys have indicated that communities with low in-come in the United states are more burdened with bed bug infestation issues than middle income as well as upper income communities (C. Wang et al., 2010) (A. Romero et al., 2017). Limited income has crippled the ability of residents to hire the best pest control service; infective pest management plans and lack of resident cooperation in these societies contribute to bed bugs infestations (C. Wang et al., 2010) (R. Cooper et al., 2015) (Wang et al. 2009, 2012 , 2014 , 2015 ; Cooper et al. 2015a).

The majority residents (80%) earned between Kenya shillings 1,000-30,000 which makes it hard for them to balance their priority needs in terms of monthly expenditure. Many of the residents in Nakuru town made Food a priority and health care services was least sought after where bed bugs prevention and control lies. The cost of

chemicals used is a limitation in the fight against bed bugs infestation among the residents interviewed leading to resurgence of bed bugs in most estates. Controlling bed bugs is quite expensive (Wang et al. 2009, Potter et al. 2013). This study finds that low income communities are more susceptible to the burden of bed bugs resurgence due to financial constraints

4.7 OBJECTIVE TWO: Cultural Practices Influencing Resurgence of Bed bugs in Nakuru Town

Table 2: Cultural Practices

Responses / Questions	**Yes {Count}**	**%**	**No {Count}**	**%**	**Don't Know**	**Refused to Answer**
Do you use any traditional method to eradicate bed bugs?	140	33	282	67	N/A	N/A
Does your culture allow modern methods of eradicating bed bugs?	348	83	22	5	52-12%	N/A
Do you currently have pet animals in your house?	108	26	311	73	N/A	3- 1%
Do you think pet animals harbor bed bugs?	87	21	251	59	82-19%	2- 1%
Have you changed any traditional lifestyle that in your opinion lead to resurgence of bed bugs?	25	6	397	94	N/A	N/A

Source: Researcher, 2018

Nakuru Town Kenya is metropolitan setting where almost all the tribes of the Kenya Republic can be found. This study investigated the role played by cultural practices among the residents in the resurgence of bed bugs. Over the years, traditional methods like hot water application, ash treatment and sun drying have been used to treat bed

bugs infestations in the households. This study found that 33% of the study respondents at the time were still using traditional methods to eradicate bed bugs in their homesteads. Traditional methods are not quite effective as the study found later and this leads to resurgence of bed bugs. On the same outcome, it was noted by this study that 67% of the respondents were not using traditional methods as they believed they are not effective and this would lead to resurgence of bed bugs in their homes.

Culture is diverse. Some cultures differs in beliefs from one tribe to the other in Kenya. Nakuru town basically host all the tribes in Kenya and this study found out that they also had certain beliefs when it comes to eradicating bed bugs. 12% of the respondents did not know whether their culture allowed modern methods of eradicating bed bugs while 5% believed that their culture did not allow modern methods of eradicating bed bugs. Majority of the respondents at 83% of the total study participants believed that their culture allowed modern methods of eradicating bed bugs. Of the 12% and 5% that did not know and believed their culture allowed modern methods of eradicating bed bugs were believed to be using traditional methods to eradicate bed bugs which are not super effective thus leading to resurgence of bed bugs in the area.

Some cultural practices like keeping pet animals is common in the Africa setting. Some of these pet animals have fur and this study noted that 26% of the study participants were keeping pet animals at the time of this study including cats and dogs. 73% of the study participants were not keeping pet animals. Pet animals can harbor bed bugs and 21% of the respondents of this study believed that pet animals harbor bed bugs, 19% did not know whether pet animals harbor bed bugs and 59% of the respondents believed that pet animals did not harbor bed bugs. This could be the one of the reasons that lead to the resurgence of bed bugs in the Nakuru estates as pet animals could aid the movement of bed bugs from one estate to another.

Due to the resurgence of bed bugs, people tend to have behavior change in order to adapt the changing nature of bed bugs infestation. This study sought to understand if respondents in Nakuru Town had changed any traditional lifestyles which in their opinion lead to resurgence of bed bugs in the estates. The study outcome was that 6% had changed traditional lifestyles that they thought would lead to resurgence of bed bugs and 94% had not changed any traditional lifestyle.

4.8 Summary Interpretation

22% of the total respondents believed that their culture do not allow modern methods of eradicating bed bugs which poses a major challenge in eradication of bed bugs. 21% of the study respondents noted that pets harbor bed bugs and that's why they don't keep pets but at the same time a notable 19% said that they did not know if pets harbor bed bugs or not.

Some of the reasons given as to why their culture do not allow modern eradication methods included; They believed bed bugs infestation is a curse from their fore fathers and that the infestation can only be dealt with via traditional methods of eradicating the bed bugs. Other respondents believed that chemicals were harmful to children and pregnant women thus did not allow any modern methods that involved chemical spraying and would only prefer the non-harmful traditional methods.

Some residents believed that bed bugs were Gods insects and therefore they should not be eradicated and quite a number believed that bed bugs infestation was brought about by witch craft and only witch craft intervention could eradicate the bed bugs and not the modern methods of bed bugs eradication.

In an FGD with Community Health Volunteers drawn from all the estates, CHV 1 and 3 noted that "the culture of migration and witchcraft lead to resurgence of bed bugs respectively." CHV 8 noted that "curses from older parents lead to the infestation". In

another FGD with the heads of households participant 2 noted that “one of the residents who had bed bugs infestation believed that the bed bugs were a sign of visit from her late husband”.

Some of the traditional practices the residents had changed included; Buying of second items as they believed some of them were infested with bed bugs and that this lead to resurgence of bed bugs in certain areas. Residents also stopped migrating from one estate to the other which aided movement of bed bugs from one are to another leading to the resurgence of bed bugs. Some residents had stopped inheriting furniture from other family members as they believed they could harbor bed bugs and bring them to their places. Other residents had stopped keeping pet animals as they believed they could harbor bed bugs and some residents moved from an earth house to a plastered house (Note that at the time of this study, about 8% of the respondents lived in earth houses). All this behavior changes was an effort to end bed bugs resurgence in Nakuru Town.

4.9 Discussion

Cultural beliefs are hindering the eradication of bed bugs infestation in Nakuru Town and this is contributing to the resurgence of bed bugs in the area. The findings of this study about cultural practices influencing the resurgence of bed bugs among the residents of Nakuru Town were very interesting. A notable section of the residents 22% believed their culture did not allow modern methods of bed bugs eradication. This posed a challenge in bed bugs control and prevention which leads to resurgence of bed bugs.

Our study agrees with that of (Newberry & Jansen, 1986) beliefs such as witchcraft, curses and spirits from under world brought bed bugs infestation. However, recent studies revealed that bed bugs spread through active dispersal, social interactions

between residents, home visits or exchange of furniture (C. Wang et al., 2010) (R. Cooper et al., 2015, p. 201). This shows there is no relation between bed bugs infestation and witchcraft and this is a cultural belief that could highly lead to resurgence of bed bugs infestation.

Use of traditional methods like sun drying and hot water treatment was common among the residents interviewed but this is not effective enough to completely eradicate bed bugs. This can lead to more resurgence. However previous literature has noted that Non-chemical application methods such as laundering infested beddings, vacuuming, heat treatment and freezing (Kells, 2006) (D. M. Elston & Stockwell, 2000) have given some of the best bed bugs-eradication results. When the infested area is vacuumed with a gadget that contains air-filter which are efficient, bed bugs debris and allergens are removed. However, there are always chances that bed bugs eggs remain on the surface as they glued on the surface by glue-like substance produced by the female egg-laying bed bugs (Kolb et al., 2009).

Heat treatments are used as alternate bed bugs treatment methods to insecticide application but should be applied by a professional to avoid burn accidents. With the right gadgets, there are high chances of heating the rooms to temperatures that are deadly to the bed bugs: at all its developmental stages, the bed bugs dies when exposed to temperatures exceeding 50°C (122°F) for 90 minutes minimum. Laundering of infested clothing's or beddings should be done on the hottest available washer and dryer settings and the highest possible temperature that the fabrics can sustain. This process ca easily kill bed bugs compared to disposing the fabrics; however, it doesn't prevent further resurgence. Freezing is only effective in less infested items and it should be done for at least four days (Kolb et al., 2009). The freezing and heating gadgets are used by trained professionals; however, many residents cannot afford the

$500 to $1500 to hire such professionals (Manuel, 2010b). The alternative way due to the cost is disposing of the infested items to avoid re-occurrence of the infestation.

4.10 OBJECTIVE THREE: Reasons for Residents Resistance to Public Health Officials to access their homes to spray and eradicate bed bugs

Houses sprayed for bed bugs

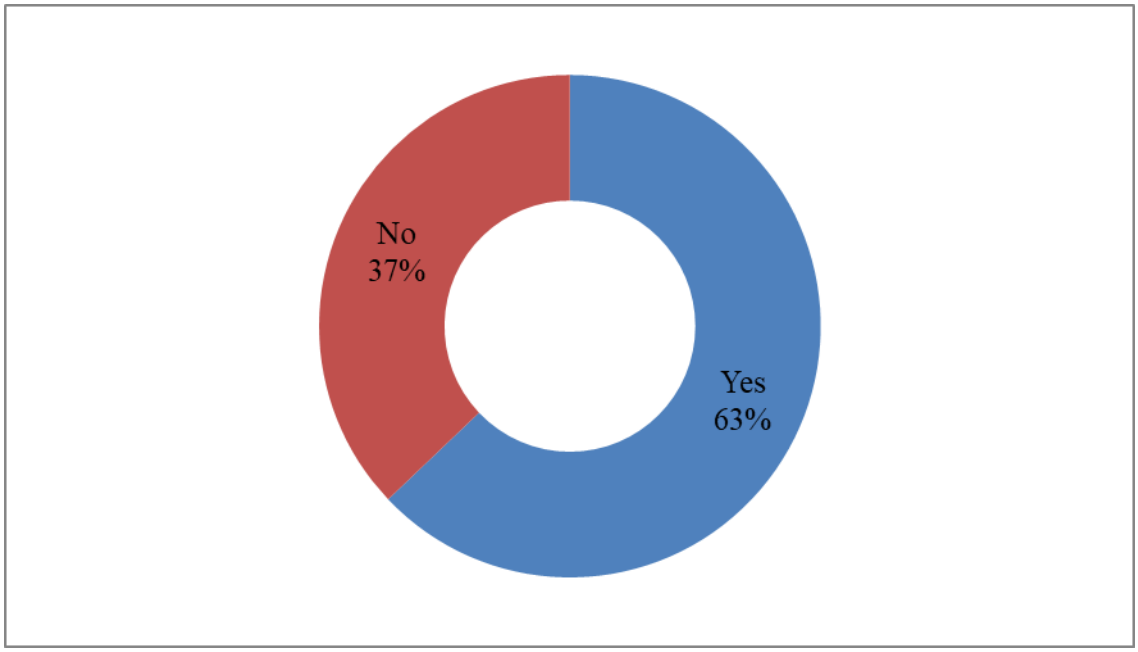

Figure 14: Houses Sprayed for Bed bugs

Spraying of bed bugs is the most common method of preventing and controlling the bed bugs infestation. This study sought to understand how many households had been sprayed for bed bugs prior to this study taking place in Nakuru Town, Kenya.

Of the 422 households interviewed, 63% of them had been sprayed for bed bugs at some point at the time of this study. This was dependent on the socio economic status as not all residents were capable of buying the chemicals or even hiring a top notch pest control personnel to do the spraying. It also depended on cultural beliefs like this study found out which hinders residents from spraying their houses for bed bugs.

This study also found that 37% of the households interviewed had not had their households sprayed for bed bugs prior to this study. This is a major factor in the

resurgence of bed bugs as it leads to dispersion of the bed bugs in other households that could have been sprayed already for bed bugs.

Who sprayed the houses?

Based on the finding of this study, 63% of the respondents had had their houses sprayed for bed bugs. This study aimed at finding out who had sprayed these households among the Ministry of Health officials, Own Self, Private firms or other players in the activity of eradicating bed bugs in Nakuru Town Kenya.

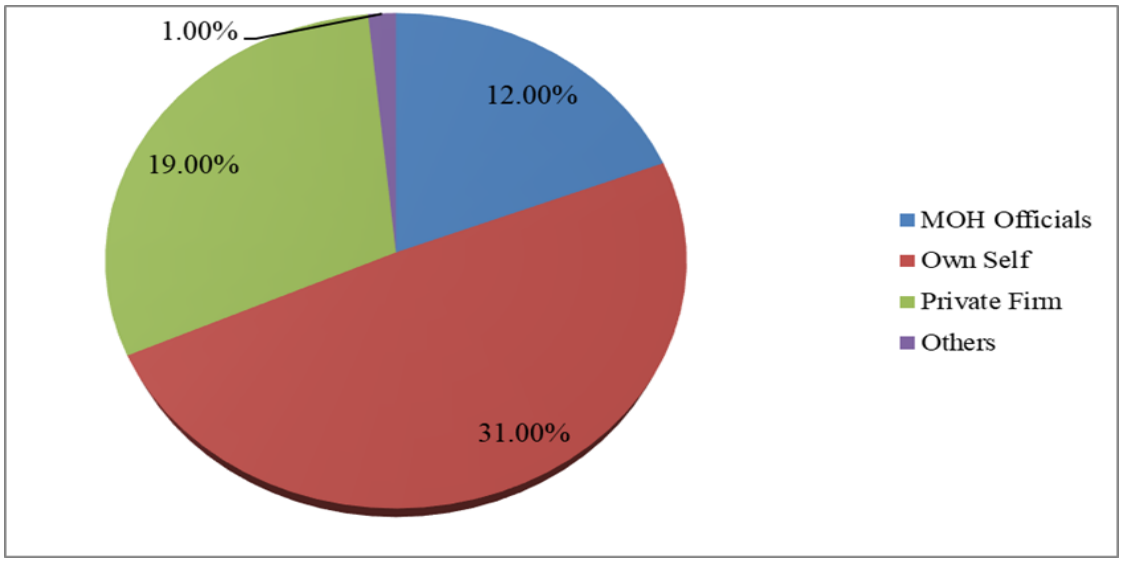

Figure 15: Who Sprayed the Houses?

This study found out that of the 63% that had their houses sprayed, 31% sprayed the houses by themselves. This is a major concern to the public health department as these are people who are not well trained to do the spraying and could not do it effectively but on the other hand there have been challenges accessing services from the public health department as is elaborated in this chapter.

Private firm sprayers can be expensive but they are the best trained to spray the houses for bed bugs. Of the 63% who had their houses sprayed in the seven estates we visited 19% had their houses sprayed by private firm at a fee.

The outcome of this study shows that only 12% of the 63% households were sprayed by Ministry of Health officials from the Public Health department. This is a major concern as public health officers are the ones who have the mandate to spray for bed bugs and they are the least sought based on these study outcomes.

What was the response of the residents when Public health officers approached them to spray?

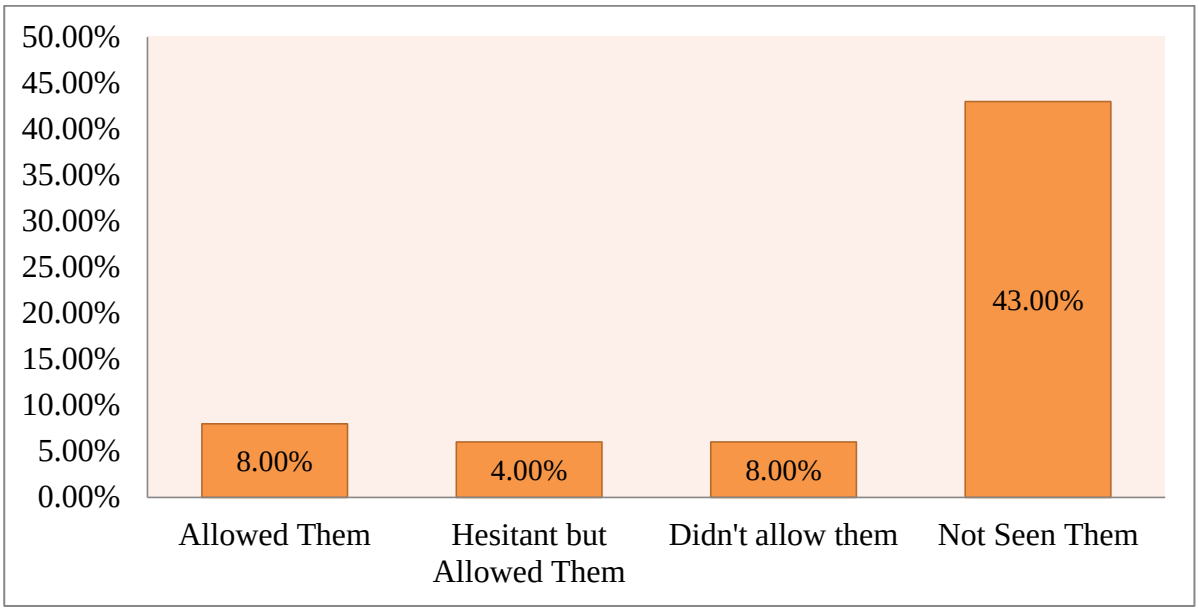

Figure 16: Response to Public Health Officers

Based on the outcome of this study 12% of the study participants had their houses sprayed for bed bugs by Public Health officials but this study sought to find out what was the response when Public health officials approached the 63% of the respondents who had their houses sprayed.

This study finds that, 43% of these respondents who had their houses sprayed prior had not seen any public health official in the neighborhood. This is a worrying trend as this shows that the public health department was either not concerned at all or something was amiss in implementing bed bugs eradication measures.

8% of the respondents noted that they had seen the public health officials but did not allow them for various reasons. Among the 63% households that had their houses sprayed, this study finds out that only 12% of the households were approached and allowed them to spray their houses for bed bugs, however, 4% of the 12% noted that they were hesitant in allowing the public health officials but allowed them anyway. This corresponds with the findings of this study that only 12% of the households had their houses sprayed for bed bugs by the public health officials of Nakuru County Government.

Residents allowing public health officers to spray for bed bugs in the future

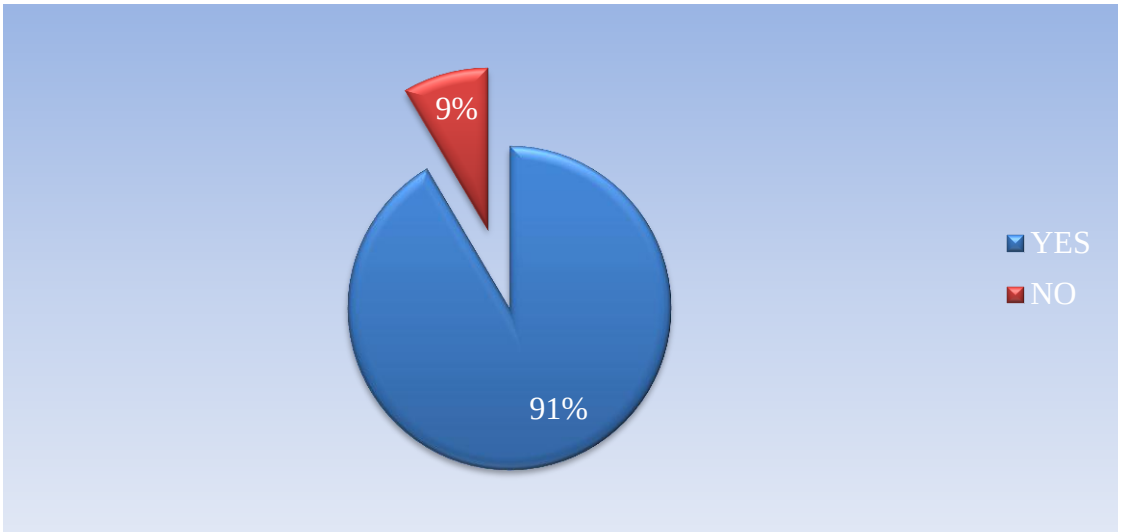

Figure 17: Allowing Public Health Officers in the Future

Bed bugs eradication remains a public health concern in Kenya. In Nakuru Town, residents are living in the brink of hope that the public health department will come up with a solution for this menace once and for all.

This study sought to find out among all the study respondents regardless of whether they had had their houses sprayed for bed bugs prior either by public health officials or

private firms or by own selves, if they would allow public health officials in the future to spray for the bed bugs in their households.

This study conclusively found out that majority of the study respondents in about 91% of the respondents would allow public health officials to spray their households for bed bugs in the future. 9% of the respondents noted that they would allow public health officials to spray their households under whatever circumstances but they had their own reasons for their resolution.

4.11 Summary Interpretation

At the time of this study, 63% of the respondents had had their houses sprayed for bed bugs and a notable 27% had not had their houses sprayed. Of the 63% respondents that had their houses sprayed, only 12% had their houses sprayed by a Ministry of Health official. Among the respondents that were approached by the MOH officials to spray for bed bugs 8% denied them entry to their houses.

Some of the reasons given by the respondents for not allowing them included; they did not have the money they asked for to be sprayed for the bed bugs and even other officials demanded for kickbacks, the officials are not effective as they do the spraying in a hurry, the children were allowed and their culture believes that chemicals put children in harm's way, the officials had come late by even 5 days after reporting thus the resident engaging other sprayers, the public health department do not issue notices on when they are sprayed to enable availability of the residents and some public health officials are not careful with furniture leading to breakages. All these were reasons given by residents as to why they did not allow the public health officials to spray their houses for bed bugs.

It is important to note that 91% of the respondents said they would allow public health officers to spray their houses in the future when all concerns are observed.

In an FGD with the community health volunteers and heads of households, all participants noted they would allow the Public health department in their households only if they don't ask for payments from the community.

4.12 Discussion

This study found that Public health officials were least sought after to curb bed bugs resurgence in Nakuru County. At the time the study was conducted in Nakuru town, at least 63% of the respondents had their houses sprayed for bed bugs. Considering multi-unit dwellings is most common for bed bugs infestation, the households that had not been sprayed for bed bugs increased the chances of bed bugs reemerging (Abejuela-Matt, 2014).

Despite the availability of MOH officials only 12% of the respondents sought the services of the health experts to spray their households. Bed bugs' causes ill health and lack of well-being making them a public health issue considering they are environmentally communicable (Aultman, 2013). People who are exposed to bed bugs bites manifest symptoms like; pain, itching, sleep loss, psychological distress etc. (Goddard & deshazo, 2009) (Rieder et al., 2012). Bed bugs' bites reactions differ from one individual to the other with some individuals experiencing bite symptoms while other individuals suffer from systemic reactions like difficulty in breathing, dysphagia, lethargy and chest tightness (Goddard & deshazo, 2009) (Stephen L. Doggett & Russell, 2009). Our study agree with that of (Carson et al., 2020) that infested residents are sometimes denied health care service or public services by service providers for the phobia of bed bugs. The public health department has the resources to eradicate the bed bugs infestation in Nakuru Town but despite this information been in the public exposure, the respondents preferred to spray by themselves. This has since

lead to the resurgence of bed bugs in the estates as the people are not well trained and they don't eradicate the bed bugs effectively (En et al., n.d.)

Resistance by some households to the MOH officials was a big challenge. Reasons given were delays by the officials to act and a not very friendly attitude. Most residents preferred to spray the bed bugs by themselves as few could afford the services of private sprayer firms due to their low economic status (Shalaby, 1970).

It is important to note residents highlighted that MOH officials were slow to act on reports though the reasons were not clear previous studies have stated that individuals who suffer bed bugs infestation are denied health care services or public services for fear of bed bugs (Aultman, 2013).

The public health department in Nakuru Town acknowledged that there is little public awareness both in the private and government sectors to the degree of infestation, treatment and control of the bed bugs. According to the Center for Disease Control and prevention a bed bugs infestation is not a reportable disease despite its communicable characteristic. In this manner, not only is it challenging to prevent its spread, but validating and tracking it can be hard to comprehend. This lack of reporting may have added to the past perceptions of complete bed bugs eradication. More so the limited resources of public health organizations are delaying the eradication since bed bugs eradication is not prioritized. It is unclear who is solely responsible for the bed bugs eradication as it cannot lie squarely on public health departments.

4.13 OBJECTIVE FOUR: Methods currently being used to control and prevent bed bugs

Presence of Bed bugs in the Households

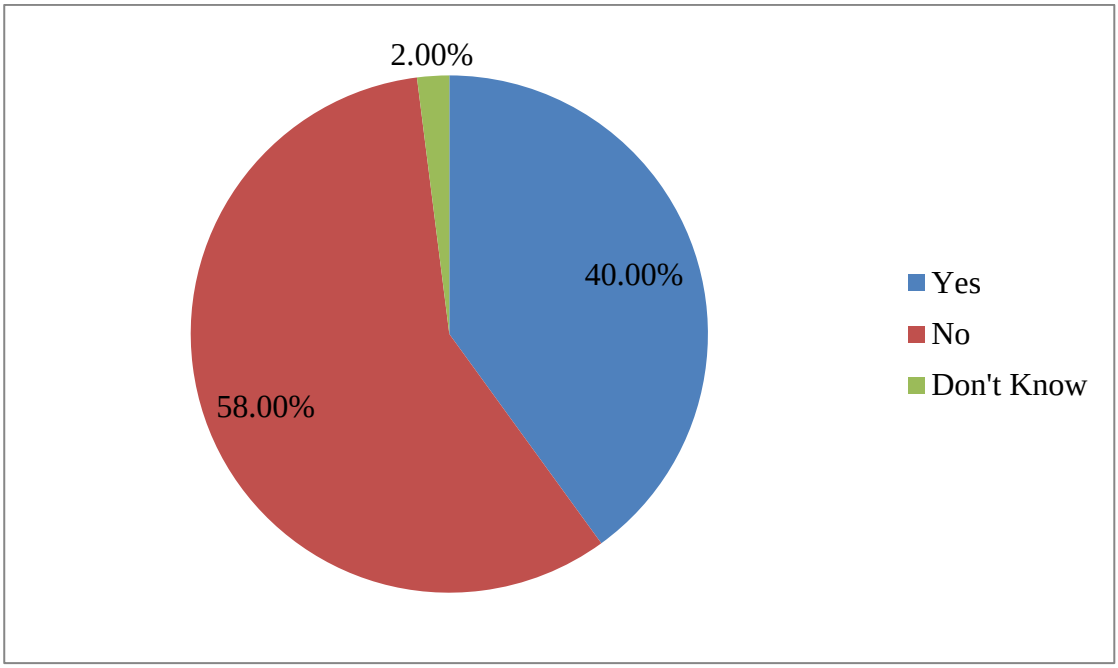

Figure 18: Prevalence of Bed bugs Infestation

At the time of this study, 40% of the households had bed bugs present in their households. This puts the bed bugs prevalence at 40% in Nakuru Town. This is a major challenge as it shows that bed bugs resurgence was at risk of happening if the bed bugs are not controlled and prevented from moving from one household to another.

58% of the households did not have bed bugs infestation at the time of this study. This implies that the households were at risk of bed bugs resurgence if they did not have control measures such as spraying their households. This study understands that the bed bugs infestation in the households was a result of negligence and ignorance from other households that have had bed bugs in the long term.

2% of the households interviewed reported that they did not know whether they had bed bugs infestation or not which poses the question whether there was little public awareness about identifying bed bugs presence in their households at the time. Limited

public awareness has in many times stalled efforts to eradicate bed bugs both by the locals and the public health department.

Households that have experienced bed bugs in the last three months

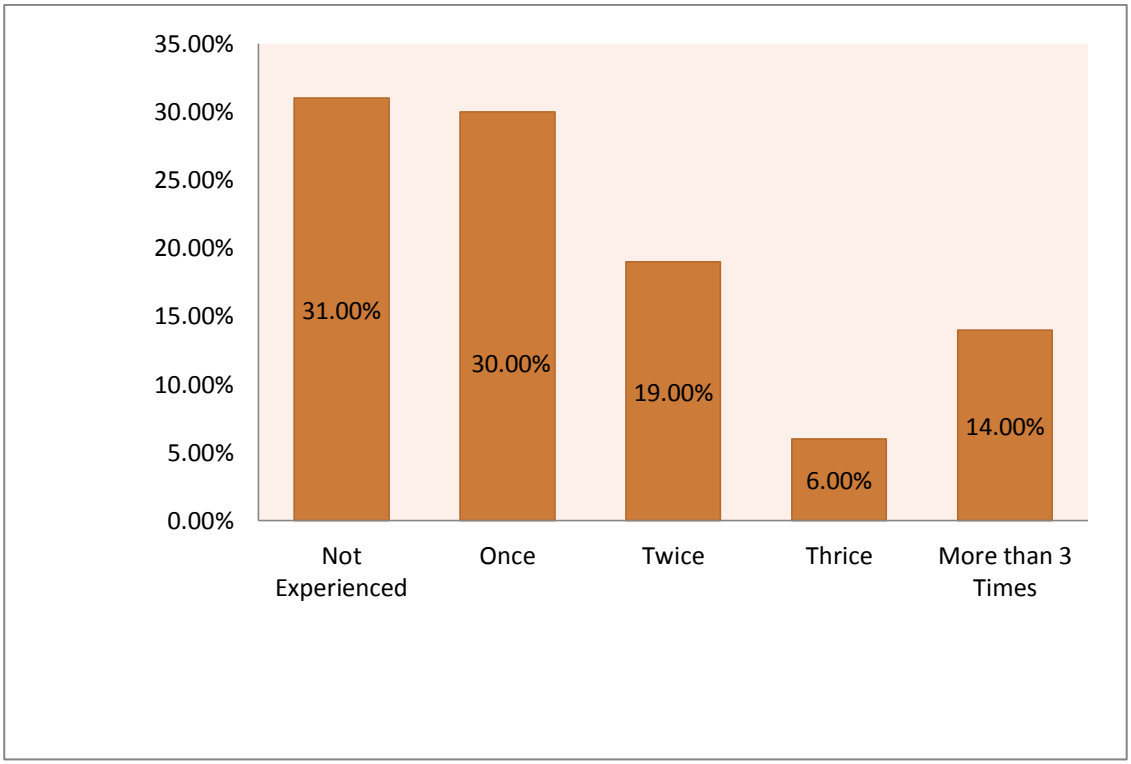

Figure 19: Experienced Bed bugs

This study aimed at finding out among the 422 households interviewed, how many of those had experienced bed bugs infestation three months before this study went into the estates to conduct this investigation.

69% of the residents interviewed reported that they had experienced bed bugs infestation in the last three months before this study took place. Of the 69%, 30% reported that they had experienced the bed bugs infestation only once in the last three months while 19% of the respondents indicated that they had experienced bed bugs infestation twice in the last three months.

In addition, among the 69% respondents that had experienced the bed bugs infestation in the last three months, 6% and 14% indicated that they experienced the infestation of

bed bugs thrice and more than three times respectively. This shows that there has been a major challenge of bed bugs infestation in the Nakuru town estates as had been reported earlier in the media outlets in Kenya.

Households currently using methods to control and prevent bed bugs

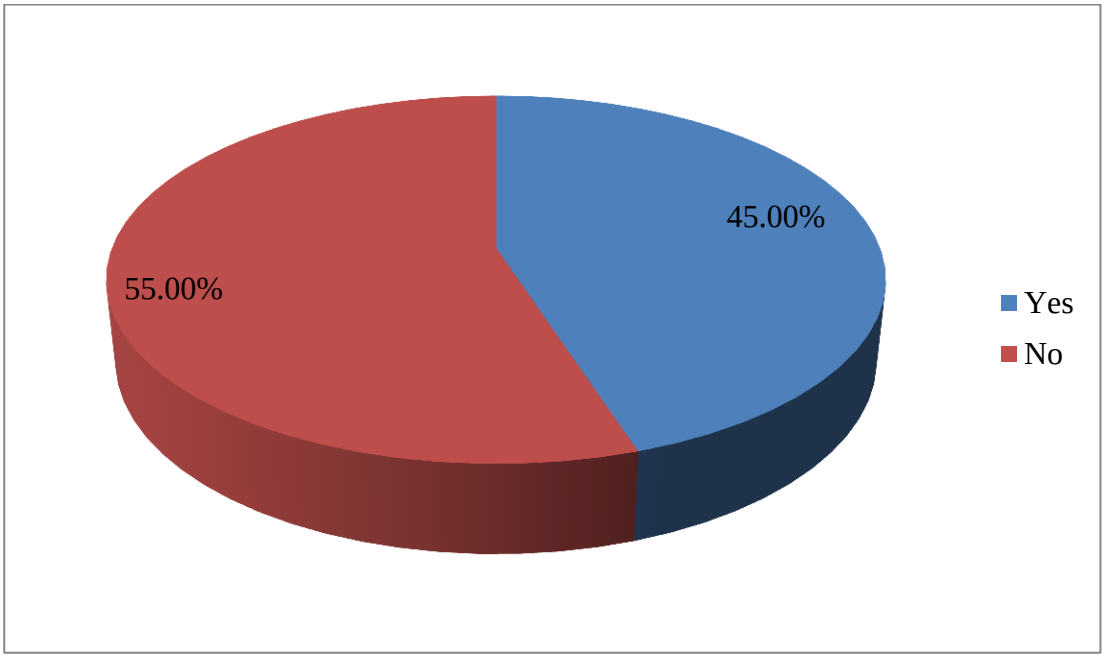

Figure 20: Households Using Current Prevention and Control Method

Based on the high prevalence of bed bugs infestation in Nakuru Town, this study investigated the number of households that were currently using methods to control and prevent bed bugs infestation at the time.

The outcome was very worrying as only 45% of the households reported to have been using current methods to control and prevent bed bugs infestation. 55% of the households reported that they were not using any methods to control and prevent the bed bugs infestation and they gave their reasons.

To prevent and control bed bugs infestation in the homesteads, concerted effort is need to use effective methods in majority of the homesteads and this aids in reducing bed bugs prevalence in the estates eventually preventing the resurgence of these insects.

Effectiveness of the methods being used by the households

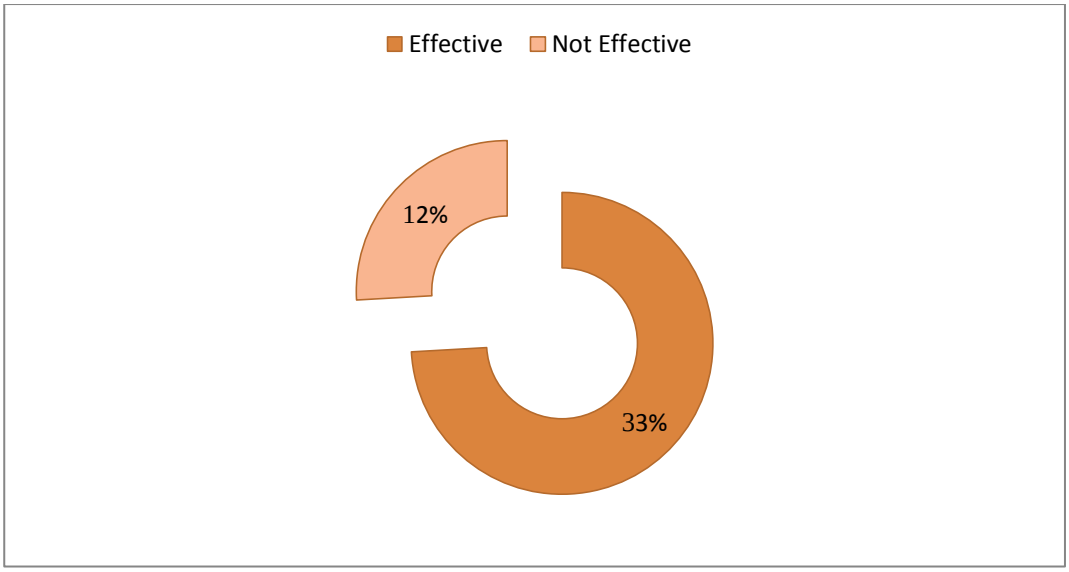

Figure 21: Effectiveness of the Methods

Among the 45% respondents that had reported to be using the current methods to control and prevent bed bugs, 33% reported that the methods were effective in eradicating bed bugs in the households. However, 12% of the respondents reported that the methods were not effective and were in turn leading to bed bugs resurgence in the estates in Nakuru, Town.

4.14 Summary Interpretation

The prevalence of bed bugs at the time of this study was at 40% of the households. A big number of the respondents at 69% had experienced bed bugs three months prior to this study. 45% of the households were using modern methods to control and prevent bed bugs. 33% of the households noted modern methods are effective in controlling and preventing bed bugs and 12% noted that modern methods were not effective.

Some of the modern methods being used include; Spraying using insecticides and pesticides such as Bamaco, Diazonal, Green leaf powder, Sevin Dudu Dust and Corazone; Observing general hygiene among the residents including laundering the clothing and beddings that are infested by bed bugs; Painting the houses and furniture to kill any underlying bed bugs eggs and heat treatment of the household items.

Some of the reasons given by the 55% respondents who were not using the modern methods included; There was no enough income to budget for chemicals to eradicate the bed bugs based on the poor economic status of the study participants; Some residents noted that the reason as to why they were not using any methods to prevent and control the bed bugs was because they did not have any bed bugs present in their homes at the time; Residents noted that current methods were not effective as bed bugs were resistant thus the reason for not using the methods; Some residents noted that they did not know of any current method to control and prevent bed bugs infestation; Others reported that their culture did not allow them to use modern methods as they were harmful to Children and pregnant women and unavailability of public health officials was reported as to why some residents did not use the modern methods as that was their only way of accessing the modern methods services.

12% of the respondents who believed the modern methods were not effective gave various reasons like; Ignorance by the neighbors to spray their homes leading to resurgence; Eggs are difficult to kill and the adult bed bugs hibernate when they are sprayed and crop up later.

In a KII with the private pest control officer, he noted that "Modern methods included spraying using insecticides such as promax, diazonol and ectomine(improvised) and they have been used for a period of over three years." He also noted that "the best result is achieved when one mixes ectomine and promax to spray their households."

Further to this interview, the Private Pest Control Officer noted some of the measures been taken to end bed bugs resurgence in Nakuru town. He said that "Sanitation and hygiene among the residents was key in curbing bed bugs resurgence in the area, Decongesting houses to reduce movement of bed bugs from one house to the other,

encouraging traditional methods to those who cannot afford the chemicals like hot water treatment and spraying of all second-hand furniture at their point of sale".

In another KII with Chief Public Health officer – Vector Control, Nakuru County he noted that the "Chemical spraying, about 6 brands are recommended (Encourages alternating the chemicals to curb resistance by the adult bed bugs)"

4.15 Discussion

The prevalence of bed bugs infestation was high at 40% in a population of 32,856. This study found out that over 60% of the respondents had experienced bed bugs infestation prior to this study. Since the 1980's bed bugs resurgence has been there but for reasons not well established by scientists but various factors influencing this surge could be socio-economic, resident practices, resistance to insecticides and non-compliance (Naylor et al., 2018). In the years between 2000 and 2005 the USNPMA (United States National Pest Management Association) indicated a 71% rise in bed bugs infestation (Gangloff-Kaufmann et al., 2006).

Modern day methods are effective in controlling and preventing bed bugs (Koganemaru & Miller, 2013) but only 45% were using such methods which included spraying with insecticides like Bamaco and Diazonal and sevin dudu dust. Globally, the main insecticide groups currently are the insect growth regulators (IGRS), pyrethroids and silicates. In some parts, some organophosphates and carbamates are still in use and more recent, arylpyroles and neonicatinoids are been used (Zhu et al., 2013) . bed bugs infested the sleeping areas in residences which was also the same in USA in a study by (MICHAEL F. Potter et al., 2008).

Treatment methods other than application of insecticides are on demand by residents. Some of these methods can be expensive, exhausting, shameful, time consuming and pose a great risk to the health status of the residents which is in contrast with a study by

(Anderson & Leffler, 2008). Heat treatment is one popular method among residents. Recent reports from University of Minesota Department of entomology, insecticide application is important and to achieve effectiveness it is recommended that residents high professional pest management individuals (J. B. Benoit et al., 2009).

Previous literature finds that, implementation of chemical and non-chemical methods should be applied although this chemical methods may pose challenges such as resistance to insecticides (Delaunay, 2012).

In the 1970s, Dichlorodiphenyltrichloroethane (DDT) was used to treat bed bugs infestation as other less toxic methods used at the time were as effective. Eucalyptus oils and mosquito repellents have been proposed but their use in bed bugs treatment has not been successful (Goddard & deshazo, 2009).

Other Nakuru residents preferred use of house hold methods like laundry cleaning and sun drying but previous studies have found that most of these household control methods are ineffective for controlling bed bugs due to bed bugs resistance (A. Romero et al., 2017) (R. Cooper et al., 2015). However, other literature done on the same have noted that fumigants used on bed bugs hiding places do not penetrate fully and their application cam harm susceptible humans. Normal bug sprayers can kill roaches and kill bed bugs instantly but it is advised that these chemicals are applied directly on the infested areas for good results (Delaunay, 2012) but in spite of these measures, bed bugs resurgence can occur.

This study found out that most residents were not using any control methods since they were not infested at the time. Bed bugs control should be consistent whether infested or not as presence of bed bugs in such multi-unit dwellings bed bugs can rapidly spread to neighboring units and cause high infestation rate (STEPHEN L. Doggett & Russell, 2008) (C. Wang et al., 2010).

An interesting finding is that quite a number of the respondents said that they were not using the modern control methods since they did not have the purchasing power. Challenges like this often slow down the fight to eradicate bed bugs in the estates hence bringing about resurgence of the bed bugs. Efforts have been made to reduce the cost of this chemicals with locals suggesting that the public health department should come up with a budgetary allocation towards bed bugs eradication in the county (C. Wang et al., 2016)

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Summary

Over the years bed bugs infestation has remained a major public health concern among the residents of Nakuru Town Kenya. Socio economic challenges have in recent years been a stumbling block in the bid to end bed bugs menace in this beautiful town of Nakuru. The findings of this study show that residents are struggling to meet ends and bed bugs prevention and control has become a thing of less budget allocation which increases the chances of bed bugs resurgence in the area. Bed bugs infestation prevention and control is expensive which makes it even harder for the residents whose main priority is food.

Cultural practices are not as vibrant but a few residents who still believe bed bugs infestation is a source of some super power have delayed any attempt by residents to fight the bed bugs.

Public health officers have been present in the county under the new constitution but they are the least sought after to curb this menace. They are well informed and trained to use modern methods and use them effectively but collaboration between the county governments' public health department and the community residents is lacking. Residents have noted a few reasons as to why they are not very welcoming to the Public Officers but have also noted that if this challenges are addressed it is an avenue they can choose.

The study finds that a notable number of residents are not using modern methods to control the bed bugs and this in return is bringing about resurgence of the insects. Bed bugs resurgence needs combine efforts from all parties to make sure there are no loopholes left in matters elimination of bed bugs.

5.1 Conclusion

This study concludes that current socioeconomic status among the residents of Nakuru Town is inhibiting the fight against bed bugs elimination. The residents don't have socio economic power to cater for expenses that comes with bed bugs prevention and control methods.

People of Nakuru Town still believe that bed bugs are brought about by witchcraft and super natural spirits. These cultural beliefs are limiting the eradication of bed bugs and leads to the resurgence in some of the households.

Public health officials are least sort after by residents to curb bed bugs infestation due to various reasons. Residents don't have a robust system of reporting bed bugs infestation in their households to MOH officials.

Respondents are not well sensitized to modern control methods which can lead to resurgence of bed bugs. A good number of the respondents believe that if one doesn't have bed bugs in their household's then prevention and control is not necessary which leads to bed bugs resurgence in the area.

5.2 Recommendations

Practice

In an effort to curb bed bugs resurgence in Nakuru Town Kenya, this study in its totality recommends that;

- County Government health department should organize communal spraying so to reach each and every household as is highlighted by the FGD with the CHVs.
- Private spraying firms and the Nakuru County Health Department to come up with more affordable methods.
- Enhance surveillance of bedbugs and research as is highlighted in KII with the chief Public health Officer in charge of vector control.

- Motivation of CHVs training and empowerment with equipment in bedbug prevention and control methods.

Further Research

While progress has been made in eradicating bed bugs, this study recommends that further research is done on bed bugs resistance to insecticides and how bed bugs have adapted to human environment in Kenya over the years.

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APPENDICES

Appendix I: Focus Group Discussion

Heads of households in the 7 Estates

Venue_____

Project Title: Determining socio-economic factors and cultural practices influencing the Resurgence of bed bugs, Nakuru Town Kenya.

The purpose of this FGD is to help establish Socioeconomic Factors influencing bed bugs resurgence; reasons for residents resistance to public health officials to access their promises; Cultural practices influencing resurgence of bed bugs and to identify methods been currently used to eradicate bed bugs in Nakuru Town. Your cooperation is highly regarded and the findings of this study shall be made public and stakeholders shall be provided with this useful information to help them devise effective ways of killing and controlling bed bugs.

THEME ONE: Socioeconomic and demographic factors influencing bed bugs resurgence in Nakuru

Question 1; Let us discuss about your sources of income?

Question 2: Does the level of your income help you to eradicate bed bugs in your premises? If yes, please explain.

THEME TWO; Cultural Practices

Question 1; please let us discuss the cultural practices in your opinion that you think lead to bed bugs infestation.

Question 2; which traditional methods do you use in eradicating bed bugs?

THEME THREE; Perception on Spraying Bed bugs

Question 1: Have you ever experienced bed bugs infestation in your premises?

Question 2: Who would you call if you had bed bugs infestation in your premises?

Question 3: Would you allow public health officials to spray bed bugs infestation in your premises? If no, let us discuss the reasons.

END

Community Health Volunteers

Venue_____

Project Title: Determining socio-economic factors and cultural practices influencing the resurgence of bed bugs, Nakuru Town Kenya.

The purpose of this FGD is to help establish Socioeconomic Factors influencing bed bugs resurgence; reasons for residents resistance to public health officials to access their promises; Cultural practices influencing resurgence of bed bugs and to identify methods been currently used to eradicate bed bugs in Nakuru Town. Your cooperation is highly regarded and the findings of this study shall be made public and stakeholders shall be provided with this useful information to help them devise effective ways of killing and controlling bed bugs.

THEME ONE: Socioeconomic and demographic factors influencing bed bugs resurgence in Nakuru

Question 1; Let us discuss about your sources of income?

Question 2: Does the level of your income help you to eradicate bed bugs in your premises? If yes, please explain.

THEME TWO; Cultural Practices

Question 1; Please let us discuss about which cultural practices in your opinion think they lead to bed bugs infestation.

Question 2; Which traditional methods do you use in eradicating bed bugs?

THEME THREE; Perception on Spraying Bed bugs

Question 1: Have you ever experienced bed bugs infestation in your premises?

Question 2: Who would you call if you had bed bugs infestation in your premises?

Question 3: Would you allow public health officials to spray bed bugs infestation in your premises? If no, let us discuss the reasons.

END

Appendix II: Key Informant Interviews

KII (I)

Public Health Officer – Vector Control, Nakuru County.

Venue_____

Project Title: Determining socio-economic factors and cultural practices influencing the resurgence of bed bugs, Nakuru Town Kenya.

Face to Face Interview

The purpose of this interview is to help establish causes of bed bugs resurgence, measures been taken by Public health department to eradicate bed bugs and to identify methods been currently used to eradicate bed bugs in Nakuru. Your cooperation is highly regarded and the findings of this study shall be made public and stakeholders shall be provided with this useful information to help them devise effective ways of killing and controlling bed bugs.

Questions;

1. What is the situation of bed bugs infestation like in Nakuru County?
2. What are the measures your office is taking to eradicate bed bugs?
3. Which are the most used methods in Nakuru County to eradicate bed bugs?
4. What would be the causes of bed bugs resurgence in Nakuru County?
5. What recommendations would you give in the campaign to eradicate bed bugs in Nakuru?

END OF INTERVIEW

Private Pest Control Officer.

Venue_____

Project Title: Determining socio-economic factors and cultural practices influencing the resurgence of bed bugs, Nakuru Town Kenya.

Face to Face Interview

The purpose of this interview is to help establish current methods been used to eradicate bed bugs, Prevention measures to reduce bed bugs resurgence and Socioeconomic and cultural practices influencing resurgence of bed bugs in Nakuru Town. Your cooperation is highly regarded and the findings of this study shall be made public and stakeholders shall be provided with this useful information to help them devise effective ways of killing and controlling bed bugs.

Questions;

1. What are the current methods being used to eradicate bed bugs in Nakuru Town?
2. What is the most effective method to eradicate bed bugs in Nakuru Town?
3. Which are the prevention measures been taken to reduce bed bugs resurgence?
4. What is the relationship like between socioeconomic factors and methods you use to eradicate bed bugs?
5. What are some of the cultural practices challenges you have faced in your line of work?
6. What recommendations would you give in the campaign to eradicate bed bugs in Nakuru?

END OF INTERVIEW

Officer In charge (Nakuru East & West) – Lands and Housing.

Venue_____

Project Title: Determining socio-economic factors and cultural practices influencing the resurgence of bed bugs, Nakuru Town Kenya.

Face to Face Interview

The purpose of this interview is to help establish types of housing in Nakuru East and West, measures been taken by lands and housing department to eradicate bed bugs and to identify reporting status currently used to report bed bugs infestation in Nakuru. Your cooperation is highly regarded and the findings of this study shall be made public and stakeholders shall be provided with this useful information to help them devise effective ways of killing and controlling bed bugs.

Questions;

1. What are the most common type of housing in Nakuru East and West?
2. In your opinion what type of houses are likely to harbor bed bugs?
3. What measures is your office taking to curb bed bugs resurgence in Nakuru East and Nakuru West?
4. What is the reporting status of bed bugs infestation by residents in relation to housing?
5. In the future, what measures would you recommend in an attempt to end bed bugs Resurgence?

END OF INTERVIEW

Appendix III: Questionnaires

Bed bugs, Survey tool (questionnaire)-Nakuru County, September 2018

Project Title: Determining socio-economic factors and cultural practices influencing the resurgence of bed bugs, Nakuru Town Kenya.

Name of Sub-county: _____

Name of Estate:_____

Name of Enumerator:_____

Date of data collection: _____

Instructions: Tick one answer from the choices provided or write your answer in the spaces provided**.**

SECTION ONE: CHARACTERISTICS OF TYPE OF HOUSE

1. Type of Floor

1. Earth
2. Murom
3. Cemented
4. Tiles

9. Other

2. Type of Roof

1. Grass Thatched
2. Iron sheets
3. Permanent slab

9. Other

3. Type of Home

1. Rented
2. Owner occupier

9. Other

4. Type of Walls

1. Earth
2. Earth and Plastered
3. Timber
4. Iron sheets
5. Permanent

5. Number of rooms occupied

1. One
2. Two
3. Three
4. Four
5. More than five

SECTION TWO: SOCIO-ECONOMIC AND DEMOGRAPHIC FACTORS

6. Respondent's Relation to household head

1. Head of Households
2. Spouse
9. Other_____

7. Gender

1. Male
2. Female

8. Age of respondent

1. 18-23
2. 24-29
3. 30-34

4. 35-39
5. 40-44
6. 45-49
7. >50

9. Level of Education of the respondent

1. None
2. Primary
3. Secondary
4. Tertiary and above

11.Main source of income of the head of the household

1. Employed
2. Self employed
3. Business
4. School

9. Other_____

12. Monthly income

1. None
2. < KES 1000
3. KES 1001- 5000
4. KES 5001- 10000
5. KES 10001- 30000
6. KES 30001-50000
7. > KES 50000

13. **Main monthly expenditure**

1. Food

2. Clothing
3. Household items
4. Fees
5. Health care
8. Other

SECTION THREE; Resident Practices

14. What is your ethnic background? (Optional)

_____

15. Do you use any traditional method to eradicate bed bugs?

1. Yes
2. No

b. If yes, which method is it?

_____

16. Does your culture allow modern methods of eradicating bed bugs?

1. Yes

2. No

3. Don't know

b. If no, state the reason below?

_____

17. Do you currently have pet animals in this house?

1. Yes

2. No

3. Refused to answer

B. If yes, which pet animals?

18. Do you think pet animals harbor Bed Bugs?

1. Yes
2. No
3. Don't Know
4. Refused to answer

19. Have you changed any traditional lifestyle that in your opinion lead to presence of bed bugs in your house?

1. Yes
2. No

B. If yes, which traditional lifestyle?

SECTION FOUR; Resistance to Public Health Officials Spraying bed bugs

20. How many times have you experienced bed bugs infestation in past three months?

1. Not experienced
2. Once
3. Twice
4. Thrice
5. More than three times

21. Are you currently having bed bugs?

1. Yes
2. No
3. Don't Know

22. Has your house ever been sprayed by bed bugs?

1. Yes
2. No

B . If yes how many times in the past three months

1. Once
2. Twice
3. Thrice
4. More than three times

23. Who sprayed?

1. Ministry of Health officials
2. NGOs
3. Ministry of Livestock
4. Other

24. What was your response when the public officers wanted to spray your house for bed bugs?

1. Allowed them to access my house
2. Was hesitant ,nevertheless allowed them
3. Did not allow them

B. If did not allow them, what were the reasons:

_____

_____

_____

25. Would you allow public health officers to spray your home for bed bugs in future?

1. Yes

2. No

B. If no why would you not allow them? Provide reasons

_____

_____

_____

26. In your opinion do you think do bed bugs spread diseases?

1. Yes
2. No
3. Don't know

B. If yes which ones?

_____

_____

_____

SECTION FIVE: CURRENT PREVENTION AND CONTROL METHODS USED

27. Are currently using any methods to kill and control the bed bugs?

1. Yes

2. No

B. If yes which ones? List them below

_____

_____

_____

C. If no why not? Provide reasons below

_____

_____

_____

28. For how long in terms of weeks have you been using this/these method(s)

_____

_____

29. In your view are these methods effective in killing and controlling spread of bed bugs?

1. Yes
2. 2. No

B. If no why do think they are not effective?

_____

_____

_____

We have come to the end of our interview.

I wish to thank you very much because of your valuable time to answer the questions.

The findings of this study shall be made public and stakeholders shall be provided with this useful information to help them devise effective ways of killing and controlling bed bugs.

END.

Appendix IV: Transcription of the KII and FGD

FOCUS GROUP DISCUSSION

Heads of Households

T**HEME ONE – SOCIOECONOMIC FACTORS AND CULTURAL PRACTICES INFLUENCING THE RESURGENCE OF BED BUGS IN NAKUTRU TOWN KENYA**

Q1; Let us discuss about your sources of Income

P1 –

- "Self employment"
- Small scale businesses

P2-

- "There is lack of employment among the youths so there is very little income"

P3-

- "Business / self employment"
- "Support from my kids who some are employed and others are in businesses"

P4-

- "Unemployment is high Nakuru East"
- "Youth projects income"

P5-

- "Business of selling fruits and cereals"

P6-

- "Hustling around the area"

P7

- "Casual employment from the county government"

P8

- "Businesses"

Q2; Does the level of your income help you to eradicate bed bugs in your premises?

P1-

- "Insecticides are expensive and our income cannot help us purchase them"
- Cannot sustain modern methods

P2,3,4,5,6,7,8

- "Modern methods not sustainable by the current economic power"

THEME TWO – CULTURAL PRACTICES

Q2; Please let us discuss about which cultural practices about in your opinion think they lead to bed bugs infestation

P1-

- "Culture of sharing hanging lines in the estates aid in movement of bed bugs"

P2-

- "Spirits from the dead, one resident had lost her husband and then bed bugs infested her home and she said it was her husband who had visited her"

P3-

- "Research scientists from Egerton University brought them"

P4-

- "Belief that cockroaches brought them"

P5-

- "Migrating culture from one place to another and from one estate to the other"

P6-

- "Bed bugs brought by cockroaches"

P7-

- “Belief that it is a curse as a form of poverty”

P8-

- “Beliefs that bed bugs are brought by evil spirits”

Q2; Which traditional methods do you use in eradicating bed bugs?

P1-

- “Omo water application”

P2-

- “Paraffin Application”

P3-

- “Use of pepper – they go mad”

P4-

- “Herbal powders “Minus Kunguni”

P5-

- “Hot water treatment for furniture and infested beddings”
- “Applying varnish on the furniture”

P6-

- “Hot water treatment for infested clothes”

P7-

- “Sun drying household items”

P8-

- “Physical killing”

THEME THREE – PERCEPTION AND SPRAYING OF BED BUGS

Q1; Have you ever experienced bed bugs infestation in your premises?

- Participants noted that 90% of the residents have experienced bed bugs
- One participant noted that she had not experienced bed bugs infestation

Q2; Who would you call if you had bed bugs infestation in your promises?

- P1- "own self"
- P2- "pest control"
- P3 – "fumigation people"
- P4-" own self"
- P5 – "own self"
- P6 – "own self"
- P7 – "pest control"
- P8 – "own self"

Q3; Would you allow public health officials to spray bed bugs in your premises? If no let us discuss the reasons

- All participants noted that they would allow public health officials in their premises to come spray bed bugs
- Participants noted that there should be polio campaigns to eradicate bed bugs

Recommendations from the FGD

- Enhance public awareness about bed bugs eradication
- Continuous spraying of the houses
- Enhance public reporting of bed bugs reporting
- Observe integrity in the process of spraying bed bugs
- Equality in charges across households
- Engage CHVs in the bed bugs eradication programs

Community Health Volunteers

THEME ONE – SOCIOECONOMIC FACTORS AND CULTURAL PRACTICES INFLUENCING THE RESURGENCE OF BED BUGS IN NAKUTRU TOWN KENYA

Q1; Let us discuss about your sources of Income

P1- "Casual employment" – Kaptembwa

P2 – "employment" - Bondeni

P3- "self employment" - Kivumbini

P4-" Self employment" - Kivumbini

P5- "self employment" – Lakeview

P6 –" Business/ self employment" – Flamingo

P7 – "50/50 Employment, businesses" in Mwariki

P8- 'Casual laborers" - Rhoda

Q2; Does the level of your income help you to eradicate bed bugs in your premises?

P1-

- "Food and children is a priority not bed bugs eradication"
- "Prefers less expensive methods"

P2-" Kaptembwa disparity in socio economic status"

P3-"In Bondeni , disparity in socio economic status leads to resurgence"

P4- "Not everyone is able to purchase the chemicals in Manyani"

P5- "In Lakeview food is a priority and prefers less expensive methods like hot water"

P6 – "In Flamingo, income is limited and cannot purchase chemicals continuously"

P7-" In Mwariki there is low socio economic status and people don't prioritize eradication of bed bugs"

P8-“ In Rhoda, there is informal settlement where food is a priority”

THEME TWO – CULTURAL PRACTICES

Q2; Please let us discuss about which cultural practices about in your opinion think they lead to bed bugs infestation

P1- “culture of migration from one place to the other”

P2-“Hanging clothes outside the estates”

P3-“ witchcraft from witches”

P4-“ curse beliefs from kalenjins”

P5- “unhygienic practices like having unwashed beddings”

P6- “doesn’t believe it is culture”

P7 – “circumcision ceremonies in churches leads to migration of bed bugs from those gatherings to homes”

P8-“curse from God and Dr. Owuor had prophesied 3 months before the infestation in 2017 in Nakuru stadium”

Q2; Which traditional methods do you use in eradicating bed bugs?

P1-“parafin treatment to kill eggs”

P2- “omo treatment, painting sun drying and paraffin treatment”

P4- “Physical killing”

P5- “Burning infested mattresses”

P6- “Sun drying infested furniture”

P7-“Hot ash treatment”

P8- “Selling them and buying new items”

THEME THREE – PERCEPTION AND SPRAYING OF BED BUGS

Q1; Have you ever experienced bed bugs infestation in your premises?

All CHVs had experienced bed bugs in their premises

Q2; Who would you call if you had bed bugs infestation in your promises?

P1- "pest control"

P2- "Pest control"

P3- "self-treatment"

P4- "self-treatment"

P5-" Public health"

P6-" Health department"

P7 – "Health department"

P8 – "Community Based solution"

Q3; Would you allow public health officials to spray bed bugs in your premises? If no let us discuss the reasons

- All participants noted yes but on condition that residents are not asked to pay
- Involve landlords

Recommendations

- Health inspection to be enhanced
- Public health to collaborate with CHVs to spray
- Treat bed bugs like an emergency
- Involve landlords in eradication
- Motivation of CHVs training and empowerment with equipments
- Avail more affordable and effective chemicals
- Develop policy on bed bugs eradication

Key Informant Interview – Nakuru Town

Chief Public Health Officer – Vector Control

Project Title: DETERMINING SOCIO-ECONOMIC FACTORS AND CULTURAL PRACTICES INFLUENCING THE RESURGENCE OF BED BUGS (*CIMEX HEMIPTERUS);* NAKURU TOWN, KENYA.

Q1. What is the situation of bed bugs infestation in Nakuru County?

- "There has been variation within the years but recently resurgence has been rampant due to various reasons"
- "The bed bugs resurgence has mostly been affected by climate change over the years as the hot climate favors bed bugs movement"
- "There is notable high prevalence during warm seasons like January to April"
- "High Prevalence was noted in 2017 with over 2000 households affected in Nakuru East and West"

Q2. What are the measures your office is taking to eradicate bed bugs?

- "We have an active vector control unit funded by the County Government of Nakuru"
- "Due to high cost of chemicals used to eradicate bed bugs very few benefit as most people cannot afford due to low socio-economic status"

Q3. Which are the most used methods in Nakuru to eradicate bed bugs?

- "Chemical spraying about 6 brands are recommended (Encourages alternating the chemicals to curb resistance by the adult bed bugs)"
- "Hot water treatment on infected furniture and beddings"
- "Traditional herbal concoctions that disperse out the bed bugs"
- "Paraffin and diesel applications on furniture infested with bed bugs"

Q4. In your own opinion, what are the causes of bed bugs resurgence in Nakuru?

- "Poor housing due to low socio economic status"
- "Movement from one house to another and from one estate to the other"
- "Use of second hand furniture inherited from relatives and friends or bought from the stores"
- "Being a transit town, Nakuru plays host to people from far frank areas and this could be a source of bed bugs carried from hotels and public transport vehicles"
- "Students from boarding quarters transfer the bed bugs to the estates"
- "Resistance by adult bed bugs to certain chemicals has highly brought bed bugs"

Q5. What recommendations would you give in the campaign to eradicate bed bugs?

- "Enhance public awareness about bed bugs control"
- "Enhance surveillance of bed bugs and research"
- "Improve on funding from County government to buy chemicals"

KII (II)

Lands and Housing – Officer In Charge – Nakuru East & West

Project Title: DETERMINING SOCIO-ECONOMIC FACTORS AND CULTURAL PRACTICES INFLUENCING THE RESURGENCE OF BED BUGS (*CIMEX HEMIPTERUS);* NAKURU TOWN, KENYA.

Q1. The most common types of housing in Nakuru East and West?

- "Single unit houses are the most common in all the estates"
- "Permanent houses are common in Flamingo and Kivumbini estates"
- "Semi permanent houses are common in Bondeni and Lakeview estates"

Q2. What type of houses is likely to harbor bed bugs?

- "Depends on the tenants hygiene"

- "Semi-permanent houses are likely to harbor more bed bugs"
- "Single unit houses lead to more movement of bed bugs due to over population"

Q3. What measures is your office putting in place to curb bed bugs resurgence?

- "Enhancing civic education on bed bugs control among the residents in all estates"

Q4. What is the reporting status of bed bugs infestation by residences in relation to housing?

- "Early 80's reporting of bed bugs and other rodents was effective"
- "In the recent past, reporting has really declined"

Q5. In the future, what measures would you recommend in an attempt to curb bed bugs infestation in Nakuru?

- "Ministry concerned to increase funding to enable us to buy chemicals and sprayers that will be used by the locals and this bed bugs resurgence will end"
- "Repainting of all houses and this will help eradicate debugs hiding in wall cracks and also improve hygiene"
- "In relation to President's big four agenda people to move from single unit housing to self-contained housing. This will reduce overcrowding and also curb bed bugs migration"

KII (III)

Private pest Control

Project Title: DETERMINING SOCIO-ECONOMIC FACTORS AND CULTURAL PRACTICES INFLUENCING THE RESURGENCE OF BED BUGS (*CIMEX HEMIPTERUS);* **NAKURU TOWN, KENYA.**

Q1. What are the current methods been used to eradicate bed bugs in Nakuru?

- “Spraying using insecticides such as promax, diazonol and ectomine(improvised)”
- “They have been used for a period of over three years”

Q2. Which is the most effective method to eradicate bebdbugs?

- “Spraying the infected areas and furniture extensively over a period of time”
- “Best results are achieved by mixing ectomine and promax to effectively kill the bed bugs as some have proved resistance to some chemicals”

Q3. Which are the prevention measures been taken to reduce bed bugs resurgence in Nakuru?

- “Sanitation and hygiene in the households and around the estates”
- “Decongesting the houses to reduce movement of bed bugs”
- “Encouraging traditional methods to those who cannot afford the chemicals like hot water treatment on furniture and laundry”
- “Spraying of all second hand furniture at their place of storage and sale point to reduce the chances of bed bugs been transferred to the households”

Q4. What is the relation of socioeconomic factors and the methods you use to eradicate bed bugs?

- “Not all people are able to afford the charge fee of two rooms at KES 800 due to the low incomes and lack of employment”
- “Only about 30% of the residents can afford to buy the chemicals individually but not over longterm plans”
- “Most prefer to spray by themselves to reduce cost but since they are not trained they are not effective hence the resurgence in some areas in the estates”

Q5. What recommendations would you give to help curb bed bugs resurgence in Nakuru?

- "Painting of houses to improve on hygiene and kill the eggs on wall cracks because the smell of fresh paint has been known to repel bed bugs"
- "County Government should organize communal spraying so to reach each and every household in the estates and also motivate the residents"
- "Community to enhance reporting of bed bugs infestation in their households to improve on swift action from the health department"
- "Private spraying firms to come up with more affordable methods to fit in to the low socioeconomic status of the residents"

Appendix V: Map of Nakuru County

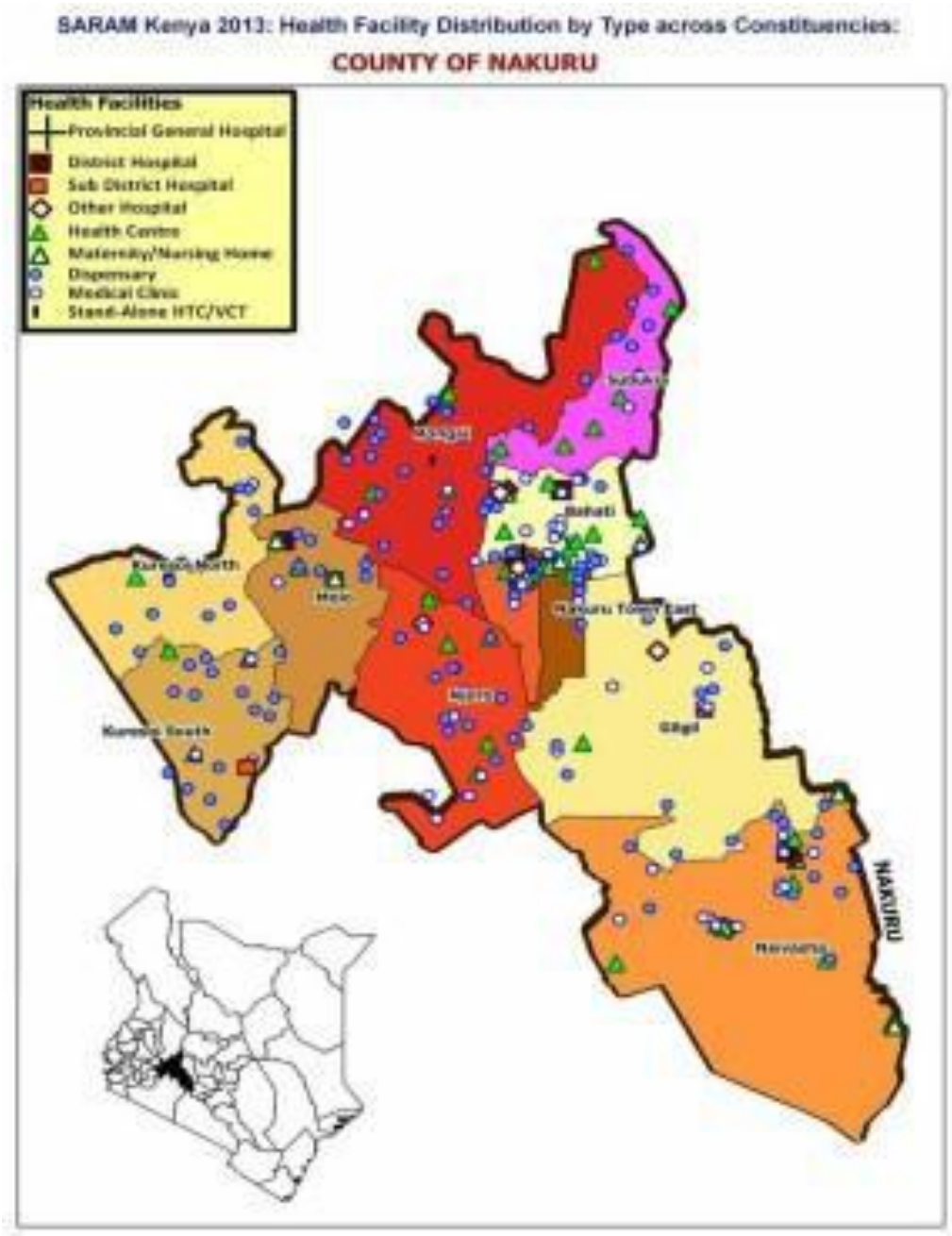


Figure 22-Map of Nakuru County

Source: Google maps, 2018

Appendix VI: Consent Form

Mount Kenya University

Understanding Socio-Economic and Demographic factors Influencing the Resurgence of Bed bugs (*Cimex hemipterus);* Case study of Nakuru Town, Kenya.

RE: CONSENT FORM

Dear Respondent,

I the above mentioned investigator wish to inform you that I am carrying out a study to determine the socioeconomic factors and cultural practices that influence the resurgence of bed bugs in your estate. I realize that bed bugs infestation is a major public health problem in this area and would wish to have a better understanding of the reasons why this is case here.

I therefore request that you participate in this study by providing information in answering questions and if need be allow the researcher to inspect some of your household items such as furniture to confirm the presence of bed bugs.

The overall goal of this study is to find ways of controlling and preventing the spread of bed bugs. You shall be free to withdraw from the study at any point without giving reasons. It is important to note that there shall be no direct benefits for your participation, however, the community at large shall benefit if we have better ways of controlling the bed bugs.

The findings of this study shall be made public in workshops, conferences and publications, however, your personal and details shall remain anonymous and not disclosed to a third party without your permission.

If you accept please append your signature here----------
date----------

Thank you for your acceptance.

Name of enumerator----------

Signature----------

Date ----------

Any questions regarding this study should be directed to the Principal Investigator:

Dennis Muriithi {+254 704 396155}

Appendix VII: Certificate of Ethical Clearance

Mount Kenya University

JUNE 28, 2018

Ref. No. MKU/ERC/0890

CERTIFICATE OF ETHICAL CLEARANCE

This is to certify that the proposal titled **"DETERMINING SOCIO-ECONOMIC FACTORS AND CULTURAL PRACTICES INFLUENCING THE RESURGENCE OF BEDBUGS (*CIMEX HEMIPTERUS*), NAKURU TOWN, KENYA"** Whose Principal Investigator is Mr Dennis Mwangi Muriithi (MPH/2017/70857) has been reviewed by Mount Kenya University Ethics Review Committee (ERC), and found to adequately address all ethical concerns.

Mr Francis W. Makokha
Secretary, Mount Kenya University ERC

Sign: _____ Date: 28.06.2018

Prof. Francis W. Muregi
Chairman, Mount Kenya University ERC

Sign: _____ Date: 28/6/2018

The Chairman
Mount Kenya University
Ethics Review Committee
P. O. Box 342 - 0100, Thika

Appendix VIII: Introduction Letter – School of Postgraduate Studies

Mount Kenya University

SCHOOL OF POSTGRADUATE STUDIES

MPH/2017/70857

02nd July, 2018

The Director, Research Coordination Division
National Commission for Science, Technology & Innovation
Utalii House, 8th & 9th Floor
P.O Box 30623- 00100
NAIROBI

Dear Sir/Madam,

RE: DENNIS MWANGI MURIITHI - REGISTRATION NO. MPH/2017/70857

The purpose of this letter is to introduce the above named student who is pursuing **Master of Public Health** in the Department of **Epidemiology and Biostatistics** in the School of **Public Health.**

The title of his research is *"Determining Socio-Economic Factors and Cultural Practices Influencing the Resurgence of Bedbugs (Cimex Hemipterus), Nakuru Town, Kenya."*

He has been cleared by the University's Ethics Review Committee (Certificate attached) and now has to proceed to the field to collect data for his research between July and **September 2018.**

Any assistance accorded to him will be highly appreciated.

Thank you.

Mount Kenya University
Dean, School of Postgraduate Studies
P. O. Box 342 - 01000
Thika

Dr. Samuel Karenga, PhD
Dean, School of Postgraduate Studies
Enc

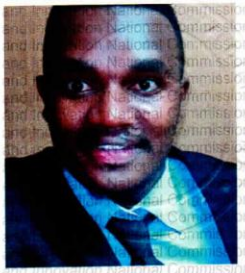
Appendix IX: NACOSTI Permit

THIS IS TO CERTIFY THAT:
MR. DENNIS MWANGI MURIITHI
of MOUNT KENYA UNIVERSITY,
245-10300 Kerugoya,has been
permitted to conduct research in
Nakuru County

on the topic: *DETERMINING SOCIO-ECONOMIC FACTORS AND CULTURAL PRACTICES INFLUENCING THE RESURGENCE OF BEDBUGS (CIMEX HEMIPTERUS) NAKURU TOWN, KENYA.*

for the period ending:
25th July,2019

Permit No : NACOSTI/P/18/21614/23855
Date Of Issue : 26th July,2018
Fee Recieved :Ksh 1000



.....
Applicant's Signature

.....
Director General
National Commission for Science, Technology & Innovation

Appendix X: Research Authorization Letter- NACOSTI

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone:+254-20-2213471, 2241349,3310571,2219420
Fax:+254-20-318245,318249
Email: dg@nacosti.go.ke
Website : www.nacosti.go.ke
When replying please quote

NACOSTI, Upper Kabete
Off Waiyaki Way
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No. **NACOSTI/P/18/21614/23855**

Date: **26th July, 2018**

Dennis Mwangi Muriithi
Mount Kenya University
P.O. Box 342-01000
THIKA

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Determining socio-economic factors and cultural practices influencing the resurgence of bedbugs (cimex hemipterus) Nakuru Town, Kenya"*** I am pleased to inform you that you have been authorized to undertake research in **Nakuru County** for the period ending **25th July, 2019.**

You are advised to report to **the County Commissioner and the County Director of Education, Nakuru County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

BONIFACE WANYAMA
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Nakuru County.

The County Director of Education
Nakuru County.

Appendix XI: Research Authorization Letter- County Commissioner

THE PRESIDENCY
MINISTRY OF INTERIOR AND
CO-ORDINATION OF NATIONAL GOVERNMENT

Telegram: "DISTRICTER" Nakuru
Telephone: Nakuru 051-2212515
When replying please quote

COUNTY COMMISSIONER
NAKURU COUNTY
P.O. BOX 81
NAKURU.

Ref No. CC. SR .EDU 12/1/2 VOL.111/147

20th August 2018

TO WHOM IT MAY CONCERN

RE:- RESEARCH AUTHORIZATION
DENNIS MWANGI MURIITHI

The above named from Mount Kenya University has been authorized to carry out research on "***determining socio-economic factors and cultural practices influencing the resurgence of bedbugs (climex hemipterus)***" *in Nakuru County for a period ending 25th July* 2019.

Please accord him all the necessary support to facilitate the success of his research.

JUDITH ANYANGO
FOR COUNTY COMMISSIONER
NAKURU COUNTY

Appendix XII: Research Authorization Letter- County Director of Education

MINISTRY OF EDUCATION

STATE DEPARTMENT OF EARLY LEARNING OF BASIC EDUCATION

Telegrams: "EDUCATION",
Telephone: 051-2216917
When replying please quote
Email:cdenakurucounty@gmail.com
Ref.CDE/NKU/GEN/4/1/21 VOL.VII/78

COUNTY DIRECTOR OF EDUCATION
NAKURU COUNTY
P. O. BOX 259,
NAKURU.

20th August, 2018

TO WHOM IT MAY CONCERN

RE: RESEARCH AUTHORIZATION –DENNIS MWANGI MURIITHI
PERMIT NO. NACOSTI/P/18/21614/23855

Reference is made to letter NACOSTI/P/18/21614/23855
26th July, 2018.

Authority is hereby granted to the above named to carry out research on ***"Determining socio-economic factors and cultural practices influencing the resurgence of bedbugs (Cimex hemipterus)" in Nakuru Town, Kenya"*** *for* a period ending ***25th July, 2019.***

Kindly accord him the necessary assistance.

COUNTY DIRECTOR OF EDUCATION
NAKURU COUNTY

GEORGE ONTIRI
FOR: COUNTY DIRECTOR OF EDUCATION
NAKURU

Copy to:

Mt. Kenya University
P.O Box 342 - 001000
THIKA

Appendix XII: Similarity Index Check

SOCIO-ECONOMIC FACTORS AND CULTURAL PRACTICES INFLUENCING THE RESURGENCE OF BED BUGS (Cimex hemipterus); NAKURU TOWN, KENYA.

ORIGINALITY REPORT

12%	10%	6%	4%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	labmed.ascpjournals.org Internet Source	3%
2	academic.oup.com Internet Source	1%
3	Submitted to Kenyatta University Student Paper	<1%
4	Williams, Katelyn, and Monte S. Willis. "Bedbugs in the 21st Century: The Reemergence of an Old Foe", Laboratory Medicine, 2012. Publication	<1%
5	Changlu Wang, Narinderpal Singh, Chen Zha, Richard Cooper. "Bed Bugs: Prevalence in Low-Income Communities, Resident's Reactions, and Implementation of a Low-Cost Inspection Protocol", Journal of Medical Entomology, 2016 Publication	<1%

Similarity index report without references

23-04-2021