KNOWLEDGE AND PRACTICES ON ENVIRONMENTAL MANAGEMENT FOR MALARIA CONTROL IN KORE AND AHERO IRRIGATION SCHEME, NYANDO SUB-COUNTY, KISUMU COUNTY, KENYA.

BY

OSARA ADHIAMBO BENTER

A THESIS SUBMITED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF PUBLIC HEALTH IN EPIDEMIOLOGY AND POPULATION HEALTH

SCHOOL OF PUBLIC HEALTH AND COMMUNITY DEVELOPMENT

MASENO UNIVERSITY

DECLARATION

1. THE STUDENT

I, Osara Adhiambo Benter hereby declare that this thesis is my original work and has not been submitted for the award of a degree or diploma in any other university or college.

Osara Adhiambo Benter

PG/MPH/027/2008

Signature …….. Date ……

2. THE SUPERVISORS

We, the undersigned, confirm that this thesis has been submitted for examination with our approval as University supervisors:

Professor Rosebella .O. Onyango

School of Public Health and Community Development

Maseno University

Signature…… Date……

Professor Rose Kakai

School of Medicine

Maseno University

Signature…… Date……

ACKNOWLEDGEMENT

First of all, I am grateful to the almighty God for the divine intervention in this academic endeavor.

I owe my deepest gratitude to my supervisors Prof. Rosebella Onyango and Prof. Rose Kakai who, despite the long time this work has taken, conceded and accepted to review my work and advise accordingly. Their patience, guidance, assistance, critiques and encouragement saw me through this study. Indeed, their unreserved support and invaluable guidance is an inspiration.

My sincere appreciation also goes to all the lecturers, School of Public Health, Maseno University (Kisumu Campus) who taught me, for their valuable contributions, and for imparting knowledge to me.

I acknowledge and thank all those who contributed to the success of my research project and subsequent preparation of this report.

Special thanks go to my family for the patience and understanding they extended to me. I am grateful for the moral support.

DEDICATION

This dissertation is dedicated to all malaria endemic countries, especially Kenya, where the burden of malaria disease is borne each day. I also dedicate this dissertation to my family (Phil, Paul and Patton), whose patience, support and inspiration I enjoyed through this academic journey.

ABSTRACT

Malaria remains one of the most prevalent vector borne diseases especially in Sub Saharan Africa contributing to morbidity and mortality of both adults and children. Knowledge in malaria control and prevention methods especially environmental management can reduce the population density of the vectors thus lessen malaria prevalence. The objectives of this study were to: determine knowledge on environmental management for malaria control, identify the most effective environmental management practices for malaria control and examine the influence of socio-demographics on knowledge and practices in environmental management of malaria control among the residents in Kore and Ahero irrigation scheme in Nyando Sub-county, Kisumu County, Kenya. A cross-sectional study design with systematic random sampling of 323 respondents was applied. Quantitative and qualitative data were collected through semi-structured questionnaires, focus group discussions and key informant interview guides. Quantitative data was processed and analyzed using SPSS while context and thematic analysis was done on qualitative data. Results showed that respondents were well aware of the links between mosquitoes, the environment, and malaria except that there were some misconceptions. They pointed mosquitoes as risk factor of malaria, (94.4%), pointed stagnant water as factors that increase mosquito population (91.0%), they also pointed out stagnant water as mosquito breeding habitats (82.7%). Respondents reported various environmental preventive measures whereby use of bed nets was found to be the most effective. Education, gender and occupation were found to be the most important demographic factors associated with certain knowledge and practices on environmental management for malaria control. Misconceptions about malaria transmission and its cause still exist. Knowledge about preventive measures does not necessarily translate into improvement in practices. There is a need for appropriate health education addressing attitudes towards taking health action. More qualitative research should be done to address issues of culture and attitude on environmental management for malaria control and increased participation in effective techniques should be promoted.

TABLE OF CONTENTS

ABBREVIATIONS

ACT	Artemisinin-Based Combination Therapies
CDC	Center for Disease Control
CI	Confidence Interval
DOMC	Division of Malaria Control
FGD	Focus Group Discussion
HBM	Health Belief Model
IRS	Indoor Residual Spraying
ITN	Insecticide Treated Net
IVM	Integrated vector management
KCIDP	Kisumu County Integrated Development
KEDDP	Kisumu East District Development Plan
KII	Key Informant Interview
KMIS	Kenya Malaria Indicator Survey
LLIN	Long-Lasting Insecticidal Nets
SPSS	Statistical Package for Social Sciences
SSA	Sub-Saharan Africa
TICE	Tamarack Institute for Community Engagement
WHO	World Health Organization

OPERATIONAL DEFINITION OF TERMS USED IN THE STUDY

A household - The entity in which respondents live together and have a meal from a common cooking facility.

Adult Member -- Respondent aged over 18 years.

Bush clearing – The act of cutting down all the vegetation on the compound.

Cause of a disease – An external factor like pathogen in a respondent, which negatively affects his or her function.

Confidence interval - Gives an estimated range of values so defined that there is a specified probability that the value of a parameter lies within it.

Community – Respondents living in the same geographical region of the study area.

Community participation – is the active involvement of the respondents in eliminating mosquito breeding habitats

Environmental management- This is a way of eliminating mosquito breeding habitats by installing and maintaining drains, removing pools of stagnant water, managing vegetation, filling areas that collect water, irrigating by alternating and altering rivers to create faster flowing water.

Effective environmental management practice – this is an immediate or noticeable potential of the environmental malaria control methods applied by the respondents in reducing the adult mosquito population, stopping the nuisance of biting or reducing the breeding habitats.

Knowledge – Ability of the respondents to state true facts about management of the environment in order to control malaria.

Malaria- Disease caused by an infected female *Anopheles* mosquito. People with malaria often experience fever, chills, and flu-like illness.

Practice – Workouts done regularly by the respondents in order to manage the environment for malaria control.

Risk factor of a disease; Situation or something important for a respondent to get a disease. It can be related to agent, host or environment.

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Malaria remains one of the world's greatest public health challenges (World Health Organization (WHO), 2015a)). In 2016, it was estimated that over 216 million cases were reported (WHO, 2016). Malaria is an endemic disease in over 100 countries and almost half of the population worldwide is at risk of contracting the disease. Reports have indicated that over one million people die annually (WHO, 2015a). Additionally, about 90% of all mortality cases estimated at (525,600) in 2013 occurred in Africa. Children are the age of five are the most affected and their deaths estimated at 81.8% (430,000) (Quenneh, 2016). While Africa accounts for over 90% of the disease burden worldwide, sub-Saharan Africa is the most affected region (Bhatt *et al.,* 2015). Although the fight against malaria has reduced the impacts significantly, the disease remains one of the greatest threats to socio-economic development in the world and is also one of the major disease burdens in sub-Saharan Africa (SSA) (Bain *et al.,* 2013).

Malaria is a major threat to public health and is the leading cause of morbidity and mortality in Kenya (KMIS, 2015). Out of 34 million Kenyans, approximately 25 million are estimated to be at risk of malaria, which is more than 70% of the population at risk (Chitunhu and Musenge, 2012). An estimated 6.7 million new clinical cases each year, with 4000 deaths occurring particularly among children, make malaria a major health burden for Kenya (Halliday *et al.,* 2014). Division of Malaria Control (DOMC) (2009) also confirms that malaria control is not just a health issue, but an overall development issue since malaria is a driver of poverty, a debilitating disease that affects millions of Kenyans each year and is unfortunately fatal to many thousands. In the same opinion Atieli *et al.,* (2009) confirm that Kore and Ahero irrigation scheme in

Nyando Sub-County Kisumu Kenya is a malaria endemic region where transmission occurs throughout the year.

Studies on malaria control indicate that numerous factors interact to influence transmission levels (Randell, 2008). High temperature and heavy rainfall in the summer season leads to the highest malaria transmission, especially in Africa (Chitunhu & Musenge, 2012). According to Harvell *et al.,* (2009), environmental conditions and human activities play an important role in influencing the transmission of infectious diseases, including malaria. Mutero *et al.,* (2004), further state that human-induced micro-environmental changes, such as the construction of irrigation schemes and dams, have been shown to dramatically increase mosquito populations in an area by creating new breeding habitats. Environmental management removes the mosquito breeding sites, thus lowering the population densities of malaria vectors (Fillinger & Lindsay, 2011). Despite those climatic factors, Chitunhu & Musenge (2012) observe that malaria transmission is also influenced by the socioeconomic conditions and knowledge of and access to malaria prevention tools as well as the healthcare services.

Inadequate knowledge in malaria prevention measures hinder progress in the fight against the disease (Benelli & Mehlhorn, 2016). Sound environmental management practices that enhance malaria prevention require effort from all individual members of the household (Fillinger & Lindsay, 2011). Reports from WHO (2014) indicated that among communities where there is sufficient knowledge in malaria control prevention measures, there is low prevalence of the disease. Knowledge in malaria prevention methods vary from one community to another with rural communities most deficient resulting to high prevalence of the disease (WHO, 2015a).

Socio-demographic factors affect living environment due to difference in access to resources and knowledge of living practices (Cummuns *et al.,* 2007). Elderly individuals and children at tender ages are among the most vulnerable people to malaria due to inadequate knowledge following challenges encountered sensitization programs (Tchombe *et al*., 2018). In particular, elderly persons are not able to attend malaria prevention and control seminars. Children under the age of five years may not have the capacity to influence their living environment to prevent malaria and may be too you to acquire and implement the required knowledge (Walker *et al.,* 2011).

Chirebvu (2014) points out that information on how these factors interact to expose communities and individuals to malaria infections needs to be investigated systematically in each geographical setting, in conjunction with climate related factors. According to Pinchoff *et al.,* (2016), understanding individual, household and environmental factors associated with increased malaria risk is necessary to inform and optimize control strategies. The purpose of this study therefore was to explore the existing community knowledge and practices on environmental management for malaria control in Ahero and Kore irrigation scheme county assembly wards in Nyando Sub-County Kisumu Kenya.

1.2 Statement of the Problem

Malaria is a major threat to public health and is the leading cause of morbidity and mortality in Kenya (KMIS, 2015). There is inadequate knowledge in malaria control an prevention measures especially among rural households (Benelli & Mehlhorn, 2016). Atieli *et al.,* (2009) pointed out that, Kore and Ahero irrigation scheme in Nyando subcounty, are located in a malaria endemic zone in Kenya. Environmental management remains a challenge among the rural households owing to the fact that some of the practices require modifications that may face bottlenecks due

to poverty. Access to information and ability to implement sound malaria prevention practices faces challenges due to defined social roles in the target community.

1.3 Justification for the Study

Understanding of community knowledge about malaria presents a suitable ground for designing the most effective malaria control programs that can lead to behavior change which can lead to malaria prevention. Environmentally sound management practices are important for prevention of malaria and other vector borne diseases. The participation of every individual member of households is important in the management of malaria control and prevention programs and is highly dependent on understanding by the community members. This study is in support of the practices which have been fronted by WHO (2015a) in which active participation and empowerment of rural communities to their effectiveness of malaria control interventions and sustainability of their outcomes have been duly promoted. The findings of this study contributed to the body of knowledge by providing information meant to enable policy makers design effective environmental management as part of an integrated approach to malaria vector control programme in the study area and other parts of the world.

1.4 Aim and Objectives of the Study

1.4.1 Aim of the Study

To assess knowledge and practices on environmental management for malaria control in Kore and Ahero irrigation scheme in Nyando sub-county, Kisumu county, Kenya.

1.4.2 Specific Objectives

i. To determine knowledge on environmental management for malaria control among residents of Kore and Ahero irrigation scheme in Nyando Sub-county, Kisumu County, Kenya.
ii. To identify environmental management practices considered most effective by the respondents for malaria control among the respondents in Kore and Ahero irrigation scheme in Nyando Sub-county, Kisumu County, Kenya
iii. To examine influence of socio-demographics on knowledge and practices in environmental management of malaria control among the residents in Kore and Ahero irrigation scheme in Nyando Sub-county, Kisumu County, Kenya.

1.5 Research Questions

i. What is the knowledge on environmental management for malaria control among residents in Kore and Ahero irrigation scheme in Nyando Sub-county, Kisumu County, Kenya?
ii. Which environmental management practice is considered most effective by the respondents for malaria control in Kore and Ahero irrigation scheme in Nyando Sub-county, Kisumu County, Kenya?
iii. What influence do socio-demographics of the respondents have on knowledge and practices for malaria control in Kore and Ahero irrigation scheme in Nyando Sub-county, Kisumu County, Kenya.

CHAPTER TWO

LITERATURE REVIEW

2.1 Knowledge on Environmental Malaria Control at Community Level

Knowledge on environmental malaria control is important for the implementation of appropriate and effective interventions (Mutero *et al.*, 2012). Greater knowledge and active practices regarding malaria as a disease are critical in establishing effective control measures (Sultana *et al.*, 2017). According to Singh *et al.*, (2014), local knowledge and practice related to malaria is important for the implementation of culturally appropriate, sustainable, and effective interventions. Gobena *et al.*, (2013) points out that inadequate knowledge is the main challenge to the appropriate use of these interventions at individual and community levels. In the same opinion, Adongo, Kirkwood & Kendall (2005) agree that understanding local knowledge about malaria can help in designing sustainable community-based malaria control programmes that will lead to behaviour change and adoption of new ideas and technology. It is therefore important to establish communities' knowledge and practices on malaria control particularly in rural areas which face a high burden of the disease (Mboera *et al.*, 2007).

A number of studies have been conducted about knowledge relating to malaria in Africa. These studies found that misconceptions concerning malaria are still common (Singh *et al.*, (2014); Adebayo *et al.*, (2015), in responding to similar situation, say that health education programs have been used in many situations to increase community understanding and participation in malaria control activities such as identifying breeding habitats, observing larval mosquitoes, and teaching techniques for elimination of mosquito breeding sites (Atkinson *et al*., 2010). Randell, (2008) argues that if people have a comprehensive understanding of the mosquito life cycle and a habitat requirement, it is likely that they will be more effective in controlling these habitats to

reduce the mosquito population. For people knowledge and perception of malaria influence both prevention and treatment –seeking behavior (Mazigo *et al.,* 2010).

2.2 Malaria Control Strategies at Community Level

In 2008, WHO issued a position statement supporting Integrated Vector Management (IVM) as set out in the Global Strategic Framework for Integrated Vector Management (WHO, 2008). All the tactics of standard vector control are included in the IVM approach (Musoke, *et al.,* 2013). According to Musoke *et al.,* (2013), the specific strategies involved can be classified as: First, personal protection – use of ITNs especially for pregnant women and children under five years of age, and insecticide sprays; secondly reducing mosquito breeding sites – draining stagnating water including filling holes and ditches with soil, and removing vessels that can potentially hold water for mosquito breeding; larviciding in large pools of water which cannot be easily eliminated such as those resulting from brick making and sand mining; and clearing unnecessary vegetation around homes; and thirdly, reducing entry of mosquitoes into houses by installing mosquito proofing in windows, ventilators and open eaves, and closing windows and doors early in the evenings.

As advocated by the WHO, the combined use of all the proven tactics and available malaria control tools is the most effective way to check the spread of malaria (Burrows *et al.,* 2013) Like other approaches to vector control, IVM relies on an understanding of how environmental factors affect the distribution and densities of different species of vectors, and how effectively control measures reduce vector-human contact, vector survival and the overall intensity of pathogen transmission (Prüss-Üstün & Neira, 2016). Naranjo *et al.,* (2014) add that its principal strength is that each individual intervention contributes to the overall reduction of the malaria burden in the population when applied in a practical, economically sustainable manner in the community

while protecting the environment. This should be linked with a strong commitment and concerted action by governments and international organizations (WHO, 2015b).

2.2.1 Community Participation on Environmental Malaria Control

Hart (2013) defines community participation as a method of people working together through community structures in order to raise awareness and identify local ideas, concerns, priorities, and opportunities to enable them achieve sustained provision of appropriate services. It is widely conceived that community involvement is integral to vector control, and can achieve sustainable results in a shorter time by mobilizing all segments of society to focus on awareness and the determinants of the problem (Kibe *et al*, 2006).

Atkinson *et al*., (2011) point out that successful malaria control at community level needs to take human behaviour, socio-cultural and economic context into account in parallel with biomedical interventions. On the other hand Ingabire *et al*., (2014) explain that, engagement and participation of communities in planning, implementing and evaluating a malaria control program helps to ensure that a program resonates with issues important to them and that findings are locally relevant. There is a large evidence-base where horizontal approaches have been successful due to a strong partnership between community and program implementers. The key elements of these programmes are: first, generation of a feeling of empowerment; second, local ownership and responsibility; and, third, the application of action-oriented and participatory approaches (Atkinson, *et al.,* 2010*).*

Communities can effectively be involved in reducing nearby mosquito breeding sites by local drainage efforts in villages, fields and around ponds and in improving and screening homes and responding to the need for early diagnosis and treatment (Mboera, *et al.,* (2013). Prüss-Üstün &

Neira, (2016) advice that, in order for environmental management techniques to succeed in reducing the malaria burden in an area, widespread community participation is essential. On the other hand Price *et al.,* (2011) argues that, if only a small percentage of people destroy breeding habitats around their homes, mosquitoes will simply breed in nearby bodies of water and no reduction in the total mosquito population will occur. Therefore, a threshold amount of stagnant water must be drained in order for the mosquito population to be significantly reduced in a community. This highlights the importance of viewing environmental-based malaria control as a collective action problem. In this situation, if the majority of people in a community contribute a small amount of time to performing environmental management, the entire community will benefit from reduced malaria incidence. .

MalERA Consultative Group on Vector Control (2011), argues that malaria control strategies may face major social and cultural challenges that negatively influence the choice, acceptance and use of malaria control interventions. According to Mutero, *et al*., (2015), one of the major obstacles that affect African communities with regard to environmental malaria control is the willingness of the community members. Ingabire, *et al*., (2014) further clarifies that lack of involvement of the community in malaria elimination, misuse of mosquito nets, and misconceptions of malaria preventive measures were cited as problems among community residents. This hindered the success of malaria elimination. Karunamoorthi (2011) therefore recommend that the key ingredient for vector control success is the willingness of community members to adopt and apply integrated malaria management tools as a cornerstone in the malaria control efforts.

2.2.2 Effective Malaria Control Measures

In Africa, most malaria vector control strategies have focused on the use of Insecticide-treated bednet (ITNs) and Indoor Residual Spraying (IRS) (Ranson *et al.,* 2011). Insecticidal measures for protection against adult mosquitoes, including ITNs and IRS, are among the best established and most effective methods of the prevention of malaria (Killeen, 2014).The impacts of pyrethroid-treated nets and IRS are clearly proven and they remain the most commonly advocated means for individuals and communities to tackle their local malaria problems (Mabaso *et al*., 2004). Ingabire *et al*., (2015) on the other hand claim that Long Lasting Insecticidal Nets (LLIN), IRS and malaria case treatments with Artemisinin-based Combination Therapy (ACT) have proved to significantly reduce malaria cases but may not necessarily lead to complete elimination of the disease.

IRS can be most effective to control malaria by applying and expanding the IRS to up to 80% of structures and dwellings in the target area. (Nejati *et al*., 2015) The processes of IRS effectiveness requires households acceptance which is deeply associated with willingness of households to accept residual insecticides during spraying (Mazigo *et al*., 2010; WHO 2013). Ng'ang'a *et al*., (2008) argue that although strategies like ITNs and IRS have been found to reduce the risk of malaria in communities where they have been used effectively, a number of additional measures can be implemented at household level to significantly reduce mosquito vectors responsible for transmitting malaria and other diseases such as dengue and yellow fever. WHO (2012) on the other hand points out that malaria vectors are increasingly becoming resistant to the pyrethroid insecticides that are commonly used with LLINs and IRS. According to a recent report, resistance is now widespread and affects all African countries with ongoing malaria transmission (Hemingway, 2014). Aware of the limitations of exclusive reliance on

chemical interventions, the WHO has advocated the combined use of all the proven tactics and available malaria control tools as the most effective way to check the spread of malaria (Flint & Van den Bosch, 2012).

2.3. Influence of Socio-Demographics Factors to Knowledge and Practices on Malaria Prevention

A clear understanding of the social and behavioral risk factors, and knowledge gaps, related to exposure to malaria are essential when developing guidelines and recommendations for more effective disease prevention in many malaria endemic areas of the world (Bashar *et al.,* 2012). Many studies have attempted to identify household and individual level factors associated with malaria. Some of the factors studied include access to health facilities (WHO 2015b), type of housing that people live in (Yamamoto *et al.,* 2010), proximity of human settlements to vector breeding sites (Barros *et al.,* 2011), vector abundance and socioeconomic status (Kilpatrick & Randolph, 2012), gender, occupation and residential mobility (Siri *et al.,* 2010), presence of domestic animals near homesteads (Yared *et al.,* 2014) and use of preventive methods such as bed nets (WHO 2015b). Chirebvu *et al.,* (2014) points out that information on how these factors interact to expose communities and individuals to malaria infections needs to be investigated systematically in each geographical setting, in conjunction with climate related factors. According to Pinchoff *et al.,* (2016), understanding individual, household and environmental factors associated with increased malaria risk are necessary to inform and optimize control strategies. In most cases, these human related risk factors are known to aggravate the extent of climate related problems (Chirebvu *et al.,* 2014).

Socio-demographic factors such as education and gender are identified as important determinants that influenced practice of malaria elimination measures, especially related to possession and

usage of mosquito nets (Mazigo *et al.*, 2010). A study conducted on community knowledge and perceptions about indoor residual spraying for malaria prevention in the Soroti District of Uganda showed that older respondents, those with higher education as well as those who were knowledgeable about IRS had a positive perception about the intervention (Ediau *et al.*, 2013). Opiyo *et al., (*2007) on the other hand pointed out that education beyond primary school level increased the probability of respondents knowing mosquito bites as the sole cause of malaria by 3–4 times in western Kenya.

A study done by Atieli *et al.,* (2011), on ITN ownership, usage, and malaria transmission in the highlands of Western Kenya, noted that level of education and knowledge about malaria transmission were some of the significant reasons affecting ownership and usage of ITNs. Another study done by Chirebvu *et al.,* (2014) on assessment of risk factors associated with malaria transmission in Tubu village, Northern Botswana reported that, those houses with at least a member having primary or secondary level of education had knowledge about malaria and had a significantly high level of ITN ownership than those with no knowledge. Chirebvu *et al.,* (2014) in this same study recommended that an understanding of the link between malaria transmission, climatic variables, and other human related factors is therefore necessary for developing appropriate measures that will significantly reduce transmission and perhaps eliminate malaria from endemic areas.

Religion is generally established as a fundamental determinant of human behavior and a powerful provider to diversity in belief and value systems among human societies. It influences our action, our decision, inspirations, goals, motivations, principles and our contentment (Maigemu, 2015). According to Heiman, *et al.*, (2004), religious beliefs and exercises have optimistic purpose, permitting the individual to adjust to normative expectation of the group,

assuring collective solidarity. A study by Montgomery, *et al.,* (2010) indicated that religious belief systems can also result in negative or positive perceptions about the malaria preventive methods. For example, the study reported partial acceptance of IRS among traditional healers' households where it was believed that the insecticide could negatively affect the performance of traditional rituals.

2.4 Conceptual Framework

The conceptual framework gives a depiction on how the variables are related to one another as shown in Figure 2.1 below. The independent variables in this study include knowledge and practices on environmental malaria control. The dependent variable is environmental malaria control while the intervening variables are the socio-demographic characteristics

In case of malaria prevention, use of environmental management should be accompanied by appropriate knowledge of the mosquito ecology and pathogen transmission process. It is therefore conceptualized that knowledge on environmental control would influence the practice of environmental management that would eventually reduce mosquito population hence control malaria. The two variables under study were considered critical hence the study assessed knowledge and practices on environmental management for malaria control in Kore and Ahero irrigation Scheme, so as to fill the gap presented by the literature review.

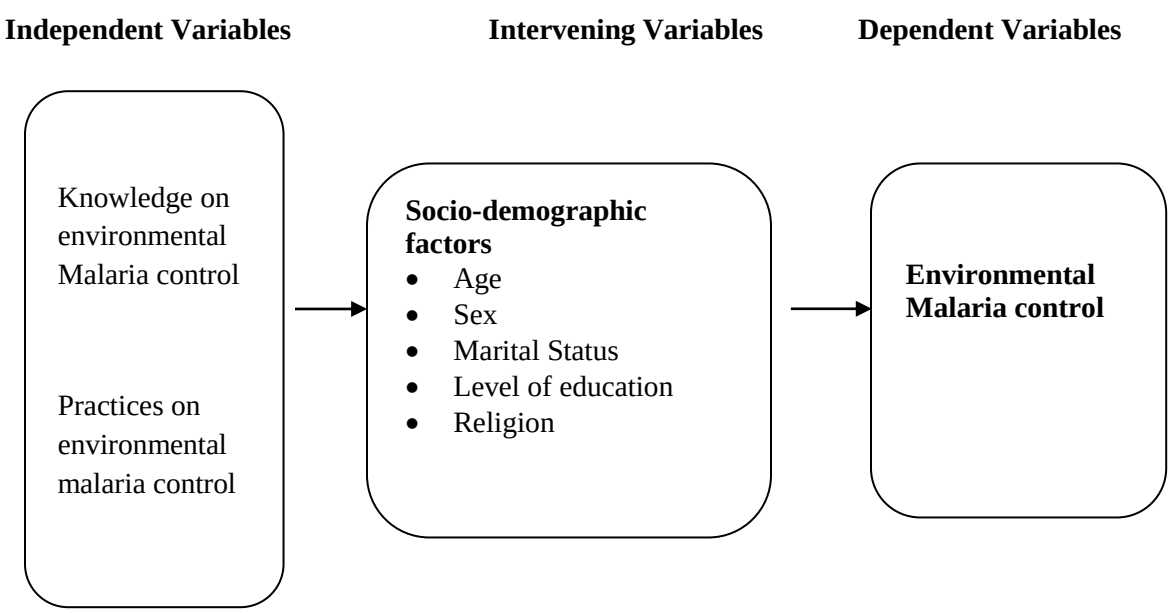


Figure 2.1: Conceptual Framework

Source: Modified PRECEDE-PROCEED Model (Matlo, 2012).

CHAPTER THREE

METHODOLOGY

3.1 Study Area

This study was carried out in Kore and Ahero irrigation scheme county assembly wards in Nyando Sub-County (Appendix V) (Murono *et al*., 2018). Nyando Sub-County lies between longitude 33° 20' - 35° 20' East and latitude 0° 20' - 0° 50' South. The area covers a total of approximately 163 km2 (KBNS, 2015). According to Atieli, *et al*., (2009), the study area within the sub-county is located 24 km southeast of Kisumu county, 15 km south of the Equator at an altitude of 1,150 m above sea level (latitude 34.90E and 34.97E and longitude 0.11S and 0.16S). It covers an area of 29 km^2 and has a population of 350,353 (KNBS, 2010).

Annual mean temperatures vary between 17°C and 32°C. The area is relatively humid due to its proximity to Lake Victoria. The local climate is characterized by three peaks of rains with an average annual rainfall of 1,000 – 1,800 mm and an average relative humidity of 65%. The first peak of rains occurs between March and July, with an average monthly rainfall of 150 – 260 mm. The other rainy season occurs in August. Short rains occur between September and October and have an average monthly rainfall of at least 125 mm. The dry period occurs between December and February (Atieli, *et al*., (2009).

The area is dominated by black soils which develop deep cracks in dry season that allow a lot of rain water to penetrate at the beginning of the rainy season. During the onset of the rainy season, the soils expand, cracks close and water cannot infiltrate the soil further leading to flooding of the plain terrain. In addition, the Sub-County is located on the low ridges into which rivers occasionally break causing loss of property and human life due to flooding (KCIDP, (2013); KEDDP, (2008)). The main land use activities in the catchment include indigenous and

plantation forests, agriculture and shrub land. On the upper reaches of the catchment, agricultural activities include subsistence farming of food crops (e.g. maize, millet, sorghum, potatoes) and cash crops (e.g., tea, coffee, and sugarcane) and dairy farming.

This area has suffered extensive deforestation in the past to create room for human settlement and farming, mostly without regard to best land use management practices, putting severe environmental strain on the lower catchment, including Nyando Wetland. On the lowlands within the Kano Plains, large-scale sugarcane plantations, rain-fed food crops and rice production, as well as cattle grazing are common. The extremely heavy soils combined with a warm climate, relatively low rainfall and repeated flooding make farming an unattractive as an economic venture. Urban centres and industries in the catchment include Nandi Hills and Kericho on the upper reaches, Chemilil, Muhoroni and Londiani on the middle-reaches and Ahero near the river mouth.

3.2 Study Design

A community based cross-sectional study design was employed to gather both quantitative and qualitative data methods in order to describe knowledge and practices related to environmental management for malaria control among the study communities.

3.3 Study Population

Households in Kore and Ahero irrigation scheme in Nyando Sub-County were considered as source population of the study**.** This study mainly targeted 323 adult members of households at village level, community leaders and community health workers. Since environmental management for malaria control is an intervention that requires entire community participation, the study sought to capture the ideas of all of them to meet its objective.

3.4 Sample Size Determination

The study had a sampling frame of 12,592 (KNBS 2010), from which a sample size was calculated by Fisher, *et al*.,(1998) formula, as cited in Mugenda & Mugenda, (2003). Thus:-

$$n = \frac{Z^2pq}{d^2}$$

where:

n = desired sample size (if the target population is greater than 10,000)

z = standard normal deviate at the required confidence level, set at 1.96

p = people at risk of malaria in Kenya estimated at 70% (Munala & Kariuki, 2009).

q = Statistical notation for 1-P

d = margin of error at 5%

(Fisher *et al*., 1998

Therefore, Z= 1.96; p = 0.7; q = 0.3; d = 0.05

In substitution,

$$n = \frac{1.96^2 x\ (0.7)\ (0.3)}{0.05^2} = 322.7$$

Hence, a sample of **323** households was estimated for the study region.

3.5 Sampling

3.5.1 Sampling Techniques

Systematic sampling technique was used to select households. Lists of the households given by village chairmen were used as a sampling frame.

3.5.2 Sampling Procedure

A systematic sampling was used to select the 323 household respondents from the sampling frame of 12,592. This was done by selecting every fixed interval (K^{th}) household from the compiled list of the households as given by the village elders. The K^{th} number was obtained by dividing 12,592 by 323. This resulted in a sampling interval of 38. Thus every 38^{th} household, starting from a randomly picked number within the first 38 households was selected. This continued until all the required 323 households were selected.

3.6 Inclusion and Exclusion Criteria

3.6.1 Inclusion Criteria

Household's head or their spouse from the selected households in the study villages who had stayed in the study area for at least one year and consented was interviewed. This included any other person aged above 18 years acting as the head of household if household head was not available.

3.6.2 Exclusion Criteria

Visitors, household heads who had not stayed in the study area for at least one year, household heads who did not consent and any other person below 18 years was not interviewed.

or persons below 18 years from the selected households in the study villages who had not stayed in the study area for at least one year and/or those who were not consented were not interviewed.

3.7 Study Variables

Independent variables

- Knowledge on environmental malaria control
- Practices on environmental malaria control

Dependent variable

- Environmental malaria control

Intervening variable

- Socio-demographic factors

3.8 Study Instruments

To collect the necessary data, several instruments were applied. These instruments included; semi structured questionnaire guide (Appendix II) for community household members, Focus Group Discussion guide (Appendix III) for other selected adult community members and Key Informant Interview guide (Appendix IV) for community leaders.

Qualitative data were collected using Key Informant Interviews (KII) and Focus Group Discussions (FGD). Fossey *et al.*, (2002) recommends qualitative research, for it facilitates in-depth understanding of issues pertaining to community practices. Quantitative data was collected using semi structured questionnaires, which was developed based on the study objectives and were used to collect information from the selected households in each village.

It is advantageous to use both qualitative and quantitative methods concurrently since there is the possibility of assessing varied objectives and both methods complement each other as quantitative methods provide hard data for answering questions while qualitative methods provide in-depth information. Both methods also reduce bias as they check each other (Mugenda & Mugenda, (2003); Kombo & Tromp, (2006).

3.9 Training the of Data Collectors

Data collectors were trained before commencement of the study. The principal researcher trained the data collectors on use of the research tool, administration of questionnaires and collection of complete and reliable data. Adherence to participants' confidentiality and privacy was also discussed. The principal researcher ensured that data collectors were properly conversant with all instructions and questions in questionnaires to minimize errors during data collection.

3.10 Pre-testing the Study Instrument

The study instruments were pretested in the field at Obumba county assembly ward in Nyando Sub-County. A total of 16 questionnaires were administered in 16 households, which is 5% of the sample size as proposed by Mugenda & Mugenda (2003). This was purposely to help ensure correct design of instruments, flow of questions, ease of understanding and posing of questions, and to gauge the length of time required to administer the questionnaire. Any unclear and distorted questions were corrected before commencing the fieldwork. Research activities were later undertaken in June 2011.

3.11 Data Collection Procedure

Semi-structured questionnaires were administered to 323 randomly selected household heads or their representatives. Only one adult was interviewed per household. Each selected household was visited using a village chairman as a guide. If any head of household declined to participate, that household was substituted with the household located directly to its right. A household roster was collected from the village chairman for each study village. The total number of households per village was determined by the village population. The questions focused on various sub-themes like, socio-demographic characteristics of the respondent, issues concerning knowledge and practices related to environmental management for malaria control among the

study communities. Questionnaires were prepared in English and verbally translated into the local language (Luo) during interview time when necessary.

Qualitative data collection activities were held in study villages. Four focus group discussions (FGDs) each having eight to twelve participants were conducted in the two regions and participants were purposively sampled from the community based on inclusion criteria. The participants of the discussion consisted of an age-representative sample of men and women from each village who discussed the topics contained in the surveys in more detail. The FGDs were homogenous by sex. FGD samples for adult men and women were held separately, considering the cultural norm and opportunity for free expression of opinion. The discussions were organized at a common place such as community centres and *barraza* meeting points, accessible to all socio-economic groups. The principal researcher moderated the FGD discussions, while all the discussions were audio recorded and noted down by one data collector.

Three Key informant interviews (KIIs) were also conducted with key informants (village chairmen and community health workers). The key informants were purposively selected according to their roles and responsibilities with malaria service delivery and influence on the community in the study area. The discussions revolved around the themes on malaria and mosquito knowledge, land use and irrigation, information sources and community participation in environmental management for controlling malaria.

3.12 Data Coding Entry and Quality Control

Quantitative data questionnaires were corded with serial number and entered into SPSS to facilitate tracing of questionnaires during data cleaning. Data entered into SPSS was cleaned by checking completeness. Any inconsistencies noted were resolved by re-examining the questionnaires as part of the quality control. During data collection, Quality control was

observed through verification of questionnaires for completeness immediately after each data collectors handed in the questionnaires to the principal researcher and any missing information or clarification was sought from the respondents.

3.13 Data Analysis and management plan

The quantitative data collected were cleaned, coded and entered in SPSS version 20. Descriptive statistics were used to measure frequencies and percentages of variables. The results were presented in form of tables, pie charts and graphs. A bivariate analysis (Chi-square test) was applied to examine the influence of socio-demographics on knowledge and practices in environmental management of malaria among the study communities. A cut-off value of $P = 0.05$ was used to determine statistical significance in all analysis that was conducted for this study. These results were presented in form of figures and tables.

All the KIIs were conducted by the principal researcher who recorded all the discussions with the key informants. All recordings were later transcribed and translated into English by the principal investigator. All the data collected were then kept well for reference. For qualitative data analysis, the investigator transcribed verbatim-recorded information in a transcript. Transcription was conducted on a daily basis. After transcription, the transcripts were corded into themes based on research questions. Final analysis included comparison of the findings between groups by themes and triangulation with quantitative data based on research question and study objective..

3.14 Ethical Consideration

Approval for the study was first obtained from Maseno University, School of Graduate studies (Appendix VI). The study also received ethical approval from the Ministry of Education Science and Technology (Appendix VII). In addition, the heads of the communities were involved in

population sensitization to participate in the survey. The questionnaire was administered after explaining the purpose of the study. Both written (Appendix I) and verbal informed consents were obtained from the participants. Respondents were given the right to refuse to take part in the study as well as to withdraw any time during the interview. Confidentiality of information was maintained throughout the study period.

CHAPTER FOUR

RESULTS

4.1 Introduction

This chapter deals with information on the data analyzed and the processes of data analysis involved. It has information relating to inferential statistics and descriptive statistics, especially the findings made.

4.2 Response Rate

A total of 323 (100% response rate) individuals in various households were successfully interviewed**.** There were a total of 323 questionnaires to the respondents on which data was sought for making of summaries based on the statistical procedures outlined in the chapter on research methodology.

4.3 Socio-Demographic Characteristics of the Respondents

4.3.1 Gender

The study participants consisted of 62.5% (n=202; CI: 57.3 – 66.9) female, and 37.5% (n=121; CI: 32.3 – 42.8) male (Table 4.1).

Table 4.1: Gender of the Respondents

Gender	N=323	95% CI
	n	**%**
Male	**121**	**37.5**
Female	**202**	**62.5**

4.3.2 Age

Figure 4.1 indicates that 46.3% (n=150; CI: 42.1-51.0) of the respondents were 45 years and above. The rest of the respondents were fairly evenly distributed across the remaining age groups

with those aged between 18 and 25 years being 18.3% (n=59; CI: 14.7-22.3), those aged between 26 and 35 years at 17.1% (n=55; CI: 12.4 – 21.6) and those aged between 36 and 45 at 18.3% (n=59; CI: 14.6 -22.0).

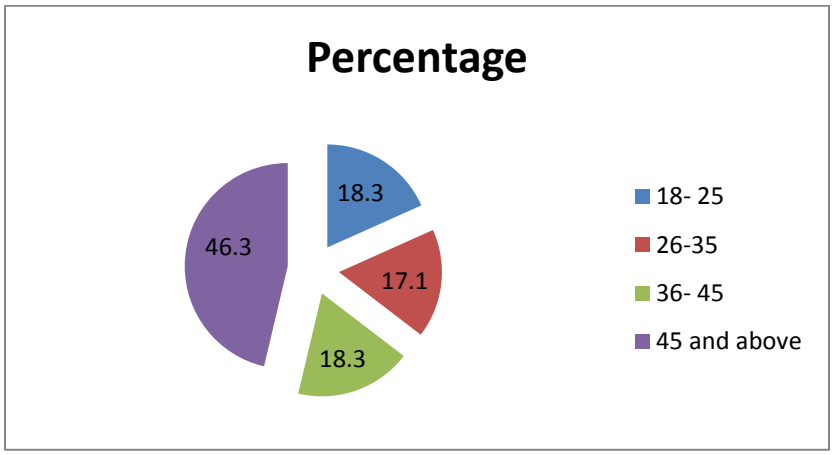


Figure 4.1: Age of the Respondents

4.3.3 Marital Status

The majority of the respondents 71.2% (n=230; CI: 66.3 – 75.9), were married as opposed to only 4.0% (n= 13; CI: 1.9 – 5.9), 2.2% (n=7; CI: 0.7-4.0) and 22.6% (n=73; CI: 17.6 – 27.4) who were single, divorced and widowed respectively (Figure 4.2).

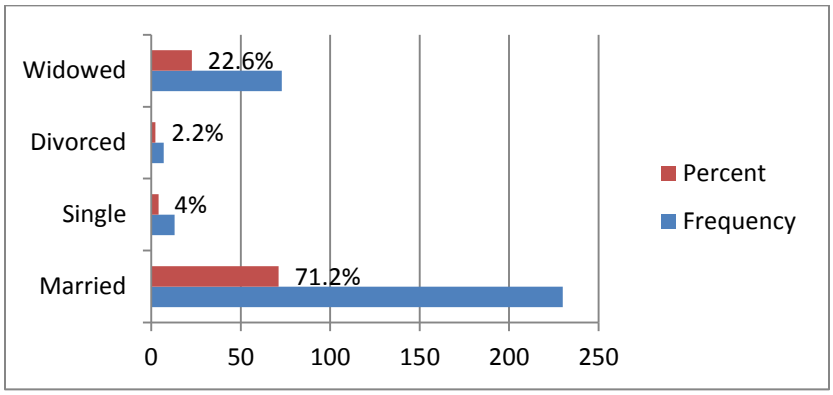


Figure 4.2: Marital Status of the Respondents

4.3.4 Education

Table 4.2 shows that 54.5% (n=176; CI: 48.8 – 59.6) had only acquired primary education. 19.2% (n=62; CI: 15.2 – 23.2) had no formal education. Of all the respondents, only 26.3% (n=85) were educated beyond primary school.

Table 4.2: Level of Education of the Respondents

Education level	N=323	95%CI
	n	%
not gone to school	62	19.2
primary school level	176	54.5
secondary school level	77	23.8
post-secondary	6	1.9
university level .	2	0.6

Figure 4.3 below demonstrate that, among the 19.2% of the respondents who had no formal education, there were more women than men. On the other hand, both male and female equally attained primary education and above.

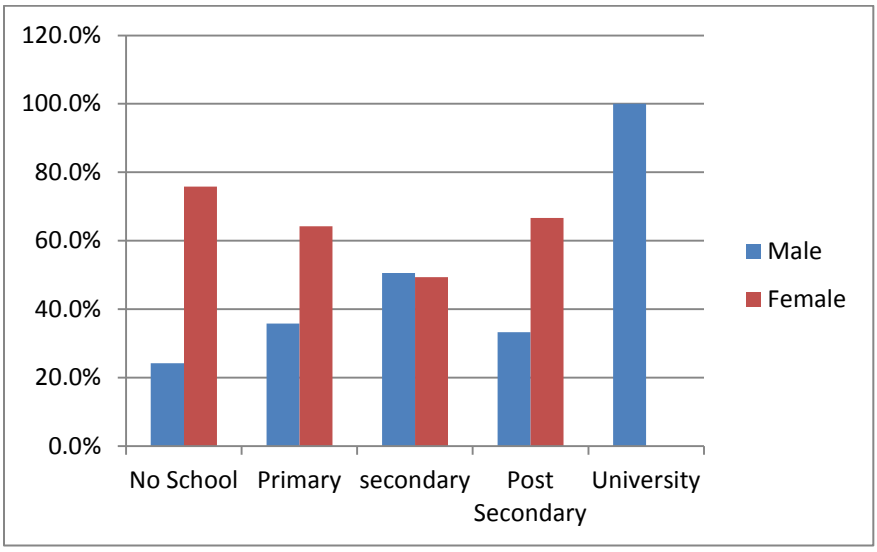


Figure 4.3 Respondents' Level of Education versus Gender

4.3.5 Occupation

Figure 4.4 shows that most of the study participants, 71.2% (n=230; CI: 65.9-76.2) were small scale farmers, others were in business 20.7% (n=67; CI: 17.0 – 24.1), some were employees 1.9% (n=6 CI: 0.6 – 3.4 and the rest were unemployed 6.2% (n= 20; CI: 3.4-9.6).

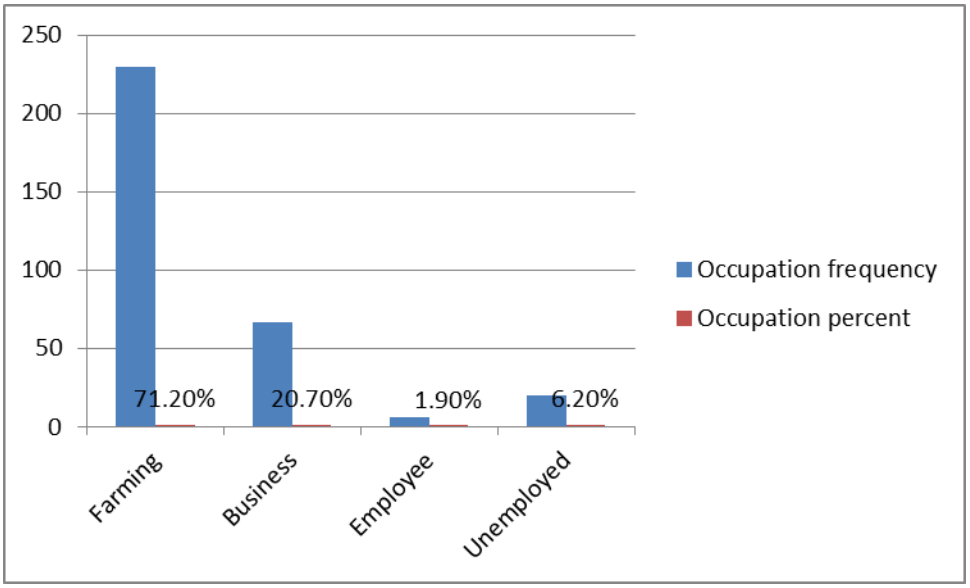


Figure 4.4: Occupation of the Respondents

4.3.6 Religion

Table 4.3 indicates that almost all 99.7% (n=322; CI: 99.4- 100) of the respondents were Christian. Only 0.3% (n=1; CI: 0.0 – 0.9) was a Muslim.

Table 4.3: Religion of the Respondents

Religion	Frequency	Percent
	N=323	**95%CI**
Christian	322	99.7
Muslim	1	0.3
Total	323	100

4.4 Knowledge on Risk Factors of Malaria

Table 4.4. Indicates that most of the respondents 94.4% (n=305; CI: 92.6-96.0) knew correctly that mosquitoes were a risk factor for malaria.

The FGD respondents also confirmed this position as illustrated in the following quotation.

> "*Mosquitoes transmit malaria to humans, when an infected mosquito bites another person*" (*Male FGD participant, Wasiese Village).*

Table 4.4: Respondents Knowledge on risk Factors of Malaria (Objective 1)

Risk factors	**N = 323**		**95%CI**	
	Yes		No	
	n	**%**	**n**	**%**
Mosquito bites	305	94.4	18	5.6
Stagnant water	70	21.7	253	78.3
Evil Spirits	1	0.3	322	99.7
Stepping on cold water	26	8.0	297	92.0
Fleas and ticks	3	0.9	320	99.1
Bushy places	22	6.8	301	93.2

Other risk factors of malaria mentioned included stagnant water 21.7% (n=70; CI: 74.0 – 82.0);stepping on cold water 8.0% (n=26; CI: 5.6 – 10.8), evil spirits 0.3% (n=1; CI: 0.0 – 0.9), fleas/ ticks 0.9% (n=3; CI: 0.0 – 2.2) and bushy places 6.8% (n=22; CI: 4.6 - 9.3). These incorrect risk factors of malaria were also mentioned in FGDs and KII as below.

> *"Other people take frequent showers. Others also drink this raw water. This is what brings this problem" (Female FGD participant, Kochieno Village).*

> *"You see…people here just drink the available stagnant water around without boiling. This is what sometimes brings to them this problem of malaria"* (*Male FGD participant, Konunga Village)*

> *"When we work in the rice farms, we step in water for a long time; this is one of the things that 'brings' malaria to our people here" (community leader, Kobura village)*

4.4.1: Knowledge on Factors that Increase Mosquito Population

Notably, as shown in Table 4.5, most of the respondents 91.0% (n=294; CI: 87.9 – 94.4) knew rightly that stagnant water contribute greatly to the increase of mosquitoes. Other factors mentioned in addition to stagnant water were bushy places 58.2% (n=188; CI: 52.6 – 62.7), disposed containers 22.3% (n=72; CI: 17.6 – 26.6), farming methods 5.9% (n=19; CI: 3.7 – 8.0) and domestic animals 0.9% (n=3; CI: 0.0 – 2.2).

Table 4.5: Respondents' Opinion on Factors that Increase Mosquito population (Objective 1)

Factors	N = 323		95%CI	
	Yes		No	
	n	%	n	%
Bushy places	188	58.2	135	41.8
Stagnant water	294	91.0	29	9.0
Farming methods	19	5.9	304	94.1
Disposed containers	72	22.3	251	77.7
Domestic animals	3	0.9	320	99.1

4.4.2 Knowledge on Relationship between Heavy Rainfall and Mosquito Population

Majority of the respondents 84.8% (n=274; CI: 80.8 – 88.8) were able to reason that heavy rainfall increases mosquito population due to more stagnant water (Table 4.6). 64.1% (n=207; CI: 57.6 – 69.3) stated that in addition to stagnant water, heavy rainfall increases mosquito population due to more vegetation. Some respondents related heavy rainfall to warm temperature and decrease in mosquito population. The FGD participants also reported a higher incidence of malaria during the rainy season. Some respondents related rains to more mosquito breeding sites hence more cases of malaria.

> "*During rainy seasons there is stagnated water all over the area, and most of the people have rice and maize farms close to their houses, thus the grasses in the farms contribute to mosquitoes" (Female FGD participant, Kochieno Village)*

Table 4.6: Perception of the Respondents on Heavy Rainfall versus Increased Mosquito population (Objective 1)

Heavy rainfall increases mosquitoes due to	**N = 323**			**95%CI**
	Yes		NO	
	n	%	n	%
More stagnant water	274	84.8	49	15.2
More vegetation	207	64.1	116	35.9
Warm temperature	15	4.6	308	95.4
Does not affect mosquitoes	1	0.3	322	99.7
Decrease mosquito population	14	4.3	309	95.7

4.4.3 Knowledge of Vector-Breeding Habitats

The majority 82.7% (n=267; CI: 77.6 – 86.3) of the respondents were rightly aware of a major breeding habitat as stagnant water. However, others mentioned other breeding habitats as disposed containers 14.6% (n=47; CI: 11.1 – 18.6, bushy places 15.5% (n=50; CI: 83.3 – 91.3) and also dark places in the house 0.9% (n=3; CI: 0.0 – 2.2) in addition as in Table 4.7.

FGD participants presented varied responses about mosquito larvae habitats. Some respondents mentioned stagnant water while others mentioned places that were ecologically unlikely to support growth of larval Anopheles mosquitoes (e.g., bushes, latrine pits, and rubbish pits).

> "*Most of the time, you will find the immature mosquitoes resting on top of the stagnant water around" (Female FGD participant, Kobura Village*)

> *"Immature mosquitoes also rest in damp places like where people throw garbage, and even in the latrine pit." (Male FGD participant, Madiaba Village)*

Table 4.7: Respondents' Knowledge of Vector-Breeding Habitats (Objective 1)

Breeding Habitats	N = 323			95%CI
	Yes		No	
	n	%	n	%
Stagnant water	267	82.7	56	17.3
Disposed container	47	14.6	276	85.4
Dark places in houses	3	0.9	320	99.1
Bushy places	50	15.5	273	84.5

4.4.4 Knowledge of Relationship between Mosquito Larvae and Malaria

Majority of the respondents 87.3% (n=282; CI: 83.3 – 91.3), knew correctly that reduction of mosquito larvae would reduce malaria. On the other hand 6.8% (n=22; CI: 4.3- 9.3), could not relate the mosquito larvae with malaria, while a few respondents 5.9% (n=19; CI: 3.7 – 8.0), did not know whether reduction of mosquito larvae would reduce malaria incidences (Figure 4.5).

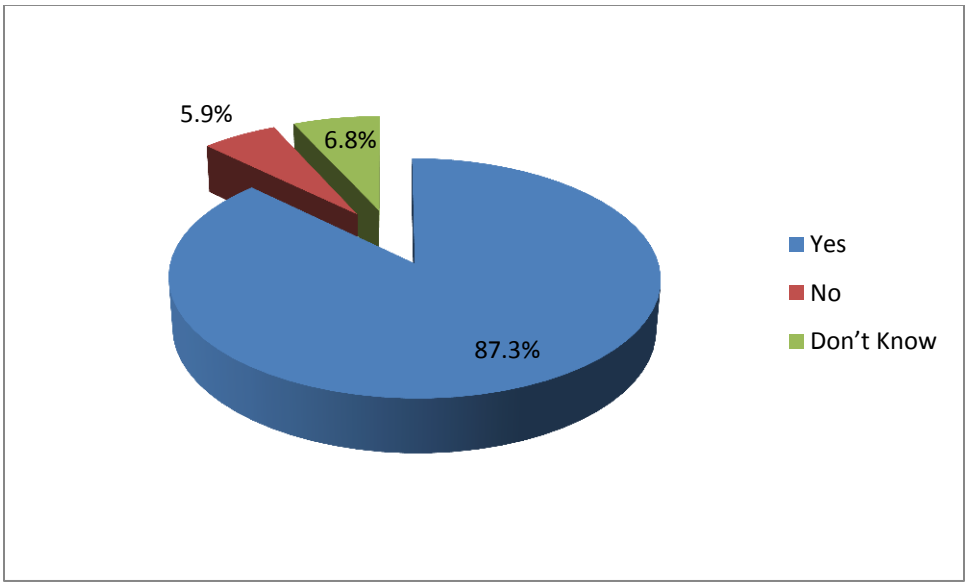


Figure 4.5: Respondents Relating Mosquito Larvae to Malaria (Objective 1)

In an in-depth understanding in the qualitative interviews about symptoms and signs of malaria as well as information sources, the respondents mentioned the symptoms of Malaria as feeling cold, shivering, weakness, intermittent fever, vomiting, diarrhea and headache. They also mentioned that they got information about malaria from C.D.C staff that mostly carried out different activities on research within their villages. Nearby health centers, community dispensary and *barazas* were also mentioned as sources of information

"Malaria is the common illness in this area. Whenever you see someone diarrhearing, Vomiting, having a lot of headache and weakness, know that they are suffering from Malaria" (Female FGD participant, Wasagra village).

"

We get this information about malaria from the C.D.C people who frequently visit with us for research; sometimes we also get information when we attend barazas. Mostly women get the information when they visit health centers and community dispensaries". (Female FGD participant, Kochieno Village)

4.5 Knowledge of Preventive Measures

Table 4.8 indicates that majority reported bed nets 89.8% (n=290; CI: 87.0 – 92.6), as a malaria preventive measure. Clearing vegetation was mentioned by 60.4% (n=195; CI: 56.0 – 64.7). 39.0% (n=126; CI: 34.1 – 44.6) of the respondents believed that malaria can be prevented through draining stagnant water. Other preventive methods reported by the respondents were insecticide spray 12.7% (n=41; CI: 9.6 – 15.8) and burning of disposed containers 6.5% (n=21; CI: 4.3 = 8.4). Traditional methods like burning of cow dung smoke14.2% (n=46; CI: 11.1 – 17.6), use of traditional plants 3.4% (n=11; CI: 2.2 – 5.0) were reported in small percentages in the study area. These findings triangulated well with the qualitative data. For example in the FGD, on the question on "What can be done to reduce the population of mosquitoes." Respondents reported prevention modalities that could be applied".

Table 4.8: Malaria Prevention Methods reported by the respondents (Objective 2)

Practices to reduce mosquito population	N = 323		95%CI	
	Yes		No	
Drain stagnant water around home	n	%	n	%
	126	39.0	197	61.0
Clear grass and bush around home	195	60.4	128	39.6
Use bed nets	290	89.8	33	10.2
Spray insecticides in the houses	41	12.7	282	87.3
Burn disposed containers	21	6.5	302	93.5
Use traditional plant	11	3.4	312	96.6
Use cow dung smoke	46	14.2	277	85.8

Use of mosquito bed nets was mentioned among the respondents. Other modalities mentioned included interfering with the breeding places by using paraffin on stagnant water, cleaning compounds, use of mosquito coil, fumigating the house in the evenings with smoke from cow dung, weeds or waste from crops.

> "*Every evening I burn cow dung cakes or waste of harvest to produce smoke so as to keep the mosquitoes away before I close all the windows and doors." (Female FGD participant, Obumba Village)*

> *"Every time I see any stagnant water around me, I usually pour paraffin on the stagnant water to help in the interfering of the breeding places of the mosquito. The only challenge that i usually experience with this, is that sometime i lack money to purchase the paraffin" (Male FGD participant, Kolal Village).*

Further in the KIIs, respondents reported their role towards malaria prevention methods and other health problems. They mentioned that they talk to those suffering from different health problems and advise them on how they can prevent the occurrence of common diseases including malaria. The following quotation illustrates what one of them reported.

> *"I talk to people during the 'barazas' to ensure that they keep their surroundings clean from bush and dirty water. I also tell them to burn cow dung and wastes from harvests, so*

as to chase the mosquitoes in the evenings."(Area Sub- Chief, KII participant, Kobura Village)

When asked in an FGD whether they would be willing to participate in the environmental management for malaria control programme, FGD respondents reported that it was not possible. The reported reasons for not participating were lack of time, lack of commitment to the community work and lack of incentive to award the work done within the community. Some of their reports are given in the following quotation:

"*Members of the community cannot participate because most people don't see the importance of draining water and managing vegetation, for they do not gain anything in return" (male FGD participant, Ombeyi village).*

"*There are occasions that through chief, we have been informed to clear bushes and drain the stagnant water around our homes but just a few people respond to the call, and they don't maintain the practice for long." (Male FGD participant, Wangaya village).*

4.6 Effective Environmental Management Practices for Malaria Control

When asked which among the vector control methods applied gave immediate noticeable potential in reducing adult mosquito population, the majority of the respondents 85.4% (n= 276; CI: 81.7-88.9) mentioned bed nets. Besides bed nets, others felt that clearing grass and bush around the home was also effective 36.8% (n=119; CI: 32.2 – 41.8). Draining stagnant water around the home was also considered effective by 27.6% (n=89; CI: 23.5 – 31.9). The rest of the control methods like insecticide spray, use of larvicides and the traditional methods were mentioned in small percentages in the study (Figure 4.6).

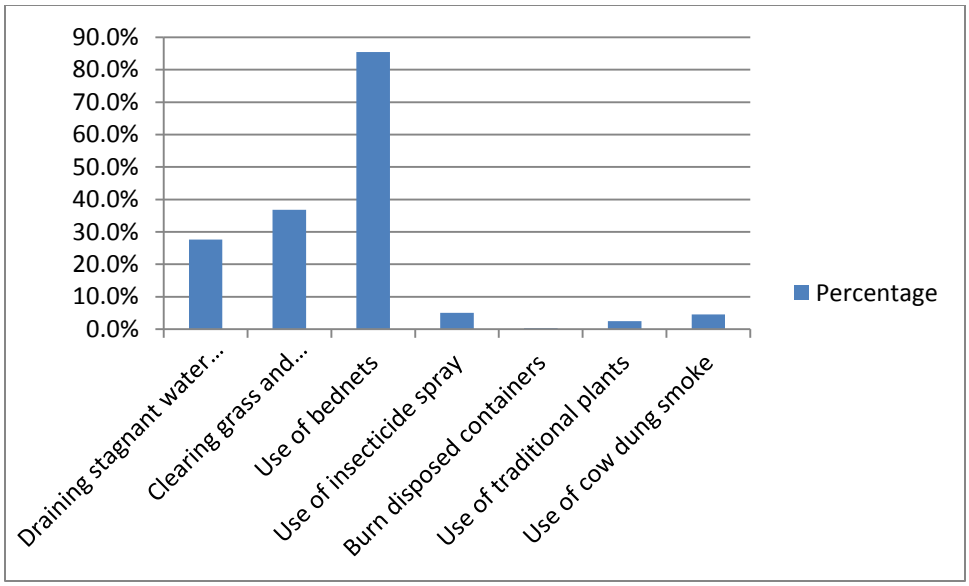


Figure 4.6: Effective Malaria Prevention Methods for the Respondents. (Objective 2)

Among respondents who reported that bed nets were the most effective protective method against malaria, 97.2% (n=314; CI: 95.7 – 98.1) confirmed ownership of one or more nets. Of these, 54.2 %(n=175; CI: 48.3 – 60.1) said they had treated their nets, 35.9% (n=116; CI: 31.0-40.2) had not treated their nets, while 9.3% (n=30; CI: 0.0- 1.9) were not sure whether their nets were treated or not. Majority 95.0% (n=307; CI: 92.9 – 96.6). of the respondents, indicated that they slept under a bed net the night before the interview, which was held during the main malaria transmission season. Most of them 87.9% (n=284; CI: 84.5 – 90.7), reported that they sleep under a net throughout the year, while a few 9.3% (30) only used a net when mosquitoes are abundant. In 97.2% of the net-owning households, almost every family member in various households was reported to be using nets 81.4% (n=263; CI: 77.1 – 85.4).

FGDs respondents also confirmed use of bed net as the most effective method for community members.

> "*Most of us find bed net working very well. That is why you cannot miss it in each home. Mosquito nets keep the mosquitoes away when we sleep" (Female FGD participant Kobura Village)"*

4.7 Influence of Socio-Demographics on Knowledge and Practices

Table 4.9, Table 4.10 and Table 4.11 describe the socio-demographic influence on knowledge and practices of environmental management of malaria. Gender, occupation and education were identified as important factors influencing certain knowledge and practices on malaria control. For example in gender only 28.9% of men and 17.3% women associated stagnant water as a malaria risk factor (P=0.014); both males (90.1%) and females (81.7%) associated rainy season with increased mosquito population (P=0.042). Stagnant water associated with gender (p=0.001) with 91.7% of males and 77.2% females.

Practices such as clearing of grass and bush (P=.001), use of bed nets (p=.001) and use of traditional plants (p=0.001) were associated with gender. For example clearing grass and bushes, more males (71.9%) than females (53.5%) made the association; however, use of bed nets as a malaria preventive measure associated with both females (94.1%) and males (82.6%).

Table 4.9: Influence of gender on knowledge and practices (Objective 3)

Knowledge and practices	N=323	95%CI		
	% Responses	Gender		*P*
Knowledge		**Male**	**Female**	values
Stagnant water as a risk factor for malaria	21.7	28.9%	17.5%	**0.014**
Increased rain increases mosquitoes due to stagnant water	84.8	90.1%	81.7%	**0.042**
Stagnant water as a mosquito breeding habitat	82.7	91.7%	77.2%	**0.001**
Practices				
Clearing grass and bush	60.4	71.9%	53.5%	**0.001**
Use of bed nets	89.9	82.6%	94.1%	**0.001**
Use of traditional plants	3.4	6.6%	1.5%	**0.014**

Considering stagnant water as a malaria risk factor was found to be associated with Occupation (P=0.045). More (37.5%) of unemployed people considered stagnant water as a malaria risk factor as opposed to 23.5% of famers, 16.7% of employees and 10.4% of those in business. Considering disposed containers as a factor that increase mosquito population, was again significantly associated with Occupation (P=0.000), For example, 62.5% of the unemployed associated disposed containers with increased mosquito population as opposed to 37.5% of business people, 15.2% farmers and 16.7% employees.

Practices such as draining stagnant water (P=0.002) burning disposed containers (P=0.000) and use of cow dung smoke (P=0.013) were associated with Occupation. For example, in draining stagnant water, more of those in business (59.7%) made the association as opposed to 43.8% unemployed, 33.0% famers, and 16.7% employees. On the other hand in burning disposed containers and using cow dung smoke, more employees 50% and 33.3% made the association respectively.

Table 4.10: Influence of occupation on knowledge and practices (Objective 3)

Knowledge	**N=323**	**95%CI**				
	% Responses	Occupation				*P* values
		Farming	**Business**	**Employee**	**Unemployed**	
Stagnant water as a risk factor	21.7	23.5%	10.4%	16.7%	37.5%	**0.045**
Disposed Containers increases mosquitoes	22.3	15.2%	37.3%	16.7%	62.5%	**0.000**
Practices						
Draining stagnant water	39.0	33.0%	59.7%	16.7%	43.8%	**0.002**
Burning disposed containers	6.5	6.1%	6.0%	50.0%	.00%	**0.000**
Use cow dung smoke	14.2	17.8%	3.0%	33.3%	6.3%	**0.013**

Clearing of grass and bush around home (P=0.004), draining stagnant water around the home (P=0.004) and spaying insecticide (P=0.034), was associated with education. For example those who had attained post-secondary education (66.7%) associated clearing grass and bush around the home and draining stagnant water around the home (83.3%). Further, all of whom had attained post-secondary education and university education reported that spraying insecticide was not an environmental practice for malaria prevention.

Table 4.11: Influence of education on practices (Objective 3)

Practices		N=323		95%CI			
	% Responses	Education					*P* values
		Not gone to school	**Primary education**	**Secondary education**	**Post-secondary education**	**University**	
Draining stagnant water	39.0	32.3%	33.0%	58.8%	66.7%	50%	**0.004**
Clearing grass and bushes	60.4	41.9%	60.8%	72.7%	83.3%	50.0%	**0.004**
Spray insecticides	12.7	8.9%	11.3%	16.7%	0.00%	0.00%	**0.034**

CHAPTR FIVE

DISCUSSION

5.1 Introduction

This chapter presents discussion of the findings of this study. The results have been discussed exhaustively and comparison made with relevant literature. The discussion has also been done guided by the objectives and an attempt to answer the research questions that have been highlighted in the study.

5.2.1. Knowledge of the Respondents on Environmental Management for Malaria Control

The knowledge was determined on the basis of statements framed to gauge opinion. Each of statements related to an element within the concept of the extent of knowledge with regard to environmental management for malaria control. Unlike many malaria-endemic-prone and malaria-epidemic-prone settings in Africa, as stated by Deressa *et al.,* (2003), knowledge on the risk factor associated with malaria was relatively good in Ahero and Kore irrigation scheme. The results of the survey indicate that the majority of community members in the study area 305 (94.4%) were knowledgeable on the links between environmental conditions, mosquitoes, and malaria. This is probably due to the fact that the area is prone to malaria and failing to adhere to environmental management practices would lead to attack. Similar observations were made in Ethiopia, where almost all 98.2% of the respondents knew that mosquito bite transmits malaria (Astatkie, 2010). A comparable observation was also made in other malaria endemic countries such as India (Vijayakumar *et al*., 2009) and Ethiopia (Karunamoorthi & Kumera, 2010).

Majority of the Respondents (84.8%) were knowledgeable that heavy rainfall increases mosquito populations due to presence of more stagnant water. This finding, to a large extent, is in agreement with that from Mvomero Tanzania where majority, 87% of respondents, believed that

greater or heavy rainfall increases mosquito populations, leading to more malaria cases (Randell, 2008). The community had knowledge of the different possible sources of mosquitoes. Majority of the community members mentioned that the mosquito breeds in stagnant water (82.7 %). Previous studies in Ethiopia confirmed similar findings whereby the community identified stagnant water as the source of mosquitoes (Jimma *et al.,* 2005; Deressa *et al.,* 2003).

Despite the fact that respondents were able to link between environmental conditions, mosquitoes and malaria, few respondents showed misconceptions on the mode of transmission and prevention methods. One of the key respondents mentioned use of paraffin on the stagnant water yet this practice is regarded as a pollutant to the environment. Similar observations have been made in almost all KAP studies on malaria, in Kenya (Opiyo *et al.,* 2007) and other parts of the world (Simsek & Kurcer,2005). Such misconceptions should be corrected through simple health education messages if malaria prevention and the national elimination programmes have to sustain and increase their successes.

5.2.2 Effective Environmental Management Practices Applied by the Respondents for Malaria Control

It was established that the respondents had knowledge on environmental preventive measures. Multiple preventive measures were reported by the respondent. This is consistent with what was observed by Ng'ang'a *et al.* (2008). It is also in agreement with what was observed in Nigeria and Ethiopia where it was also indicated that community members were aware of malaria control practices (Olayemi *et al.,* 2012; Abate *et al.,* 2013). Knowledge on the use of bed net as a preventive measure against mosquito bite was highest among the respondents (89.8%). Similar high level of knowledge on preventive use of bed net had been observed in other studies in Ethiopia (Abate *et al*., 2013).

Despite the fact that the respondents were able to mention multiple mosquito preventive measures so as to control malaria, the findings from FGDs indicated that, applying these practices as a community responsibility was just a verbal claim. Reported reasons for not applying the practices were, lack of commitment, and lack of incentive to award the work done within the community. Similar observations have been made in other studies in different parts of the world whereby despite the right knowledge on malaria control practices nobody accept to apply practices (Mutuku *et al.,*2006). This then implies that knowledge alone may not be always a strong enough motivating forces to encourage people to undertake the time-consuming practice of draining stagnant water or engaging in other environmental management techniques. According to Singh *et al.,* (2014) knowledge does not necessarily translate into improved practice of preventive measures. In a similar view, Randell (2008) argues that it is important to note that education is merely one component of a successful community-based environmental management programme. Such a programme must understand time and resource constraints along with other drivers of household behaviours.

Based on the outcomes of this survey, the majority respondents 85.4% (276) confirmed to have had immediate effect in reducing the number of mosquitoes through bed nets. Clearing grass, bush and draining stagnant water followed with a few respondents considering them as effective. The findings of this study indicate use of bed net as the most effective method. Other studies have also documented similar results in this regard. For example; a study done by Hawley *et al.,(*2003) in western Kenya explain that ITNs have proved to be one of the most effective malaria prevention measures as it does not only reduce malaria transmission by as much as 90% under clinical trials but also reduces the indoor vector population.

5.3 Influence of Socio-Demographics on Knowledge and Practices in Environmental Management of Malaria Control.

The study sought to determine the influence of socio-demographics on knowledge and practices. Gender, occupation and education, were identified as important determinants that influenced certain knowledge and practices on malaria control. More male (28.9%) mentioned stagnant water as a risk factor for malaria. Both males and females associated rainy season with increased mosquito population and as well linked stagnant water as a mosquito breeding habitat. In clearing of grass and bushes, more males (71.9%) than females (53.5%) made the association; however, both females (94.1%) and males (82.6%) associated use of bed nets with malaria prevention.

Majority of those unemployed (37.5%) mentioned stagnant water as a risk factor for malaria. 62.5% of the unemployed associated disposed containers with increased mosquito population as opposed to other occupations. In draining stagnant water, more of those in business (59.7%) made the association as opposed to other occupations. On the other hand in burning disposed containers and using cow dung smoke, more employees made the association. Those who had attained post-secondary education (66.7%) were associated with clearing grass and bush around the home and draining stagnant water around the home (83.3%). Further, all of whom had attained post-secondary education and university education reported that spraying insecticide was not an environmental practice for malaria prevention.

Previous studies done at Rusinga Island, Western Kenya by Opiyo *et al.*, (2007), were confirmed by this study in which age and education were seen to be the prime factors responsible for a good knowledge and behaviour. This study also supports the findings of a study done at rural northwest Tanzania by Mazigo *et al.*, (2010), which reported that socio-demographic factors

such as education and gender are identified as important determinants that influenced practice of malaria elimination measures, especially related to possession of mosquito nets and their usage. Another study done by Chirebvu (2014) on assessment of risk factors associated with malaria transmission in Tubu village, Northern Botswana also reported similar findings that, those houses with at least a member having primary or secondary level of education had knowledge about malaria and with significantly high level of ITN ownership than those with no knowledge.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter presents conclusions drawn and recommendations made which are based on the findings of the study. These conclusions are based on the three objectives which guided the study.

6.2 Conclusions .

i. The study revealed that the respondents had knowledge on environmental management for malaria control except that there were some misconceptions whereby some respondents reported stepping on cold water, evil spirits, drinking contaminated water, bites from fleas and ticks as risk factors for malaria

ii. Environmental practices such as draining stagnant water around homestead, clearing grass and bush around homestead, use of bed nets, use of insecticides in the houses, burning disposed containers, use of insect repellent plants to interrupt the biting activity, and use of cow dung smoke to keep mosquitoes away, were reported by the respondents. Among the reported practices, Use of bed nets was found to be the most effective.

iii. Education, gender and occupation were found to be the most important demographic factors associated with certain knowledge and practices on environmental management for malaria control

6.3 Recommendations

i. Studies on myths and misconceptions related to the risk factors and transmission of malaria is recommended.

ii. It would be prudent to conduct a study to investigate whether the knowledge about malaria prevention measures are translated to actions.

iii. Appropriate health education on malaria should address attitudes towards taking health action.

6.4 Suggestions for Further Study

i. Factors that hinder the respondents from practicing environmental management for malaria control should be assessed.

ii. More qualitative research should be done to address issues of culture and attitude on environmental management for malaria control

iii. Similar research should be done in other areas so as to increase the availability of data necessary to support and guide malaria control and prevention policy.

REFERENCES

Abate, A., Degarege, A., & Erko, B. (2013). Community knowledge, attitude and practice about malaria in a low endemic setting of ShewaRobit Town, northeastern Ethiopia. *BMC Public Health*, ***13*****(1),** 312.

Adebayo, A. M., Akinyemi, O. O., & Cadmus, E. O. (2015). Knowledge of malaria prevention among pregnant women and female caregivers of under-five children in rural southwest Nigeria. *Peer J Journal, **3***, 79.

Adongo, P. B., Kirkwood, B., & Kendall, C. (2005). How local community knowledge about malaria affects insecticide-treated net use in northern Ghana. *Tropical Medicine & International Health*, ***10*****(4**), 366-378.

Astatkie, A. (2010). Knowledge and practice of malaria prevention methods among residents of Arba Minch Town and Arba Minch Zuria District, Southern Ethiopia.*Ethiopian Journal of Health Science,* **20(3),** 185-193.

Atieli, H., Menya, D., Githeko, A., & Scot, T. (2009). House design modifications reduce indoor resting malaria vector densities in rice irrigation scheme area in western Kenya. *Malaria Journal*,**8**,108.

Atieli, H., Zhou, G., Afrane, Y., Lee, M., Mwanzo, I., & Githeko, A. (2011). Insectice Treated Net (ITN) Ownership, Usage, and Malaria Transmission in the Highlands of Western Kenya. *Parasites and Vectors*,**4**,1–10.

Atkinson, J.A., Fitzgerald, L., Toaliu, H., Taleo, G., Tynan, A., Whittaker. M., Riley, I., & Vallely, A. (2010). Community participation for malaria elimination in Tafea Province, Vanuatu: Part I. Maintaining motivation for prevention practices in the context of disappearing disease. *Malaria J*ournal, **9**, 93-10.

Atkinson, J. A., Vallely, A., Fitzgerald, L., Whittaker, M., & Tanner, M. (2011). The architecture and effect of participation: a systematic review of community participation for communicable disease control and elimination. Implications for malaria elimination. *Malaria journal*, ***10*****(1),** 225.

Bain, L. E., Awah, P. K., Geraldine, N., Kindong, N. P., Siga, Y., Bernard, N., & Tanjeko, A. T. (2013). Malnutrition in Sub–Saharan Africa: burden, causes and prospects. *Pan African Medical Journal*, ***15*****(1).**

Barros, F. S. M., Arruda, M. E., Gurgel, H. C., & Honorio, N. A. (2011). Spatial clustering and longitudinal variation of Anopheles darlingi (Diptera: Culicidae) larvae in a river of the Amazon: the importance of the forest fringe and of obstructions to flow in frontier malaria. *Bulletin of entomological research*, ***101*****(6),** 643-658.

Bashar, K., Al-Amin, H. M., Reza, M.d.S., Islam, M., Asaduzzaman and Ahmed T. U. (2012). Socio-demographic factors influencing knowledge, attitude and practice regarding malaria in Bangladesh. *BMC Public Health*, **1, 10**.

Benelli, G., & Mehlhorn, H. (2016). Declining malaria, rising of dengue and Zika virus: insights for mosquito vector control. *Parasitology research*, ***115*****(5),** 1747-1754.

Bhatt, S., Weiss, D. J., Cameron, E., Bisanzio, D., Mappin, B., Dalrymple, U., & Wenger, E. A. (2015). The effect of malaria control on Plasmodium falciparum in Africa between 2000 and 2015. *Nature*, ***526*****(7572**), 207.

Burrows, J. N., van Huijsduijnen, R. H., Möhrle, J. J., Oeuvray, C., & Wells, T. N. (2013). Designing the next generation of medicines for malaria control and eradication. *Malaria journal*, ***12*****(1)**, 187.

Chirebvu, E., Chimbari, J.M., & Ngwenya, N.B. (2014). Assessment of Risk Factors Associated with Malaria Transmission in Tubu Village, Northern Botswana. *Malaria Research and Treatment.* Available: https://www.hindawi.com/journals/mrt/2014/403069. [Accessed 20 June 2014, at 2000 hrs].

Chitunhu, S., & Musenge, E. (2012). Direct and indirect determinants of childhood malaria morbidity in Malawi: a survey cross sectional analysis based on malaria indicator survey data. *Malaria Journal*, **14, 1**–9.

Cummins, S., Curtis, S., Diez-Roux, A. V., & Macintyre, S. (2007). Understanding and representing 'place'in health research: a relational approach. *Social science & medicine*, ***65*****(9**), 1825-1838.

Deressa, W., Ali, A., & Enquoselassie, F. (2003). Knowledge, attitude and practice about malaria, the mosquito and antimalarial drugs in a rural community. *Ethiopian Journal of Health Development*.***17*****(2)**:99-104.

DOMC - Division of Malaria Control, (2009). Ministry of Public Health and Sanitation. Towards a Malaria-Free Kenya: National Malaria Strategy 2009–2017. Nairobi, Kenya. Available:

http://www.nationalplanningcycles.org/sites/default/files/country_docs/Kenya/kenya_national_malaria_strategy_2009-2017.pdf. [Accessed 27 March 2015, at 2030hrs]

Ediau, M., Babirye, J. N., Tumwesigye, N. M., Matovu, J. K.B., Machingaidze, S., Okui, O. and Waiswa, P. (2013). Community knowledge and perceptions about indoor residual spraying for malaria prevention in Soroti district, Uganda: a cross-sectional study. *Malaria Journal*.**12:**170

Fillinger, U., & Lindsay, S. W. (2011). Larval source management for malaria control in Africa: myths and reality. *Malaria journal*, ***10*****(1**), 353.

Flint, M. L., & Van den Bosch, R. (2012). *Introduction to integrated pest management*. Springer Science & Business Media. New York. Plenum Press.

Forero, D.A., Chaparro, P.E., & Vallejo, A.F. (2014). Knowledge, attitudes, and practices of malaria in Colombia. *Malaria Journal*, **13, 1**–1.

Fossey, E., Harvey, C., McDermott, F., & Davidson, L. (2002). Understanding and evaluating qualitative research.*Australian and New Zealand Journal Psychiatry*, **36,717**–732.

Gobena, T., Berhane, Y., & Worku, A. (2013). Women's knowledge and perceptions of malaria and use of malaria vector control interventions in Kersa, Eastern Ethiopia. *Global Health Action,* **6, 20**

Halliday, K.E. Okello, G., & Turner, E.L. (2014). Impact of intermittent screening and treatment for malaria among school children in Kenya: a cluster randomised trial. A *PLOS Medicine*, **11, 1**–16.

Hart, R. A. (2013). *Children's participation: The theory and practice of involving young citizens in community development and environmental care*. Routledge. New York. Earthscan.

Harvell, D., Altizer, S., Cattadori, I. M., Harrington, L., & Weil, E. (2009). Climate change and wildlife diseases: when does the host matter the most? *Ecology*, ***90*****(4)**, 912-920.

Hawley, W.A., Phillips-Howard, P.A., Terkuile, F.O., Terlouw, D.J., Kolezak, M.S., & Hightower, A.W. (2003). Community-wide effect of permethrin-treated bed nets on child mortality and malaria morbidity in western Kenya. *American Journal of Tropical Medicine Hygiene*, **68 (l4**),121-127.

Hemingway, J. (2014). The role of vector control in stopping the transmission of malaria: threats and opportunities. *Philosophical Transaction of the Royal Society of London*, **56**, 345

Heiman, A., Just, D., McWilliams, D., & Ziberman, D. (2004). Religion, religiosity lifestyle and food consumption.*ARE Update Quarterly Newsletter,* **8(2),** 9-11

Ingabire, C. M., Alaii, J., Hakizimana, E., Kateera, F., Muhimuzi, D., Nieuwold, I., & Koenraadt, C. J. (2014). Community mobilization for malaria elimination: application of an open space methodology in Ruhuha sector, Rwanda. *Malaria journal*, ***13*****(1**), 167.

Ingabire, C.M., Rulisa, A., Van Kempen, L., Muvunyi, C., Koenraadt, C.J.M., Van Vugt, M., & Alaii, J. (2015). Factors impeding the acceptability and use of malaria preventive measures: implications for malaria elimination in eastern Rwanda. *Malaria Journal*, **14 (1),**136.

Jimma D, Tesfaye G, Deressa, W., & Woyessa A. (2005). Base-line survey for the implementation of Insecticide–treated mosquito nets in malaria control in Ethiopia. *Ethiopian Journal Health Development*,**19**,16-23

Karunamoorthi, K. and Kumera A. (2010). Knowledge and health seeking behavior for malaria among the local inhabitants in an endemic area of Ethiopia: Implications for control. *Health*, **2**, 575-581.

Karunamoorthi, K. (2011). Vector control: a cornerstone in the malaria elimination campaign. *Clinical Microbiology and Infection*, ***17*****(11**), 1608-1616.

Kenya Malaria Indicator Survey (KMIS). (2015). National Malaria Control Programme (NMCP), Kenya National Bureau of Statistics (KNBS) and I, International. Nairobi, Kenya, and Rockville, Maryland, USA: NMCP, KNBS, and ICF International: 2016.

Kenya National Bureau Statistics (KNBS) (2010).The 2009 population and housing center.Governmentprinters.Volume 1. Available: http.//www knbs.or.ke (Accessed 27 March 2011, at 2030hrs)

Kenya National Bureau of Statistics(KNBS). (2015): Kisumu County statistical abstract; pp. 1-80

Kibe, L. W., Mbogo, C. M., Keating, J., Molyneux, S., Githure, J. I., & Beier, J. C. (2006). Community based vector control in Malindi, Kenya. *African health sciences*, ***6*****(4).**

Killeen, G. F. (2014). Characterizing, controlling and eliminating residual malaria transmission. *Malaria journal*, ***13*****(1**), 330.

Kilpatrick, A. M., & Randolph, S. E. (2012). Drivers, dynamics, and control of emerging vector-borne zoonotic diseases. *The Lancet*, ***380*****(9857**), 1946-1955.

Kisumu County Integrated Development (KCIDP) (2013). Plan: First County integrated development plan 2013-2017. Kenya vision 2030; pp. 1-285.

Kisumu East District Development Plan (KEDDP) (2008). Ministry of State for Planning National Development and vision 2030. Office of Prime Minister Republic of Kenya. 2008-2012 plan.

Kombo, D.K. and Tromp, D.L.A. (2006).*Proposal and Thesis Writing*. Nairobi: Pauline Publications Africa.

Mabaso, M.L., Sharp, B., & Lengeler, C. (2004).Historical review of malarial control in southern African with emphasis on the use of indoor residual house-spraying.*Tropical Medicine and International Health*, **9**, 846–856.

Maigemu, Y.A. (2015). Influence of Religion on Malaria Control Practices among Household Heads in Zamfara State North West Nigeria**.***Journal of Culture, Society and Development***, 10,** 56-90.

MalERA Consultative Group on Vector Control. (2011). A research agenda for malaria eradication: vector control. *PLoS medicine*, ***8*(1)**.

Matlo, C. (2012). Using the PRECEDE-PROCEED Model. Retrieved from http://www.sfu.ca/uploads/page/23/GERO820. . [Accessed 09 June 2018, at 1040 hrs]

Mazigo, H.D., Obasy, E., Mauka, W., Manyiri, P., Zinga, M., Kweka, E.J., & Heukelbach, J. (2010). Knowledge , Attitudes , and Practices about Malaria and Its Control in Rural Northwest Tanzania. *Malaria Journal*, **6,** 231

Mboera, L. E., Makundi, E. A., & Kitua, A. Y. (2007). Uncertainty in malaria control in Tanzania: crossroads and challenges for future interventions. *The American journal of tropical medicine and hygiene*, *77***(6**), 112-118.

Mboera, L.E., Mazigo, H.D., Rumisha, S.F., & Kramer, R.A., (2013). Towards malaria elimination and its implication for vector control, disease management and livelihoods in Tanzania. *Malaria World Journal*, **4**, 19.

Montgomery, C.M., Munguambe, K., & Pool, R. (2010).Group-based citizenship in the acceptance of indoor residual spraying (IRS) for malaria control in Mozambique.*Social Science and Medicine*, **70(10**), 1648–1655.

Mugenda, O.N., & Mugenda, A.G. (2003). *Research Methods: A Quantitave and Qualitative Approach* .Nairobi: ACTS press.

Munala, L., & Kariuki, S. (2009). Malaria in Kenya: A briefing for World Malaria Day. Available.www.kenyaimagine.com//Malaria-in-Kenya-a-briefing-for-World-. [Accessed 10 February 2010, at 2310 hrs]

Murono D.A, Wabuyele E, Muoria P.K., & Abuto-J.O. (2018). Distribution of Partheniumhysterophorus Linn and its Impacts on Biodiversity in Nyando Sub-County, Kisumu County, Kenya Available: https://www.researchgate.net/publication/326261406_ [accessed Oct 09 2018 at 1000hrs].

Musoke, D., Karani, G., Ssempebwa, J. C., & Musoke, M. B. (2013). Integrated approach to malaria prevention at household level in rural communities in Uganda: experiences from a pilot project. *Malaria Journal*, **12,** 327.

Mutero, C. M., Schlodder, D., Kabatereine, N., & Kramer, R. (2012). Integrated vector management for malaria control in Uganda: knowledge, perceptions and policy development. *Malaria journal, **11*****(1)**, 21.

Mutero, M. C., Mbogo, C., Mwangangi, J., Imbahale, S., Kibe, L., Orindi, B., Girma, M.,Njui, A., Lwande, W., Affognon, H. , Gichuki, C., & Mukabana, R.W. (2015). An Assessment of Participatory Integrated Vector Management for Malaria Control in Kenya. Environment Health Perspect. *MalariaJournal,* **123 (11),**1145–1151.

Mutuku, F. M., Bayoh, M. N., Gimnig, J. E., Vulule, J. M., Kamau, L., Walker, E. D., Kabiru, E., & Hawley, W. A. (2006). Pupal habitat productivity of Anopheles gambiae complex mosquitoes in a rural village in western Kenya. *American Journal of Tropical Medicine Hygiene*, **74(1**), 54-61.

Naranjo, D. P., Qualls, W. A., Jurado, H., Perez, J. C., Xue, R. D., Gomez, E., & Beier, J. C. (2014). Vector control programs in Saint Johns County, Florida and Guayas, Ecuador: successes and barriers to integrated vector management. *BMC public health*, ***14*****(1**), 674.

Nejati, J., Mahjoob, M., Kiyani, M., Keyhani, A., & Hasanzehi, A. (2015).Status of Indoor Residual. Ghana End Of Spray Report. *American Journal,* **23**,59-67

Ng'ang'a, P.N., Shililu, J., Jayasinghe, G., Kimani, V., Kabutha, C., Kabuage, L., Kabiru, E.,Githure, J., & Mutero, C. (2008). Malaria vector control practices in an irrigated rice agro-ecosystem in central Kenya and implications for malaria control. *Malaria Journal*.**7:** 146

Olayemi, I. K., Omalu I. C., Abolarinwa, S. O., Mustapha, O.M., Ayanwale, V.A., & Mohammed, A.Z. (2012*)*. Knowledge of malaria and implications for control in an endemic urban area of north central Nigeria. *Asian Journal of Epidemiology*, **5**, 42-9.

Opiyo, P., Mukabana, W. R., Kiche, I., Mathenge, E., Kellen, G. F., & Fillinger, U. (2007). An exploratory Study of Community Factors relevant for Participatory Malaria Control on Rusinga Island, Western Kenya. *Malaria Journal*, **6**, 48-50

Pinchoff, J., Chaponda, M., Shields, T.M., Sichivula, J., Muleba, M., & Mulenga, M. (2016). Individual and Household Level Risk Factors Associated with Malaria in Nchelenge District, a Region with Perennial Transmission: A Serial Cross-Sectional Study from 2012 to 2015, **11(6),** 10.

Price, P. W., Denno, R. F., Eubanks, M. D., Finke, D. L., & Kaplan, I. (2011). *Insect ecology: behavior, populations and communities*. Cambridge University Press.

Prüss-Üstün, A., & Neira, M. (2016). *Preventing disease through healthy environments: a global assessment of the burden of disease from environmental risks*. World Health Organization.

Quenneh, T. N. (2016). Insecticide Treated Nets as an Effective Malaria Control Strategy in Liberia.

Randell, H. (2008). Environmental Management for Malaria Control: knowledge and practices in Mvomero District, Master's Thesis Nicholas School of the Environment and Earth Sciences of Duke University, Tanzania.

Ranson, H., N'guessan, R., Lines, J., Moiroux, N., Nkuni, Z., & Corbel, V. (2011). Pyrethroid resistance in African anopheline mosquitoes: what are the implications for malaria control? *Trends in parasitology*, ***27*(2**), 91-98.

Simsek, Z., and Kurcer, M.A. (2005). Malaria: knowledge and behavior in an endemic rural area of Turkey. *Public health*. **119(3),** 202-208.

Singh, R., Musa, J., Singh, S., & Ebere, U.V. (2014). Knowledge, attitude and practices on malaria among the rural communities in aliero, northern Nigeria. *Journal of family medicine and primary care*, ***3*(1),**39.

Siri, J. G., Wilson, M. L., Murray, S., Rosen, D. H., Vulule, J. M., Slutsker, L., & Lindblade, K.A. (2010). Significance of travel to rural areas as a risk factor for malarial anemia in an urban setting.*The American journal of tropical medicine and hygiene*, ***82*(3**), 391-397.

Sultana, M. Sheikh, N. Mahumud, R. A. Jahir, T., Islam, Z., & Sarker, A. R. (2017). Prevalence and associated determinants of malaria parasites among Kenyan children. *Tropical Medicine and Health*, **45**, 25.

Tchombe, T. M., Wirdze, L., & Muki, A. N. (2018). Enhancing the Health and Education of Deprived Children: Implications for Sustainable Development in Cameroon. In *Developmental Science and Sustainable Development Goals for Children and Youth* (pp. 139-154). Springer, Cham.

Vijayakumar, K. N., Gunasekaran, K., Sahu, S. S., & Jambulingam, P. (2009). Knowledge, attitude and practice on malaria: A study in a tribal belt of Orissa state, India with reference to use of long lasting treated mosquito nets. *Actra Tropica*, **112,**137-42.

Walker, S. P., Wachs, T. D., Grantham-McGregor, S., Black, M. M., Nelson, C. A., Huffman, S. L. & Gardner, J. M. M. (2011). Inequality in early childhood: risk and protective factors for early child development. *The lancet*, ***378*(9799**), 1325-1338.

World Health Organization (WHO), (2008). WHO position statement on integrated vector management.*Weekly*Epidemiological Record, **83,** 177-181

World Health Organization (WHO), (2012).Global Plan for Insecticide Resistance Management in Malaria Vectors. Geneva. Available: http:// www.who.int/malaria/publications/atoz/gpirm/en/.[Accessed 27 March 2014, at 2020 hrs.]

World Health Organization (WHO), (2013).Indoor Residual Spraying.An Operational Manual for Indoor Residual Spraying (IRS).For Malaria Transmission Control and Elimination. Available: http:// *www.malariaeradication.org/.../indoor-residual-spraying-operational-manual-irs-mala.* [Accessed 12 June 2016, at 1015 hrs.]

World Health Organization (WHO), (2015a). *World malaria report 2014*. World Health Organization.

World Health Organization. (2015b). *Global technical strategy for malaria 2016-2030*. World Health Organization

World Health Organization (WHO), (2016). *World health statistics 2016: monitoring health for the SDGs sustainable development goals*. World Health Organization.

Yamamoto, S., Louis, V. R., Sié, A., & Sauerborn, R. (2010). Household risk factors for clinical malaria in a semi-urban area of Burkina Faso: a case–control study. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, ***104*****(1)**, 61-65.

Yared, S., Deribe, K., Gebreselassie, A., Lemma, W., Akililu, E., Kirstein, O. D., & Hailu, A. (2014). Risk factors of visceral leishmaniasis: a case control study in north-western Ethiopia. *Parasites & vectors*, ***7*****(1)**, 470.

APPENDICES

APPENDIX 1: CONSENT FORM

I am from Maseno University, conducting a study in Kore and Ahero irrigation scheme sub-locations. I am interested in understanding knowledge and practices on environmental management for malaria control in this area. I do not plan to talk to all residents in this area, but have selected several to ask to represent views of all residents in this area. You are one of those selected to give your views. The information you give me will be strictly used for learning purposes and also be of use to the Kenyan policy makers and malaria control program managers to design an effective, sustainable and appropriate malaria control programs.

Your participation to this research project is voluntary and you will not receive any direct benefit like money or any kind for the interview. The answers I get from you and several others will be analyzed to get the general resident's knowledge and practices concerning environmental management for malaria control. There is no right or wrong answer to anything that will be discussed. This survey will take approximately one hour to complete. If you decide to participate in this study, the information you give will be treated with maximum confidence. Again, if you participate, you are free to skip any questions you do not wish to answer or withdraw any time.

Do I have your permission to continue? Yes/ No (If 'Yes' continue with discussion.

In case of 'No' thank the group/individual and move on)

TIME STARTED …….TIME ENDED:……..

APPENDIX II: SURVEY QUESTIONNAIRE GUIDE

Questionnaire number …….

DATE …….

Name of the interviewer ……

Name of the village ……

Section1:Socio-demographic Information

For every head of the household, record the following

1a. Age (In years) (1) Below 25 years old. (2) Between 26 and 35 years old (3) Between 36 and 45 years old (4) Above 45 years old	1b. Gender [1] male [2] Female	1c. Relation to head of H/H [1] Head [2] Wife [3] Child [4] Sibling [95] Other	1d. Marital status [1] married [2] Single [3] Divorced [4] Widowed	1e. Highest level of education attained [1] Not gone to school at all [2] Primary education [3] Secondary school [4] Post-secondary vocation [5] University	1f. Main occupation [1] Farming [2] Business [3] Employee [4] Unemployed
1 2 3 4	1 2	1 2 3 4 5 95	1 2 3 4	1 2 3 4 5	1 2 3 4 5

1. Religion

[1] Christian

[2] Muslim

[3] No religion /Pagan

[95] Other _____

Section 2: knowledge on environmental management for malaria control

3. What are the risk factors for malaria?

[1] Mosquitoes

[2] Stagnant water

[3] Evil spirits

[4] Stepping on Cold Water.

[5] Flees and Ticks

[6] Busy Places.

[95] Other _____

[99] Don't know

4. Are mosquitoes present in your household or community?

[1] Yes

[2] No

[99] Don't know

If yes continue to sub questions:

5. What factors do you think increase the number of mosquitoes in your community and around your home?

[1] Bushy places

[2] Stagnant water

[3] Farming methods

[4] Disposed Containers

[5] Domestic Animals

[95] Other _____

[99] I don't know

6. How does increased rain during the wet season affect mosquito population?

[1] It increases their population due to more stagnant water

[2] It increases their population due to more vegetation

[3] It increases their population due to warmer temperature

[4] It does not affect their population

[5] It decreases their population

[95] Other _____

[99] I don't know

7. What kinds of water bodies do you have around your home?

[1] Ponds

[2] Wells

[3] Flooded rice fields

[4] Canals

[5] Rivers

[6] Wetlands/Springs

[95] Other _____

8. How far from your home is the closest water body (e.g. pond, stream, river, swamp or canal)?

[1] Seconds walk

[2] Minutes' walk

[3] Hours walk

[99] Don't know

9. Is the closest body of water flowing or stagnant?

[1] Flowing

[2] Stagnant

10. Are there any living organisms in this body of water?

[1] Yes (Go to 11a)

[2]No

11a.What kinds of living organisms have you seen in the water?

[1] Plants

[2] Fish

[3] Insects (Go to q. 11b)

[4] Snails

[5] Snakes

[6] Frogs

[7] Larva (Go to q. 11 b)

[95] Other _____

If insects or larvae were mentioned, ask

11b. what kind of insects or larvae live in the body of water?

[1] Mosquitoes

[95] Other: _____

12. Where can mosquito larvae be found?

[1] In stagnant water

[2] In the disposed Containers

[3] Dark places in the houses

[4] Bushy places

[95] Other _____

[99] Don’t know

13. Does reducing the population of mosquito’s larvae help to reduce malaria?

[1] Yes

[2] No

Section 3: Environmental management control practices for malaria control

14. Which environmental practice would you apply to control malaria?

[1] Drain stagnant water around the home

[2] Clearing grass and bushes around the home

[3] Use bed nets

[4] Spray insecticides inside home

[5] Burn disposed containers

[6] Use traditional plants

[7] Use cow dung smoke

[95] Other _____

[99] I don't know

Section 4: Effective environmental management practices for malaria control.

15. Which environmental management practices do you find most effective to control malaria?

[1] Drain stagnant water around the home

[2] Clearing grass and bushes around the home

[3] Use bed nets

[4] Spray insecticides inside home

[5] Use commercial larvicides

[6] Use traditional plants

[7] Use cow dung smoke

[95] Other

[99] I don't know

If use of nets were mentioned, ask

16. Do you have mosquito nets in this household?

[1] Yes (Go to Q 17)

[2] No

17. Who in your household uses a mosquito net?

[1] Children

[2] Pregnant women

[3] Children and women

[4] Men

[5] Everyone

[6] Parents

[99] Don’t Know

18. How frequently do you (Your family) sleep under these nets

[1] Throughout the year

[2] Rainy season

[3] Dry Season

[99] I don’t know

19. Did you sleep under mosquito net lat night?

[1] Yes

[2] No

[99] Don’t know /not sure

20. Could I please see your mosquito net (s)?

[1] Yes

[2] No

21. For each net, record the following

Net.	A. is the net hanging over a bed/mat [1] yes [2] No	B. what is the condition of the net? (**observe don't ask**) [1] intact [2] with small holes [3] large holes /torn	C, How much did this net cost? (1)Below 50 ksh (2) Between 51 and 100 ksh (3) Between 101 and 150ksh (4) Free (5) Above 151	D. Was it subsidized under certain project? [1] Yes [2] No [-9] Don't Know	E. was this net ever treated with insecticide [1] Yes [2] No **(go to next net**) [-9] Don't know	F.was the net treated in the past six months [1] Yes [2] No [-9] Don't know	E. Is this a permanent /long lasting insecticide treated net? [1] yes [2] No [-9] I don't know	G.how much did it cost to retreat the net (1)Below 50 ksh (2) Between 51 and 100 ksh (3) Between 101 and 150ksh (4) Free (5) Above 151
Net 1	1 2	1 2 3	1 2 3 4 5	1 2 -9	1 2 -9	1 2 -9	1 2 -9	1 2 3 4 5
Net 2	1 2	1 2 3	1 2 3 4 5	1 2 -9	1 2 -9	1 2 -9	1 2 -9	1 2 3 4 5
Net 3	1 2	1 2 3	1 2 3 4 5	1 2 -9	1 2 -9	1 2 -9	1 2 -9	1 2 3 4 5
Net 4	1 2	1 2 3	1 2 3 4 5	1 2 -9	1 2 -9	1 2 -9	1 2 -9	1 2 3 4 5
Net 5	1 2	1 2 3	1 2 3 4 5	1 2 -9	1 2 -9	1 2 -9	1 2 -9	1 2 3 4 5
Net 6	1 2	1 2 3	1 2 3 4 5	1 2 -9	1 2 -9	1 2 -9	1 2 -9	1 2 3 4 5
Net 7	1 2	1 2 3	1 2 3 4 5	1 2 -9	1 2 -9	1 2 -9	1 2 -9	1 2 3 4 5
Net 8	1 2	1 2 3	1 2 3 4 5	1 2 -9	1 2 -9	1 2 -9	1 2 -9	1 2 3 4 5
Net 9	1 2	1 2 3	1 2 3 4 5	1 2 -9	1 2 -9	1 2 -9	1 2 -9	1 2 3 4 5

APPENDIX III: FOCUS GROUP DISCUSSION GUIDE

Questionnaire number …….

DATE …….

Name of the interviewer ……

Name of the village ……

Malaria and Mosquito Knowledge

1. What do you think transmits malaria?
2. What are the symptoms and signs of malaria?
3. How do mosquitoes transmit malaria to humans?
4. What factors affect the number of mosquitoes in your community?
5. What can be done to reduce the number of adult mosquitoes in your community?
6. Where can you find immature mosquitoes?
7. What can be done to reduce the population of immature mosquitoes

Land use and irrigation

8. What kinds of crops do you grow?

a. Which of these crops do you irrigate?

b. What irrigation methods do you use on these crops?

c. How long have you been irrigating these crops?

9. What kinds of water bodies do you have around your home and in your community?

a. What kinds of plants and /or animals do you see in these bodies of water?

b. What kinds of insects live in these bodies of water?

10. What types of agricultural practices do you feel increase or decrease the populations of mosquitoes?
11. During which farming seasons are people most likely to get malaria?

Environmental management and community participation

12. What activities have you ever performed in order to reduce mosquitoes population?

Probe for the following bellow:

i. Install drains

ii. Remove stagnant water

iii. Manage vegetation

iv. Change irrigation techniques

a. **If yes**, do you feel the technique(s) are effective?

b. **If no**, would you consider performing any of these activities for future malaria control?

13. Let's say that a malaria control programme was started in your community which required everyone to manage vegetation and remove stagnant water from around their homes. If the majority of households participated, this programme would help to reduce mosquito populations in the village;

i. Would you be willing to participate in this programme? Why or why not?

ii. Do you feel that other members of your community would participate in a programme like this? Why or why not?

iii. What factors would make a person in your community more/less likely to participate in a programme like this?

Information sources

14. Where do you usually get information about health issues?

15. Where do you usually get information about malaria in particular?

16. What type of information do you get and how often?

APPENDIX IV: KEY INFORMANT INTERVIEW GUIDE

Questionnaire number …….

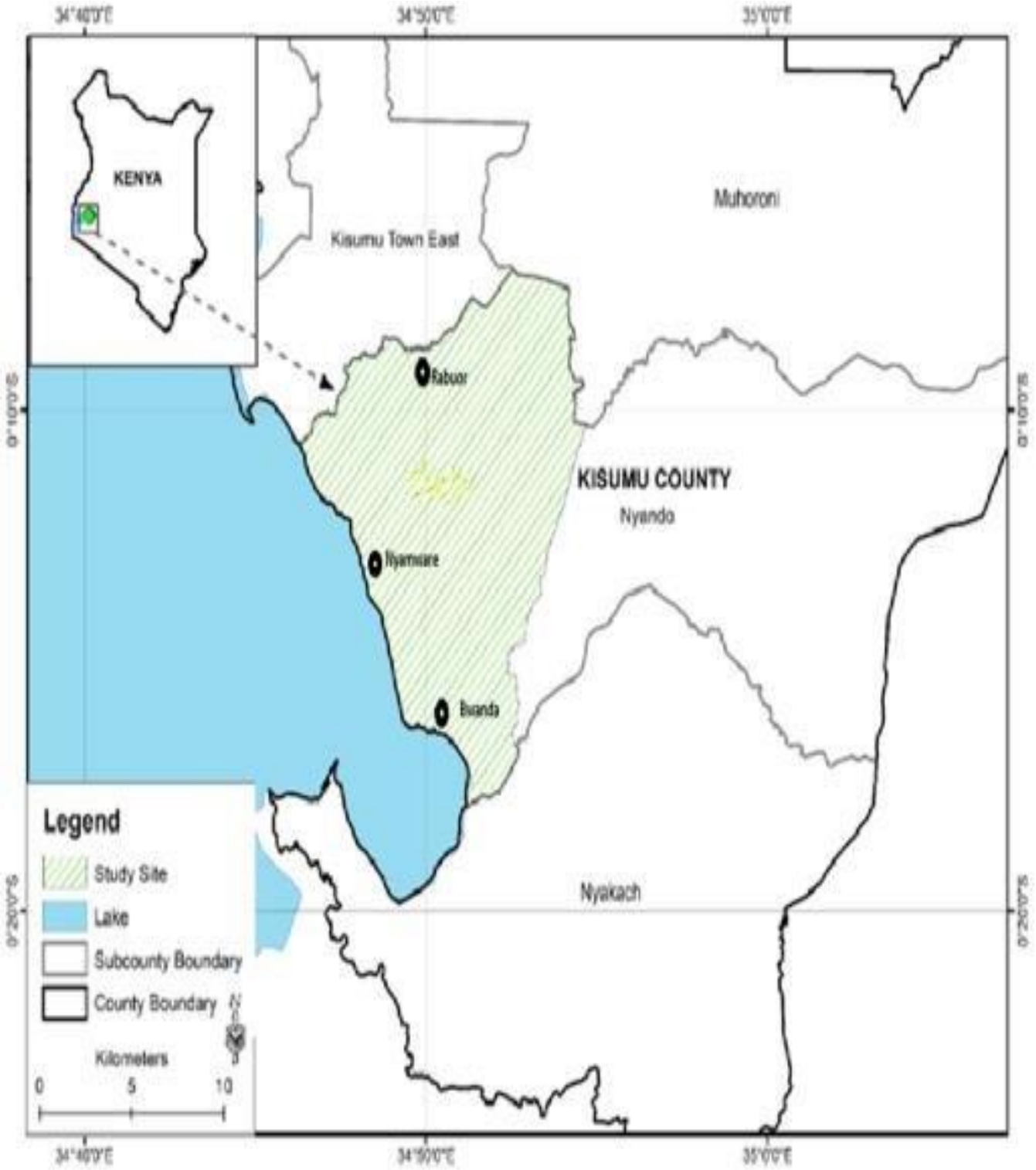
DATE …….

Name of the interviewer ……

Name of the village ……

1. What are the main health problems that your community faces?
   (a) As a leader in this community, which of these problems are you most concerned about. What is your role towards the problem.
   (b) For health problems mentioned, how likely is the community to experience each health problem in the next year.
2. What do you think transmits malaria?
3. What do you do to reduce the number of mosquitoes in your community?
4. Does your village currently perform any activities (Health, education, social, economic etc) which requires most or all of the community members to participate?
5. What environmental management do you apply to control mosquito in your community.

APPENDIX V: MAP SHOWING NYANDO SUB-COUNTY, KISUMU COUNTY, KENYA.



APPENDIX VI: RESEARCH APPROVAL FROM MASENO UNIVERSITY

TEL: (057) 51622/51267/51110
FAX: (057) 51221/51153/51011

School of Public Health and Community Development
Siriba Campus
Private Bag
MASENO,
KENYA

REF: MU/ESPUDEC/PG/MPH/0027/08 03-06-2010

District Commissioner
Nyando District

Dear Sir

RE: MS. OSARA ADHIAMBO BENTER (PG/MPH/027/2008).

The above named person is an MPH student in the School of Public Health and Community Development who has successfully finished her course work and is now ready to collect her data for thesis writing.

Her research is on the "*Knowledge and Practices on Environmental Management for Malaria Control in Kore and Ahero Irrigation Scheme, Western Kenya*"

The objective of Ms. Osara's study is to find out the way in which the residents of Kore and Ahero Irrigation schemes manage their environment to prevent malaria.

The study will be carried out in selected households in Kore and Ahero irrigation schemes.

We Support this study because its findings and recommendations will be passed on to the relevant policy makers to help them put in place actions that can help in the improvement of environmental management and the reduction of malaria in Kore and Ahero and other malaria prone-areas in the country.

I therefore, request you to support Ms. Osara's study and allow her to collect data from the selected samples.

Yours sincerely,

MASENO UNIVERSITY
DIRECTOR
ESPUDEC

Prof. Rosebella O. Onyango
Chairman: Postgraduate Studies Committee
School of Public Health and Community Development.
Cc/
Asst. Chief Ahero Irrigation Schemes
Asst. Chief Kore sub-location

APPENDIX VII: RESEARCH APPROVAL FROM NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

REPUBLIC OF KENYA

NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Telegrams: "SCIENCETECH", Nairobi
Telephone: 254-020-241349, 2213102
254-020-310571, 2213123.
Fax: 254-020-2213215, 318245, 318249
When replying please quote

P.O. Box 30623-00100
NAIROBI-KENYA
Website: www.ncst.go.ke

Our Ref: **NCST/RRI/12/1/MED-011/60/4**

Date: **24th May, 2011**

Benter Adhiambo Osara
Maseno University
P. O. Private Bag
MASENO

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on **"Knowledge & practices on environmental management for malaria control in Kore & Ahero irrigation schemes, Western Kenya"** I am pleased to inform you that you have been authorized to undertake research **in Nyando District** for a period ending ***30th June, 2011.***

You are advised to report to **the District Medical Officer of Health & the District Commissioner, Nyando District** before embarking on the research project.

On completion of the research, you are expected to submit **one hard copy and one soft copy** of the research report/thesis to our office.

P. N. NYAKUNDI
FOR: SECRETARY/CEO

Copy to:

The District Commissioner
Nyando District

The District Medical Officer of Health
Nyando District