ASSESSMENT OF KNOWLEDGE ON MALARIA EPIDEMIC MONITORING INDICATORS AMONG HEALTH CARE PROVIDERS IN GREATER NYANDO SUB-COUNTIES

BY

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Declaration

I, Robert G. Wathondu declare that this thesis is a result of my original work and it has not been presented in any other institution for any award.

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Dedication

This thesis is dedicated to my beloved wife Shekila Karendi, my son Noel Wathondu and my Daughter Nadia Nyambura.

Abstract

Malaria is a mosquito-borne disease caused by *Plasmodium* parasites. Epidemics occur in areas where most of the conditions for malaria transmission are present, contributing to over 90% of the estimated 650 million clinical malaria cases reported annually in the world, and approximately 41% of the world's population which is at risk of contracting malaria. Detection by health care workers of a malaria epidemic depends on knowledge on malaria monitoring indicators that include vulnerability, transmission and early detection. In Kenya, malaria epidemics have been reported in the greater Nyando sub-counties but the knowledge on malaria monitoring indicators amongst the health workers in the sub-counties is unknown. The significance of this study was to provide information on what the health care workers believe is a common health problem in the community, how malaria is transmitted within that community, and if there are early detection tools or techniques used in detection of malaria outbreaks in the community. Information gathered was to shed light on interventions required by the health care worker to reduce malaria infections in that community. The aim of the study was to assess the knowledge on malaria epidemic monitoring indicators among health care providers in Greater Nyando sub-counties. This was a descriptive cross-sectional study which included 141 health care workers (HCWs) working in health facilities in Greater Nyando Sub-counties. The specific objectives were to determine the health care providers knowledge on malaria vulnerability indicators, malaria transmission indicators and to examine health care providers knowledge on malaria early detection indicators. Purposive random sampling for HCWs was used to select staff to be interviewed to assess their knowledge on malaria epidemic monitoring indicators using a questionnaire in a personal digital assistant (PDA) having the Epi Surveyor software. The results indicated that majority of the HCWs were nurses (n=111; 79%), worked in dispensaries (n=56; 40%) and were from Upper Nyakach (n=54; 38%). In the community, the HCWs believed that malaria was a very common infection (n=140; 99%) in adults (n=128; 91%) and children (n=123; 87%). Not using an Incecticide Treated Net (ITN) (n=140; 99%) and bushes (n=136; 96.5%) were mentioned as major causes of malaria spread. The HCWs believed that malnutrition (n=135; 96%), HIV/AIDS (n=127; 90%), movement from endemic areas (n=94; 67%), poor drainage (n=132; 93.6%) floods (n=139; 99%), and rain (n=131; 93%) were contributors to malaria infection in the area. The HCWs were aware of malaria surveillance (n=141; 100%) activities that could be used for prediction (n=122; 87%) and planning (n=119; 84%) for malaria epidemics. These results show that awareness of malaria epidemic indicators in known among the HCWs though knowledge on specific interventions is lacking. Health promotion and design of specific malaria messages locally is recommended. Determining malaria thresholds and continuous monitoring of the epidemic curves would significantly visualise the risks due to malaria epidemics and adequate interventions implemented. There is need to strengthen malaria surveillance by closely monitoring malaria transmission and actions taken by the communities affected with specific interventions. Further research on knowledge and practice of the communities should be done to enable well designed health interventions that are practical to reduce malaria epidemics.

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Abbreviations

AIDS	Acquired Immune Deficiency Syndrome
CRPF	Chloroquin Resistance *Plasmodium Falcipurum*
CRPV	Chloroquin Resistance *Plasmodium Vivax*
ENSO	El Niño Southern Oscillation
HIV	Human Immunodeficiency Virus
MOH	Medical Officer of Health
MoH	Ministry of Health
PDA	Personal Digital Assistant
PMO	Provincial Medical Officer
WHO	World Health Organization
WHO/AFRO	World Health Organization, African Region office

Definition of Terms

El Nino A periodic change in the currents of the Oceans that occurs every five to eight years and brings unusually warm water to the coast. It often leads to severe climate disruption to countries in and beside the Pacific.

Endemic Describes a disease occurring within a particular area, region.

Epidemic An outbreak of a disease that spreads more quickly and more extensively among a group of people than would normally be expected.

Indicator Something observed or calculated that is used to show the presence or state of a condition or trend.

Vulnerability Is a time frame within which defensive measures are reduced, compromised or lacking.

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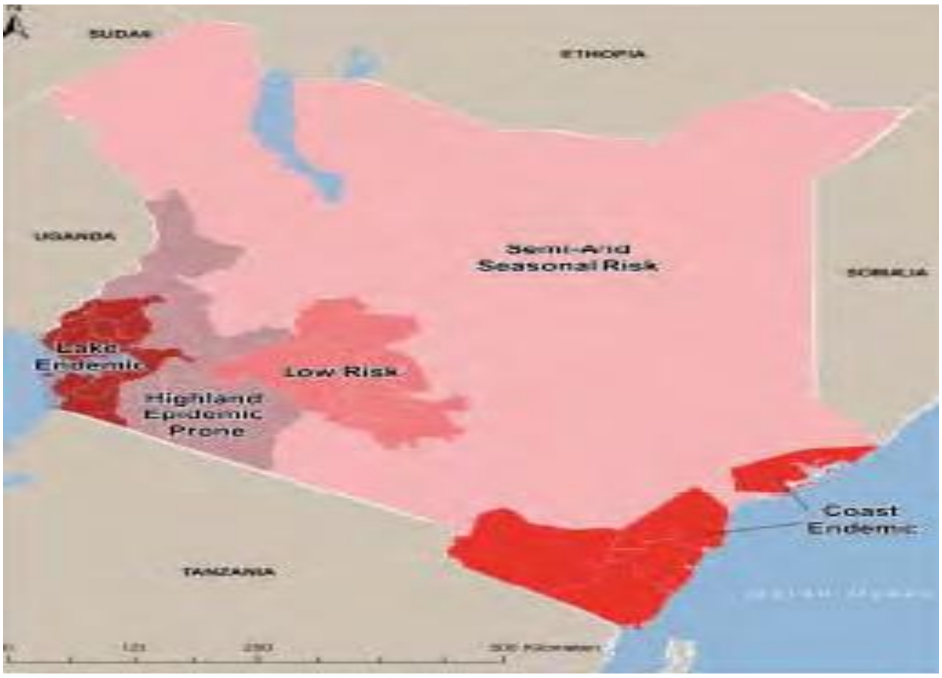
CHAPTER ONE: Introduction

1.1 Background information

Malaria is a mosquito-borne disease caused by *Plasmodium* parasites. These parasites are spread to people through bites of infected female *Anopheles* mosquitoes (WHO, 2015). According to World Health Organization (WHO), a malaria epidemic is defined as the occurrence, in excess, of the expected number of malaria cases in a given area in a defined period. Malaria epidemics occur in areas or situations where most of the conditions for malaria transmission are present (WHO, 2000a). The conditions that necessitate malaria transmission include, climatic conditions (rainfall, temperature and humidity), presence of vector (*Anopheles*), and host immunity factors (WHO, 2015). Epidemics can occur when malaria attacks vulnerable populations. In such situations, people of all age groups are at risk of death or severe disease. Epidemics of *Plasmodium falciparum* malaria, the most severe form of the disease, can be devastating if not controlled in a timely manner (WHO, 2006a).

In Kenya, malaria is a major public health concern, where it accounts for about 31% of outpatient consultations and 5% hospital admissions (USAID, 2014). The country is divided into four malaria epidemiological zones (Fig. 1.1). These zones include the endemic zones in the coastal and western regions that are particularly close to the Indian Ocean and Lake Victoria basin that are between 0-1300 meters above sea level. Highland epidemics zones found in the western highlands that are found above 1000-3000 meters above sea level. The semi arid and arid areas of eastern region experience malaria during the rainy season. The low risk malaria transmission zone that includes the central highlands and Nairobi. The Greater Nyando Sub-counties is found in the Lake Victoria Basin endemic region which has a high perennial malaria transmission rate (USAID, 2014).



1.1: Map of Kenya showing malaria epidemiological zones

The WHO worked with all countries classified as malaria prone to develop a global strategy for malaria control. This strategy has four elements which include providing early diagnosis and prompt treatment, to plan and implement selective and sustainable preventive measures including vector control, to detect early, contain or prevent epidemics and to strengthen local capacities in basic and applied research (WHO, 2006b). The strategy was widely endorsed, and efforts to implement it have shaped the development of malaria epidemics control in most countries. It has been adapted to the needs of different regions; in Africa, for instance, a Regional Malaria Control Strategy for 1996 to 2001 was developed by a Task Force for Malaria Control convened by the WHO African Regional Office, (WHO, 2006b).

Studies carried out in malaria prone countries to determine malaria vulnerability have shown that host immunity factors (Riley, 2002; Afrane, 2005), age (Carneiro, *et al.,* 2010; Perry *et al,* 2011), vitamin deficiency (SanJoaquin & Molyneux, 2009) and HIV (Weinke *et al,* 1990) lead to increased malaria infection. There is no literature from Kenya especially from health care workers knowledge on these factors. Studies in malaria endemic areas to determine knowledge on factors regarding malaria transmission indicate that factors such as peoples movement (Bruce, 2002), usage of Insecticide-treated nets (ITNs) and indoor residual spraying (IRS) (Fullman, *et al.*, 2013). In Africa where unregulated urbanization is taking place, there is inadequate sanitation and poor housing thus increased human-vector contact and vector breeding sites (United Nations, 1997; Beck, 1977). Malaria is mainly found where climatic factors such as temperature, humidity, and rainfalls are available (CDC, 2004). Nyando is located near the equator and is prone to floods thus making the area ideal for sustained malaria transmission.

Thus the detection of a malaria epidemic depends on knowledge of indicators and health workers need to know or be empowered with knowledge on malaria epidemic monitoring indicators (WHO, 2000b).

1.2 Statement of the Statement

Malaria epidemics have caused unimaginable hardship to humanity as well as loss of millions of human life, from kings to commoners, from time immemorial. Many human settlements were decimated, civilizations declined, wars lost and advance of humanity halted due to malaria epidemics. Until 1897, when the mosquito vector was identified by Ronald Ross, people tried to protect themselves by various methods that they deemed fit (Sinden, 2004).

Delacollette (2002) documented data that indicated an acutely high morbidity and mortality rates occurring during malaria epidemics in Africa and also in Kenya. This had also been the case in the lake region of Nyanza province and the result was that it constrained the resources available and has become a top political and public health concern.

Nyando sub-counties health report 2010 showed that there were over 164,208 malaria cases recorded for 2010 in the sub-counties which accounts for 45.8% of all morbidity cases. More than one thirds of these cases were as a result of epidemics of malaria and this indicates a high burden to health resources in the sub-counties. Malaria epidemics may occur shortly after the floods that create conducive environment for mosquito breeding and also gives rise to movement of people to higher grounds.

Knowledge on malaria monitoring indicators among the health workers has not yet been documented in Greater Nyando sub-counties and thus not known. With the increasing number of epidemics this may cause a dramatic increase in morbidity and mortality rates and also increase the disease burden to health care resources which can be avoided.

1.3 Purpose of the Study

The purpose of this study is to assess the knowledge of malaria epidemic monitoring indicators among the health workers in Greater Nyando sub-counties so that the respective managers can design appropriate intervention measures to tackle the malaria epidemics and map the way forward to reduce the same.

1.4 Broad objective

To assess the knowledge on malaria epidemic monitoring indicators among the health care providers in Greater Nyando sub-counties.

1.4.1 Specific objectives

1. To determine health care providers knowledge on malaria vulnerability indicators.

2. To determine health care providers knowledge on malaria transmission indicators.
3. To examine health care providers knowledge on malaria early detection indicators.

1.5 Research Questions

1. What is the health care provider's knowledge on malaria vulnerability indicators?
2. What is the health care provider's knowledge on malaria transmission indicators?
3. What is the health care provider's knowledge of malaria early detection indicators?

1.6 Justification

Cognizant of the fact that resources are getting more scarce because of competing priorities, the need to utilize the few available effectively and efficiently is necessary. It is therefore necessary to develop a long lasting solution to malaria epidemics. The current option of admitting and treating patients is expensive because of mass volumes of patients during epidemics, time consuming and sometimes not yielding the favourable results.

Knowledge on malaria epidemic monitoring indicators can reinforce local preparedness, and allow health care providers, local authorities and communities to use cost-effective and timely control options to prevent excessive malaria cases and deaths and thus reducing the burden on health care resources. This can also be justified by WHO (1998) National Malaria Strategy (2001-2010) which identifies malaria epidemic preparedness and response as a key approach to the containment of malaria epidemics in Kenya. The key is to be able to react decisively and rapidly to prevent and control a malaria epidemic.

The results of this study will help hospital management teams by shedding light on their knowledge and capacity as concerns' malaria epidemics.

1.7 Significance of the study

The findings of this study will provide information in regards to what the health care workers believe as a common health problem in the community, how malaria is transmitted within that community, and if there are early detection tools or techniques that they use in detection of malaria outbreaks in the community. Since health care workers provide a health service, then the information gathered here will shed light on interventions required by the health care worker to reduce malaria epidemics in that community.

CHAPTER TWO: Literature Review

2.1 Introduction

This chapter reviews literature on systematic identification, synthesis, analysis and summary of written material that contain information on the research topic. Related research studies, articles from professional journals, reports and books were reviewed both locally, regional and globally in order to establish other researchers' findings and views.

It will further assist in interpreting the study findings and in developing recommendations for improved services and for further research. It has been divided into various sections dealing with particular specific objectives.

2.2 Knowledge of Health Care Workers on Malaria Vulnerability Indicators

2.2.1 Human Immune Factors as Malaria Vulnerability Indicators

Although the human immune system can kill parasites, it can also damage the body and contribute to severe disease an example is in the case of malaria. This can be seen in people living in malaria endemic areas who tend to be infected repeatedly; over time, they gradually acquire immunity to malaria. This immunity includes the development of mechanisms that can kill parasites or inhibit the replication of parasites. Another paradox is found in travelers from non-endemic areas who move to endemic areas and get malaria. In this case, severe malaria is more common in adults than in children. Indeed, death rates are five times higher in people over the age of 20 than in those under 20. This becomes even more complicated if they are predisposed to a malaria outbreaks or epidemics (Riley, 2002).

The development of immunity to malaria is a function of the intensity and duration of exposure to infections. Measuring functional immunity to malaria remains a serious problem. However, proxies such as parasite density have been used to indicate suppression of parasitemia by the immune system. Major antigens linked to immune responses have been used as makers of the immune response. Studies in western Kenya indicate that areas of unstable transmission in the highlands, the prevalence of circumsprozoite protein (CSP) was 13% in adults over 40 years of age whereas in the stable transmission lowlands, approximately 65% of children were antibody positive. Thus, the human population in the highland site has fewer people with immunity and this renders them vulnerable to severe forms of malaria during epidemics (Afrane, 2005).

Equally important is the development of another type of immunity: one that will limit the body's own immune response to the parasite. Without this latter type of immunity, the immune system can go into overdrive in its attempts to kill the parasites, and acute febrile symptoms and severe malaria can result. Persons, who have yet to develop this immunity, are thus at greater risk of clinical malaria, severe disease and death during malaria epidemics (Sinden 2004).

Some biologic characteristics and behavioral traits can influence an individual's risk of developing malaria and, on a larger scale, the intensity of transmission in a population which can lead to epidemics. Biologic characteristics present from birth can protect against certain types of malaria. Two genetic factors, both associated with human red blood cells, have been shown to be epidemiologically important. Persons who have the sickle cell trait (heterozygote for the abnormal hemoglobin gene HbS) are now more frequently found in Africa and in persons of African ancestry than in other population groups (CDC, 2004). Unfortunately there have been no studies on healthcare workers knowledge local information from health care workers on malaria morbidity data as an early malaria outbreak indicator.

2.2.2 Age as Malaria Vulnerability Indicators

A study by Perry *et al*, (2011) documented that when children contract *Plasmodium falciparum*, a vector exquisitely sensitive to changes in temperature and precipitation, they have a higher complication rate (severe anemia, cerebral malaria, and long-term neurologic sequelae) and a higher mortality rate relative to older populations, presumably because they have less acquired functional immune response. Similarly, prenatal or childhood exposure to specific toxins, toxicants, infectious agents, or conditions such as under nutrition can produce disease and dysfunction that lasts through childhood and in some cases first manifests only in adulthood (Perry *et al,* 2011). A systematic review carried out in 2010, analyzed malaria studies data from Sub Saharan Africa and indicated that malaria is evenly distributed among children below 10 years, but major sequleae is experienced in younger children especially those below five years (Carneiro, et al., 2010). During epidemics, children may be more vulnerable to complications and higher mortality. There have been no studies on healthcare workers knowledge local information from health care workers on age as Malaria vulnerability Indicators as a cause of early malaria outbreak indicator.

2.2.3 Vitamin A Deficiency as Malaria Vulnerability Indicator

Vitamin A is an essential nutrient required for maintaining immune functions, playing an important role in the regulation of cell mediated immunity and humoral antibody response (SanJoaquin & Molyneux, 2009). Vitamin A deficiency and malaria are both highly prevalent health problems in Africa. Vitamin A deficiency affects over 30 million children, most of whom are in the under five years age-group being the most affected by malaria. A low serum retinol concentration (a marker of vitamin A deficiency) is commonly found in children suffering from malaria, but it is not certain whether this represents pre-existing vitamin A deficiency, a contribution of malaria to vitamin A deficiency, or merely an acute effect of malaria on retinol metabolism or binding. In a systematic review of malaria and vitamin A deficiency, available evidence in support of a causal relationship in each direction between vitamin A deficiency and malaria is reviewed. If such a relationship exists, and especially if this is bidirectional, interventions against either disease may convey an amplified benefit for health (SanJoaquin & Molyneux, 2009).

2.2.4 Effectiveness of Insecticide-Treated Nets and Indoor Residual Spraying as Malaria Vulnerability Indicators

Insecticide-treated nets (ITNs) and indoor residual spraying (IRS) are two vector control measures currently used in the prevention of malaria transmission. In several countries in sub-Saharan Africa, household ownership of ITNs has been scaled up rapidly over the last few years (Fullman, *et al.,* 2013). IRS, while typically used for low malaria risk or epidemic-prone regions, has been further advocated for use in high and medium malaria transmission settings (Fullman *et al,* 2013).

2.2.5 HIV infection as Malaria Vulnerability Indicators

Man has known Malaria for centuries and AIDS has been around for nearly 2 decades. Malaria has already killed millions and continues to kill nearly 3 million every year. As of 1999, nearly 36 million people around the world were infected with HIV and 5 million had died of AIDS related illness. In this millennium, both diseases are expected to infect and kill many more around the world. But the bigger tragedy is that HIV infection is on a dramatic increase in those countries where malaria is already an uncontrollable problem (Dayachi *et al,* 1991).

It has always appeared that malaria does more harm to HIV patients and HIV transmission than vice versa. Studies from the African countries have thrown light on this aspect. Malaria has potent immunosuppressive effects. It has been found that patients with HIV infection who contract malaria tend to deteriorate rapidly into AIDS related complications. Malarial infection supposedly accelerates the replication of HIV (Weinke *et al*, 1990).

The current understanding of the human immune response to malaria and HIV leads us to expect that either infection might influence the clinical course of the other. Many other types of infections are associated with at least a transient increase in HIV viral load. Hence, it is logical to expect malaria to do the same and potentially accelerate HIV disease progression. On the other hand, the control of malaria parasitemia is immune mediated, and this prevents most malarial infections from becoming clinically apparent in semi-immune adults in endemic areas. The immune deficiency caused by HIV infection should, in theory, reduce the immune response to malaria parasitemia and therefore increase the frequency of clinical attacks of malaria (Chandramohan *et al*, 2008).

Evidence indicates an interaction between HIV-1 and malaria in pregnancy, causing more peripheral and placental parasitemia, higher parasite densities, clinical malaria, anemia, and increased risks of adverse birth outcomes. HIV-infected women remain susceptible to the effects of malaria whether or not they are pregnant. Placental HIV-1 viral load is increased in women with placental malaria, especially those with high parasite densities. However, the effect of malaria on mother-to-child transmission of HIV is unclear because published studies to date have given conflicting findings. Suggestions were that the discrepancy might be due to variations in maternal immunocompetence. That is, immunocompromised mothers have deranged chemokine and cytokine profiles, less protective immune responses, and consequently higher parasite densities and viral loads, leading to an increased risk of mother-to-child transmission of HIV (Ned *et al*, 2005).

HIV infection may increase the burden of malaria by increasing susceptibility to infection or by reducing the preventive and therapeutic efficacy of antimalarial drugs, since both are dependent on the immune response of the host. However, the first reports in the 1990s failed to demonstrate significant interactions between malaria and HIV in coinfected children and adults who had acquired semi-immunity to malaria, possibly due to limitations of the study designs and lack of information on the degree of immunosuppression (Chandramohan *et al,* 2008).

In the early 2000s, the clinical impact of HIV infection on malaria infection and disease was revealed and appeared to be dependent on the dynamics of malaria transmission and the degree of HIV-associated immunosuppression. HIV-infected individuals who have not acquired immunity against malaria show a marked increase in malaria severity, in contrast to those with naturally acquired immunity to malaria, in whom HIV infection is associated with only a moderate increase in clinical malaria. More recently, malaria has been reported as a risk factor of concurrent HIV infection at the population level especially affecting non pregnant adults, children and pregnant women (Karp and Auwaerter, 2007).

Both diseases, which are considered a cause and consequence of poverty, share determinants of vulnerability. The potential consequences and public health impact of their overlapping geographical distribution have been described and studied in recent years. Interactions of the two diseases have been found at the level of the host's vulnerability to infection. HIV infection is a risk factor for clinical and severe malaria, and *Plasmodium falciparum* infection is a risk factor for increased HIV viral load. Moreover, dual infection has been shown to feed the spread of both diseases in sub-Saharan Africa and treatment of coinfected patients raises concerns on the potential for drug interactions (WHO, 2005). The greater Nyando sub-counties has a high prevalence of both HIV and malaria necessitating the need to prevent malaria epidemics in order to protect people agaist against undesirable outcomes associated with HIV.

KNOX (2006) discovered that when people with HIV also get infected with the malaria parasite, the HIV viral load in their blood increases sevenfold and stays high for many weeks. He suspected that people with more viral load in their systems might be more likely to transmit it to others. He conducted a study in Kisumu which has high transmission of malaria, and the study showed that one third of the adults also had HIV. Analysis of data on malaria, HIV, and sexual behavior in Kisumu reveals that malaria raised HIV infection rates in Kisumu by 5 percent over the past 20 years, which translates to 8,500 HIV cases in Kisumu of about 200,000 adults. Those HIV-weakened immune systems account for almost a million extra malaria cases in Kisumu over the past 20 years (KNOX, 2006).

2.3 Knowledge of Health Care Workers on Malaria Transmission Indicators

2.3.1 Human Population Movement as Malaria Transmission Indicator

Historically, population movement has contributed to the spread of disease. Failure to consider this factor contributed to failure of malaria eradication campaigns in the 1950s and 1960s Bruce (2002). The movement of infected people from areas where malaria was still endemic to areas where the disease had been eradicated led to resurgence of the disease. As people move, they can increase their risk for acquiring the disease through the ways in which they change the environment and through the technology they introduce, for example, through deforestation and irrigation systems. Such activities can create more favorable habitats for Anopheles mosquitoes; at the same time, workers may have increased exposure to the vectors (Bruce, 2002).

The decision-making process leading to population movement can best be understood in the light of "push and pull" forces. When their needs can no longer be met in a particular environment, people move elsewhere. The "push factor" could be environmental degradation, population pressure on land, droughts, famines, conflict, or loss or lack of employment. When people are satisfied with their situation but believe that a move elsewhere will provide new and attractive opportunities, a "pull factor" is involved Pim and Lisbeth, (2006). This pull factor could be better political, economic, or social opportunities or improved living conditions. Push and pull factors can operate simultaneously; for example, people can be pushed by environmental deterioration and scarce resources and pulled by the economic opportunities offered by development projects. The Nyando sub-counties is prone to frequent floods that have forced people ro move to higher grounds with limited resources. Population movements can be differentiated by their temporal and spatial dimensions. Temporal dimensions include circulation and migration. Circulation encompasses a variety of movements, usually short-term and cyclical, involving no longstanding change of residence. Migration involves a permanent change of residence (Pim and Lisbeth, 2006).

The unprecedented increase in mobility in the last few decades has led to greater concern about the relationship between mobility and malaria. There are a number of reasons for increased mobility. First, sophisticated forms of transport now permit the swift movement of people over huge distances. Air travel has increased by almost 7% a year in the last 20 years and is predicted to increase by >5% a year during the next 20 years. Second, in the developing world a rapidly increasing population is putting pressure on scarce resources, leading to major population redistribution. This particularly involves the movement from rural to urban areas. Third, natural disasters such as droughts and floods have created approximately 25 million environmental refugees. Finally, conflict, often a result of population pressures and environmental degradation, displaces vast numbers of people. We examine the impact of population movement on malaria transmission (WHO, 1996).

In terms of spatial dimensions, the movements to and from malaria prone areas are of epidemiologic importance. People who move can be categorized as either active transmitters or passive acquirers. Active transmitters harbor the parasite and transmit the disease when they move to areas of low or sporadic transmission. Passive acquirers are exposed to the disease through movement from one environment to another; they may have low-level immunity or may be non immune, which increases their risk for disease. Based on the above definitions, a typology can be devised that identifies categories of population movement. Different activities can be associated with these categories, and these activities, in turn, can be associated with differing risks for malaria transmission. All types of population movement can be accommodated in this typology, and people may exhibit more than one type of mobility (Prothero, 1977).

An interesting hypothesis, hotly debated in the current literature (Hughes *et al*, 2001 and Mu, 2002) is that when Africans experienced a dramatic change in their environmental and behavioral practices 10,000 years ago, shifting from hunter-gatherers to farmers, malaria started to infect humans. Most recently, migration is believed to have initiated malaria transmission in African highlands. A study in Kenya shows that malaria cases were first registered upon the returning of soldiers from World War I between 1918 and 1919. One quarter of the indigenous population was infected (Lindsay and Martens, 1998). In Brazil, malaria transmission reached its lowest level in 1970, but increased more than tenfold in one decade as a result of the massive population movement of non-immune people, mainly from the South of the country, to the Amazon. Later, in the mid 1980's, return movement from the Amazon initiated malaria outbreaks in the South of Brazil (Monte-Mór and Roberto, 2007).

2.3.2 Urbanization as Malaria Transmission Indicator

The world's urban population is growing at four times the rate of the rural population Urban pull is prevalent throughout the developing world, with rural-to-urban migration taking place faster than ever before (Lindsay and Martens, 1998).

Sub-Saharan Africa is the most rapidly urbanizing region in the world (Knudsen, 1992), and the urban population in India has doubled in the last 2 decades (Sharma, 1999). When accompanied by adequate housing and sanitation, urbanization can lead to a decrease in malaria through reductions in human-vector contact and vector breeding sites. However, in developing countries, rapid, unregulated urbanization often leads to an increase in or resumption of malaria transmission because of poor housing and sanitation, lack of proper drainage of surface water, and use of unprotected water reservoirs that increase human-vector contact and vector breeding (United Nations, 1997).

Specifically related to urban malaria in Africa, some of the pioneering and most comprehensive studies were done in Brazzaville, Congo, during the 1980's. Beck, (1977) conducted a study, Primary breeding sites were identified, and detailed entomological and parasitological data were collected. Virtually all breeding sites in the rural villages near Brazzaville originated from manmade environmental transformations in urban areas. These examples illustrate the impacts of urbanization on malaria. However, these impacts vary in magnitude and direction according to the environmental and cultural context in which they take place. City planning that took account of the ecological features of malaria risk could, in principle, substantially reduce the transmission problem. However, such coordinated planning has occurred very infrequently in African urban development. One notable exception is the malaria control that has been incorporated in multiple instances over the past 100 years in Dar-es-Salaam, Tanzania (Beck, 1977).

2.3.3 Epidemiology of Malaria Drug Resistance as Malaria Transmission Indicator

The development of resistance to drugs poses one of the greatest threats to malaria control and has been linked to recent increases in malaria morbidity and mortality. Drug resistance has been confirmed in only 2 of the 4 human malaria parasite species, *Plasmodium falciparum and P. vivax* (WHO, 2001a).

Chloroquine resistant *Plasmodium falciparum* (CRPF) first developed independently in 3 to 4 foci in Southeast Asia, Oceania, and South America in the late 1950's and early 1960's. Since then, chloroquine resistance has spread to nearly all areas of the world where falciparum malaria is transmitted including Africa (WHO, 2003).

Plasmodium falciparum has also developed resistance to nearly all of the other currently available antimalarial drugs, such as sulfadoxine, pyrimethamine, mefloquine, halofantrine, and quinine. Although resistance to these drugs tends to be much less widespread geographically, in some areas of the world, the impact of multi-drug resistant malaria can be extensive (Greenberg, 1989), especially in epidemics.

Chloroquine resistant *Plasmodium vivax* (CRPV) malaria was first identified in 1989 among Australians living in or traveling to Papua New Guinea. CRPV has also now been identified in Southeast Asia, on the Indian subcontinent, and in South America. Vivax malaria, particularly from Oceania, also exhibits decreased susceptibility to primaquine (WHO, 2003).

The vast majority of areas of endemic malaria show resistance to chloroquine (the oldest, cheapest treatment). Resistance to sulfadoxine-pyrimidine is emerging in most affected areas. Resistence to mefloquine has been observed in South-east Asia (areas of multi-drug resistance). No clinically relevant resistance has been observed with artemisinin and related derivatives (Wongsrichanalai *et al*, 2003). There have been no studies on healthcare workers knowledge local information from health care workers on Malaria Transmission Indicators as a cause of early malaria outbreak indicator.

2.4 Knowledge of Health Care Workers of Malaria Early Detection Indicators

2.4.1 Unusual increase in Rainfall as Early Detection indicator

Where malaria is found depends mainly on climatic factors such as temperature, humidity, and rainfalls. Malaria is transmitted in tropical and subtropical areas, where *Anopheles* mosquitoes can survive and multiply and also where the parasites can complete their growth cycle in the mosquitoes. Temperature is particularly critical. For example, at temperatures above 20°C (68°F), *Plasmodium falciparum* (which causes severe malaria) can complete its growth cycle in the *Anopheles* mosquito, and thus can be transmitted. The highest transmission is found in Africa South of the Sahara. Generally, in warmer regions closer to the equator transmission will be more intense, malaria is transmitted year-round, and *P. falciparum* predominates (CDC, 2004). Nyando is located near the equator.

The effects of rainfall on both the vectors and parasites of malaria are easily seen in the latitudinal and altitudinal boundaries to malaria transmission. Some studies have been done on the subject, yielding differing results as to which factor or factors are most responsible for the increase in malaria. Most of the studies, however, do not take into account all of the factors that are related to malaria transmission. This makes it difficult to assess the true determinants of malaria in each. In Pakistan, rainfall along with humidity in December, predicted malaria rates fairly well (Lindsay and Patz, 1999).

A study of epidemics of malaria in different areas of the highlands of Kenya found that increased rainfall, drug resistance, temperature and relative humidity were related to the epidemics (Woube, 1997). A number of studies relate the El Niño Southern Oscillation (ENSO) to malaria epidemics. Many areas have experienced periodic malaria epidemics every five to eight years, which may have been related to the ENSO cycle. Malaria epidemics in the former British Punjab, Pakistan, Sri Lanka, the highlands of Uganda, Columbia, Argentina, Ecuador, Peru, and Bolivia were proposed to be associated with ENSO cycles (Bouma, 1995).

In Kenya Malaria transmission is influenced by meteorological conditions, including rainfall and humidity, and often exhibits strong seasonality. However, transmission is not directly associated with flooding. Such events may coincide with periods of high risk for transmission and may be exacerbated by increased availability of the vector's breeding sites mostly artificial containers caused by disruption of basic water supply. The risk for outbreaks can be influenced by other complicating factors, such as changes in human behavior, increased exposure to mosquitoes while sleeping outside, movement from non-endemic to endemic areas, a pause in disease control activities, overcrowding or changes in the habitat that promote mosquito breeding like landslide, deforestation, river damming, and rerouting of water (John *et al* 2007).

2.4.2 Malaria Morbidity data as Malaria Early Detection Indicator

The detection of an epidemic depends on indicators selected for surveillance. The pre-conditions, therefore, include a functional Health Management Information System (HMIS) and a sentinel surveillance system with sensitive and specific indicators. Geographical Information System (GIS) has become one of the tools used in HMIS (WHO, 2000 [B]).

For more than 50 years, the mantra of "one million annual deaths due to malaria" has been cited by scientists and journalists. Until recently, this estimate had generally gone unexamined in regard to its accuracy, clinical components, and economic implications. A study by Cabe (2001) shows that, at a minimum, between 700,000 and 2.7 million people die annually from malaria, over 75% of them African children. Data presented in the report show that over 85% of these malaria-induced childhood deaths are due to anemia, low birth weight, and hypoglycemia.

It also reported that between 400 and 900 million acute febrile episodes occur annually in African children under the age of 5 living in malaria-endemic regions, and that this number will double by 2020 if effective control interventions are not implemented. This is notable because high fevers and febrile convulsions in infants and children can retard brain development, often resulting in impairments in high-order cognitive function such as planning, decision-making, self-awareness, and social sensitivity. Of all the manifestations of malaria, those impacting cognition and behavior are the subtlest, least defined, and have the most profound implications for children, families, and societies. The data also presents new information about the cause-effect connections between malaria and poverty. For example, growth of income per capita from 1965 to 1990 for countries with severe malaria transmission was only 0.4% per year, whereas economic growth for countries with fewer malaria infections was 2.3% per year, more than 5 times higher (Cabe, 2001). Unfortunately there is no local information from health care workers on malaria morbidity data as an early malaria outbreak indicator.

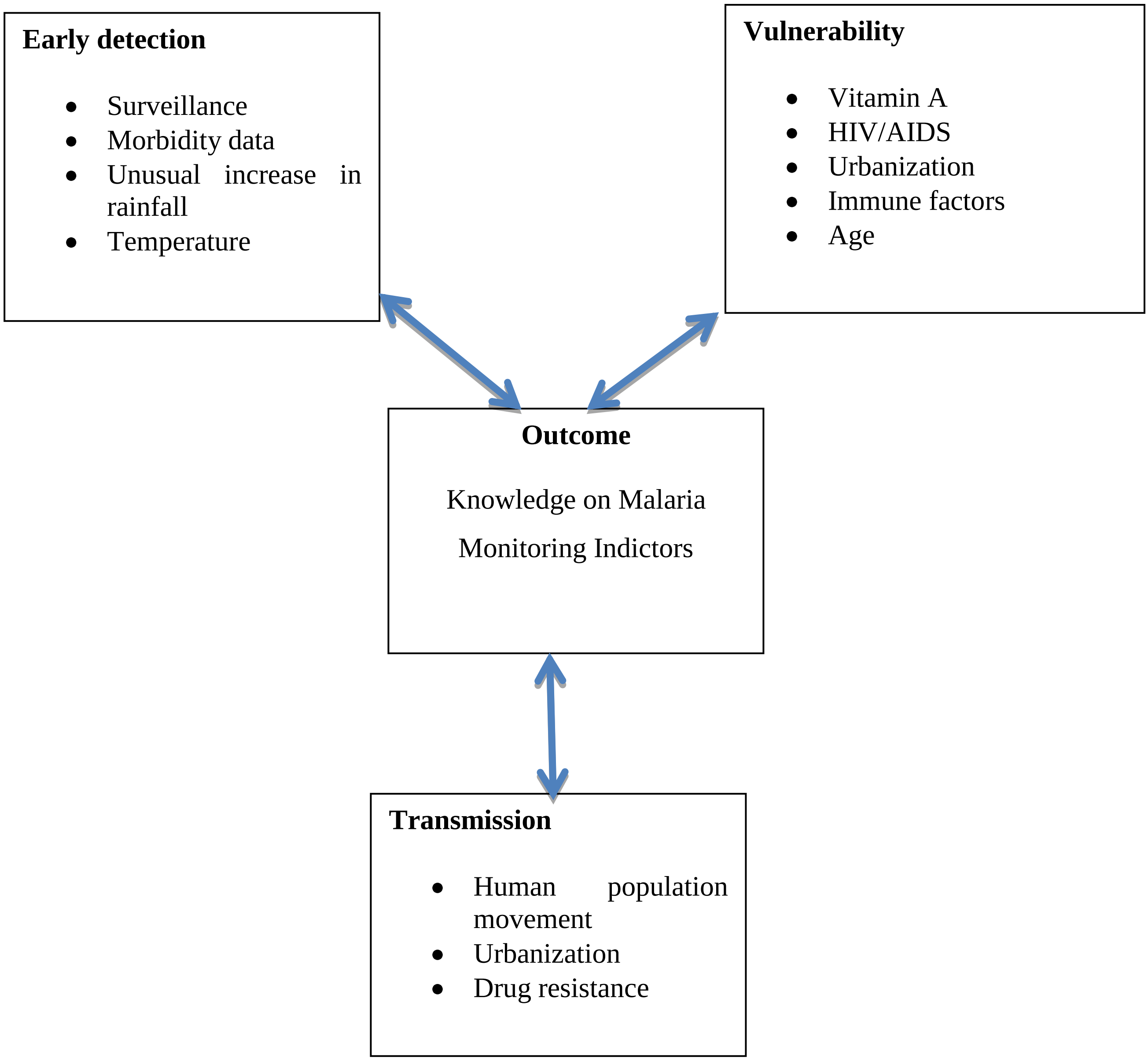
2.4.3 Malaria Surveillance as Early Detection Indicator

Constant malaria monitoring and surveillance systems have been highlighted as critical for malaria elimination. The absence of robust monitoring and surveillance systems able to respond to outbreaks in a timely manner undeniably contributed to the failure of the last global attempt to eradicate malaria. Surveillance systems that can gather, store and process information, from communities to national levels, in a centralized, widely accessible system will allow tailoring of surveillance and intervention efforts. Different systems and, thus reactions, will be effective in different endemic, geographical or socio-cultural contexts. Investing in carefully designed monitoring technologies, built for a multisectoral dynamic system, will help to improve malaria elimination efforts by improving the coordination, timing, coverage, and deployment of malaria technologies (Barclay *et al*, 2012). There have been no studies on healthcare workers knowledge local information from health care workers on malaria early detection indicators as a cause of early malaria outbreak indicator.

2.5 Summary of knowledge gaps

There is no local knowledge on health care providers on malaria vulnerability indicators as well malaria transmission indicators and also on malaria early detection indicators as a cause early malaria epidemic outbreak indicator.

2.6 Conceptual Framework



CHAPTER THREE: Methodology

3.1 Introduction

This chapter describes the study area, materials, and the methodology that were used to conduct the study, it includes a description of the study area, the study design, study population, sample size determination, sampling methods and data analysis methods that were used for the study.

3.1.1 Study area

The study was conducted in Greater Nyando sub-counties which is one of the twelve sub-countiess in Nyanza province curved from Kisumu sub-counties; it is composed of several administrative divisions which include Muhoroni, Miwani, Nyando, Lower Nyakach and Upper Nyakach. It covers an area of approximately 1168.4 square kilometers, with a population of approximately 369,543 persons in 2010 projected from figures of 2009 Kenya population census. Its located 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) (**see appendix 2**).

Annual mean temperatures vary between 17°C and 32°C. The area is relatively humid due to its proximity to Lake Victoria. 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.

The population is mainly youthful with 65 percent of them aged below twenty five years. Those aged 65 years and above account for only 4 percent of the total population (MoH Nyando, 2010)

Table 3.1 shows the distribution of 38 health facilities among the various divisions in the sub-counties, Nyando has 3 GoK hospitals, 6 health centers, 19 dispensaries, 6 mission and 4 private facilities.

Table 3.1 Health Facilities distribution for Greater Nyando Sub-counties

Division	Hospitals (GoK)	Health Center	Dispensary	Mission	Private	Total
Lower Nyakach	1	1	3	0	0	5
Miwani	0	2	3	0	0	5
Muhoroni	1	0	5	2	2	10
Nyando	1	0	4	1	1	7
Upper Nyakach	0	3	4	3	1	11
Totals	**3**	**6**	**19**	**6**	**4**	**38**

3.2 Study design

A cross-sectional descriptive study was used for the study. The design was chosen in favor of other designs because it maximized reliability of data collected and was also economical in terms of finance and time saving. To achieve the best results both qualitative and quantitative data analysis methods were used in the study.

3.2.1 Study Population

All 241 health care providers working in health facilities in Nyando sub-counties formed the study sample population which included doctors, nurse’s public health officers and clinical officers (Appendix 5).

3.2.2 Sample Size

The objective of sample size determination is to produce a sample of health care workers in order to reduce bias and to calculate a sample size needed, and to measure a given proportion with a degree of accuracy at a given level of statistical significance. To provide a sample of health care workers, a formula by Fisher's *et al.,* (1998), cited in Wayne W. D. (1996), was used to determine the required sample. Therefore,

$$n = \frac{Z^2 (P)(q)}{d^2}$$

Where n = Sample size,

Z = standard normal deviate with 95% confidence interval =1.96

p = estimated proportion of health workers with knowledge on malaria indicators (0.5),

q = 1-p

d = precision - level of significance (0.05).

$n = 1.96^2 \times 0.5\ (0.5) / 0.05^2 = 384.16$

Since the target population size is less than 10,000 to standardize the sample size

$$Nf = \frac{n}{1 + (n/N)} \quad \frac{384.16}{1 + (384.16/210)} = 135.78$$, rounded up to **136**

Providing for 10% non-response, the sample size was adjusted using this adjustment formula:

10% of 136 = 13.6, rounded up to **14**

Therefore, adding adjusted population size (136) to the 10% non-response (14), the sample size was calculated to 140.

3.3 Sampling procedure

Purposive sampling method was used to determine the study area, which is Greater Nyando sub-counties, Nyanza province. All facilities were selected and health care providers from within the health facilities were selected randomly and the number was achieved by probability proportion that entailed getting the ratio of health providers to the total number of health facilities 136/38 = 3.57. 3 to 4 health workers per facility (also depending on the total number in the facility) were selected for interview until the desired sample was achieved. This method was preferred as it provided high precision rate that was required in the study. See **appendix 5** for distribution of respondents.

3.3.1 Inclusion criteria

Health care providers who were on duty and were willing to respond during the study period. These included health workers in the health facility who are doctors, nurses, public health officers and clinical officers.

3.3.2 Exclusion criteria

Health care providers who were not on duty and not willing to participate during the study period. Also excluded were hospital administrators and cleaners.

3.4 Data Collection

An interviewer schedule was used to collect data (Appendix 1) and this was administered electronically using a personal digital assistant (PDA). The process involved; designing an electronic interviewer schedule by software (Epi surveyor) which was loaded in the PDA, the questions flowed as they appeared in the interviewer schedule. After it was designed the PDA was pre tested in Kisumu East sub-county. There after the questionnaire was was revised and re tested to ensure that it collected the right information. The data was then collected using the PDA and transferred daily to a computer. Transfer of data from the PDA to the computer was done by synchronized data transfer; the data was converted to be compatible with Microsoft Excel® and Ms Access. The Epi surveyor software was capable of executing some data analysis.

3.4.1 Data Analysis and presentation

Data analysis was carried out in Microsoft Excel®, where descriptive statistics was carried out. These descriptive statistics quantitatively describe or summarize the data collected using frequencies, rates, proportions, including the mean, mode and standard deviation to describe the various questions that were being tested and was presented in text, tables and graphs.

3.4.2 Minimizing Bias

The interviewer schedule was pre tested among a sample of health care providers at Kisumu sub-county hospital and amendments done. The sample that was selected was large enough to give statistical power which yielded good results of the situation, and cleaning of data was done as the research continued. The sampling methods that's were used were adequate enough for getting the best sample size.

3.5 Ethical Statement

Permission to carry out the study was obtained from the Provincial Medical Officer of Health for Nyanza province (Appendix 3), and copied to sub-counties Medical officer of Health for Greater Nyando sub-counties, hospital administrators of the various health facilities. Verbal consent was obtained from the healthcare providers who were being interviewed.

Chapter Four: Results

4.0 Introduction

This chapter deals with presentation of the research findings, which are then presented in the form of frequencies, percentages, tables and charts. These findings were analyzed according to the study objectives while analyses were done by descriptive statistics.

4.1 Characteristics of study subjects

The total number of health facility respondents sampled was 141. Of the participants sampled, majority of the respondents (n=54; 38%) were from Upper Nyakach, followed by Nyando (n=31; 22%) divisions. The lowest number of respondents were from Miwani division (n=12; 9%). This is shown in figure 4.1 below.

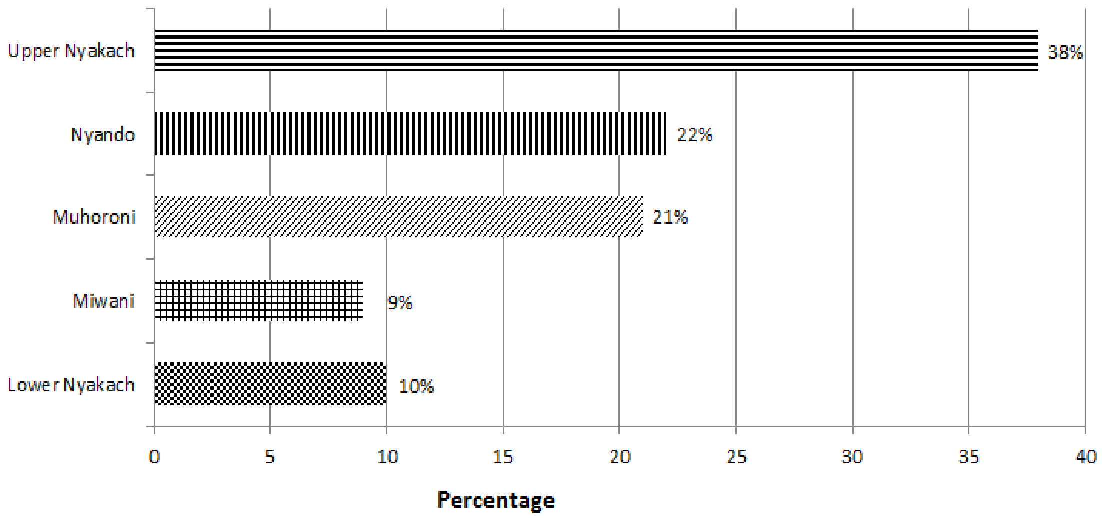


Figure 4.1: Percentage distribution of respondents by divisions in Greater Nyando Sub-counties (n = 141)

Of the health facilities sampled, majority of the respondents were from dispensaries (n= 56; 40%), followed by mission health facilities (n=31; 22%). The least number of respondents were from private health facilities (n=9; 6%) as shown in Table 4.1 below.

Table 4.1: Number of respondents by health facility type

Facility Type	Respondents	Percentage (%)
Hospital	16	11
Health Centers	29	21
Dispensary	56	40
Missions	31	22
Privates	9	6
Totals	**141**	**100**

In terms of health professionals sampled, majority of the respondents were nurses (n=111; 79%), followed by public health officers (n=15; 11%), then clinical officers (n= 11; 8%), and lastly doctors (4; 3%) of the total respondents (n=141) as shown by the figure 4.2 below. Figure 4.2 shows the frequency of the sampled respondents (n=141).

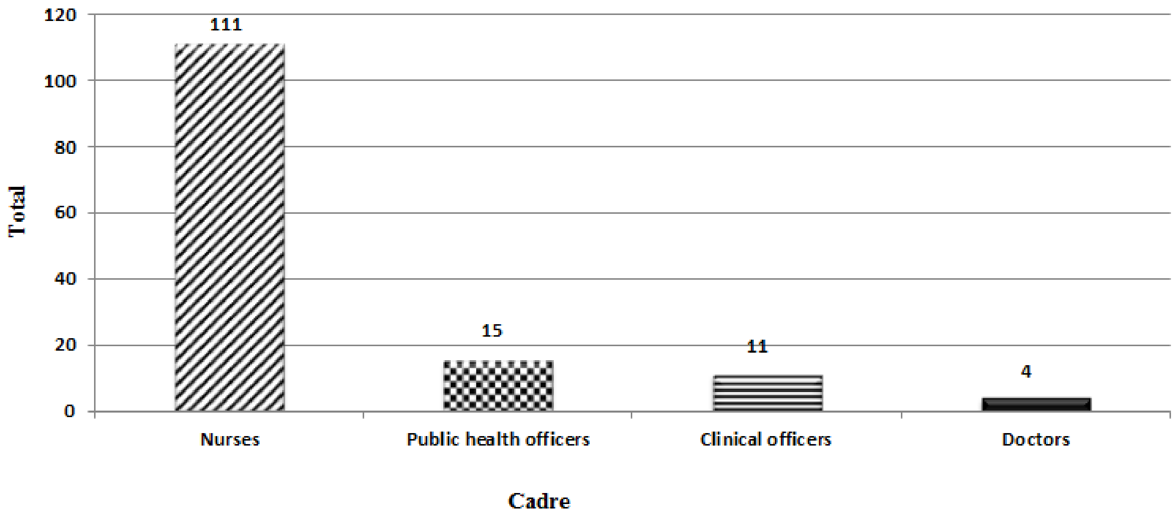


Figure 4.2: Distribution of cadre of respondents (n = 141)

The mean age of respondents work experience was 18 years while maximum was 27 years respectively.

4.2 Malaria vulnerability indicators

Figure 4.3 shows the percentage distribution of adult disesases according to the respondents (n=141) sampled. According to the respondents, the most common infection among adults was malaria (n=128; 91%), followed by diarrhoeal diseases (n=118; 84%), then respiratory diseases (n=111; 79%). Diseases of the skin (n=56; 40%) were the minority. This is shown in the figure 4.3 below.

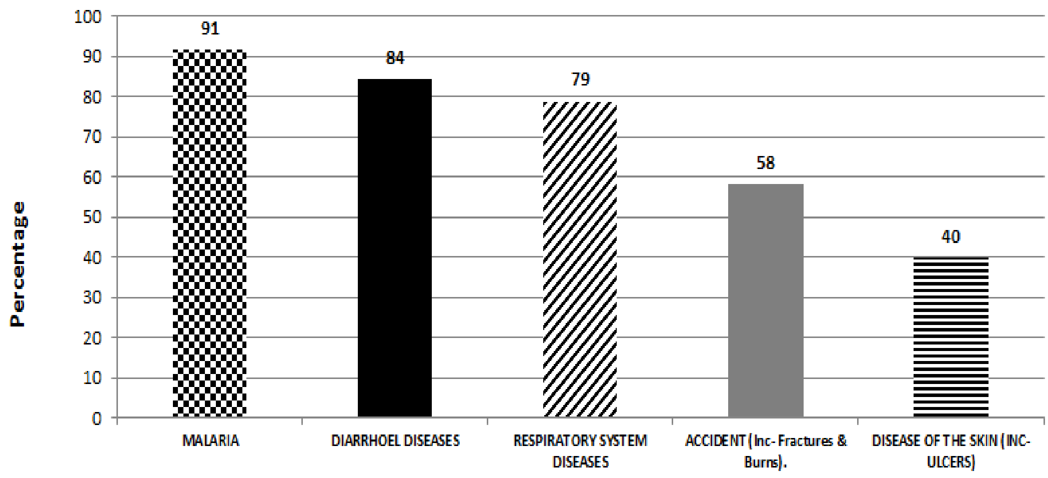


Figure 4.3: Common disease among adults (n = 141)

Figure 4.4 shows the percentage distribution of childhood disesases according to the respondents (n=141) sampled. According to the respondents, the most common infection among children was diarrhoeal diseases (n=128; 91%), followed by intestinal worms (n=124; 88%), then malaria (n=123; 87%). The respiratory system diseases (n=106; 75%) were least common among children. This is shown in the figure 4.4 below.

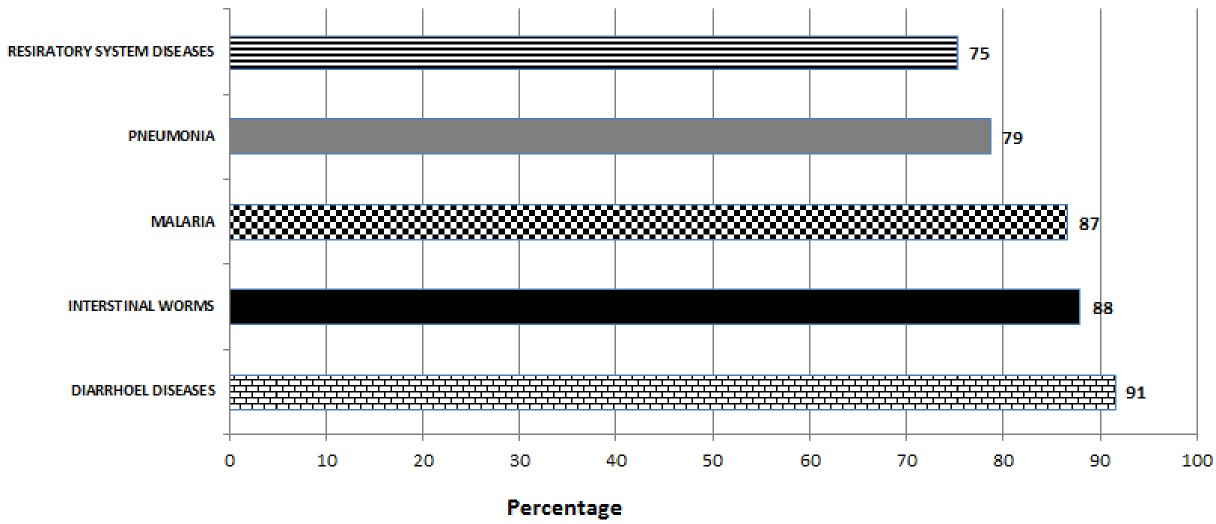


Figure 4.4: Common disease among children (n= 141)

Majority of the respondents (n=140; 99%) sampled in the study were of the opinion that malaria was a problem in the community. This is shown by the Figure 4.5 below.

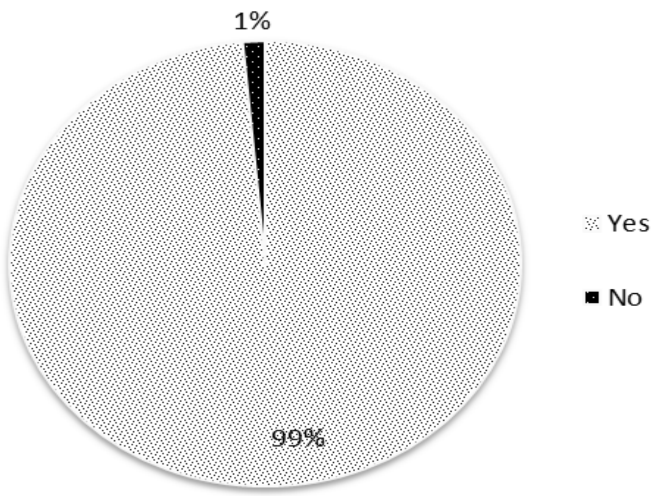


Figure 4.5: Malaria cases within the community (n = 141)

The above figure 4.5 shows the proportion of respondents who point out that malaria is a common problem in the community.

When asked what are the major causes of malaria in the community, majority of the respondents (n=140; 99.3%) were of the opinion that not using ITNs was associated with malaria. The second most common opinion voiced was the presence of bushes (n=136; 96.5%), was also cited as a possible cause of malaria. This was followed by poor sanitation (n=98; 69.5%) and lastly stagnant water (n=76; 53.9%). This is shown on table 4.2 below.

Table 4.2 Frequency and percentage of responses to possible cause of malaria.

	Responses	Percentage (%)
Bushes	136	96.5%
Stagnant water	76	53.9%
Poor sanitation	98	69.5%
Not Using ITNs	140	99.3%

When the respondents were asked about malnutrition in the community, majority of the respondents (n=135; 96%) perceived malnutrition as a problem in the community, while the other respondents sampled (n=6; 4%) were of the opinion that malnutrition is not a serious problem in the community. This is shown in Figure 4.6 below.

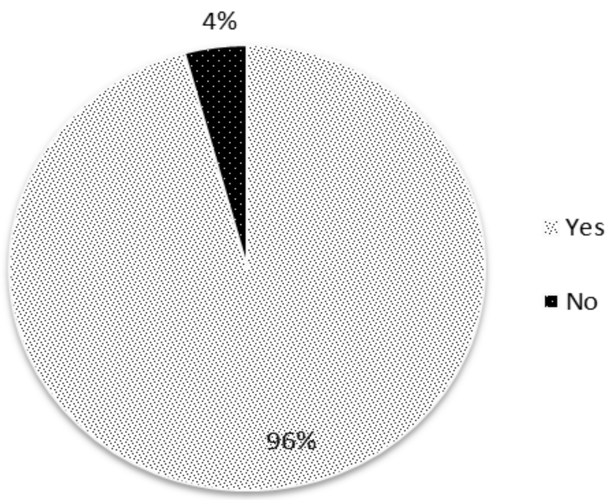


Figure 4.6: Percentage Distribution of Perceived Malnutrition within the community

Prevalance of under five malnutrition rate as perceived by health workers was at a mean 10.3%, maximum 14.0% and minumum 8%. Asked on the effects of malnutrition on the occurrence of malaria, all respondents pointed that malnutrition lowers the immunity against malaria cases hence resulting to high prevalence of malaria. It was also found that low immunity was a problem among those visiting the facility all the respondents affirming that low immunity was a problem in the community.

Figure 4.7 shows the proportion of respondents who perceived HIV and AIDS as a problem in the community. All respondents pointed that high rate of HIV and AIDS increases malaria cases. It was also found that majority (n=127; 90%) of the respondents perceived HIV/AIDS as a problem in the community, while a minority (n=14; 10%) did not share the same perception. This is shown in figure 4.7 below.

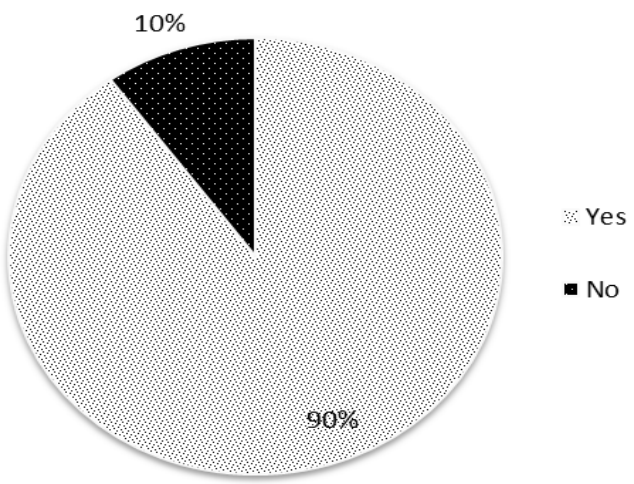


Figure 4.7: Proportion of health workers perception on HIV and AIDs as a problem (n = 141)

The repondents were then asked to rate the HIV prevelance in the community and this is shown by Table 4.3 below. This study revealed that all respondents perception was that high rate of HIV resulted to high rates of malaria cases. Asked about the place where malaria observed in the community occurred, majority (n=127; 90%) of respondents said that most of the malaria cases occurred from within the sub-counties while major sub-counties hospital had referrals from within and outside the sub-countiess.

Table 4.3: Decription of the rate of HIV prevalalnce as rated by repondents

	HIV rate
Mean	14.25%
Max	16%
Min	9%

4.3 Malaria transmission indicators

This study found that about 94 respondents representing 67% had observed that population movement within the community led to travelling from endemic areas to possible non endemic areas hence leading to high prevalence of malaria in the areas visited. In addition, about 44 respondents representing 33% had observed that movement within community surrounding the health facilities led to more mosquito bites from endemic areas hence increasing the number of malaria cases in the facilities.

4.3.1 Effects of Urbanization on Malaria Cases.

Majority of the respondents (n=132) representing 67% had attributed malaria outbreaks to poor water drainage in crowded areas. Many respondents (n=124) representing 88% felt that the disposal of waste also contributed to increases of malaria cases. A few respondents (n=43) representing 31% felt that empty containers also contributed to increase in malaria cases within the community. This is shown in the table 4.4 below.

Table 4.4: Effects of urbanization of occurrence of malaria cases

	Responses	(%)
Poor water drainage in crowded areas	132	94
Poor disposal of waste	124	88
Empty containers	43	31

4.3.2 Effects of Weather on Malaria Cases

All respondents were of the opinion that the community is affected by extreme weather condition that favored spread of malaria. Most respondents felt that floods (n=139; 99%) and rains (n=131; 93%) as the most common weather conditions that lead to the increase of malaria in the community because of increased breeding grounds for mosquitoes. Extreme heat (n= 69; 49%) and cold weather (n=22; 16%) were thought not to contribute highly to increase of malaria cases in the community. This is shown in the table 4.5 below.

Table 4.1: Common weather conditions in Nyando and those Associated with Malaria cases

	Number	%
Common Weather Conditions In Nyando		
Flood	139	99%
Extreme heat	69	49%
Rain	131	93%
Cold weather	22	16%
Weather conditions Associated to Malaria Cases		
Humid environment	17	12%
Breeding grounds	126	89%
Flooding	138	98%
Stagnant water	96	68%

4.4: Malaria Surveillance and early detection indicators

4.4.1 Malaria Surveillance Systems

All respondents (n=141; 100%) were aware of an existing surveillance systems for monitoring the occurrence of malaria. In addition, majority 106 (75%) of the respondents said that the surveillance system was integrated and included other conditions such as immunization, TB and HIV.

4.4.2 Early Malaria Detection Indicators

The respondents believed that data collected by the authorities for surveillance activities was used to predict occurrence of malaria cases/ epidemics (n=122; 87%), showing which month had more cases (n=119; 84%) and could be used for planning (n=79; 56%) and monitoring and evaluating (n=56; 40%) malaria control programmes. This is shown in Table 4.7 below.

Table 4.7: Use of surveillance data to predict occurrence of malaria cases.

	Responses	**(%)**
Months with many cases	119	84%
Predict Malaria epidemics	122	87%
Planning for Epidemics	79	56%
Monitoring and evaluation of surveillance	56	40%

Chapter Five: Discussion

5.1 Introduction

This chapter deals with discussion based on the findings and literature review following order of the specific objectives were drawn in respect of 141 respondents who were interviewed and gave their views on the study.

5.2 Discussion

5.2.1 Health care provider's knowledge on malaria vulnerability indicators

The results from the research indicated that healthcare workers had knowledge on malaria indicators, stating malaria as a common infection among the adult population and children in the study area. This were congruent with Perry *et al*, (2011) who stated that children have a higher complication rate (severe anemia, cerebral malaria, and long-term neurologic sequelae) and a higher mortality rate relative to older populations. Age has been majorly connected with severe malaria cases where malaria in children is further complicated due to lack of immunity to the *Plasmodium species* which are causative agent of malaria. Adults who are natives of malaria endemic areas acquire the infection early in childhood and develop natural immunity compared to non immune patients (Schwartz, *et al.,* 2001). This non immunity to malaria has been shown to increase mortality in adults who are more than 70 years than in children below 10 years (Schwartz, *et al.*, 2001; Broderick, *et al.,* 2015).

Countries in sub-Saharan Africa are encouraged to use ITNs. These ITNs are to be used in epidemic-prone regions, plus also in high and medium malaria transmission settings. The use of ITNs has been shown to decrease mortality in children below 5 years by 15-30% in Nigeria (Tobin-West & Alex-Hart, 2011), and 33% in Kenya (Nevill, *et al.*, 1996). Since malaria was a common infection in both children and adult population in the community, majority of the respondents in this study were of the opinion that not using ITNs would expose an individual to the malaria transmitting parasite. There is no known data on utization of ITNs in the homestaeds locally. None of the respondents mentioned indoor residual sprays (IRS). In the malaria control strategy, the use of ITNs and IRS have been recommended as ways of controlling malaria. The ITNs are associated with significant reduction of malaria morbidity in high and medium transmission settings, while IRS appears effective in medium and low transmission settings. Thus the use of both interventions should provide a synergistic effect, as shown by studies carried out in South Africa that indicate that the use of ITNs and IRS could reduce mortality in children below 5 years if used in participatory communities (Fullman, *et al.*, 2013).

Living in close proximity to swamps and forests was said to be associated with malaria disease transmission. Therefore the clearing of bushes as mosquito hiding places, especially around the homestead and draining of stagnant water are useful methods recommended for controlling malaria. The respondents highly associated the presence of bushes as major source that leads to malaria transmission after not using ITNs. The respondents then mentioned that poor sanitation and stagnant water also leads to malaria transmission. Habitats such as bushes, forests, swams, stagnant water have been shown to contribute highly to the increased proliferation of *Anopheles* breeding sites and microclimates that enhance and prolong vector survival leading to increased malaria transmission (Ernst, et al., 2009**)**.

Majority of the respondents perceived that malnutrition is a major problem in the community. This majority of respondents related malnutrition to the lowering of the patients' immunity thus making one very susceptible to malaria infections. The findings of many studies in regards to malaria and malnutrition have been contradictory. Some studies indicate that some malnourished and stunted children may significantly have low immune response to malaria (Fillol, *et al.,* 2009), while other studies have found that there are no associations between the risk of malaria and malnutrition (Carswell, *et al.,* 1981; Deribew, *et al.,* 2010). In other studies, there is an increased risk of contracting malaria epecially in children patients with stunted growth and underweight (Deen et al., 2002; Ehrhardt, et al., 2006).

All the respondents pointed that low immunity was a problem among those visiting the facility, this was in congruence with Dayachi and others (1991) stated that Vitamin A deficiency affects over 30 million children under 5 years which increases all-cause mortality and related illnesses. Afrane, (2006), on studies in western Kenya which indicate that areas of unstable transmission in the highlands, the prevalence of circumsprozoite protein (CSP) was 13% in adults over 40 years of age whereas in the stable transmission lowlands, approximately 65% of children were antibody positive making them more vulnerable to severe forms of malaria during epidemics.

5.2.2 Health care provider's knowledge on malaria transmission risk indicators

The process of urbanization includes physical landscape modification and transformation of the surrounding environment. Moreover, urbanization involves significant socio-economic change; generally improved health, housing and increased wealth (Dye, 2008). These factors which are very common to urban areas will lead to marked entomological, parasitological and behavioural effects (Alirol, *et al*., 2011). In the developed regions, the process of urbanization reduces malaria transmission, primarily because urban environments may not provide suitable breeding sites, and the pollution of existing larval habitats by chemicals generally affect malaria vectors (Alirol, *et al*., 2011). However, in less developed regions, especially those undergoing rapid and unprecedented urbanization, urbanization may lead to increased malaria outbreaks and or transmissions. This is due to increased population growth, poor levels of hygiene, increasing urban poverty, deteriorating urban environment due to unplanned developments. Densely packed housing in shanty towns or slums and inadequate drinking-water supplies, garbage collection services, and surface-water drainage systems combine to create favourable habitats for the proliferation of vectors and reservoirs of communicable diseases such as malaria (Knudsen & Slooff, 1992; Keiser, et al., 2004; Tatem, et al., 2013). The respondents in this study cited the presence of poor water drainage in crowded areas and poor disposal of wastes in the study site as possible causes of increased malaria. This results tend to agree with studies by Molineaux (1988) and United Nations (1997), where they found out that in developing countries, rapid urbanisation often leads to an increase in resumption of malaria transmission because of poor housing and sanitation and also lack of drainage of surface water and use of unprotected water reservoirs that increased human-vector contact and vector breeding.

This result also agrees with the study by Sharma (1999) in India which stated that adequate housing and sanitation, urbanization can lead to a decrease in malaria due to human-vector contact and vector breeding sites. Also manmade environmental transformation in urban areas has an impact on malaria. This results above agree with the results from WHO (1996) that in developing world, a rapidly increasing population was putting pressure on scarce resources and natural disasters such as floods droughts had created approximately 25 million environmental refugees that have caused environmental degradation and had strong impact on malaria transmissions. On the contrary, a study in Kenya (John *et.al.* 2007) shows that transmission is not associated with flooding. Further research is necessary to establish the situation in Nyando.

The results above also have been compounded by the movement from one environment to another which increases the risk for malaria transmission. Also the results agrees with the study in Kenya by Lindsay and Martens (1998) and that from Brazil by Monte-mor (2007) on malaria transmission that attributed the disease to migration by human movements that increased malaria by tenfold in one decade as a result of the massive population movements. However, there seems to have greater knowledge by the healthcare workers on malaria risk but little human activities to eliminate the disease in the region. The study results also further indicates that 94 (67%) of the respondents had population movements within the country from endemic to non-endemic areas which cause high prevalence of malaria.

Infections of malaria and HIV/AIDS have been shown in studies to interact bidirectionally and synergistically to each other. HIV infection can increase the risk and severity of malaria infection and the increased parasite burdens might facilitate higher rates of malaria transmission. Individuals in malaria-endemic areas that are considered semi-immune to malaria can also develop clinical malaria if they are infected with HIV. Also malaria infection is associated with strong CD4+ cell activation and up-regulation of proinflammatory cytokines, providing an ideal microenvironment for the spread of the virus among CD4 + cells and thus for rapid HIV-1 replication (WHO, 2005; Alemu, et al., 2013). In this study, all the respondents had a high perception that the high rate of HIV infections in that community resulted to high rates of malaria cases. KNOX (2006) found that when people with HIV also get infected with the malaria parasite, the amount of HIV in their blood shoots up to sevenfold and stays high for many weeks. In Kisumu they found malaria raised HIV infection rates by 5 percent over the past 20 years. This translates into 8,500 HIV cases in this town of about 200,000 adults. Those HIV-weakened immune systems account for almost a million extra malaria cases in Kisumu (KNOX, 2006).

5.2.3 Health care provider's knowledge of malaria early detection indicators

Weather condition contributed to the occurrence of malaria. In this study, flooding was cited as a major cause of increased breeding grounds for mosquitoes. This is in congruence to three studies carried out by Woube, (1997) on the epidemics of malaria in different areas of the highlands of Kenya. The study (Woube, 1997) found that increased rainfall was related to the epidemic, another study found that increasing temperature and relative humidity were also involved.

Resistance to drugs poses the greatest threats to malaria control (WHO, 2001a). The study found that most of the healthcare workers were aware 127 (90%) of the existence of the malaria. However, there was little evidence on what was done to reduce the prevalence and cases to manageable levels. Communities were not using ITNs 140 (99%), the environment was very bushy 136 (96.5%), and there was also poor water drainage in crowded areas 132 (94%), poor waste disposal 124 (88%) and floods 139 (99%). Though all this could attributable to increase in malaria prevalence, it was noted that the knowledge among the population studied was also weak by attributing high rates of HIV and AIDS to increase in malaria cases.

All respondents affirmed that there is a surveillance system on malaria which was integrated with activities on only HIV, Tuberculosis control and immunisations. The data they collected could be used to predict occurrences of malaria 122 (87%) and determine the malaria threshold while, no specific interventions were designed to reduce the epi-curves but only displays the data for visualization. The data was not used by the healthcare workers to design specific interventions for community actions, therefore surveillance was deemed to be weak for action, Barclay 2012 stated constant malaria monitoring and surveillance systems have been highlighted as critical for malaria elimination. The absence of robust monitoring and surveillance systems able to respond to outbreaks in a timely manner undeniably contributed to the failure of the last global attempt to eradicate malaria epidemics.

Chapter Six: Conclusions and Recommendations

6.1 Introduction

This chapter presents a summary of the study as demonstrated in the preceding chapters highlighting major conclusions and Recommendations on the study.

6.2 Conclusions

6.2.2 Knowledge on malaria vulnerability indicators

There was knowledge on malaria indictors and the specific causes that accelerate the increase of the malaria cases up to epidemic level. This was not translated to specific interventions to reduce the prevalence to manageable levels and subsequently eliminate the disease in the region.

There should be an advocacy use of ITNs, especially in Nyando which is epidemic-prone region and these interventions it to reduce the prevalence of malaria the disease in the region. There should be a community based approach in management nutrition especially with homesteads by conducting outreaches and also offering supplementary feeding programs

The respondents should encourage the community to go for VCT this will reduce HIV infection and have a high immune system and this will translate to less vulnerability to malaria infections.

6.2.3 Knowledge on malaria transmission indicators

Respondents cited population movement as a risk factor for malaria transmission. Furthermore bushes, poor drainage and sanitation caused by uraniztion were stated to be factors that aggravated the breeding cites for the vectors thus increasing the rate of infections.

Resistance to drugs poses the greatest threats to malaria control and most of the respondents were aware however, there was little evidence on what was done to reduce the prevalence and cases to manageable levels.

6.2.4 Knowledge of malaria early detection indicators

Weather conditions contributed to malaria epidemics and also malaria surveillance was weak that required strengthening with epidemic curves closely monitored and actions taken by the communities affected.

The managing teams of the facilities should keep monitoring and surveillance systems so as to respond to outbreaks in a timely manner thus reducing malaria infections and deaths.

6.3 Recommendations

1. The health workers should advice the use ITNs to the community. This will significantly reduce the malaria prevalence to manageable epidemic levels. Prevention is better than cure. Health promotion to communities to reduce the burden and practice of not using the ITNs and health seeking behaviour reducing self-medications.

2. Management of nutrition by conducting outreaches and also offering supplementary feeding programs

3. Health workers to be holding health promotions to the community to go for VCT and also be to be using condoms protection,

4. The health workers through the support from governance of Kenya should implement the community strategy in full in this area. Well-designed community dialogue and action days will allow communal cleaner-ups, clearing of the bushes and drainage of the stagnant water.

5. Surveillance on malaria is not timely. The health facility workers should be able to draw epidemic curves and continuously monitoring the disease. It should also involve the critical health workers to update the data sets and prioritise malaria on the list.

6. Provide adequate resources for the public health interventions to allow all communities reduce the prevalence.

6.4 Recommendations for future research

Further research on behaviour and practice of the communities should be done to enable well designed health interventions that are practical to reduce the risk of malaria epidemics.

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Appendix 1: Interviewer Schedule

INTERVIEWER SCHEDULE FOR THE ASSESSMENT OF KNOWLEDGE ON MALARIA EPIDEMIC MONITORING INDICATORS AMONG HEALTH WORKERS IN NYANDO SUB-COUNTIES

Divison ………………………………. **Facility Type…………………………….**

Agency ……………………………… **Date………………………………………**

1. Cadre of respondent……………… 2. Working experience (yrs)……………………..

3. What are Common diseases among adults? 4. What are Common diseases among <5yr olds?

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5. Is Malaria a problem within the community attending this facility? Yes ☐ No ☐

6. What do you think are the possible causes of malaria?

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7. Is malnutrition a problem within the community attending the facility? Yes ☐ No ☐

8. Is malnutrition a problem within the community attending the facility? ……………………………………………………..………………………

9. How would the rate of malnutrition affect the occurrence of malaria cases?

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10. Is Low immunity a problem within the community attending the facility? Yes ☐ No ☐

11. How would the rate/ levels of immunity affect the occurrence of malaria cases?

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12. Is HIV/AIDS a problem within the community attending this facility? Yes ☐ No ☐

13. What is the rate of HIV in the facility? ....

14. How would the rate of HIV affect the malaria cases?

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15. Where do most of the cases of malaria recorded in this facility come from?

Within the sub-counties ☐

Outside the sub-counties ☐

Not Known ☐

16. How would the population movement within the community surround the facility affect the occurrence a malaria cases?

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17. How would urbanization of towns within the facility affect the occurrence of malaria cases?

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18. Is the region in within the facility affected by extreme weather conditions? Yes ☐ No ☐

19. If so which weather conditions are common?

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20. How would the weather conditions affect/contribute to occurrence of malaria cases?

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21. Are there surveillance activities or teams within the facility? Yes ☐ No ☐

22. Which surveillance activities are being carried out by the teams?

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23. How can data collected for surveillance activities be used to predict occurrence malaria cases/epidemics?

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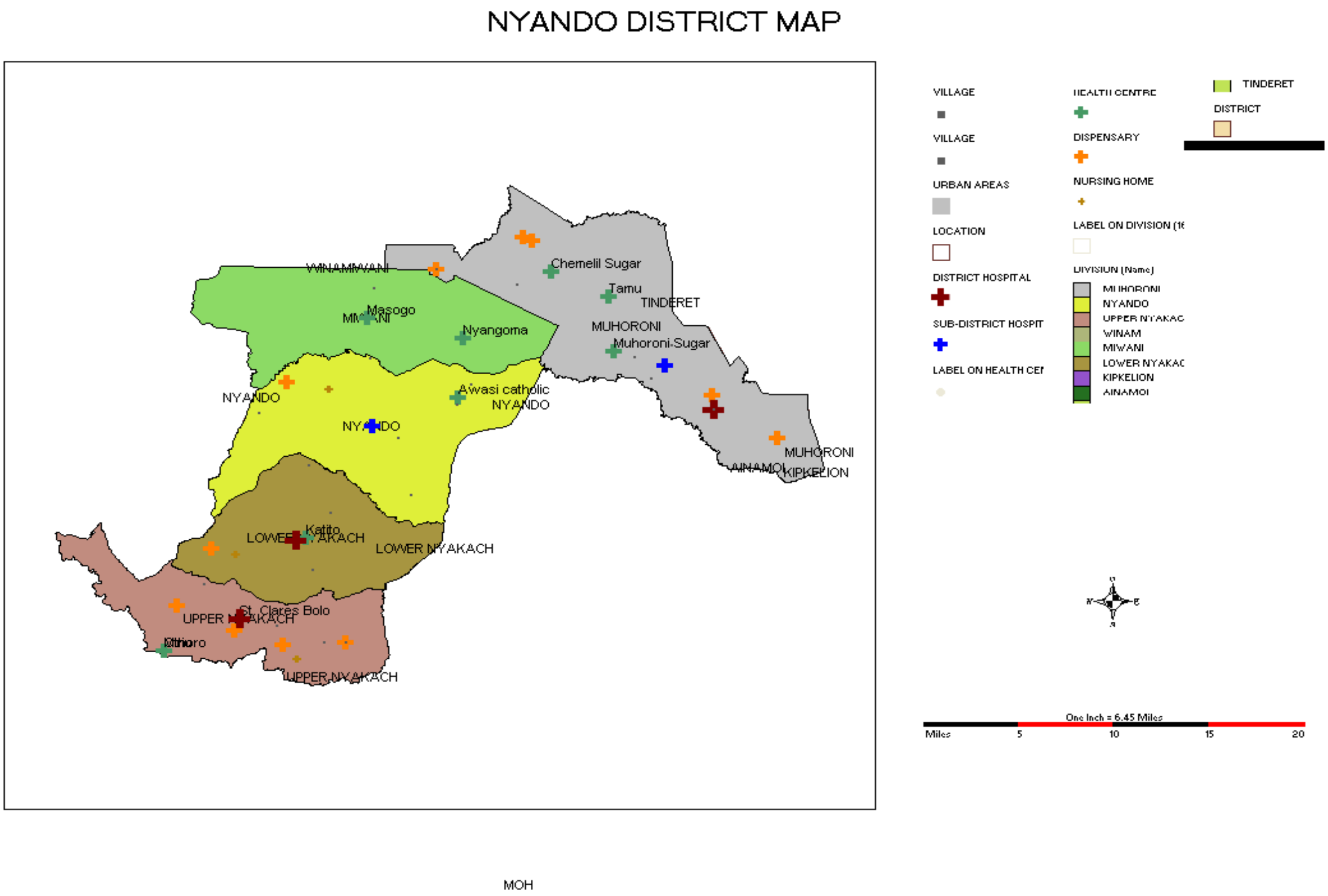
Appendix 2: Map of Greater Nyando Sub-counties



Its located 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

Appendix 3: Letter of Authority

Telegrams: "PRO-MINHEALTH", Nyanza
Telephone: Nyanza 057217131
Fax: 057217131
E-mail: pmonyanza@yahoo.com

When replying please quote

forwarded. 15/12/2010

Ref: No. Res / 6 / MA

Ministry of Health

PROVINCIAL MEDICAL HEADQUARTERS
NYANZA PROVINCE
P.O. Box 7489
NYANZA

15th December, 2010

RE: AUTHORITY TO COLLECT DATA FOR A RESEARCH PROPOSAL IN HEALTH FACILITIES IN NYANDO DISTRICT

The Provincial Medical Officer of Health is in receipt of your request letter dated 10th December 2010 on the above subject. It is noted that the research proposal is part fulfillment the requirements for your Masters in MPH Studies in assessment of knowledge on Malaria epidemic monitoring indicators among health care providers Nyando district.

This office has no objection to collection of data in the all health facilities across the Nyando District. On completion of the research, you are requested to share the research thesis/report with Provincial Medical Officer of Health.

Kioko

Jackson Kioko

Provincial Medical Officer

Nyanza Province

Appendix 4: Table of Demographic indicators for Greater Nyando sub-counties (MOH Nyando, 2010)

1	Area	1168sqkm
2	Density	
3	Growth rate	3.4%
4	Crud Birth Rate	44.1%
5	Crude Death Rate	22.4%
6	Total fertility rate	5.7
7	% of births to women of 15-19yrs	15.3%
8	Mean age at 1st birth	19.4
9	Mean age at 1st marriage	25.7
10	Infant mortality rate	116.1/1000
11	Under 5 mortality rate	201/1000
12	Life expectancy for males	37.7 years
13	Life expectancy for females	42.9 years
14	Sex ratio M/F	1:2
15	% pop below 18 years of age	52.8%
16	% pop above 55 years	7.8%
17	% of urban population	10.7%
18	Net migration rate males	0.4%
19	Net migration rate males	1.3%
20	Median age	17.1
21	% of economically active with a wage employment	25.4%
22	% of children workers 5-17yrs	24%
23	Average house hold size	4.3
24	Average no of persons per room	1.6
25	Houses with access to piped water	16.8%
26	Houses with access to electricity	3.9%

Appendix 5: Staff of Greater Nyando Sub-counties by Cadre (MOH Nyando, 2010)

Cadre	Muhoroni sub-counties		Total	Nyakach Sub-counties		Total	Nyando sub-counties	Total	Grand Total
	Miwani	Muhoroni		Lower Nyakach	Upper Nyakach		Ahero		
Doctors				1	3	4	1	1	**5**
Pharmaceutical Technologist					1	1	2	2	**3**
Physiotherapist					1	1			**1**
Laboratory Technologists				2	2	4	4	4	**8**
Laboratory Technician	2		2		4	4	3	3	**9**
Health Record & Information Officers				1		1	1	1	**2**
Health Record & Information Technicians				1		1			**1**
Nutritionists							2	2	**2**
RCO	1		1	6	12	18	8	8	**27**
Public health officer	3	4	7	1	1	2	7	7	**16**
Public health technician	3	5	8	4	1	5	5	5	**18**
Health Administrative Officer					1	1	2	2	**3**
Medical Engineering							2	2	**2**
ICT Officer				4		4			**4**
Drivers					2	2	2	2	**4**
BSC Nursing				1	12	13	1	1	**14**
Support Staff (Casuals)	4	2	6		13	13	5	5	**24**
CHEWs	2		2		2	2	3	3	**7**
Community Oral H/ Officer					1	1			**1**
Social Worker							1	1	**1**
Clerk/ cashier	6		6		8	8	14	14	**28**
Occupation							1	1	**1**
KRCHN				19	22	41	19	19	**60**
Grand Total	**21**	**11**	**32**	**40**	**86**	**126**	**83**	**83**	**241**

Appendix 6: Distribution of respondents

Cadre	Muhoroni sub-counties		Total	Nyakach Sub-counties		Total	Nyando sub-counties	Total	Target population	Cluster sample size	Proportion
	Miwani	Muhoroni		Lower Nyakach	Upper Nyakach		Ahero				
Doctors				1	3	4	1	1	5	4	3%
RCO	1		1	6	12	18	8	8	27	11	8%
Public health officer	3	4	7	1	1	2	7	7	16	4	3%
Public health technician	3	5	8	4	1	5	5	5	18	11	8%
BSC Nursing				1	12	13	1	1	14	5	4%
KRCHN				19	22	41	19	19	60	42	30%
Enrolled nurses	16	12	28	24	17	41	29	29	98	64	45%
Grand Total	**23**	**9**	**16**	**56**	**68**	**124**	**70**	**70**	**210**	**141**	**100%**