EFFECTIVENESS OF INSECTICIDE TREATED NETS IN REDUCING MALARIA MORBIDITY AMONG SCHOOL GOING CHILDREN IN KENYA

IRENE NTHEMBA MUTUKU

W62/60799/2011

A RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE IN MEDICAL STATISTICS UNIVERSITY OF NAIROBI

Declaration

This research project is my original work and to the best of my knowledge has not been presented for a degree in any other University.

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

Irene Nthemba Mutuku

This research project has been submitted with my approval as a supervisor

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

Dr. Anne Wang'ombe

Institute of Tropical and Infectious Diseases (UNITID), University of Nairobi, Kenya

Dedication

I dedicate this to my family, my husband (Kamangu Waithaka) and children (Waithaka and Muthoni) for their timeless patience, support and encouragement as I pursued my studies.

Acknowledgement

I would like to thank Dr. Thomas Achia, Dr. Anne Wang'ombe and Dr. Noor AM for their guidance and patience as I pursued this challenging project.

My Sincere gratitude to all the members of the Division of Malaria Control, Beatrice Machini, Kenya Bureau of Statistics and Silas Mulwa for assisting me with the data and information I needed.

I would like to thank all the graduate students, Geoffrey Arunga and staff of UNITID, who contributed in one way or another to my experience here at the University of Nairobi.

Last but not least, I want to thank my family, who have supported me throughout my entire academic studies. Without the help of all the mentioned people, this project could not have come to fruition.

God Bless you all.

List of abbreviations and acronyms

MDG's-	Millennium Development Goals
DOMC-	Division of Malaria Control
PMI -	Presidents Malaria Initiative.
P falciparum -	Plasmodium falciparum
WHO -	World Health Organization
MOPK -	Malaria Operational Plan Kenya
GOK –	Government of Kenya
NMS –	National Malaria Survey
KNBS –	Kenya National Bureau of Statistics
NASSEP IV-	National Sample Survey and Evaluation Programme
UNITID –	Institute of Tropical and Infectious Disease
KMIS –	Kenya Malaria Indicator Survey

Abstract

Malaria is one of the leading causes of morbidity and mortality in Kenya. It can have a devastating effect on children's education. Repeated infections cause children to miss large periods of school. Anaemia, a side-effect of frequent Malaria attacks, causes chronic fatigue and interferes with children's ability to concentrate and learn. Use of ITNs for protection against Malaria bites has been the primary vector control method used in Kenya.

Secondary data analysis was done on KMIS 2010 data which was a cross-sectional survey, a sample of all districts in Kenya. This study was carried out to determine the prevalence of Malaria and investigate the effect of ITN use in Malaria prevention among school going children in Kenya. Malaria prevalence was highest among the 5-9 year olds with 40.27% while 29.55% were those between 10-14 years old. Malaria prevalence was very high in the Lake endemic region at 86.79%. Other factors that affected Malaria prevalence significantly were household wealth index quintile and mother's highest education level. Despite ITN ownership in this study being at 64.88%, ITN utilization however remained low at 39.34% among those owning the ITNs. ITN utilization notably declined with age. Majority of ITN users were the under fives 40.46%, those aged 5-9years at 30.62% and 21.92% for the 10-14 year olds.

There is need for continued mass ITN distribution campaigns, to include the school going children where the bulk of the children population is, paired with sensitization on the importance of ITN ownership and utilization in order to maximize on their protective role against Malaria.

TABLE OF CONTENT

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Malaria is one of the leading causes of morbidity and mortality in Kenya and it kills an estimated 34,000 children under five in Kenya every year (PMI, 2012). Seventy seven percent of Kenya's population lives in areas where the disease is transmitted and it is responsible for thirty percent of out-patient visits (requiring more than eight million out-patient treatments at health facilities each year) and fifteen percent of all hospital admissions. About 3.5 million children are at risk of infection and developing severe malaria (PMI, 2012).

Millennium Development Goal Six (MDG 6) is dedicated to malaria, HIV/AIDS and other diseases by 2015. Malaria contributes to approximately one percent of gross domestic product (GDP) loss, accounting for 40 percent of health spending and 30 percent of household expenditure in endemic countries. Young children are much more vulnerable to the disease. Malaria can have a devastating effect on children's education. Repeated infections cause children to miss large periods of school. Anaemia, a side-effect of frequent malaria attacks, causes chronic fatigue and interferes with children's ability to concentrate and learn. Repeated illnesses from malaria can also exacerbate any malnutrition, which can both decrease the effectiveness of anti-malaria drugs and increase children's susceptibility to the other main killer diseases: diarrhoea and pneumonia. The impact of malaria on children remains a serious obstacle to the

achievement of many of the Millennium Development Goals (MDGs), Goal one to eradicate extreme poverty and Goal two; universal primary education (WHO, 2011).

The cost of malaria to Africa is estimated at $12.5 billion per year, which represents 1.3 percent of affected countries economic growth (GDP). In some countries, malaria accounts for up to 40 percent of total health expenditure and 20-50 percent of hospital admissions. Productivity is reduced and staff turnover increased by illness-related absenteeism and children's education is severely disrupted. Rural and poor populations carry the overwhelming burden of malaria because access to effective treatment is extremely limited. In rural areas, infection rates are highest during the rainy season - a time of intense agricultural activity. Research indicates that families affected by malaria harvest 60 percent less crops than other families (UNDP, 2011).

1.1.1 Malaria Situation in Kenya

Malaria transmission and risk in Kenya is determined largely by altitude, rainfall patterns and temperature and therefore varies considerably across the country. The variations in altitude and terrain create contrasts in the country's climate, which ranges from hot and humid tropical along the coast to temperate in the interior and very dry in the north and northeast. There are two rainy seasons—the long rains occur from April to June and the short rains from October to December. The temperature remains high throughout these months. The hottest period is from February to March and the coldest from July to August. All four species of human Plasmodium occur with Plasmodium falciparum causing the most severe form of the disease and accounting for 98% of all malaria

infections. The major malaria vectors are members of the Anopheles gambiae complex and Anopheles funestus.

About 70% of the population of Kenya is at risk of malaria. The majority of this at-risk population (27 million) lives in areas of low or unstable transmission where Plasmodium. falciparum parasite prevalence is less than 5%. However, an estimated 3.9 million people live in areas of Kenya where the parasite prevalence is estimated to be greater than 40% and malaria remains a serious risk. To assist in this situation, the Government of Kenya's (GOK) Division of malaria Control (DOMC) and Presidential Malaria Initiative (PMI) support key interventions to prevent and treat malaria in line with the National Malaria Strategy (NMS) 2009-2017; providing insecticide-treated mosquito nets (ITNs) as one of the key interventions. The GOK's policy is to distribute ITNs free to pregnant women at antenatal clinics and to children under one year of age.

1.1.2 Insecticide-Treated Nets (ITNS)

The use of ITNs for protection against mosquito bites is a practical, highly effective, and cost-effective intervention against malaria (Lengeler, 2004). Kenya has met the Roll Back Malaria (RBM) household ITN coverage target of sixty percent (60%) according to Noor et al., 2007.

The 2009-2017 National malaria Strategy promotes universal ITN coverage, defined as one net per two people, within prioritized regions of the country. In 2011, Kenya was conducting a rolling mass distribution campaign to scale up to universal coverage and

usage of ITNs in priority endemic areas. This was the first mass distribution of ITNs in Kenya since 2007. Other distribution strategies include free or highly-subsidized ITNs provided through antenatal care (ANC) clinics, routine ITN distributions through the expanded program on immunization services, child health action days, community-based initiatives, and retail outlets. In 2010, household ownership of ITNs was 48%, while proportions of children under five years and pregnant women who slept under an ITN the previous night were 42% and 41% respectively.

Under the 2009-2017 Kenya NMS, one of the objectives of the DOMC is to attain universal coverage of ITNs, defined as reaching a ratio of one ITN for every two people, in conjunction with increasing use of those ITNs to 80%, within prioritized regions of the country by 2013. Universal coverage is to be achieved through multiple distribution channels including mass distribution of ITNs to all households in the targeted regions every three years, routine distribution to all pregnant women and children under one year, and social marketing of ITNs at subsidized prices in targeted markets. Funding from the successful Global Fund Round 10 malaria grant, in combination with significant contributions from other donors, will enable Kenya to maintain national coverage.

CHAPTER TWO

LITERATURE REVIEW

2.1 Global Perspectives on Malaria Prevalence

Recent national household survey data for 18 malaria endemic countries in Africa were assembled to indentify information on use of ITNs by age and sex. In general, the pattern of overall ITNs use with age was similar by country and across the three country groups with ITNs use initially high among children <5 years of age, sharply declining among the population aged 5-19 years, before rising again across the ages 20-44 years and finally decreasing gradually in older ages. For all groups of countries, the highest proportion of the population not protected by ITNs (38% - 42%) was among those aged 5-19 years (Noor AM et al., 2007*).*

In malaria-endemic Africa, school-aged children are the least protected with ITNs but represent the greatest reservoir of infections. With increasing school enrollment rates, school-delivery of ITNs should be considered as an approach to reach universal ITNs coverage and improve the likelihood of impacting upon parasite transmission (Noor AM et al 2007*).*

The use of mosquito nets and the prevalence of plasmodium falciparum infection in South Central Somalia were done to examine in more detail the effects of ITN use on plasmodium falciparum infection prevalence. Mantel-Haenszel odds ratios were calculated that adjust for the effects of age and sex within each livelihood grouping.

Overall, after adjusting for livelihood, sex and age, the use of bed nets had a protective effectiveness against parasite infection of (54%, 95% CI: 44–63, P<0.001) (Noor AM et al 2008).

A separate study was undertaken in the Farafenni area of The Gambia to determine the relation between morbidity from malaria in children and the use of bed-nets (mosquito-nets). From comparisons of parasite and spleen rates in bed-net users and in non-users it seemed that bed-nets had a strong protective effect (D'Alessandro U, 1995).

Measurement of morbidity and mortality cross-sectional surveys were conducted to assess the impact of bed nets on malaria-related morbidity in November 1996 (baseline, before ITNs were distributed to intervention villages), February– March 1998, and November–December 1998.

Malaria-related morbidity was common in population of children, though somewhat lower in ITN compounds. Approximately one-third of the population had moderate anemia, while approximately one-fourth had a parasitemia level greater than5, 000 parasites/mm3. Multivariable statistics confirm that ITNs significantly reduce measures of malaria-related morbidity. ***(***Killeen GF, 2007***)***

Spatial analyses of the effect of insecticide treated bed nets (ITNs) on nearby households both with and without ITNs was performed in the context of a large-scale, group-randomized, controlled mortality trial in Asembo, western Kenya. Results illustrate a

protective effect of ITNs on compounds lacking ITNs located within 300 meters of compounds with ITNs for child mortality, moderate anemia, high-density parasitemia, and hemoglobin levels ***(***William A 2003***).***

Insecticide Treated Nets (ITNs) has been one of the main strategies for malaria transmission reduction (Jonathon, 2002). ITNs are low cost and highly effective way of reducing the incidence of malaria in people who sleep under them. By preventing malaria, ITN reduces the need for the frequent malaria treatment and the pressure on health services (Osero, 2005; WHO, 2003; Lengeler, 2000). One of the priorities of the Global strategic plan for roll back malaria for 2005-2015 is to support countries to implement effective malaria control interventions nationwide and to put greater emphasis on community-based advocacy and social mobilization as a vital process in increasing demand for, and the use of interventions, one of which is the use of the ITNs (RBM, 2005). Long-lasting insecticide-treated nets (LLINs) serve as a protective barrier against mosquito bites and have been found to be a highly-effective method for pre-venting malaria (Lengeler, 2004). Participants involved in a study conducted in Kenya reported a positive benefit of LLINs, most commonly that they and their family did not get sick from malaria any more (68%) (Dye et al, 2010). Sleeping under ITNs remains an important strategy for protecting pregnant women and their newborns from malaria-carrying mosquitoes (WHO 2011). The use of ITN is one of the most cost effective interventions against malaria; it has been found to reduce clinical episodes of malaria by 50% as well as the prevalence of high density parasitaemia (Sharp et al 2007).

Dramatic declines in malaria disease caused by Plasmodium falciparum have been reported across a range of settings within sub-Saharan Africa. These declines are associated with increased distribution of long-lasting insecticide-treated nets (LLINs) (O'Meara et al, 2008; Sharp et al 2007). ITNs have been shown to avert around 50% of malaria cases, making protective efficacy significantly higher than that of untreated nets which provide about half the protection of nets treated with an effective insecticide (Richards et al, 1996)

The effects of insecticide-impregnated bed nets on mortality and morbidity from malaria have been investigated during one malaria transmission season in a group of rural Gambian children aged 6 months to 5 years. Sleeping under impregnated nets was associated with an overall reduction in mortality of about 60% in children aged 1–4 years. Thus, insecticide-impregnated bed nets provided significant protection in children against overall mortality, mortality attributed to malaria, clinical attacks of malaria, and malaria infection. ***(***Ceesay SJ, 2010***)***

A study was undertaken in the Farafenni area of The Gambia to determine the relation between morbidity from malaria in children and the use of bed-nets (mosquito-nets). From comparisons of parasite and spleen rates in bed-net users and in non-users it seemed that bed-nets had a strong protective effect. ***(***Peter D, 2002***)***

In a controlled trial of insecticide-treated bed nets in lowering child mortality, The Gambia initiated a National Insecticide Impregnated Bed net Programme (NIBP) in 1992 with the objective of introducing this form of malaria control into all large villages in The Gambia. Five areas with a population of 115,895 were chosen as sentinel sites for evaluation of the programme. During the first year of intervention, a 25% reduction was achieved in all-cause mortality in children 1-9 years old living in treated villages (rate ratio 0.75 [95% CI 0.57-0.98], p = 0.04). A decrease in rates of parasitaemia and high-density parasitaemia, an increase in mean packed-cell volume (rate ratio 0.75 [95% CI 0.59-0.98], p = 0.04) and an improvement in the nutritional status of children living in treated villages were also detected (D'Alessandro U., Olaleye B. et al 1995).

An intervention trial was undertaken in a rural area of The Gambia to assess the impact on malaria morbidity of the use of bed nets. Bed nets were allocated at random among a group of 16 Fulahamlets, where they were previously rarely used. The incidence of febrile episodes with associated malaria parasitaemia throughout the rainy season and the prevalence of splenomegally and parasitaemia at the end of the rainy season were determined in 233 children aged 1–9 years who slept under bed nets and in 163 children who did not. Bed nets were used correctly by the children in the study cohort, but direct observations showed that a significant number of children left their nets for a period during the night. There was no significant difference in the incidence of clinical attacks of malaria or in any other malaria metric measurement between the two groups. Thus, bed nets were not effective in reducing malaria morbidity in this group of children ***(***Magesa SM, 1991***)***.

The incidence of clinical attacks of malaria was significantly less in Gambian children aged 1–9 years who slept in villages where all the bed nets (mosquito nets) were treated with permethrin than in children who slept in control villages with placebo-treated nets. Significant differences in changes in spleen size and in packed cell volume were also observed between the 2 groups during the course of a rainy season. No side effect was noted. Treatment of bed nets with insecticide is a form of malaria control that is well suited to community participation and can readily be incorporated into primary health care programmes. Insecticide-treated nets may be more effective in areas of seasonal or low intensity transmission than in areas with heavy perennial challenge. (Snow RW, 1988).

The apparent protection from bed nets demonstrated in previous retrospective surveys may have been due to an increased number of infective bites being received by exposed individuals sleeping close to users of bed nets. Point-referenced prevalence of infection data for children aged 1–10 years was collected from published and grey literature and geo-referenced. The model-based geo statistical methods were applied to analyze and predict malaria risk in areas where data were not observed. Topographical and climatic covariates were added in the model for risk assessment and improved prediction. A Bayesian approach was used for model fitting and prediction**. (**Kazembe et al 2007**).**

Plasmodium infections among school children in Igbo-Eze South Local Government of Enugu State, Nigeria, were studied between July and December 2005. The relationship

between the use of malaria control measures and the prevalence of plasmodium infections was investigated.

The prevalence of plasmodium falciparum infections also varied significantly ($p < 0.05$) among the age groups, with age groups 4-6 (35.1%) and 10-12 (14.2%) having the highest and lowest prevalence rates respectively. Males (23.1%) had a significantly higher prevalence rate than females (18.5%). The prevalence of malaria was significantly lower among pupils using preventive measures; 5.9% among pupils using mosquito bed net as against 21.2% among those not using bed nets and 4.6% for pupils living in screened houses as against 24.1% for those not living in screened houses (Ekpenyong, 2008).

In a trial of pyrethroid impregnated bed nets in an area of Tanzania holoendemic for malaria, children aged 1-10 in five villages were contacted fortnightly. Their axillary temperatures, reports of fevers and blood slides were taken. Following the introduction of permethrin impregnated nets into two estate villages the slide positivity for falciparum malaria declined markedly. In traditional villages the introduction of impregnated nets had less convincing effects than in the estate villages and DDT spraying had no perceptible effect on malaria. Over all villages there was a clear relationship between axillary temperature greater than 37.4 degrees C, reports of fever and high parasitaemia. Malaria fever was defined in this way, and found in some cases significant reductions in occurrence of such fever following some time after introduction of permethrin impregnated nets. No such effects were found with lambdacyhalothrin nets or with DDT spraying (Liymo EO, 1991).

Malaria prevalence in children under 10 was modeled using climatic population and topographic variables as potential predictors. After the regression analysis, spatial dependence of the model residuals was investigated. Kriging on the residuals was used to model local variation in malaria over and above which is predicted by the regression model. Multivariable models showed a significant association of malaria risk with elevation, annual maximum temperature, rainfall and potential evapotranspiration (PET). However in the prediction model, the spatial distribution of malaria risk was associated with elevation, and marginally with maximum temperature and PET.

A double-blind controlled trial was undertaken from August 1990 to February 1991 among Karen children on the Thai-Burmese border to evaluate the effects on malaria incidence and prevalence of permethrin-treated bed nets. Three hundred and fifty schoolchildren, aged 4 to 15 years, were allocated at random to receive either a permethrin-impregnated net or a non-treated net. The incidence of malaria infections, confirmed by a blood film, was assessed during 6 months. Three surveys were conducted, on admission and 3 and 6 months later, to measure the prevalence of infections and spleen rates. Compliance was assessed by monthly home visiting. The use of permethrin-treated bed nets reduced the number of parasitemic Plasmodium falciparum infections by 38% and the number of symptomatic episodes by 42% (Luxemburger C.1994).

2.2 Kenyan Perspective

A study was conducted in order to determine whether children that slept under untreated bed nets were protected against both malaria infection and clinical disease compared with children not sleeping under bed nets. The study was conducted in Kilifi District, Kenya, during the malaria season (June—August 2000) and involved 416 children aged <10 years. Data collected from a cross-sectional survey showed evidence of protection against malaria infection among children sleeping under untreated bed nets in good condition compared with those not using nets (adjusted odds ratio [AOR] = 0.4, 95% CI 0.22–0.72, P = 0.002). There was no evidence of a protective effect against infection when comparing those that used untreated bed nets that were worn and those not using nets (AOR = 0.75, 95% CI 0.34–1.63, P = 0.47). When these same children were followed-up during the malaria season, there was evidence of a lower rate of clinical malaria among those that used untreated nets in good condition (adjusted incidence rate ratio = 0.65, 95% CI 0.45–0.94, P = 0.022), while the rate of clinical malaria among those that used untreated bed nets that were worn was similar to that of those that did not use bed nets. In the face of persistent failure of communities to take up net retreatment, there is hope that untreated nets will offer some protection against malaria infection and disease compared with not using nets at all.

Permethrin-impregnated curtains and bed-nets were used to prevent malaria in western Kenya. The effectiveness of permethrin-impregnated (0.5 g/m2) bed-nets and curtains as malaria control measures was evaluated in Uriri, Kenya in 1988. One hundred five families were randomly assigned to 1 of 3 study groups (control, bed-net, or curtain). All

participants were cured of parasitemia with pyrimethamine/sulfadoxine. Selective epidemiologic and entomologic parameters were measured weekly, while knowledge, attitude, and practices surveys were conducted at the beginning and end of the 15 week study. Plasmodium falciparum infections per person week at risk were significantly higher in the control group than in either the curtain group (5.42 vs. 2.35 cases/100 person week's risk) or the bed-net group (5.42 vs. 3.77 cases/100 person week's risk). The curtain group had fewer infections per person week at risk than the bed-net group (2.35 vs. 3.77 cases/100 person week's risk). A difference was found in clinical malaria among the groups: 45% of persons in the bed-net and curtain groups vs. 30% of those in the control group reported no episodes of fever and chills (chi 2, P less than 0.05). Indoor resting Anopheles gambiae or An. funestus were found on 94 occasions in the control houses, but only twice in the treated houses during weekly visits to each house over the study period (chi 2 P less than 0.001). The pyrethrum knockdown method produced similar results with a total of 195, 23, and 3 An. gambiae and An. funestus collected in the control, bed-net, and curtain houses during the same period, respectively (Sexton JD, 1990).

2.3 Justification

Nearly 28 million Kenyans live in areas of malaria risk, a majority of them, children under the age of 15 years. Investments in malaria control over the last five years have had a positive impact on the overall morbidity and mortality that is due to malaria. This is evidenced by the reduction in infant and child mortality experienced in Kenya between 2003 and 2009 and the significant reduction in malaria prevalence in Coast Province. The

reduction in malaria transmission has also shifted the burden of disease to older children (5–10 years), who now have the highest prevalence of malaria.

The Ministry of Public Health and Sanitation considers malaria a national priority and remains firmly committed to malaria control efforts in Kenya in line with the Ministry's vision of A nation free of preventable diseases and ill health, the national development agenda as outlined in Kenya Vision 2030, and the aims of the Millennium Development Goals.

Most of the malaria control activities (distribution of ITNS included), target the pregnant mothers and children under five years of age, school going children (5-14years) often neglected.

2.4 Research Questions

1. What is the prevalence of malaria among the school going children in Kenya?
2. What is the pattern of ITN use among the school going children?

2.5 Broad Objective

The broad objective of the study was to assess the prevalence of malaria in Kenya among the school going children and investigate ITN use in endemic regions.

2.5.1 Specific Objectives of the Study

1. To describe malaria prevalence among school going children in Kenya.
2. To describe the effect of ITN use in malaria prevention among school going children in Kenya.
3. To describe the pattern of ITN use among school going children in Kenya.
4. To identify the factors associated with ITN use among school going children in Kenya.

CHAPTER THREE

METHODOLOGY

3.1 Kenya Country Profile

Bordered by Ethiopia to the north, Sudan to the northwest, Somalia to the east, Tanzania to the south and Uganda to the west, the Republic of Kenya covers a total area of 582,646 square kilometers with a 536-kilometre stretch along the Indian Ocean in the southeast. It straddles the Equator in eastern Africa, lying across latitudes 5°North to 5°South and longitudes 34°East to 42°West. The land rises from sea level at the Indian Ocean in the east to 5,199 meters at the highest peak of Mount Kenya. About 80 per cent of the land area, mostly in the north and northeast, is arid or semi-arid and only 20 per cent is arable. Much of the arable land is in the highlands and the Lake Victoria Basin in the southwest of the country. The Great Rift Valley bisects the Kenya highlands into east and west. The highlands are cool and agriculturally rich areas where both large and smallholder farming are carried out. The variations in altitude and terrain create contrasts in the country's climate, which ranges from hot and humid tropical along the coast to temperate in the interior and very dry in the north and northeast. There are two rainy seasons – the long rains and the short rains. The long rainy season occurs from April to June and the short rainy season from October to December. The temperature remains high throughout these months. The hottest period is from February to March and the coldest from July to August. Administratively, Kenya is currently divided into eight provinces, which in turn are subdivided into districts, then divisions, locations and sub-locations. In August 2010,

the country enacted a new Constitution in which the provinces will be replaced by 47 semi-autonomous counties once fully implemented.

3.2 The Population

According to the 2009 Population and Housing Census, Kenya's population stood at 38.6 million (KNBS, 2010). Previous census results indicated an annual population growth rate of 2.9 per cent per annum during the 1989–1999 period a reduction from 3.4 per cent recorded for both the 1969–1979 and 1979–1989 intercensal periods. A decline in fertility rates and realization of the efforts contained in the National Population Policy for Sustainable Development (GOK, 2000) were the major drivers of this decline in population growth. For example, the crude birth rate has shown a steady decline from 54 births per 1,000 population in 1979 to 48 in 1989, then to 41 in 1999 and to 35 in 2009 (KNBS and ICF Macro, 2010). In contrast, mortality rates increased during the 1990s as a result of increased HIV/AIDS related deaths, a decline in health services and escalating poverty. For a long time the crude death rate was on the decline, but the period 1989–1999 reported an increase to 12 per 1,000 population from 11 per 1,000 for the 1979–1989 period. The infant mortality rate decreased from 119 deaths per 1,000 live births in 1969 to 88 in 1979, and to 68 in 1989, but then increased to 77 per 1,000 in 1999 (CBS, 1994, 2001). More recent data show some declines, however, with child mortality falling from 115 deaths per 1,000 in 2003 (CBS et al., 2004) to 74 deaths per 1,000 in 2008–2009 (KNBS and ICF Macro, 2010).Kenya's population is characterized as "very young". The 2009 population census reports that 43 per cent of the population is under 15 years and only 4 per cent is aged 65 and older (KNBS, 2010). This is attributed to the high fertility and declining mortality in the past. The country's urban population, now

constituting 32 per cent of the total population, grew from 3.8 million in 1989 to 12.4 million in 2009 (KNBS, 2010). This growth contributes to the proliferation of informal urban settlements, leading to environmental degradation and deteriorating public health standards (CBS, 1994, 2001).

The data used in this study was taken from the Kenya malaria Indicator Survey (KMIS) 2010. A sample of 7,200 households for the 2010 KMIS was selected to be representative of the entire household population in Kenya. The design for the survey used a representative probability sample to produce estimates for the four malaria epidemiological zones with the endemic zones divided into lake endemic and coast endemic to make five zones: Highland epidemic-prone, Lake endemic, Coast endemic, Seasonal risk/Semi-arid and Low risk. In addition, in each zone, clusters were categorized into urban and rural areas and provided two implicit domains for analysis at the national level. The survey used the National Sample Survey and Evaluation Programme (NASSEP) IV sampling frame. The frame is nationally representative and was developed by the KNBS after the 1999 Census to support two-stage cluster sample surveys. The first stage sampling process involved selection of enumeration areas (EAs) and creation of 1,800 clusters with probability proportional to measure of size with the districts as the first level of stratification. From the frame, a representative sample of 240 clusters was selected for the 2010 KMIS with a uniform sample of 30 households allocated to each cluster. The resulting sample of 7,200 households was designed so as to produce estimates of most of the key malaria indicators including the prevalence of anaemia in children aged 6 months through 14 years for the specified domains.

3.3 Household and Cluster Sampling

A first-stage selection involved selection of the clusters by KNBS for the specified domains.

The clusters were selected from the NASSEP IV frame with equal probability within each frame stratum. The selection of the clusters was expected to retain the probability proportional to measure of size design used in creation of the frame. A second-stage sampling was conducted at the time of field work using personal digital assistants (PDAs). All households within a cluster were to be listed using PDAs fitted with global positioning units and a simple random sample of 30 households per cluster selected for interviewing. Every attempt was to be made to conduct interviews in the 30 selected households, and up to three visits were expected to be made to ascertain compliance in case of absence of all household members (or any household members in the case of malaria parasite testing) to minimize potential bias. Non-responding households were strictly not to be replaced.

3.4 Study Domains

Data from the whole country was used in order to identify regions with increased malaria prevalence and identify the regions which need more resource allocation in malaria prevention and subsequent eradication. The 2010 KMIS was a representative probability sample designed to produce estimates for the specified domains from household populations in Kenya. The level of malaria endemicity in Kenya varies from one area to

another and can be classified into five malaria endemicity regions. These regions, listed below, served as the domains for the survey.

1. Highland epidemic prone

2. Lake endemic

3. Coast endemic

4. Semi-arid, seasonal risk

5. Low risk

In addition, the five regions are categorized into either urban or rural areas and implicitly provide two domains for analysis, at the national level.

3.5 Sampling Frame

The sampling frame for 2010 KMIS was the National Sample Survey and Evaluation Programme (NASSEP) IV. The frame is a two-stage stratified cluster sample format. The first stage involved selection of primary sampling units (PSUs), which were census enumeration areas (EAs), using the probability proportional to measure of size method, with the districts as the first level of stratification. The second stage involved the selection of households for various surveys. EAs were selected with a basis of one measure of size (MOS) defined as the ultimate cluster with an average of 100 households and constituting one (or more) EAs. The MOS was defined with a lower limit of 50 households and an upper limit of 149 households. Prior to selection, those EAs with fewer than 50 households were merged with the neighboring ones to form the minimum

requirements for the MOS. During listing of selected EAs for the frame, those with more than 149 households were segmented and only one segment randomly picked to constitute a cluster. NASSEP IV has a total of 1,800 clusters with 1,260 being rural areas while the remaining 540 are urban. The frame has undergone regular updates.

3.6 Sample Size and Allocation

Secondary data has been used for this study. The sample size of 7,200 households that was used in the 2007 KMIS was maintained for the 2010 KMIS. The precision for key malaria indicators for populations at greater risk of malaria (pregnant women and children aged five years and below) are important for KMIS. The number of pregnant women, at a given time, is smaller than the number of children aged five and below and, therefore, indicators based on pregnant women are the determinants for the sample size. The allocation of the sample to the domains was done using the power allocation method. This method was appropriate, instead of proportional allocation, to ensure that the domain with the lowest proportion of households was oversampled for valid estimates.

3.7 Data Preparation and Statistical Analysis

The data used in this analysis is KMIS 2010 and belongs to KNBS. The survey was conducted during the peak malaria transmission season July-September in the year 2010.

Permission to use the data was sought through a letter from UNITID to KNBS through DOMC.

The data was in different files in Ms Excel files. Variable of interest were chosen using Stata 11, all the files containing variables of interest were merged to create one big file

from which the analysis was done. New variables of interest were created to meet our study objectives. These variables are;

3.8 Defined Terms

Malaria positive – Malaria status for the child determined the laboratory results, either positive or negative.

Net_own – Answer to the question; does the family own any net used for sleeping

Slept_net –answer to the question; did anyone sleep under this net yesterday night

Qh07 – age of the child

Qh04 – sex of the child

Mother_educ – Mother's highest educational level

hh_age_cat – age of the house hold head

hv219- sex of the household head

sroom_cat – number of rooms used for sleeping

qhwlthi - house hold wealth index quintile

qhtype – type of residence (Urban/rural)

Malaria_zone – malaria endemic zone/region

qhprov – region/province of residence

hhweight_lb – house hold weight

labres – laboratory results for malaria

Endemic regions:

1. Highland epidemic prone
2. Lake endemic
3. Coast endemic
4. Semi-arid, seasonal risk
5. Low risk

Province:

1. Nairobi
2. Central
3. Coast
4. Eastern
5. North Eastern
6. Nyanza
7. Rift valley
8. Western

Wealth Index quintile

1. Very poor
2. Poor
3. Middle class
4. Rich
5. Very rich

Age category (qh07)

1. Under 5 years
2. 5-9 years
3. 10-14 years

To meet our objectives from the 7,200 households, 13252 children were eligible for analysis.

Graphs, tables and text have been used to describe key findings. Descriptive summaries of infection prevalence were generated using STATA 11 and MS Excel 2007. To account for the clustered nature of the data, the *svy logistic* command in STATA was used with the cluster as the primary sampling unit (*psu*) stratified by type of residence (urban/rural). All results were weighted (weight = 1/probability of selection) to account for unequal probabilities of selection of clusters across type of residence (urban/rural). To test for differences in proportion of child's (bed-net use related variable is listed as a binary variable with their mean as the cut-off point) between malaria positive and malaria negative household a Pearson chi-square test according to survey design (cluster and stratification) was used and the test statistic converted to an F-statistic using the second-order Rao and Sott correction .A logistic regression analysis was performed. Variables with a p value < = 0.05 level in the multivariable analysis (converted F-statistic) were included in a stepwise logistic regression procedure.

3.9 PEARSON'S CHI SQUARE

Pearson's chi square can be used for nominal or ordinal explanatory and response variables. Variables can have any number of distinct levels. It tests whether the

distribution of the response variable is the same for each level of the explanatory variable (H_0: No association between the variables)

r = number of levels of explanatory variable

c = number of levels of response variable

Can be used for nominal or ordinal explanatory and response variables

Variables can have any number of distinct levels

Notation to obtain test statistic

Rows represent explanatory variable (r levels)

Columns represent response variable (c levels)

Marginal distribution of response and expected cell counts under hypothesis of no association

$$\hat{\pi}_1 = \frac{n_{.1}}{n_{..}} \quad \cdots \quad \hat{\pi}_c = \frac{n_{.c}}{n_{..}}$$

$$E(n_{ij}) = n_{i.}\hat{\pi}_j = \frac{n_{i.}n_{.j}}{n_{..}}$$

H_0: No association between variables

H_A: Variables are associated

- $T.S.: X^2 = \sum_i \sum_j \frac{(n_{ij} - E(n_{ij}))^2}{E(n_{ij})}$
- $R.R.: X^2 \geq \chi^2_{\alpha,(r-1)(c-1)}$
- $P-val = P(\chi^2 \geq X^2)$

3.10 Logistic Regression

One statistical tool of analyzing the relationship between one variable known as dependent (response) variable and a set of independent (predictor) variables is the linear models.

For these models, the response is a continuous variable which is assumed to have normal distribution. However sometimes one may want to analyze the relationship between a categorical/discrete response variable and a set of explanatory variables. The most commonly used model for these two type of response variables are logistic and Poisson regression models.

Binary logistic regression analysis extends the techniques of multiple regression analysis to research situations in which the outcome variable is binary.

Let Y be binary outcome; then Y is coded as

Y=1 if event of interest occurs and

Y=0 if it does not occur.

For example 1= presence of malaria 0= absence of malaria.

Let Y=1 indicate that an individual developed malaria, then statistical theory tells us that the mean of Y is a probability in this case that measures the probability of developing malaria.

In logistic regression we model the natural log of the odds of event.

A simple logistic regression model is of the form:

$\log[\pi i/(1-\pi i)] = \beta_0 + \beta_1 x$ where we have only one explanatory variable.

While multi logistic regression where there are more than one explanatory variable. The formula is

$$\log[\pi i/(1-\pi i)] = \beta_0 + \beta_1 x_1 + \ldots\ldots\ldots, + \beta_k x_k;$$

Where $\beta_0, \beta_1 \ldots\ldots\ldots, \beta_k$ are known as regression parameters.

Logistic regression determines the impact of multiple independent variables presented simultaneously to predict membership of one or other of the two dependent variable categories.

Logistic regression employs binomial probability theory, in which there are only two values to predict: that probability (p) is 1 rather than 0, i.e. the event/person belongs to one group rather than the other. Logistic regression forms a best fitting equation or function using the maximum likelihood method, which maximizes the probability of classifying the observed data into the appropriate category given the regression coefficients.

The goal is to correctly predict the category of outcome for individual cases using the most parsimonious model by creating a model (i.e. an equation) that includes all predictor variables that are useful in predicting the response variable.

3.10.1 Uses of logistic regression

Prediction of group membership since logistic regression calculates the probability of success over the probability of failure; the results of the analysis are in the form of an odds ratio.

Logistic regression also provides knowledge of the relationships and strengths among the variables

3.10.2 Assumptions of Logistic Regression

Logistic regression does not assume a linear relationship between the dependent and independent variables.

The dependent variable must be a dichotomy (2 categories).

The independent variables need not be interval, nor normally distributed, nor linearly related, nor of equal variance within each group.

The categories (groups) must be mutually exclusive and exhaustive; a case can only be in one group and every case must be a member of one of the groups.

Larger samples are needed than for linear regression because maximum likelihood coefficients are large sample estimates. A minimum of 50 cases per predictor is recommended.

3.10.3 The logistic regression equation

While logistic regression gives each predictor (IV) a coefficient ‘b’ which measures its independent contribution to variations in the dependent variable, the dependent variable can only take on one of the two values: 0 or 1. What we want to predict from knowledge of relevant independent variables and coefficients is the probability (*p*) that it is 1 rather than 0 (belonging to one group rather than the other).

log transformation of the p values to a log distribution enables us to create a link with the normal regression equation. The log distribution (or logistic transformation of p) is also called the logit of p or logit(p). Logit(p) is the log (to base e) of the odds ratio or likelihood ratio that the dependent variable is 1.(For a logistic regression model, the link function is the logit**)** ,In symbols it is defined as:

$$logit(p) = log[p / (1 - p)] = ln[p / (1 - p)]$$

Whereas p can only range from 0 to 1, logit (p) scale ranges from negative infinity to positive infinity and is symmetrical around the logit of .5 (which is zero).

Logistic regression finds a ‘best fitting’ equation, using maximum likelihood method, which maximizes the probability of getting the observed results given the fitted regression coefficients.

P can be calculated with the following formula

$$P = \frac{\exp(a + b1x1 + b2x2 + b3x3) +}{(1 + \exp(a + b1x1 + b2x2 + b3x3 + \ldots)}$$

Where:

p = the probability that a case is in a particular category,

exp = the base of natural logarithms

a = the constant of the equation and,

b = the coefficient of the predictor variables

Logistic regression – involves fitting an equation of the form to the data:

Logit (p) = a + b1x1 + b2x2 + b3x3 + …

The inference for the regression coefficients is assumed that the other explanatory variables in the model are held constant, additional measure of if it is continuous. Thus for each explanatory variable X_k ;k=1,2,…..p;e^{β}_{k} is the change in risk for every additional measure of X_k if it is continuous while if it is a categorical variable then e^{β}_{k} is the odds ratio of one group to other, (where one group is the reference).

Before fitting the logistic model it is advisable to test for the significance of each explanatory variable with respect to the response variable.

If the explanatory is a categorical variable, then a chi-square test for association is done.

3.11 ODDS RATIO

Odds of an event is the probability it occurs divided by the probability it does not occur

Odds ratio is the odds of the event for group 1 divided by the odds of the event for group two.

Sample odds of the outcome for each group:

$$odds_1 = \frac{n_{11}/n_{1.}}{n_{12}/n_{1.}} = \frac{n_{11}}{n_{12}}$$

$$odds_2 = \frac{n_{21}}{n_{22}}$$

Odds Ratio

Estimated Odds Ratio:

$$OR = \frac{odds_1}{odds_2} = \frac{n_{11}/n_{12}}{n_{21}/n_{22}} = \frac{n_{11}n_{22}}{n_{12}n_{21}}$$

95% Confidence Interval for Population Odds Ratio

$$(OR(e^{-1.96\sqrt{v}}), OR(e^{1.96\sqrt{v}}))$$

$$e = 2.71828 \quad v = \frac{1}{n_{11}} + \frac{1}{n_{12}} + \frac{1}{n_{21}} + \frac{1}{n_{22}}$$

3.11.1 Interpretation

Conclude that the probability that the outcome is present is higher (in the population) for group one if the entire interval is above one

Conclude that the probability that the outcome is present is lower (in the population) for group one if the entire interval is below one

Do not conclude that the probability of the outcome differs for the two groups if the interval contains one

CHAPTER FOUR

DATA ANALYSIS AND RESULTS OF FINDINGS

4.1 Introduction

This chapter presents the data collected and its analysis.

The level of malaria endemicity in Kenya varies from one area to another. The country is divided into 5 malaria endemic zones. Of these 23.08% were sampled from the highland epidemic prone region, 24.27% from the lake endemic region, 15.41% the coast endemic region, 19.22% from the semi arid, seasonal risk region and 18.03% from the low risk region.

Administratively the country is divided into eight provinces. 1.86% was from Nairobi province, 10.15% were from the Central province, 16.52% were from the Coast province, and 11.65% were from the Eastern province, 2.71% from North Eastern province, 18.99% were from Nyanza province, 25.29% from Rift Valley province and 12.83% were from the Western province.

Sampling was also done according to the house hold wealth index quintile; that is very poor, poor, middle class, rich and very rich. 20% from each quintile was sampled.

Most of the households had one and two rooms used for sleeping (38.42% and 37.69%) respectively. Only 15.21% had three rooms used for sleeping and 8.39% four rooms used for sleeping. 0.29% had no information on the number of rooms used for sleeping.

Most of the mothers had primary incomplete education level 19.39% followed by primary complete level at 13.53%. However, from 43.99% of the respondents there was no information on mothers' highest education level.

Most of the household heads were between 36 and 50 years old at 39.23% and 29.23% were aged between 26-35 years old. Only 0.23% of the households were headed by under 18years of age.

4.2 Demographic Characteristics of the Study Population

Demographic characteristics		Percentage(%) of n
Malaria positive	Negative	89.38
	Positive	10.62
Own net used for sleeping	Yes	64.88
	no	35.12
slept under net	Yes	39.34
	No	60.66
Age Category	Under five years	38.5
	Five to nine years	33.34

	Ten to fourteen years	28.16
Sex of the Child	Male	50.23
	Female	49.77
Type of Residence	Urban	11
	Rural	89
Sex of Household Head	Male	66.86
	Female	33.14
Malaria zone	Highland epidemic	23.08
	Lake epidemic	24.27
	Coast epidemic	15.41
	Semi arid/Seasonal risk	19.22
	Low risk	18.03
Province of Residence	Nairobi	1.86
	Central	10.15
	Coast	16.52
	Eastern	11.65

	North eastern	2.71
	Nyanza	18.99
	Rift valley	25.29
	Western	12.83
Wealth index quintile	Very poor	19.99
	Poor	20
	Middle class	20.01
	Rich	20
	Very rich	20
Number of sleeping rooms	One	38.42
	Two	37.69
	Three	15.21
	Four and above	8.39
	Missing information	0.29
Mother's highest education level	No education	11.72
	Primary incomplete	19.39

	Primary complete	13.53
	Secondary incomplete	3.86
	Secondary complete	5.33
	Higher	2.18
	Missing information	43.99
Age of the household head	under_18 years	0.23
	18_25 years	6.1
	26_35 years	29.23
	36_50 years	39.23
	above_50years	25.21

Children aged less than five years were 38.5% of the sample, five to nine years 33.34% and ten to fourteen years old 28.16%.

10.62% of the children were malaria positive against 89.38% malaria negative amongst the population sampled.

64.88% of the households had mosquito nets used for sleeping whereby 39.34% of them used the mosquito nets while sleeping the previous night.

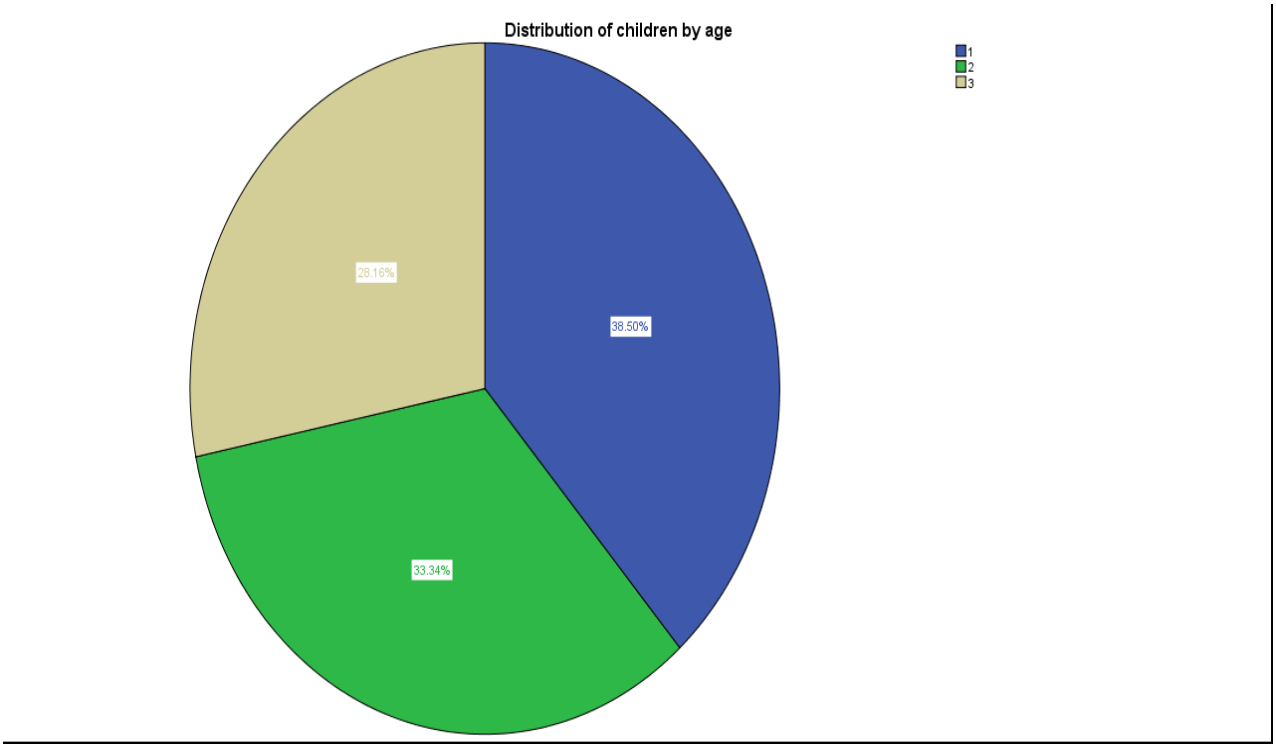
Of the children in the study population 38.5% were under 5 years old, 33.34% were 5-9 years old and 28.16% were 10-14 years old.

From the sample, the percentage of boys was 50.23% while girls accounted for 49.77%.

89% of the households reside in the rural areas while 11% resides in the urban area.

66.86% of the households were headed by males while 33.14% of the households were headed by females.

4.3 Summary Description of the Children in the Sample



Key:

- **1 is under 5 years**
- **2 is 5 to 9 years**
- **3 is 10 – 14 years**

From the pie chart above, the under five year olds were 38.5%, those aged between five years and nine years 33.34% and those aged between ten and fourteen years being 28.16%.

4.4 Percentage of children with Malaria

Age group of child	Malaria Negative	Malaria Positive	Percentage(%) positive
Under five years	4,677	425	30.18
Five to nine years	3,851	567	40.27
Ten to fourteen years	3,316	416	29.55
Total	11,844	1,408	100

From the table above we can deduce that 30.18% of children aged below 5 years were malaria positive. 40.27% of the children with malaria are 5-9 years old. While 29.55% are aged between 10-14 years old.

4.5 Malaria prevalence per Malaria zone

Malaria zone	Malaria Negative	Malaria Positive	Total	Percentage(%) positive
Highland	2,980	78	3,058	5.54

epidemic				
Lake endemic	1,994	1,222	3,216	86.79
Coast endemic	1,955	87	2,042	6.18
Semi arid/seasonal risk	2,537	10	2,547	0.71
Low risk	2,378	11	2,389	0.78
Total	11,844	1,408	13,252	

Malaria prevalence is very high in the Lake endemic region at 86.79%. In the low risk and seasonal / semi arid malaria zones, malaria prevalence was very low at 0.78% and 0.71% respectively.

4.6 Description of Malaria Prevalence by Malaria Laboratory Results (Malaria Positive) Using Chi-Square Test of Independence

Characteristics	Number of people in group, n	Number of Malaria positives, n (%)	P-value	Chi-square, (df)
Own net used for sleeping			<0.001	(2)37.4441
No	4654	391(8.33)		

Yes	8598	1017(11.83)		
slept under net			<0.001	(1)1.0636
No	8039	872(10.71)		
Yes	5213	536(10.28)		
Age Category			<0.001	(2)52.0673
Under five	5102	425(8.33)		
Five to nine	4418	567(12.83)		
Ten to fourteen	3732	416(11.15)		
Sex of the Child			0.44	(1)0.5972
Male	6657	721(10.83)		
Female	6595	687(10.42)		
Type of Residence			<0.001	(1)95.5498
Urban	1520	51(3.36)		
Rural	11732	1357(11.57)		
Sex of Household Head			<0.001	(1) 14.3964

Male	8860	878(9.91)		
Female	4392	530(12.07)		
Malaria zone			<0.001	(4)240.6492
Highland epidemic	3058	78(2.56)		
Lake endemic	3216	1222(38.0)		
Coast	2042	87(4.26)		
Semi arid/seasonal risk	2547	10(3.93)		
Low risk	2389	11(0.46)		
Province of Residence			<0.001	(7)2.4
Nairobi	247	8(3.24)		
Central	1345	2(0.15)		
Coast	2189	87(3.97)		
Eastern	1544	1(0.064)		
North Eastern	359	0(0)		

Nyanza	2517	741(29.44)		
Rift valley	3351	53(1.58)		
Western	1700	516(30.35)		
Wealth index quintile			<0.001	(4)3.4
Very poor	2649	356(13.44)		
Poor	2651	391(14.75)		
Middle class	2652	329(12.75)		
Rich	2650	250(12.41)		
Very rich	2650	82(3.1)		
Number of sleeping rooms			<0.001	(4)71.2044
One	5091	645(12.67)		
Two	4995	545(10.91)		
Three	2016	147(7.29)		
Four and above	1112	67(6.03)		

Missing information	38	4(10.53)		
Mother's highest education level			<0.001	(6)97.4501
No education	1553	103(6.63)		
Primary incomplete	2570	355(13.81)		
Primary complete	1793	173(9.65)		
Secondary incomplete	511	62(12.13)		
Secondary complete	706	32(4.53)		
Higher	289	15(5.19)		
Missing information	5830	668(11.46)		
Age , household head			<0.001	
under_18 years	31	6(19.35)	0.045	(4)9.7352
18_25 years	808	7(12.0)		
26_35 years	3873	415(10.72)		
36_50 years	5199	529(10.18)		

above_50years	3341	387(11.58)		

By cross tabulation describing malaria prevalence by malaria positive (malaria laboratory results) the following variables were significant using Pearson chi-square of Independence; Net ownership, net use(sleeping under the net the previous night), age of the child, household wealth index quintile, malaria zone, region of residence (urban/rural), highest education level of the mother, number rooms used for sleeping. Age of the household head was slightly significant (p-value = 0.045). Gender of the child was not significant in describing malaria prevalence.

4.7 Pearson's Chi Square Analysis for Malaria Prevalence

The dataset was loaded into memory and *svyset qhclust_2 [pweight=hhweight_1b]*, *strata (qhtype)* to declare the data survey data.

Using the command; *svy*: *tabulate*, two way tables of cell proportions along their uncorrected chi square and Design-based F statistic were produced.

4.7.1 Description of Malaria Prevalence by Malaria Laboratory Results (Malaria Positive) Using Chi-Square Test Of Independence

Demographic characteristics	Proportion of people in group, N	Proportion of people Malaria positives	P-value	Uncorrected chi2(df)	Design-based F
Own net used for sleeping			0.1001	(1)33.122	(1,238)2.7254

No	0.3859	0.0334			
Yes	0.6141	0.726			
slept under net			0.6972	(1)0.8180	(1,238)0.1518
No	0.6373	0.0687			
Yes	0.3627	0.0373			
Age Category			0.0126	(2)31.5500	(1.33,317.00)
Under five	0.3962	0.0356			
Five to Nine	0.3295	0.0412			
Ten to fourteen	0.2743	0.0292			
Sex of the Child			0.8540	(1)0.0473	(1,238)0.0339
Male	0.4914	0.0524			
Female	0.5086	0.0536			
Type of Residence			0.2554	(1)67.1403	(1,238)1.3000
Urban	0.1614	0.009			
Rural	0.8386	0.097			
Sex of Household			0.2037	(1) 7.9234	(1, 238)

Head					1.6245
Male	0.6769	0.0682			
Female	0.3231	0.0378			
Malaria zone			<0.0001	(4)3444.1756	(1.50, 358.13) 43.4970
Highland epidemic	0.2219	0.0045			
Lake endemic	0.2301	0.0903			
Coast endemic	0.079	0.003			
Semiarid,seasonalrisk	0.2248	7.4e-04			
Low risk	0.2443	0.0075			
Province ofResidence			<0.0001	(7)2514.1409	(2.84, 675.11) 14.2383
Nairobi	0.0672	0.0068			
central	0.0964	3.4e-04			
Coast	0.0833	0.003			
Eastern	0.1468	1.7e-04			
North Eastern	0.0455	0			

Nyanza	0.1738	0.05			
Rift valley	0.2592	0.0034			
Western	0.1276	0.0422			
Wealth index quintile			<0.0001	(4)287.9252	(3.08, 732.68) 10.4081
Very poor	0.1573	0.02			
Poor	0.1772	0.0276			
Middle class	0.2005	0.0263			
Rich	0.2154	0.0077			
Very rich	0.2496				
Number of sleeping rooms			0.0470	(4)64.5891	(2.71, 645.15) 2.7596
One	0.4007	0.0464			
Two	0.3707	0.0424			
Three	0.1508	0.0114			
Four and above	0.0729	0.0045			
Missing information	0.0049	0.0013			

Mother's highest education level			0.0001	(6) 120.7745	(4.66,1108.94) 5.7494
No education	0.093	0.0056			
Primaryincomplete	0.1938	0.0283			
Primary complete	0.14	0.0127			
Secondaryincomplete	0.0421	0.0046			
Secondary complete	0.0558	0.0022			
Higher	0.021	0.0515			
Missing information	0.4542	0.4542			
Age of the household head			0.7250	(4)6.4928	(3.02, 719.20) 0.4413
under_18 years	0.0029	4.3e-04			
18_25 years	0.0562	0.0046			
26_35 years	0.3136	0.331			
36_50 years	0.3896	0.0411			
above_50years	0.2377	0.0267			

Using the uncorrected Persons chi square and the design based F statistic, the following variables were significant in determining malaria prevalence:

Age of the child, malaria zone, Province of residence, household Wealth index, number of rooms used for Sleeping and Mothers highest education level.

4.7.2 UNADJUSTED LOGISTIC REGRESSION

4.7.2.1 Factors Affecting Malaria Prevalence a Survey Regression Analysis

Variable	Odd ratio	Std error	Z	p>|Z|	[95% Conf. Interval]	
5-9 years	1.450864	.1437234	3.76	<0.001	1.193646	1.763511
10-14 years	1.207367	.1933549	1.18	0.240	.8806964	1.655208
Highland epidemic	31.30551	10.5748	10.19	<0.001	16.0924	60.90047
Lake endemic	1.922579	.9191983	1.37	0.173	.7496158	4.930938
Coast endemic	.1598557	.1057893	-2.77	0.006	.0434051	.5887288
Semi arid seasonal risk	1.531643	1.387055	0.47	0.638	.2572589	9.118949
Central	.0315096	.03508	-3.11	0.002	.0035141	.282531
Coast	.3307197	.2911384	-1.26	0.210	.0583718	1.873774
Eastern	.0100679	.0125067	-3.70	<0.001	.000871	.1163784

North Eastern	(omitted)					
Nyanza	3.565441	2.970541	1.53	0.128	.6905852	18.40811
Rift valley	.1176771	.1026414	-2.45	0.015	.0211036	.6561882
Western	4.370776	3.631943	1.77	0.077	.8502264	22.46894
Poor	1.266698	.2826123	1.06	0.290	.8161899	1.96587
Middle class	1.034242	.2526697	0.14	0.891	.6391567	1.673544
Rich	.8779582	.2504043	-0.46	0.649	.5005645	1.539883
Very rich	.2180517	.0738509	-4.50	<0.001	.1118914	.4249348
Primaryincomplete	2.659017	.6868766	3.79	<0.001	1.598509	4.423104
Primarycomplete	1.548836	.3860297	1.76	0.080	.9479141	2.530708
Secondaryincomplete	1.894629	.520438	2.33	0.021	1.102838	3.254894
Secondarycomplete	.6525737	.2036162	-1.37	0.173	.3529231	1.206644
Higher	.8573106	.4685049	-0.28	0.778	.2921421	2.515835
Missing information	1.991616	.4427196	3.10	0.002	1.285356	3.085942
2 sleeping rooms	.9861392	.1871699	-0.07	0.941	.6785062	1.433252
3 sleeping rooms	.621726	.1609638	-1.84	0.068	.3733345	1.035381
4sleeping rooms and	.5071207	.1666447	-2.07	0.040	.2654415	.9688441

above						
Missing information	2.67326	1.467904	1.79	0.075	.906259	7.885518

Following unadjusted logistic regression, these variables were significant in determining malaria prevalence: Age of the child with under five as reference group, malaria zone, province of residence as Nairobi as the reference group, household wealth index quintile the very poor being the reference group, mothers highest education level no education as the reference group and number of rooms used for sleeping one room as the reference group.

4.7.3 Multivariable Logistic Regression

4.7.3.1 Logistic Analysis of Factors Affecting Malaria Prevalence

Variable	Odd ratio	Std error	Z	p>|Z|	[95% Conf. Interval]	
5-9 years	2.07721	.1740641	8.72	<0.001	1.762594	2.447984
10-14 years	1.830336	.1715016	6.45	<0.001	1.523258	2.199318
Lake endemic	19.05543	3.402701	16.51	<0.001	13.42829	27.04061
Coastendemic	2626252	2.75e+09	0.01	0.989	0	.
Semiaridseasonalrisk	.5202749	.1925315	-1.77	0.077	.2519066	1.074549
Low risk	.1082722	.1098185	-2.19	0.028	.0148306	.7904504
Central	.0180903	.0144771	-5.01	<0.001	.0037693	.086823

Coast	1.63e-08	.000017	-0.02	0.986	0	.
Eastern	.0016134	.0023751	-4.37	<0.001	.0000901	.0288925
North eastern	(omitted)					
Nyanza	.0368066	.0403315	-3.01	0.003	.0042974	.3152428
Rift valley	.0197556	.0211449	-3.67	<0.001	.0024245	.1609721
Western	.0349842	.0383753	-3.06	0.002	.0040753	.3003188
Poor	.9461821	.0898474	-0.58	0.560	.7855005	1.139733
Middle class	.9202475	.0920934	-0.83	0.406	.7563468	1.119665
Rich	.7337461	.0777488	-2.92	0.003	.5961442	.9031093
Very rich	.2435357	.0352326	-9.76	<0.001	.183408	.3233755
Primary incomplete	.6461355	.0963119	-2.93	0.003	.4824417	.865371
Primary complete	.4941065	.0804407	-4.33	<0.001	.3591242	.679824
Secondaryincomplete	.5880845	.1227546	-2.54	0.011	.3906277	.8853529
Secondary complete	.3991472	.0988151	-3.71	<0.001	.2456999	.6484271
Higher	.473198	.1586992	-2.23	0.026	.2452282	.913094
Missing information	.5104259	.0735712	-4.67	<0.001	.3848072	.6770524

Following multivariable (adjusted) logistic regression, the following variables were significant in determining malaria prevalence; Age of the child under five as the reference group, malaria zone highland epidemic as the reference group, province of residence Nairobi as the reference group, house hold wealth index quintile the very poor as the reference group and mothers highest education with no education as the reference group..

Therefore;

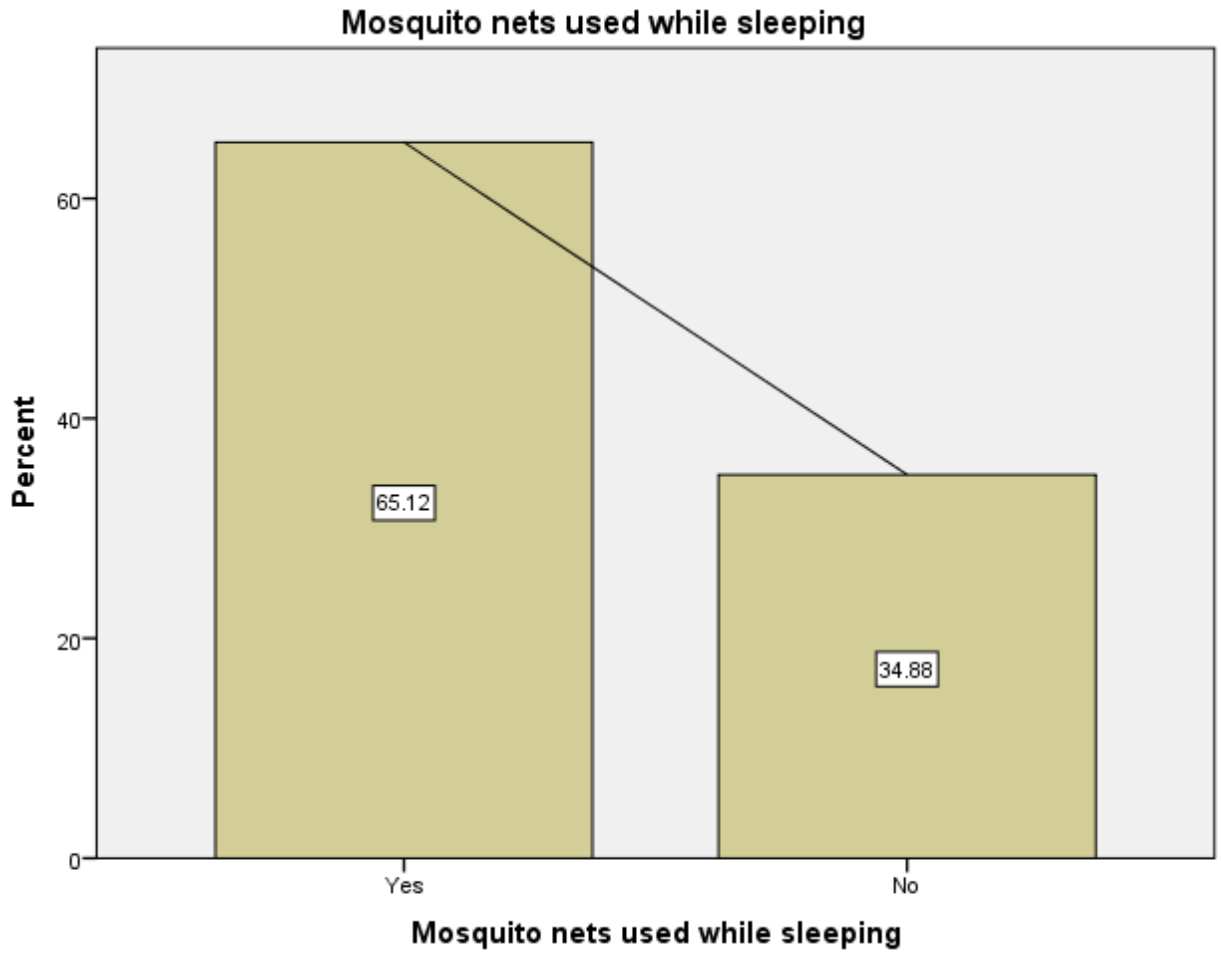
Malaria prevalence = age of child + malaria zone + household Wealth index quintile + Mothers education + province of residence

4.7.4 Description of Net Use by Sleeping Under the Net the Previous Night

4.7.4 .1 Net Ownership

Net ownership	Frequency	Percent
No	4,654	35.12
Yes	8,598	64.88
Total	13,252	100.00

64.88% of the households owned mosquito nets used for sleeping.



Bar graph showing net utilization

4.7.4 .2 Net Utilization

Net ownership	Did not sleep under the net	Slept under the net	Total
No	4,623	31	4,654
Yes	3,416	5,182	8,598
Total	8,039	5,213	13,252

Of those who owned nets used for sleeping, only 60.63% slept under them the previous night.

4.7.4 .3 Net Utilization And Malaria Prevalence

Malaria status	Did not sleep under the net	Slept under the net	Total
Negative	7,167	4,677	11,844
Positive	872	536	1,408
Total	8,039	5,213	13,252

Of those who slept under the net the previous night, 38.07% had malaria infection compared to 61.93% who had malaria infection but did not sleep under net the previous night.

4.7.4 .4 Net Utilization by Age

Age category	Did not sleep under the net	Slept under the net	Total
Under five	2,628	2,474	5,102
Five to nine	2,822	1,596	4,418
Ten to fourteen	2,589	1,143	3,732
Total	8,039	5,213	13,252

From the above table it is evident that ITN utilization declined with increase in age of the child.

4.7.4 .5 Net utilization by Malaria zone

Malaria zone	Did not sleep under the net	Slept under the net	Total	Percentage (%) slept under net
Highlandepidemic	1,957	1,101	3,058	21.12
Lake endemic	1,825	1,391	3,216	26.68
Coast endemic	953	1,089	2,042	20.89
Semiaridseasonalrisk	1,570	977	2,547	18.74
Low risk	1,734	655	2,389	12.56
Total	8,039	5,213	13,252	100

Net utilization among net owners was highest in the lake endemic region (26.68%), closely followed by Highland epidemic and the Coast endemic regions at 26.68% and 20.89% respectively.

4.7.5 PEARSON'S CHI SQUARE ANALYSIS FOR NET USE

4.7.5.1 Factors Affecting ITN Utilization among Net Owners Accounting For Sample Weight and Sample Design

Demographic characteristics	Proportion of people in group, n	Proportion of people Malaria positives	P-value	Uncorrected chi2(df)	Design-based F
Age Category			<0.0001	(2) 288.2498	(1.92, 457.34) 59.0846
Under five	0.3962	0.1773			
Five to nine	0.3295	0.1079			
Ten to fourteen	0.2743	0.0775			
Sex of the Child			0.1140	(1) 6.6850	(1, 238) 2.5164
Male	0.4914	0.1836			

Female	0.5086	0.1791			
Type of Residence			0.7747	(1) 2.8935	F(1, 238) 0.0821
Urban	0.1614	0.0612			
Rural	0.8386	0.0.3016			
Sex of Household Head			0.5074	(1) 1.8306	(1, 238) 0.4407
Male	0.6769	0.2481			
Female	0.3231	0.1146			
Malaria zone			0.0030	(4) 261.1724	(3.50, 833.75) 4.3142
Highlandepidemic	0.2219	0.081			
Lake endemic	0.2301	0.0996			
Coast endemic	0.079	0.0369			
Semiaridseasonalrisk	0.2248	0.0816			
Low risk	0.2443	0.0636			
ProvinceofResidence			0.0020	(7) 413.0854	(5.32,1266.37)= 3.7010

Nairobi	0.0672	0.017			
Central	0.0964	0.0248			
Coast	0.0835	0.0389			
Eastern	0.1468	0.0633			
North Eastern	0.0455	0.0183			
Nyanza	0.1738	0.0797			
Rift valley	0.2592	0.0712			
Western	0.1276	0.0495			
Wealth index quintile			<0.0001	(4) 287.9252	(3.08, 732.68) 10.4081
Very poor	0.1573	0.02			
Poor	0.1772	0.0276			
Middle class	0.2005	0.0263			
Rich	0.2154	0.244			
Very rich	0.2496	0.2496			
Number of sleeping rooms			0.1058	(4) 45.5313	(2.70, 643.72) 2.0996

1sleeping room	0.4007	0.1404			
2 sleeping rooms	0.3707	0.1396			
3 sleeping rooms	0.1508	0.0548			
4 sleeping rooms and above	0.0729	0.0279			
Missing information	0.0049	1.7e-05			
Mother's highest education level			0.0001	(6)120.7745	(4.66,1108.94) 5.7494
No education	0.093	0.0056			
Primary incomplete	0.1938	0.0283			
Primary complete	0.14	0.0127			
Secondaryincomplete	0.0421	0.0046			
Secondary complete	0.0558	0.0022			
Higher	0.021	0.11			
Missing information	0.4542	0.515			
Age, household head			0.0470	(4)64.5891	(2.71, 645.15) 2.7596

under_18 years	0.4007	0.0464			
18_25 years	0.3707	0.0424			
26_35 years	0.1508	0.0114			
36_50 years	0.0729	0.0045			
above_50years	0.0049	0.0013			

The following variables were important in determining ITN utilization amongst those who owned them. Age of the child, malaria zone, Province of residence, house hold wealth index, mothers highest education level and age of the household head.

4.7.5.2 UNADJUSTED LOGISTIC REGRESSION

4.7.5.3 Factors Affecting ITN Use by Sleeping Under the Net the Previous Night

Variable	Odd ratio	Std error	Z	p>|Z|	[95% Conf. Interval]	
5-9 years	.6008573	.0401736	-7.62	<0.001	.5267066	.6854471
10-14 years	.4860037	.0373327	-9.39	<0.001	.4177532	.5654046
Lake endemic	1.327062	.1856296	2.02	0.044	1.007434	1.748099
Coast	1.528925	.4223953	1.54	0.126	.8872031	2.634808
Semi arid seasonal risk	.9914105	.2120079	-0.04	0.968	.6505763	1.510806

Low risk	.6126525	.1315132	-2.28	0.023	.4013837	.9351229
Central	1.020388	.5035588	0.04	0.967	.3859695	2.697603
Coast	2.56665	1.320829	1.83	0.068	.9312991	7.07366
Eastern	2.237182	1.126069	1.60	0.111	.829976	6.030276
North Eastern	1.97369	1.161587	1.16	0.249	.6190936	6.292189
Nyanza	2.496125	1.162173	1.96	0.051	.9975368	6.246025
Rift valley	1.116282	.5301769	0.23	0.817	.4379557	2.84523
Western	1.864974	.8781822	1.32	0.187	.7375797	4.715597
Poor	1.243614	.1789363	1.52	0.131	.9366668	1.651148
Middle class	1.323182	.1854473	2.00	0.047	1.003949	1.743923
Rich	1.373956	.2580794	1.69	0.092	.9490059	1.989193
Very rich	1.985959	.3539009	3.85	<0.001	1.398007	2.821181
Primary incomplete	1.230308	.1789987	1.42	0.156	.9237164	1.63866
Primary complete	1.443691	.2374581	2.23	0.027	1.044127	1.99616
Secondary incomplete	2.153407	.4721297	3.50	0.001	1.398132	3.316683

Secondary complete	2.528045	.4870273	4.81	<0.001	1.729669	3.694934
Higher	3.12193	.7053781	5.04	<0.001	2.000401	4.872245
Missing information	.7400138	.1023533	-2.18	0.030	.5635158	.9717926
18-25 years	.5656659	.3768354	-0.86	0.393	.1522678	2.101415
26-35 years	.4758285	.3253472	-1.09	0.278	.1237279	1.829924
36-50 years	.394824	.2738287	-1.34	0.182	.1007021	1.547992
50 years and above	.2611029	.1843662	-1.90	0.058	.0649683	1.049354

The following factors were associated with ITN utilization.

Age of the child with under five year olds used as the reference group, malaria zone (low risk) with highland epidemic as the reference group ,house hold wealth index quintile with very poor as the reference group and mother's highest education level with no education as the reference group.

4.7.5.4 Multivariable logistic analysis

4.7.5.6 Factors Affecting ITN Use by Sleeping Under the Net the Previous Night

Variable	Odd ratio	Std error	Z	p>|Z|	[95% Conf. Interval]	
5-9 years	.6922583	.03088	-8.25	<0.001	.634305	.7555066
10-14years	.5856855	.0293152	-10.69	<0.001	.5309572	.6460549
Malaria_zone (low risk)	.8906177	.0120673	-8.55	<0.001	.8672775	.9145861
Poor	1.345467	.0805337	4.96	<0.001	1.196531	1.512941
Middle class	1.421688	.086598	5.78	<0.001	1.261699	1.601964
Rich	1.538677	.0949902	6.98	<0.001	1.363323	1.736587
Very rich	2.840051	.1803096	16.44	<0.001	2.507753	3.21638
primaryincomplete	1.021234	.0694	0.31	0.757	.8938817	1.16673
primarycomplete	1.028364	.0758625	0.38	0.705	.8899253	1.188338
secondaryincomplete	1.359607	.1460692	2.86	0.004	1.10145	1.678272
secondarycomplete	1.403589	.1370514	3.47	0.001	1.159113	1.69963
Higher	1.501517	.2077414	2.94	0.003	1.144888	1.969236
Missing information	.6524273	.0418969	-6.65	<0.001	.5752685	.7399351

Net utilization was significantly associated with age of the child under fives as the reference group, malaria zone highland epidemic as the reference group, house hold wealth index quintile the very poor as the reference group and mothers highest education level.

Therefore ITN use = age of the child + malaria zone + wealth index quintile + mothers highest education level.

CHAPTER FIVE

DISCUSSION, CONCLUSION AND RECOMMENDATION

5.1 Discussion of Findings

From our data malaria prevalence in Kenya still remains at 10.62%. Prevalence of malaria decreased with increasing age (5-9 years) and (10-14 years). From the 2010 Kenya malaria Indicator Survey, the overall prevalence of malaria among children aged 3 months–14 years is 11 per cent by microscopy (2010, KMIS). In 1993,Baird JK et al found that the age-specific prevalence of Plasmodium falciparum parasitemia among residents of six villages in north eastern Irian Jaya, Indonesia, the prevalence of parasitemia decreased markedly with increasing age beyond 6-10 or 11-15 years. An age-dependent naturally acquired protective immunity appeared to develop in all after 1-2 years of exposure to hyper endemic malaria. The older children living especially in endemic areas may have developed immunity against malaria before their fifth birthday, but still susceptible to parasite infection. All in all, children aged 5-14years form a larger proportion of the children population which in turn plays as a major reservoir for malaria infection (61.5%). Age was significant in determining malaria infection (OR 1.97, 95% CI 1.67-2.31 P=0.000for those 5-9 years old and OR 1.68, 95% CI 1.42-1.98 P=0.000for those 10-14 years old).

The level of malaria endemicity in Kenya varies from one area to another and can be classified into five malaria endemicity regions. Malaria prevalence was highest in the Lake endemic region at 86.79%. From our data, malaria endemic zone was significant in

determining malaria infection among children. Children from the lake endemic malaria zone had an increased risk of malaria (OR 0.87, 95%CI 13.24-26.49 P=0.000). This is consistent with the KMIS 2010 report. All four species of human Plasmodium*:* Plasmodium falciparum, Plasmodium malariae, Plasmodium ovale and Plasmodium vivaxoccur in Kenya. Plasmodium falciparum which causes the severest form of the disease accounts for 98 percent of all malaria infections. Rainfall, temperature and humidity are the determinants of the perennial transmission of malaria. From our study, it is apparent that 79.83% of malaria cases were caused by Plasmodium falciparum

Major malaria vectors in Kenya are members of An. gambiae complex and An. funestus. Kenya has four malaria epidemiological zones. Endemic areas: Areas of stable malaria have altitudes ranging from 0 to 1,300 metres around Lake Victoria in western Kenya and in the coastal regions. Rainfall, temperature and humidity are the determinants of the perennial transmission of malaria. The vector life cycle is usually short with high survival rate because of the suitable climatic conditions. Transmission is intense throughout the year with high annual entomological inoculation rates. Topography generally has a great influence on mosquito replication and thus affects the rate of malaria cases. In higher altitudes, temperatures are cooler, limiting the reproduction rate of the parasites. Higher elevations therefore result in low rise malaria cases as result of the cooler temperatures as you go through higher altitudes thereby elongating the life cycle of the malaria parasite. Shillu et al., 2003). The complexity of topography and landscape in the highlands contributes to the spatial heterogeneity of vector abundance and malaria transmission

intensity. It has implications for the survival of the vector for different altitudes (Minakawa et al., 2002).

Even though our study did not show that mother's age and highest education level, household wealth index quintile and type of residence (rural/urban) were significant in determining malaria prevalence in children, (Chalwe, Victor F) in factors associated with mortality from childhood malaria in Navrongo, Ghana in 2008; concluded that children born of older mothers (maternal age at birth of child >30 years) had a higher risk (RRR 1.28, 95%CI 1.15-1.42 P <0.0001). However, maternal education and residence had a protective effect, with children born of mothers who had some education (RRR 0.79, 95%CI 0.67-0.93 P=0.004) and residing in urban area (RRR 0.61, 95%CI 0.46-0.82 P=0.001) having a lower risk. Similarly, those children whose families are in the highest wealth index had a lower risk (RRR 0.76, 95%CI 0.63-0.91 P=0.003). However when design effects and sample weights are taken into consideration in survey logistic regression, mother's highest education level (P=0.001 using the design based F statistic of 5.7494 with4.66 and 1108.98 degrees of freedom) and household wealth index quintile (P=0.000 using the design based F statistic of 10.4081with 3.08, and 732.68 degrees of freedom) become significant.

Kenya has met the Roll Back Malaria (RBM) household ITN coverage target of sixty percent (60%) according to Noor et al 2007. Despite ITN ownership in this study being 64.88% among the families from which our children came from, ITN utilization however remained low at 39.34% among those owning the ITNs. ITN utilization measured by if one slept under the net previous night, majority of net users were the under fives 40.46%.

Those aged 5-9years were 30.62% and 21.92% for 10-14 year old, notably net usage declining with age. Net utilization had a protective effect against malaria; malaria prevalence was 38.07% among those who slept under the net compared to those who did not. This is consistent with Baume CA et al on factors associated with use and non use of mosquito nets owned in Oromia and Amhara regional states Ethiopia 2009, where 35% of net owned were not being used.

5.2 Conclusion

From our study, it shows that malaria prevalence is high among the school going children and it is affected by the age of the child, malaria Zone, household wealth index quintile, mothers educational level and province of residence. Net utilization among those who own them is not maximal and is significantly affected by age of the child, malaria zone, household wealth index quintile and mothers highest education level.

5.2 Recommendations

Net distribution programmes to target schools where most of the children population is found.

Health education by policy makers in conjunction with health workers to emphasis on ITN utilization among those who own them.

Recommend further analysis of this data especially for the spatial effect of malaria prevalence.

REFERENCES

Baume CA, Reithinger R, Woldehanna S**: Factors associated with use and non-use of mosquito nets owned in Oromia and Amhara regional states, Ethiopia.** Malar J 2009, 8:264.

Binka FN, Adongo P: **Acceptability and use of insecticide impregnated bednets in northern Ghana.** Trop Med Int Health 1997, 2(5):499-507.

Ceesay SJ, Casals-Pascual C, Nwakanma DC, Walther M, Gomez-Escobar N, et al. (2010) **Continued Decline of malaria in The Gambia with Implications for Elimination.** PLoS ONE 5(8): e12242. doi:10.1371/journal.pone.0012242

Cox SE, Doherty CP, Atkinson SH, Nweneka CV, Fulford AJ, Sirugo G, Rockett KA, Kwiatkowski DP, Prentice AM 2008**.Haptoglobin genotype, anaemia and malaria in Gambian children.** Trop Med Int Health. Jan;13(1):76-82.

D'Alessandro U, Olaleye BO, McGuire W, Langerock P, Bennett S, Aikins MK, Thomson MC, Cham MK, Cham BA, Greenwood BM**: Mortality and morbidity from malaria in Gambian children after introduction of an impregnated bednet programme**. Lancet 1995, 345(8948):479-483.

Howard S, Omumbo JA, Some ES, Donelly CA, Snow RW (2000) **Evidence for a mass community effect of insecticide treated bed nets on the incidence of malaria on the Kenyan Coast**. Trans R Soc Trop Med Hyg 94: 357–360

Killeen GF, Smith TA, Ferguson HM, Mshinda H, Abdulla S, Lengeler C, Kachur SP: **Preventing childhood malaria in Africa by protecting adults from mosquitoes with insecticide-treated nets**. PLoS Med 2007, 4(7):e229.

Lengeler C. **Insecticide-treated nets for malaria control: real gains**. Bull World Health Organ.2004;82:84.

Magesa SM, Wilkes TJ, Mnzava AE, Njunwa KJ, Myamba J, Kivuyo MD, Hill N, Lines JD, Curtis CF: **Trial of pyrethroid impregnated bednets in an area of Tanzania holoendemic for malaria.** Acta Trop 1991, 49(2):97-108.

Noor AM, Amin AA, Akhwale WS, Snow RW: **Increasing coverage and decreasing inequity in insecticide-treated bed net use among rural Kenyan children.** PLoS Med 2007, 4(8):e255.

Noor AM, Moloney G, Borle M, Fegan GW, Shewchuk T, Snow RW: **The use of mosquito nets and the prevalence of Plasmodium falciparum infection in rural South Central Somalia**. PLoS One 2008, 3(5):e2081.

Peter Diggle, Rana Moyeed, Barry Rowlingson and Madeleine Thomson: **Childhood malaria in the Gambia: A Case-Study in Model-Based Geostatistics** Journal of the Royal Statistical Society. Series C (Applied Statistics) Vol. 51, No. 4 (2002), pp. 493-506

Phillips-Howard PA, Nahlen BL, Kolczak MS, Hightower AW, ter Kuile FO, Alaii JA, Gimnig JE, Arudo J, Vulule JM, Odhacha A, Kachur SP, Schoute E, Rosen DH, Sexton JD, Oloo AJ, Hawley WA: **Efficacy of permethrin-treated bed nets in the prevention of mortality in young children in an area of high perennial malaria transmission in western Kenya**. Am J Trop Med Hyg 2003, 68(4 Suppl):23-29.

Phillips-Howard PA, ter Kuile FO, Nahlen BL, Alaii JA, Gimnig JE, Kolczak MS, Terlouw DJ, Kariuki SK, Shi YP, Kachur SP, Hightower AW, Vulule JM, Hawley WA: **The efficacy of permethrin-treated bed nets on child mortality and morbidity in**

western Kenya II. Study design and methods. Am J Trop Med Hyg 2003, 68(4 Suppl):10-15.

Ter Kuile F, Terlouw D, Phillips-Howard P, Hawley W, Friedman J, et al. (2003**) Impact of permethrin-treated bed nets on malaria and all cause morbidity in young children in an area of intense perennial malaria transmission in western Kenya**: cross-sectional survey. Am J Trop Med Hyg 68: 100–107.

Vanden Eng JL, Thwing J, Wolkon A, Kulkarni MA, Manya A, Erskine M, Hightower A, Slutsker L: **Assessing bed net use and non-use after longlasting insecticidal net distribution: a simple framework to guide programmatic strategies**. Malaria Journal 9:133.

William A. Hawley, Penelope A. Phillips-Howard, Feiko O. ter Kuile, Dianne J. Terlouw, John M. Vulule, Maurice Ombok, Bernard L. Nahlen, John E. Gimnig, Simon K. Kariuki, Margarette S. Kolczak, *et al.* **Community-wide effects of permethrin-treated bed nets on child mortality and malaria morbidity in western Kenya.**Am J Trop Med Hyg. 2003 April; 68(4 Suppl): 121–127

Appendix A

DO FILE

```
#delimit;
clear;
clear all;
*mata: mata clear;
set mem 800m;
set more off;
cap log close;
log using "C:\Users\doctor\Desktop\sils\ Final 2010 KMIS _log.smcl",append;
** Getting the data **
*use "C:\Users\doctor\Desktop\sils\Final 2010 KMIS",clear;
di _N;
** Formatting the Dataset **;
codebook qh215 labres;
** Malaria positivity **;
gen malaria_positive=0;
replace malaria_positive=1 if labres=="1";
codebook malaria_positive labres;
label var malaria_positive "malaria status";
** LLN/ITN Net Use **;
gen net_use=0;
replace net_use=1 if qh113==1;
codebook qh113 net_use;** Slept Under a Net **;
gen slept_net="";
replace slept_net="Yes" if qh124=="1";
replace slept_net="No" if qh124~="1";
for var qh124 slept_net:tab X,m;
gen slept_netf="";
replace slept_netf="1" if slept_net=="Yes";
replace slept_netf="0" if slept_net=="No";
 destring slept_netf, generate(slept_netb);
/*
** For qh124 - did anyone sleep under this net last night? **;
** Keep only those who had nets **;
```

```
keep if qh113==1;

**slept_net==qh124 did anyone sleep under this net last night?; net_own== qh113 does your household have

any mosquito nets that can be used while sleeping?**

** Formatting the categorical variables **;

*codebook QH07 QH04 QHPROV NFAC1_1 QH124 MALARIA_ZONE HV220 HV219 QHTYPE QCED3 HC2 SPECIES_ID;

drop qhwlthi;ren nfac1_1 qhwlthi;

gen sroom_cat="";

replace sroom_cat="a_1_room"                    if (hc2==0 | hc2==1);

replace sroom_cat="b_2_rooms"                   if  hc2==2;

replace sroom_cat="c_3_rooms"                   if  hc2==3;

replace sroom_cat="d_4_And_Above_rooms" if (hc2>=4 & hc2~=99);

replace sroom_cat="e_Missing Data" if hc2==99;

for var sroom_cat hc2:tab X,m;

gen hh_age_cat="";

replace hh_age_cat="a_under_18 years"     if hv220<18 & hv220~=.;

replace hh_age_cat="b_18_25 years"    if hv220 >=18 & hv220<26;

replace hh_age_cat="c_26_35 years"    if hv220 >=26 & hv220<36;

replace hh_age_cat="d_36_50 years"    if hv220 >=36 & hv220<51;

replace hh_age_cat="e_above_50years"    if hv220 >=51 & hv220!=.;

tab hh_age_cat,m;

gen mother_educ="";

replace mother_educ="g_Missing Data" if qced3==9;

replace mother_educ="a_No education" if qced3==0;

replace mother_educ="b_Primary incomplete" if qced3==1;

replace mother_educ="c_Primary complete" if qced3==2;

replace mother_educ="d_Secondary incomplete" if qced3==3;

replace mother_educ="e_Secondary complete" if qced3==4;

replace mother_educ="f_Higher" if qced3==5;

for var mother_educ qced3:tab X,m;

**Descibe net ownership (net_own)and net usage(slept_net)**

tab slept_net net_own, chi2;

        */

** Descriptives for Malaria Positives by each of the Categorical Variables **;

*for var net_own slept_net  qh07 qh04 qhprov qhwlthi  malaria_zone hh_age_cat hv219 qhtype qced3 sroom_cat species_id:tab X malaria_positive,m;

** Chi-Square Tests of Association **;
```

```
for var  net_own slept_net qh07 qh04  qhwlthi qhprov malaria_zone hh_age_cat hv219 qhtype
mother_educ:tab X malaria_positive,m chi2;

** Descriptives for Net Use(slept_netb)  by each of the Categorical Variables **;

*for var qh07 qh04 qhprov qhwlthi qh124 malaria_zone hh_age_cat hv219 qhtype mother_educ sroom_cat
species_id:tab X slept_net,m;

** Chi-Square Tests of Association **;

for var  qh07 qh04 qhprov qhwlthi qh124 malaria_zone hh_age_cat hv219 qhtype qced3:tab X
slept_net,chi2 m;

*for var sroom_cat species_id:tab X slept_netb,exact;

** Logistic Regression Models with Malaria Positivity (malaria_positive) as the response variable **;

*for var slept_net qh07 qh04  qhwlthi malaria_zone hh_age_cat hv219 qhtype sroom_cat mother_educ:tab
X malaria_positive,m;

** xi is used when you have a predictor variable with more than two categories **;

xi:logistic malaria_positive i.qh07;

** The unadjusted Models **;logistic malaria_positive slept_net;*logistic malaria_positive qh07;

tab qh04 malaria_positive,m;logistic malaria_positive qh04;xi:logistic malaria_positive i.qhwlthi;

xi:logistic malaria_positive i.malaria_zone;xi:logistic malaria_positive i.hh_age_cat;

xi:logistic malaria_positive i.hv219;xi:logistic malaria_positive i.mother_educ;xi:logistic malaria_positive
i.qhprov ;

xi:logistic malaria_positive i.sroom_cat;

 ** The Adjusted Models **;

xi:logistic malaria_positive slept_net i.qh07 qh04 i.qhwlthi i.malaria_zone i.hh_age_cat hv219 sroom_cat
i.mother_educ i.qhprov i.sroom_cat;

** END OF THE Logistic Regression for the with Malaria Positivity (malaria_positive) as the response
variable **;

** Logistic Regression Models with Net use (slept_net) as the response variable **;

*for var slept_net qh07 qh04  qhwlthi malaria_zone hh_age_cat hv219  sroom_cat qhprov qhtype
mother_educ:tab X malaria_positive,m;

** The unadjusted Models **;

tab slept_netb malaria_positive,m;logistic slept_net malaria_positive ;

** xi is used when you have a predictor variable with more than two categories **;

logistic slept_netb qh04;xi:logistic slept_net i.qh07; xi:logistic slept_net i.qhwlthi;

xi:logistic slept_net i.malaria_zone;xi:logistic slept_net i.hh_age_cat;xi:logistic slept_net i.hv219;

xi:logistic slept_net i.mother_educ;xi:logistic slept_net i.qhprov ;xi:logistic slept_net i.sroom_cat;

** The Adjusted Models **;

xi:logistic slept_net i.qh07 qh04 i.qhwlthi i.malaria_zone i.hh_age_cat hv219 i.mother_educ i.qhprov
i.sroom_cat;

log close _all;

** Descriptives for net use(slept_net)  by each of the Categorical Variables **;
```

```
*for var qh07 qh04 qhprov qhwlthi qh124 malaria_zone hh_age_cat hv219 qhtype mother_educ sroom_cat species_id:tab X slept_net,m;

** Chi-Square Tests of Association **;

for var qh07 qh04  qhwlthi  malaria_zone qhprov hh_age_cat hv219 qhtype sroom_cat mother_educ:tab X slept_net,m chi2;

** Chi-Square Tests of Association **;

tab slept_netb malaria_positive,m chi2;

*/

** Changing the variable to numeric **;

*gen hhweight_1b=subinstr( hhweight_1,",","",.);

*destring hhweight_1b,replace force;

destring hhweight_1,gen(hhweight_1b) ignore(",","?");

*gen real_b=real(qhclust_1);

**********

 tabulate slept_net malaria_positive,m chi2;

* encode slept_net, generate(sleptnetb);

/*

destring [slept_net] , {generate(slept_netb)|replace}

label define slept_net_label 1"yes" 0"no",modify

label values slept_net slept_net_label

label define yesnob 0 No 1 Yes;

label values  slept_net yesnob;

**********

label define yesnob 0 no 1 yes; label values  slept_net yesno

svy: regress malaria_positive slept_net

*/** To identify the number of clusters by Malaria Zone **;

duplicates report malaria_zone qhclust;

duplicates drop malaria_zone qhclust,force;

byso malaria_zone:gen nclusters_new=_N;

tab malaria_zone nclusters_new,m;

** To identify the number of HOUSEHOLDS in a cluster in a Malaria Zone **;

duplicates report malaria_zone qhclust houseid;

duplicates drop malaria_zone qhclust houseid,force;

byso malaria_zone qhclust:gen nhholds_new=_N;

byso malaria_zone:tab qhclust nhholds_new,m;

** To identify the number of clusters by residence type **;

duplicates report qhtype qhclust;
```

```
duplicates drop qhtype qhclust,force;

byso qhtype qhclust:gen ncluster_rtyp=_N;

byso qhtype:tab qhclust ncluster_rtyp,m;

** Generating the new nclusters variable (nclusters_new) **;

gen nclusters_new=.;

replace nclusters_new=47 if malaria_zone==1;

replace nclusters_new=50 if malaria_zone==2;

replace nclusters_new=34 if malaria_zone==3;

replace nclusters_new=49 if malaria_zone==4;

replace nclusters_new=60 if malaria_zone==5;

byso malaria_zone:tab nclusters_new,m;

*byso malaria_zone:tab qhclust nhholds,m;

**survey data analysis**

**to survey set**;

svyset qhclust_2 [pweight=hhweight_1b], strata(qhtype);

svydescribe;

**two way tables for the survey data describing malaria prevalence using malaria_positive **;

svy: tabulate slept_net malaria_positive;svy: tabulate qh07 malaria_positive;svy: tabulate qh04
malaria_positive;

svy: tabulate qhwlthi malaria_positive;svy: tabulate malaria_zone malaria_positive;svy: tabulate qhprov
malaria_positive;svy: tabulate hh_age_cat malaria_positive;svy: tabulate hv219 malaria_positive;

svy: tabulate qhtype  malaria_positive;svy: tabulate sroom_cat malaria_positive;svy: tabulate mother_educ
malaria_positive;

**two way tables for the survey data describing net use  with(slept_net)**;

svy: tabulate qh07 slept_net;svy: tabulate qh04 slept_net;svy: tabulate qhwlthi slept_net;

svy: tabulate malaria_zone slept_net;svy: tabulate qhprov slept_net;svy: tabulate hh_age_cat slept_net;

svy: tabulate hv219 slept_net;svy: tabulate qhtype  slept_net;svy: tabulate sroom_cat slept_netb;

svy: tabulate mother_educ slept_net;

**Survey logistic regression for malaria prevalence using malaria_positive **;

** xi is used when you have a predictor variable with more than two categories **;

xi:svy:logistic slept_netb malaria_positive ;xi:svy:logistic malaria_positive qh04;xi:svy:logistic
malaria_positive i.qh07; xi:svy:logistic malaria_positive i.qhwlthi;xi:svy:logistic malaria_positive
i.malaria_zone;xi:svy:logistic malaria_positive i.hh_age_cat;xi:svy:logistic malaria_positive
i.hv219;xi:svy:logistic malaria_positive i.mother_educ;xi:svy:logistic malaria_positive i.qhprov
;xi:svy:logistic malaria_positive i.sroom_cat;

**Adjusted survey regression**

xi: svy: logistic malaria_positive slept_net i.qh07;

xi:logistic malaria_positive i.qh07 qh04 i.qhwlthi i.malaria_zone i.hh_age_cat hv219 i.mother_educ
i.qhprov i.sroom_cat;
```

```
**Survey logistic regression for net use using slept_net **;

** xi is used when you have a predictor variable with more than two categories **;

xi:svy:logistic slept_netb malaria_positive xi:svy:logistic slept_net qh04;xi:svy:logistic slept_net i.qh07;

xi:svy:logistic slept_net i.qhwlthi;xi:svy:logistic slept_net i.malaria_zone;xi:svy:logistic slept_net
i.hh_age_cat;

xi:svy:logistic slept_net i.hv219;

xi:svy:logistic slept_net i.mother_educ;

xi:svy:logistic slept_net i.qhprov ;

xi:svy:logistic slept_net i.sroom_cat;

**Adjusted survey regression**

xi: svy: logistic slept_net i.qh07;

xi:logistic slept_net i.qh07 qh04 i.qhwlthi i.malaria_zone i.hh_age_cat hv219 i.mother_educ i.qhprov
i.sroom_cat;

** CONTINUE FROM HERE **;

** Saving the formatted Dataset **;

save "C:\Users\doctor\Desktop\sils\ Final 2010 KMIS ",replace;

** END OF FILE **;
```