EFFECTS OF INSECTICIDE TREATED BED NETS ON PREVALENCE OF MALARIA AMONG PREGNANT WOMEN IN BUMULA DIVISION OF BUNGOMA COUNTY, KENYA

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A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE (APPLIED MEDICAL PARASITOLOGY) IN THE SCHOOL OF PURE AND APPLIED SCIENCES OF KENYATTA UNIVERSITY

JANUARY, 2014
DECLARATION

Candidate

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

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To my wife Sarah and children Peter, Lynne, and Ian and to Almighty God be the glory for the many blessings and great things he has done including completing this study and even paying fees.
ACKNOWLEDGEMENTS

I realize that dissertation being a work of cooperation and assistance, it would be far from complete without due acknowledgement of the help gratefully received. It is my distinct honour and privilege to have worked under the able supervision of Prof. Elizabeth Kokwaro. Indeed, I am fortunate to get the benefit of her vast experience, valuable guidance and advise at every step of my research. With a deep sense of gratitude, I acknowledge the supervision rendered to me by my Lecturer Dr. Jenard P. Mbugi. His prudent and authoritative professional guidance helped me not only during this research work but also throughout proposal development.

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# TABLE OF CONTENTS

TITLE PAGE..........................................................................................................................i
DECLARATION .........................................................................................................................ii
DEDICATION ..........................................................................................................................iii
ACKNOWLEDGEMENTS .........................................................................................................iv
TABLE OF CONTENTS ...........................................................................................................v
LIST OF FIGURES ..................................................................................................................ix
LIST OF TABLES ....................................................................................................................x
DEFINITION OF OPERATIONAL TERMS ..........................................................................xi
LIST OF ABBREVIATIONS AND ACRONYMS .................................................................xiii
ABSTRACT ............................................................................................................................xiv

CHAPTER ONE .................................................................................................................... 1

1.0 INTRODUCTION.............................................................................................................. 1

  1.1 Background information ............................................................................................. 1

  1.2 Statement of the problem .......................................................................................... 3

  1.3 Research questions ................................................................................................... 4

  1.4 Objectives .................................................................................................................. 4

    1.4.1 General objective ................................................................................................. 4

    1.4.2 Specific objectives ............................................................................................... 5

  1.5 Null Hypotheses ......................................................................................................... 5

  1.6 Justification of the study ........................................................................................... 5

CHAPTER TWO .................................................................................................................... 7

2.0 LITERATURE REVIEW ................................................................................................... 7

  2.1 Public health importance of malaria ......................................................................... 7
2.2 Malaria transmission dynamics ................................................................. 8
2.3 Malaria vectors ......................................................................................... 10
   2.3.1 Life cycle of malaria vectors ............................................................ 10
   2.3.2 Patterns of malaria vector’s feeding and resting ................................. 11
   2.3.3 Malaria vector control ...................................................................... 12
2.4 Malaria parasites ....................................................................................... 13
   2.4.1 Lifecycle of malaria parasites ............................................................ 14
2.5 Susceptibility to malaria during pregnancy ............................................ 15
2.6 Consequences of malaria in pregnancy ................................................... 16
   2.6.1 Accumulation of parasites in the placenta ........................................... 18
2.7 Strategies to prevent malaria during pregnancy ....................................... 19
   2.7.1 Intermittent preventive treatment in pregnancy ................................ 20
   2.7.2 Insecticide-treated bed nets .............................................................. 21

CHAPTER THREE .......................................................................................... 25

3.0 MATERIALS AND METHODS ................................................................. 25
3.1 Study design ............................................................................................ 25
3.2 Study area and population ...................................................................... 25
3.3 Sample size .............................................................................................. Error! Bookmark not defined.
3.4 Data collection ......................................................................................... 28
   3.4.1 Parasitological tests for malaria parasites ....................................... 28
   3.4.2 Data management and analysis ....................................................... 30
3.5 Ethical considerations .............................................................................. 31

CHAPTER FOUR ........................................................................................... 32

4.0 RESULTS .................................................................................................. 32
4.1 Socio-demographic characteristics of the study subjects ....................... 32
4.1.1 Relationship between age of the respondents and malaria infection
4.1.2 Influence of education, occupation, age and village of residence on malaria infection
4.2 Relationship between parity and malaria infection
4.3 Relationship between gestation period and malaria infection
4.4 Net ownership by pregnant women
4.5 Category of nets owned by the pregnant women
4.5.1 Net ownership in different age groups
4.5.2 Relationship between net ownership and socio-demographic characteristics
4.5.3 Relationship between net ownership and malaria infection
4.5.4 Category of net owned and malaria infection
4.6 Conventional net retreatment
4.7 Relationship between number of times suffered from malaria and testing positive for malaria parasitaemia
4.8 Net acquisition by the respondents
4.8.1 Time of retiring to bed and malaria infection
4.8.2 Proper use of nets
4.8.3 Hindrances to net usage
4.9 Importance of owning ITNs
4.10 Reasons for not owning nets
4.11 Prevalence of malaria among pregnant women
4.12 Differences in malaria infection rates during rainy and dry seasons
4.13 Relationship between fever and malaria infection
CHAPTER FIVE ............................................................................................................. 55

5.0 DISCUSSION, CONCLUSIONS AND RECOMMENDATION ........ 55

5.1 Discussion ............................................................................................................. 55

5.2 Conclusions ......................................................................................................... 63

5.3 Recommendation ................................................................................................. 63

REFERENCES .............................................................................................................. 65

APPENDICES .............................................................................................................. 76

Appendix I: Consent form ......................................................................................... 76

Appendix II: Questionnaire ....................................................................................... 77

Appendix III - Research approval ............................................................................. 81
LIST OF FIGURES

Figure 3.1: A map showing the location of Bumula Division, Bungoma County ......................................................... 26

Figure 4.1: The percentages of respondents having positive parasitaemia among different age .......................................................... 34

Figure 4.2: Malaria infection rate in different parities ......................... 37

Figure 4.3: Malaria infection rate in different gestation periods ..................... 38

Figure 4.4: Malaria infection rate and net ownership ............................. 39

Figure 4.5: Categories of nets owned by respondents ........................................ 40

Figure 4.6: Percentage net ownership and age ........................................ 40

Figure 4.7: Relationship between net ownership and malaria infection .......... 44

Figure 4.8: Net retreatment against percentage respondents with positive parasitaemia ................................................................. 45

Figure 4.9: Percentage respondents having positive parasitaemia and the number of times the women had suffered from malaria ............... 46

Figure 4.10: Where the net was acquired from ........................................ 47

Figure 4.11: Category of net and source .................................................. 48

Figure 4.12: Regularity of tucking of nets by respondents .......................... 49

Figure 4.13: Hindrances to net ownership ................................................. 51

Figure 4.14: Malaria infections rate during rainy and dry seasons .................. 53

Figure 4.15: Relationship between body temperature and malaria infection ... 54
LIST OF TABLES

Table 4.1: Socio-demographic characteristics of the pregnant women ........33
Table 4.2: Percentage respondents with positive parasitaemia in different
levels of education .................................................................35
Table 4.3: Percentage respondents with positive parasitaemia in different
occupations ........................................................................35
Table 4.4: Probability value based on the influence of socio-demographic
factors on parasitaemia ..........................................................36
Table 4.5: Percentage net ownership among pregnant women ...............38
Table 4.6: Net ownership by the women from various villages ...............41
Table 4.7: Relationship of net ownership with marital status, level of education
and occupation ........................................................................43
Table 4.8: Category of net owned and the presence of parasitaemia ..........45
Table 4.9: Malaria infection rate and the time of retiring to bed ...............49
Table 4.10: Prevalence of malaria among pregnant women ......................52
DEFINITION OF OPERATIONAL TERMS

Anaemia in pregnancy – A pregnant woman whose haemoglobin concentration falls below 100g/l.

Conventional net – A net that has to be retreated after every six months.

Disease – All illness affecting living organism often caused by pathogens.

Gravidity – The state of being pregnant.

Insecticide Treated Net (ITNs) – A insecticide treated net that lasts 3 years before treatment.

Low birth weight – A new born weighing 2500g or less at birth.

Malaria control – Reducing malaria morbidity and mortality to a locally acceptable level through deliberate efforts using the preventive and curative tools available.

Malaria parasitaemia – Asexual blood stage of malaria parasite of any type of *plasmodium* species detected on a thick and thin blood smear.

Morbidity – The rate of incidence of a disease.

Mortality – The proportion of deaths due to a disease in a population.

Parasitaemia – The presence of parasites especially malarial forms in blood.

Parity – The number of pregnancies, complete or incomplete experienced by a woman.

Pre-term delivery – A baby born at less than 37 weeks’ gestation.

Prevalence – It is the number of malaria cases in the population at a given time divided by the population at that time, expressed per 1,000.

Primagravidae – A woman who is pregnant for the first time.

Secundigravidae – A woman who is pregnant for the second time.
Multi-gravidae – A woman who is pregnant and has been pregnant at least twice before.

Perinatal death - Death of an infant between birth and the end of the neonatal period
## LIST OF ABBREVIATIONS AND ACRONYMS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ACT</td>
<td>Artemisinin Combination Therapy</td>
</tr>
<tr>
<td>ANC</td>
<td>Ante Natal Clinic</td>
</tr>
<tr>
<td>BDHMT</td>
<td>Bungoma District Health Management Team</td>
</tr>
<tr>
<td>CDC</td>
<td>Centre for Disease Control</td>
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<tr>
<td>CQ</td>
<td>Chloroquine</td>
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<tr>
<td>DoMC</td>
<td>Division of Malaria Control</td>
</tr>
<tr>
<td>FGR</td>
<td>Fetal Growth Restriction</td>
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<tr>
<td>IPTp</td>
<td>Intermittent Presumptive Treatment in pregnancy</td>
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<tr>
<td>IRS</td>
<td>Indoor Residual Spraying</td>
</tr>
<tr>
<td>ITNs</td>
<td>Insecticide Treated Mosquito Nets</td>
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<tr>
<td>IUGR</td>
<td>Intraterine Growth Restriction</td>
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<tr>
<td>LBW</td>
<td>Low Birth Weight</td>
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<tr>
<td>MIS</td>
<td>Malaria Indicator Survey</td>
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<tr>
<td>MoPHS</td>
<td>Ministry of Public Health and Sanitation</td>
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<tr>
<td>PSI</td>
<td>Population Service International</td>
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<tr>
<td>RBM</td>
<td>Roll Back Malaria</td>
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<tr>
<td>SP</td>
<td>Sulphadoxine Pyrimethamine</td>
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<td>WHO</td>
<td>World Health Organization</td>
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ABSTRACT

Insecticide-treated nets (ITNs) for personal protection against mosquito bites have proven to be practical, highly effective, and cost effective intervention against malaria infection. Bungoma South District records malaria as the most frequently diagnosed condition in outpatients at health facilities and is the principal cause of death at the district hospital. Despite the report that ITNs have high impact on reduction of vectors of malaria, sporozoite rates, morbidity and mortality in pregnancy, there are known barriers to bed net ownership and use during pregnancy. The main objective of the study was to determine the prevalence of malaria, establish factors associated with ITN use and the level of adherence to ITN use by pregnant women during different seasons in Bumula Division, of Bungoma County. This research work adopted a longitudinal study design and was conducted at Bumula sub-District hospital. The sample size was 228 pregnant women attending antenatal clinic at the hospital. Data on net ownership verses usage, parity, and socio-economic background was collected using a structured questionnaire. Parasitological tests for malaria parasites were carried out using peripheral blood samples obtained from finger pricks of the pregnant women. Field’s stain was used for microscopic determination of malaria parasites. Relationship between net ownership and malaria infection rates was determined using a Chi-square test. A t-test was used to show the difference in infection rates during the rainy and dry season among pregnant women. Interaction between age and village of residence significantly determined malaria infection rates (P< 0.05). There was significantly higher level of long-lasting net ownership in the sampled population (P< 0.05). In the study population, 60.5% of pregnant women possessed nets and had significantly less malaria infection rates than those who did not own nets, (P < 0.05). The highest percentage of the women acquired bed nets from the antenatal clinic (80.9%). Malaria infection rates were significantly higher during the rainy season than in the dry season (P < 0.05). Among the population that possessed nets 89.9% adhered to sleeping under them while 16.9% of them experienced problems of sweating and hotness. The findings indicate that increased access to insecticide treated nets is required to lower the risk of pregnant women being infected with malaria. The Bungoma county Government should carry out free ITNs distribution campaigns during the rainy season and enhance health education to families within the villages to destroy breeding and hiding habitats of mosquitoes during the rainy season.
CHAPTER ONE

1.0 INTRODUCTION

1.1 Background information

Malaria is widespread in the tropical and sub-tropical regions of the world, with 107 countries and territories having areas at risk of transmission containing close to 50% of the world’s population (Hay et al., 2004). The global malaria burden is not evenly distributed and sub-Saharan Africa accounts for 90% of global malaria cases (WHO, 2002). Estimates of the global *Plasmodium* morbidity burden have increased in number to 515 million cases, with Africa suffering the vast majority of this fold (Snow et al., 2005).

Malaria adversely impacts on maternal health where each year, 25-30 million women become pregnant in malaria – endemic areas of Africa (Rogerson et al., 2007). The disease causes severe anaemia in pregnant women, and due to this an estimated 10,000 maternal deaths are reported. In addition, it has been reported that malaria leads to 75,000-200,000, low birth weight babies due to combination of pre-term delivery and foetal growth restriction each year (Rogerson et al., 2007). It is estimated that 6% of infant deaths could be attributed to malaria associated with low birth weight in endemic areas (Guyatt et al., 2000).

Malaria arises from an infection by any of the five species of the genus *Plasmodium* namely; *Plasmodium falciparum, Plasmodium malariae, Plasmodium ovale, Plasmodium vivax* and *Plasmodium knowlesi*. Apart from anaemia the parasites cause a variety of adverse consequences that include;
accumulation of parasites in the placenta, foetal parasites exposure, congenital infection, infant anaemia, infant morbidity and mortality as well as maternal death (Meshnick, 2007). The parasite is transmitted to humans through a bite of an infected female mosquito of the genus Anopheles (Lindsay et al., 1996; WHO/RBM, 2000).

Malaria is endemic in the Bungoma District of Western Kenya, transmission occurs throughout the year with two seasonal peaks reflecting the rainfall pattern (Ter Kuile et al, 2003). The disease is the most diagnosed in outpatient health facilities within the District and the principal cause of death at the District hospital (Bungoma District Health Management Team, 2000).

The World Health Organization (WHO) advocates a three-pronged approach to malaria control in pregnancy that includes the use of insecticide-treated bed nets (ITNs), intermittent preventive treatment (IPT), and case management (WHO, 2004). Protective bed nets treated with long-lasting insecticides prevent bites from malaria-infected mosquitoes and kill the vectors. Sleeping under ITNs can reduce the risk of a pregnant woman being infected with malaria thus lowering the risk of maternal related anaemia and low birth weight (Ter Kuile et al., 2003). The Roll Back Malaria initiative by African heads of state was to ensure 60% of the population at risk of malaria namely pregnant women and children under 5 years were using ITNs (WHO/RBM, 2000). Protection from malaria using ITNs during pregnancy is a widely advocated practice but evidence of benefits has been inconsistent
Meanwhile reports of changing disease risk have been limited to observations from selective sites, thus limiting generalisation and reports at country levels ignoring the heterogeneity within population (O’meara et al., 2007). To date, no studies have addressed the intervention of ITNs on the prevalence of malaria in pregnancy or whether changes in malaria incidence have occurred that might be related to ITNs use among pregnant women in Bumula Division.

1.2 Statement of the problem

According to reports by Steketee, (1996) malaria infections are very high in the first and second pregnancies and lower in the subsequent pregnancies due to poorly developed immunity. Furthermore, a report by Division of Malaria Control et al., (2009) indicated that malaria is responsible for 30% of outpatient consultations, 19% of hospital admission and 3-5 % of inpatient deaths in Kenya. In areas of high malaria transmission such as Western Kenya pregnant women may receive as many as 230 infective bites during their 40 weeks of gestation (Ter Kuile et al., 2003). In Bungoma district, malaria prevalence rate across all ages is upto 75%, and accounts for 39% of outpatients’ morbidity and 42% of inpatient morbidity while inpatient mortality of 36% is directly caused by malaria (Bungoma Health Management Team, 2000). Effects of malaria in pregnancy can be maternal anaemia, stillbirth, low birth weight, or even neonatal death (WHO, 2006). Despite the report that ITNs have high impact on reduction of malaria vector densities, sporozoite rates, morbidity and mortality in pregnant women, there are known
barriers to bed net ownership and use during pregnancy (Opiyo et al., 2007; Ter Kuile et al., 2003). In line with WHO recommendation for protection of malaria in pregnancy, MoPHS in Kenya adapted the treatment of clinical malaria, use of ITNs and Intermittent Preventive Treatment (IPT) to reduce the burden of malaria in pregnancy (WHO, 2004; DoMC et al., 2009). The study investigated effects of insecticide treated bed nets on prevalence of malaria among pregnant women in Bumula Division.

1.3 Research questions

i. How does the use of ITNs during pregnancy affect the prevalence of malaria during different seasons in Bumula Division of Bungoma County?

ii. What is the level of adherence to the use of ITNs by pregnant women attending antenatal clinic (ANC) in Bumula Division of Bungoma County?

iii. What factors are associated with use of ITNs by pregnant women in Bumula Division of Bungoma County?

1.4 Objectives

1.4.1 General objective

To investigate the effects of ITNs on the prevalence of malaria among pregnant women ITNs in Bumula Division, Bungoma County.
1.4.2 Specific objectives

i. To determine the prevalence of malaria among pregnant women using ITNs with respect to seasons in Bumula Division of Bungoma County.

ii. To establish the level of adherence to ITN usage by pregnant women attending antenatal clinic in Bumula Division of Bungoma County.

iii. To determine factors associated with use of ITNs by pregnant women in Bumula Division of Bungoma County.

1.5 Null Hypotheses

i. The use of ITNs during pregnancy does not affect prevalence of malaria during different seasons in Bumula Division of Bungoma County.

ii. There is no adherence to the use of ITNs by pregnant women attending ANC in Bumula Division of Bungoma County.

iii. There are no factors associated with the use of ITNs by pregnant women in Bumula Division of Bungoma County.

1.6 Justification of the study

In many areas where malaria is a problem, mosquitoes are found throughout the year with density peaks coinciding with rainy season. The Ministry of Public Health and Sanitation is rapidly increasing insecticide-treated net coverage in Kenya to combat malaria in pregnancy, but systematic data on the use of those ITNs and the factors affecting their use are scarce. It is therefore important to understand the effect of seasonal changes and use of ITNs on
malaria prevalence among pregnant women. Since Bumula Sub-district hospital attends to an average of 30 pregnant women in a week there was a need to investigate ITN use and factors associated to their use by pregnant women. This study was conducted to examine the effect of ITNs on the prevalence of malaria among pregnant women attending antenatal care at the Sub-district hospital and whether women who slept under ITNs actually suffered less from malaria.
CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Public health importance of malaria

Malaria is a severe vector-borne parasitic disease of humans, with 107 countries having areas at risk of transmission containing close to 50% of the world’s population (WHO, 2003). The global figure of deaths from malaria is nearly one million per year, most of which are children under 5 years of age and pregnant women (Snow et al., 2005). It is the most frequently diagnosed disease at outpatient clinics and hospitals in Africa (Joel et al., 2004). Warming climates could push malaria transmission to higher altitudes, resulting in more frequent epidemics among populations with little recent exposure to the disease (Lindsay et al., 1996). In East African highlands; the threat is mounting as malaria outbreaks become more frequent in areas where malaria was previously rare (Malakooti et al., 1998).

Malaria is among the leading cause of death in Kenya with over 70% of Kenya’s population or over 22 million people at risk of malaria, 75% of whom live in rural areas (Population Service International, 2006). Furthermore, clinically diagnosed malaria has remained constant over the past twelve years, averaging 30% of all outpatient visits, 15% of hospital admissions and 3-5% of inpatient deaths (MoPHS, 2008). According to a report by Bungoma District Health Management Team, (2000), malaria is the common presenting complaint at Health facilities in the district and accounts for nearly 30% of patient’s visits and 20% of inpatient admissions annually.
Each year approximately 25-30 million women become pregnant in malaria endemic areas of Africa (Steketee et al., 2005; WHO/Unicef, 2003). Pregnancy lowers cell-mediated immunity and causes immunosuppression. The prima-gravidae, are especially vulnerable to malaria and are more likely to have *Plasmodium falciparum* infection than non-pregnant women (Brabin, 1983). In Western Kenya CDC and KEMRI reported that pregnant women could receive as many as 230 infective bites during their 40 weeks of gestation (Ter Kuile et al., 2003).

2.2 Malaria transmission dynamics

The overwhelming global burden of malaria is focused primarily in the tropics and particularly in Africa because of clearly identified environmental risk factors that favour transmission of *Plasmodium* parasites. The stability and intensity of malaria transmission in any given area is largely determined by climate, hydrology and local mosquito ecology (Killeen et al., 2000). Malaria transmission is much more difficult to control in Africa than most other places because poverty and insufficient health infrastructure allow chronic *Plasmodium falciparum* infections to survive undisturbed in human hosts until they are transmitted by long-lived and anthropophilic vectors that are the most efficient in the world (Killeen *et al.*, 2000). Untreated and drug resistant malaria infections can persist in humans for months or years, and African mosquito vectors such as *Anopheles gambiae*, *Anopheles arabiensis* and *Anopheles funestus* can pick up the parasites and pass them onto another victim (Beier *et al.*, 1999). Thus stable endemic malaria can manifest itself in
Africa where people are exposed to not less than one mosquito bite per week and transmission is undetectable (Beier et al., 1999).

Malaria risk is inequitably distributed, not only at global and regional levels but also at household level because poor housing, education and access to healthcare services cause a vicious cycle between increased exposure, reduced ability to pay for treatment, intensified household cost and back again (Lindsay et al., 2002). Furthermore, malaria transmission is often facilitated in Sub-Saharan Africa because of environmental degradation; poor drainage and clearing of vegetation. These promote the proliferation of mosquito species such as An. gambiae which propagates itself in small, sunlit, transient water bodies, notably artificial habitats associated with human activities (Minakawa et al., 2002).

Malaria, poverty and environmental change are inextricably linked and remain closely associated across most of Africa today. Although a variety of new drugs and vaccines for malaria will become available in the future, most of these remain years away from realization and will not be sufficient to break the transmission cycle in most African settings (Killeen et al., 2000). This is because Sub-Saharan Africa is home to the world’s most efficient malaria vectors where transmission levels are hundreds or thousands of times higher than the threshold required to maintain endemicity (Beier et al., 1999). Methods used to prevent the spread of disease, or to protect individuals in areas where malaria is endemic, include prophylactic drugs, mosquito
eradication, and the prevention of mosquito bites by use of ITNs and application of insect repellants. The continued existence of malaria in an area requires a combination of high human population density, high mosquito population density, and high rates of transmission from humans to mosquitoes and from mosquitoes to humans (Joel et al., 2004).

2.3 Malaria vectors

Sixty out of 400 known species of Anopheline mosquitoes have been proved as vectors of human malaria (Coetzee, 2004). *Anopheles gambiae* and *An. funestus* complexes are the principal vectors of malaria in Africa (Coetzee, 2004). The *An. gambiae* complex comprises of six species namely *An. gambiae*, *An. arabiensis*, *Anopheles merus* Donitze, *Anopheles melas* Theobald, *Anopheles quadrannulatus* Theobald and *Anopheles bwambae* white (Coetzee, 2004). *Anopheles gambiae* and *An. arabiensis* are found almost throughout Kenya (Minakawa et al., 2002) where *An. gambiae* complex and *An. funestus* are the major malaria vectors.

2.3.1 Life cycle of malaria vectors

Like all flies, mosquitoes go through four stages in their lifecycles: egg, larva, pupa, and adult. In most species, adult females lay their eggs in stagnant water; some lay eggs near the water's edge; others attach their eggs to aquatic plants. Each species selects the situation of the water into which it lays its eggs and does so according to its own ecological adaptations (Spielman, et al., 2001). Such differences are important because certain ecological preferences
keep mosquitoes away from most humans, whereas other preferences bring them right into houses at night (Spielman, et al., 2001).

The first three stages—egg, larva, and pupa—are largely aquatic. These stages typically last five to 14 days, depending on the species and the ambient temperature, but there are important exceptions (Huang, et al., 2006). Mosquitoes living in regions where some seasons are freezing or waterless spend part of the year in diapauses; they delay their development, typically for months, and carry on with life only when there is enough water or warmth for the eggs to hatch and become larvae, which grow until they are able to change into pupae (Michigan Mosquito Control Organization, 2013). The adult mosquito emerges from the mature pupa as it floats at the water surface. Bloodsucking mosquitoes, depending on species, gender, and weather conditions, have potential adult lifespan ranging from as short as a week to as long as several months (Michigan Mosquito Control Organization, 2013).

2.3.2 Patterns of malaria vector’s feeding and resting

Female mosquitoes can feed on animals and humans blood. Most species show a preference for certain animals or for humans (Takken et al., 2013). They are attracted by the body odours, carbon dioxide and heat emitted from the animal or person (Takken et al., 2013). Most Anopheline mosquitoes bite at night. Some species bite just after sunset while others bite later, around midnight or in the early morning (Kawada et al., 2012). Those that bite in the early evening may be more difficult to avoid than species that feed at night. Some
species prefer to feed in forests, some outside houses and others indoors. Mosquitoes that enter a house usually rest on a wall, under furniture or on clothes hanging in the house (Lyimo et al., 2009). Mosquitoes that bite outside usually rest on plants, in holes, on trees, or on the ground, or in other cool dark places (Kawada et al., 2012). Adult females can live between 20 days and one month. The average survival is much shorter at 6 – 9 days. The average life-span of the female has direct relevance to its efficiency as a malaria vector, because it has to live long enough for the parasite to complete its life cycle approximately ten days (Kiswewski et al., 2004). On average, the flight range of adult *Anopheles* is between a few hundred metres and 2 kilometres. Therefore water collections very close to houses are more important sources of vectors than those located far away from houses (Kiswewski et al., 2004).

2.3.3 Malaria vector control

Vector control refers to methods used to decrease malaria by reducing the levels of transmission. For individual protection, the most effective insect repellents are based on DEET or picaridin (Kajfasz, 2009). Insecticide-treated mosquito nets (ITNs) and indoor residual spraying (IRS) have been shown to be highly effective in preventing malaria among pregnant women in areas where malaria is common (Lengeler, 2004).

Indoor residual spraying is the practice of spraying insecticides on the interior walls of homes in malaria-affected areas. After feeding, many mosquito species rest on a nearby surface while digesting the blood meal, so if the walls
of houses have been coated with insecticides, the resting mosquitoes can be killed before they can bite another person and transfer the malaria parasite (Enayati et al., 2010) As of 2006, the World Health Organization recommends 12 insecticides in indoor residual spraying operations, including DDT and the pyrethroids cyfluthrin and deltamethrin (WHO, 2006). This public health use of small amounts of DDT is permitted under the Stockholm Convention on Persistent Organic Pollutants, which prohibits its agricultural use (Van-den, 2009). One problem with all forms of indoor residual spraying is insecticide resistance. Mosquitoes affected by this method tend to rest and live indoors, and due to the irritation caused by spraying, their descendants tend to rest and live outdoors, meaning that they are less affected by the indoor residual spraying (Pate, et al., 2005). Efforts to decrease mosquito larva via decreasing the availability of open water in which they develop or by adding substances to decrease their development has been effective (Tusting et al., 2007). Electronic mosquito repellent devices which make very high frequency sounds that are supposed to keep female mosquitoes away do not have supporting evidence (Enayati et al., 2007).

2.4 Malaria parasites

Malaria parasites belong to the genus *Plasmodium* (Phylum Apicomplexa). In humans malaria is caused by *P. falciparum*, *P. malariae*, *P. ovale*, *P. vivax* and *P. knowlesi*. Of these *P. falciparum* is the most common cause of infection and is responsible for about 80% of all malaria cases in Western Kenya, and is also responsible for about 90% of the deaths from malaria in
Western Kenya (Snow et al., 2005). Parasitic *Plasmodium* species also infect birds, reptiles, monkeys, chimpanzees and rodents.

**2.4.1 Lifecycle of malaria parasites**

The parasite's secondary (intermediate) hosts are humans and other vertebrates. Female mosquitoes of the *Anopheles* genus are primary hosts and transmission vectors (Schlagenhauf-Lawlor, 2008). The mosquito first ingests the malaria parasite by feeding on an infected human carrier and the infected *Anopheles* mosquitoes carry *Plasmodium* sporozoites in their salivary glands (Francis et al., 2010). Once ingested, the parasite gametocytes taken up in the blood will further differentiate into male or female gametes and then fuse in the mosquito's gut. This produces an ookinete that penetrates the gut lining and produces an oocyst in the gut wall. When the oocyst ruptures, it releases sporozoites that migrate through the mosquito's body to the salivary glands, where they are then ready to infect a new human host (Vaughan et al., 2008). This type of transmission is occasionally referred to as anterior station transfer (Talman, et al., 2004).

The sporozoites are injected into the skin, alongside saliva, when the mosquito takes a subsequent blood meal. Malaria parasites in the mosquito's saliva enter the bloodstream and migrate to the person’s liver (Vaughan et al., 2008). Within 30 minutes of being introduced into the human body, they infect liver cells, multiplying in the liver cells for a period of 6–15 days. In the process they become thousands of parasites which, following rupture of the liver cells,
escape into the blood and infect red blood cells, thus beginning the red blood cell stage of its life cycle (Crowman et al., 2012).

Within the red blood cells, the parasites multiply further, periodically breaking out of their host cells to invade fresh red blood cells. Several replication cycles occur. The pathology and clinical manifestations associated with malaria are almost exclusively due to the red blood cell stage parasites (Crowman et al., 2012). The blood stage parasites are those that cause the symptoms of malaria (Bledsoe et al., 2005). When certain forms of blood stage parasites, called gametocytes, are picked up by a female Anopheles mosquito during a blood meal, they start another, different cycle of growth and multiplication in the mosquito (Crowman et al., 2012). Only female mosquitoes feed on blood while male mosquitoes feed on plant nectar (Talman, et al., 2004) thus males do not transmit the disease. The females Anopheles mosquito prefer to feed at night. They usually start searching for a meal at dusk, and will continue throughout the night until taking a meal.

2.5 Susceptibility to malaria during pregnancy

Malaria is dangerous to both the mother and foetus. Pregnant women are at greater risk of malaria infection and of symptomatic malaria disease than non-pregnant ones (Brabin, 1983), because the former are more attractive to mosquitoes (Lindsay et al., 2000). Parasite densities are higher in pregnant women than non-pregnant ones. In two studies, conducted among women residing in Yaoundé Cameroon and pregnant women attending antenatal clinic
in Idah and Igala local government areas of Kogi state, Nigeria, complexity of infections did not differ (Walker-Abbey et al., 2005; Saute et al., 2002) whereas a third study conducted in rural Mozambique to establish the prevalence of malaria parasitemia and anaemia among pregnant women showed an increase in young pregnant women (Schleiermacher et al., 2001). Together these studies suggest that the ability to limit parasite replication is impaired in pregnancy hence a relative decline to immunity (Sowunmi et al., 2003).

Pregnancy during prima-gravidae and secundi-gravidae, are especially vulnerable to malaria and are likely to have *P. falciparum* infection than non-pregnant women (Brabin, 1983). Even though it is most frequent within the first pregnancy (Brabin, et al., 2001), peaking between 13 and 16 weeks (Brabin, 1983). Young pregnant women have been found to be more susceptible to malaria (Rogerson, et al., 2000), whereas adolescents and young adult women are more commonly parasitemic than older adults (Trape, 1996). HIV infection increases susceptibility to malaria, resulting in more prevalent and higher-density infection, and a relative loss of gravidity-dependent immunity (Ter Kuile, et al., 2004).

### 2.6 Consequences of malaria in pregnancy

About 50 million women in malaria endemic areas become pregnant each year (WHO/UNICEF, 2003). Malaria infection during pregnancy is a major public health problem in Sub-Saharan Africa. It is estimated to account for
400,000 cases of severe anaemia in pregnant women and an estimated 10,000 maternal deaths each year (Guyatt et al., 2001). The disease is responsible for 35% preventable low birth weight and 3-8% of infant mortality (Steketee et al., 2001; Guyatt et al., 2001). Maternal anaemia and low birth weight are important risk factors for neonatal and infant mortality (Brabin, 1983; Steketee et al., 2001). It has been estimated that 6% infant death could be attributed to malaria associated low birth weight in endemic areas (McCormick, 1998; Guyatt et al., 2002). In high transmission areas, malaria is associated with increased incidences of maternal anaemia potentially responsible for maternal deaths, spontaneous abortion, pre-term labour, foetal distress, congenital infections, foetal death in-utero, still births, low birth weight (LBW) due to both placental parasitemia, severe anaemia and intrauterine growth restriction (IUGR) (Steketee et al., 1996). Low birth weight is a high risk factor for perinatal death and it is also correlated to morbidity and mortality during infancy (Bloland et al., 1996).

In areas where malaria transmission rates are low, maternal disease is often severe due to lack of pre-existing immunity (Duffy et al., 2005). Non-immune pregnant women appear to be at a higher risk of cerebral malaria and pulmonary oedema than other adults hence experience increased risk for abortion and stillbirth (Nosten et al., 1999). Malaria consequences are particularly deleterious in women co-infected with HIV, as they have more frequently clinical and placental malaria, more detectable malaria parasitemia and higher malaria parasite densities (Ter Kuile et al., 2004). Infection with
HIV-1 causes progressive cellular immunosuppression, and any resulting impairment in the immune response to malaria might be associated with failure to prevent infection or to suppress parasitemia and clinical disease (Good et al., 1999). Meanwhile at all gravidities they have increased risk (Ter Kuile et al., 2004). Malaria during pregnancy may also influence the development of malarial immunity during the first years of life. The report by Hesran et al., (1997), indicated that infants born from malaria placenta-infected mothers were shown to be more susceptible to develop malaria infection between four and six months of life, compared to those born from non-infected mothers. Similar results were reported in a malaria-endemic area of Malawi (Mutabingwa et al., 2005). The study suggested that offspring of placental-infected multi-gravid women had the highest risk of parasitemia during the first years of life compared to children of primi-gravidae or placental non-infected women.

Approximately 1.5 million women become pregnant each year in Kenya, and upto 70% live in areas of moderate to intense transmission of malaria. The disease contributes about 2-15% of severe anaemia and 8-14% of low birth weight in Kenya, whereas studies in malaria endemic areas estimated that 19% of LBW and 6% of neonatal deaths are due to malaria (DoMC et al., 2009).

2.6.1 Accumulation of parasites in the placenta.

In areas of stable transmission, the placenta is a protected site for parasite sequestration and growth (Krause et al., 1987). Malaria parasites in the
placenta damage placental integrity and interfere with placenta to transport nutrients and oxygen to the foetus, thereby causing intrauterine growth retardation, a factor responsible for low birth weights (Rogerson et al., 2003). Another reason for low birth weight is severe maternal anaemia caused by malaria infection (Steketee et al., 1996).

*Plasmodium falciparum* causes three specific changes in the placenta. Firstly, infected erythrocytes containing mature trophozoite and schizont parasite stages accumulate in the intervillous space sometimes due to high densities (Brabin et al., 2004). This high placental parasitemia has been associated with Pre-term Delivery (Menendez et al., 2000). Secondly, placental malaria may be accompanied by intervillous infiltrates of monocytes and macrophages, some containing malaria pigments (hemozoin). Thirdly, high density monocyte infiltrates are especially common in first pregnancy, and are associated with LBW and anaemia, while hemozoin has been associated with decreased birth weight (Rogerson et al., 2003). Malaria in early pregnancy, acting locally in the placenta or as a systemic illness, could disrupt the process of placentation and spiral artery remodelling, which continue until 20 weeks gestation (Lala et al., 2003). If this process of placentation is impaired, may lead to inadequate blood flow later in pregnancy leading to pre-term delivery (Dorman et al., 2002).

**2.7 Strategies to prevent malaria during pregnancy**

Despite the effects that malaria exerts on pregnant women and their infants, this was neglected problem, with less than 5% of pregnant women having
access to effective intervention. However, during the past decade, potentially more effective strategies for prevention and control of malaria in pregnancy have been developed and demonstrated to have a remarkable impact on improving the health of mothers and infants (Pettifor et al., 2008). The Kenyan Government recognizes malaria as a health and socio-economic burden, whose control is considered a priority investment necessary for the realization of Kenya’s vision 2030 (MoPHS, 2008). The World Health Organization recommendations for controlling malaria in pregnancy include preventive chemotherapy (Intermittent preventive treatment in pregnancy), case management of clinical malaria and use of ITNs (WHO, 2004).

2.7.1 Intermittent preventive treatment in pregnancy

In Africa, the first malaria preventive strategies were implemented in the 1950s; they consisted in weekly or bi-monthly chemoprophylaxis with chloroquine (Schultz et al., 1994). A large number of trials demonstrated the efficacy of such a chemoprophylaxis in preventing LBW, maternal anaemia and placental malaria infection (Garner et al., 2006). However, the growing resistance of malaria parasites to these drugs and the poor compliance of the women with the treatment the strategies finally showed a low efficacy (Parise et al 1998). In 1998 it was proposed, then finally implemented in 2004, that chemoprophylaxis should no longer be recommended, but replaced by intermittent preventive treatment (IPT) for all pregnant women living in areas of stable malaria transmission (WHO, 2003). Intermittent Preventive Treatment in pregnancy involves providing all pregnant mothers with
sulfadoxine-pyrimethamine with each scheduled visit and should be given at an interval of at least four weeks (MOPHS, 2010). Administration of Sulphadoxine-pyrimethamine against malaria in pregnancy in areas of high or seasonal malaria transmission has been shown to increase both maternal haemoglobin levels and the infant’s birth weight (Schultz et al., 1994; Paraise et al., 2000; Rogerson et al., 2000; Van Eijk et al., 2004). Sulphadoxine-pyrimethamine is the drug currently recommended by the WHO because of its safety and efficacy in pregnancy (WHO, 2004). Several studies have shown the high efficacy of IPT with SP, compared to placebo or chloroquine (CQ) prophylaxis, on placental infection, low birth weight newborns and severe maternal anaemia (Shultz et al., 1994; Shulman et al., 1999; Njagi et al., 2003; Van Eijk et al., 2004).

**2.7.2 Insecticide-treated bed nets**

Whereas IPT is effective in treatment of existing infection and as prophylaxis by limiting the development of infection for an interval of time in pregnancy (WHO, 2004), Insecticide-treated nets act as effective barriers against mosquito bites hence preventing transmission of *Plasmodium falciparum*. Lack of malaria vaccine and resistance of the parasite to convectional antimalarial drugs is developing rapidly leaving vector control an important option in reducing malaria transmission in developing countries (Killeen et al., 2003; Killeen et al., 2004). Insecticide-treated nets have four unique qualities, an excito-repellency property which excites mosquitoes from entering a room, and killing effect which reduces the number of mosquitoes. Finally it inhibits
the mosquitoes from feeding, making it impossible for them to feed on human
blood (Line et al., 2000). Scaling up of insecticide impregnated bed nets is
one of the major aims of the WHO Roll Back Malaria initiative (WHO, 2006),
whose objective was to have 80% of pregnant women and children under 5
years covered by ITNs by year 2010 (WHO/RBM, 2000). Kenya’s Insecticide
treated nets coverage after the 2006 mass campaign indicated that 52% of
children under five years and 58% of pregnant women had ITNs. However,
findings by Malaria Indicator Survey (MIS) show that there is a gap between
ownership and utilization of ITNs (DoMC et al., 2009).

Several studies have demonstrated the efficacy of ITNs with an overall
reduction in all-cause mortality by 19% (Binka et al., 1996). The cost-
effectiveness of ITNs relative to other forms of malaria prevention and
treatment has been widely reported (Picard et al., 1993). Despite their clearly
demonstrated effectiveness, the current rates of net coverage remain
disappointingly low in many African countries, especially among the poorest
households (WHO and UNICEF, 2003). When used properly, intact ITNs
provide almost complete protection from mosquito bites hence ITNs can
reduce the risk of a pregnant woman being infected with malaria and reduce
the risk of maternal anaemia and low birth weight (Ter Kuile et al., 2003).
Their use was found to be equivalent to the long term prophylactic use of
antimalarials (Nevill et al., 1998). Pregnant women have been specifically
designated as a high risk group and African leaders called for 60% of children
and pregnant women to be protected by effective personal protection (largely ITNs) in Africa by the year 2005 (Marchant et al., 2002).

A study conducted in Rarieda Western Kenya, beginning in 1997 showed a large community randomized trial of ITNs. The study reported that the impact of malaria transmission was reduced by 90% (Howard et al., 2003). Even though information on the impact of ITNs from randomized control trials in areas of intense perennial malaria transmission are limited (Gamble et al., 2007). Equally there have been many challenges to ITN distribution, acceptance and utilization when trying to implement large scale ITN programmes (D’Alessandro et al., 1995). Insecticides commonly used are synthetic pyrethroids (permethrin, alphacypermethrin, and deltamethrin), because of their low toxicity to humans, rapid action, excito-repellent effect, long residual effects and safety (Line et al., 2000). The repellency effect allows old torn nets to remain relatively effective (WHO/UNICEF, 2003). In Kenya a national programme run by Population Service International (PSI) introduced million of Insecticide treated bed nets, some sold at heavily subsidized prices and some distributed free of charge, began in 2004, distributing nets in 46 out of 70 districts (PSI, 2006).

Population Service International malaria control programs include delivery of insecticide treated mosquito nets, pre-packaged malaria treatment, behaviour change communications, and operational research (PSI, 2006). There is also an active commercial market for bed nets in Kenya, with an estimated 200,000
new nets traded through the retail sector every year (Lines and Shretta, 2000).

In spite of the widespread distribution of ITNs by PSI and other channels there are few descriptions of changing disease burden and the few reports available are from isolated single site observations (Butler, 2007).
CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study design

The study design was a hospital based longitudinal study, where pregnant women reporting for ANC were recruited to participate in the study. The research work was conducted during the short rainy season from August – October and dry season November-December 2010. Mosquito populations may be small just before rainy season and during dry season but they are still infectious (Yohannes et al., 2000).

3.2 Study area and population

The study was conducted at the Bumula Sub-District hospital in Bumula division of Bungoma south District of Western Province (Fig 3.1). The Division covers about 347.7 km$^2$. It has a population of 178,897 of which about 92,669 are females and 86,228 are males (Government of Kenya National Bureau of Statistics, 2010). The Division receives rainfall which varies between 1200 to 2000mm per annum. It’s received in two seasons, from March to June and August - October, Moreover the Division also experiences two dry seasons from January-March and November-December. The annual temperature ranges from 24°C - 31°C, and the average humidity is greater than 80%. The elevation varies between 1100 and 3000 metres above sea level. The area is inhabited mostly by the Bukusu, Bantu, Lubukusu-speaking people. Members are peasant farmers growing food crops for subsistence and limited animal husbandry (Government of Kenya National Bureau of Statistics, 2010).
Figure 3.1: A map showing the location of Bumula Division, Bungoma County

3.3 Sample size

The appropriate sample size for a population based cross-sectional study was determined largely by three factors; estimated prevalence of the variable of interest – (prevalence of malaria), the desired level of confidence and the acceptable margin of error. Based on simple random sampling, the sample size required was calculated according to a formula developed by Cohran (1963) as described by Israel Glenn on 7th April (2010).

\[ n = \frac{Z^2pq}{e^2} \]

Where:

- \( n \) = desired sample size.
- \( Z \) = standard normal deviate (1.96 for a 95% confidence level).
- \( p \) = Prevalence of malaria in Bungoma district 75%.
- \( q \) = 1-\( p \) (proportion in the population that does not have the characteristics being measured).
- \( e \) = desired level of precision 0.05

\[ n = 1.96^2 * 0.75 * 0.25 / 0.05^2 = 288 \]

The study involved 228 a target population of less than 10,000; hence \( n \) was adjusted as shown below

\[ nf = \frac{n}{1 + \frac{(n - 1)}{N}} \]

\( N \) = population size of expectant women expected to attend Ante-natal care during the study period (Estimated from the past 3 year ANC attendance).

\( n \) = desired sample size (when the population is more than 10,000).
\[ nf = \text{desired sample size (when the population is less than 10,000)} \]
\[ = \frac{288}{1} + \left(\frac{288-1}{1100}\right) = 228 \]

3.4 Data collection

Women in their first, second and subsequent pregnancies were recruited in the study after they signed consent forms (Appendix I). This was done when they came for their monthly antenatal visit at Bumula Sub-District hospital. A number was assigned to each pregnant woman that was recorded on a prenatal consultation form. After a complete medical examination by ANC nurse, the volunteer's brief demographic information, length of pregnancy, parity and axillary temperature were recorded in a structured questionnaire provided (Appendix II). Women were considered as having a fever when their temperature was \( \geq 38^\circ C \). Gestational age was assessed using a gestational calendar, trimester defined as first (<14 weeks), second (14–27 weeks) and third (>27 weeks). The same questionnaire was used to determine from the recruited those with ITNs and those without.

3.4.1 Parasitological tests for malaria parasites

Blood was obtained from finger prick by a laboratory technician. Holding the patient’s left hand palm up, the third finger tip from the thumb was wiped first with a piece of cotton wool lightly soaked in alcohol, there after using firm strokes dirt and grease was removed from the ball of the finger using a sterile cotton wool. These strokes also stimulated blood circulation in the tip of the finger. The finger was dried then pierced with sterile lancet and blood allowed
to flow freely without squeezing the finger. Thin and thick blood films were prepared immediately upon blood collection on the same slide. Pressure was applied gently to the finger and blood collected in a single small drop, on the middle of the slide. This was for the thin film. Further pressure was applied to express more blood which was collected in two or three large drops, on the slide, about 1 cm from the drop intended for the thin film, this was for the thick smear (Clendemani et al., 1995; Di. Ruberto et al., 1999; Moody et al., 2000).

3.4.1.1 Field's stain test for thick blood film

Large drops of blood were placed on a microscope slide, and using the edge of another clean slide spread the blood in a circular form with 3-6 movements to make an area of 1cm². The film was air dried, dipped into Field’s stain A for ten seconds after which it was dipped into tap water for three seconds and gently agitated. The slide was then dipped in Field’s stain B for 10 seconds, washed gently in running tap water for a few seconds to remove excess stain and drained vertically leaving it to dry. The preparation was examined under light microscope for detection of malaria parasites (Clendemani et al., 1995; Di. Ruberto et al., 1999; Moody et al., 2000).

3.4.1.2 Rapid Field’s stain test for thin film

The small drop was touched with the spreader and blood allowed to spread along the edge of the spreader. Firmly the spreader was pushed along the slide, keeping it at an angle of 45°. Firmly and in even contact the spreader was
pushed along the slide, making a thin smear. The blood slide was air dried, fixed in 95% methanol for 1 minute and flooded with 1 ml of Field’s stain B diluted 1 in 4 with water. An equal volume of undiluted field stain A was added immediately, mixed well and allowed to stain for 1 minute. The slide was then rinsed in running tap water to remove excess stain and drained to dry. Examination was carried out using the X100 objective lens of a compound microscope for detection of malaria parasites (Clendemani et al., 1995; Di. Ruberto et al., 1999; Moody et al., 2000).

3.4.2 Data management and analysis

Data was edited, coded and entered into computer using MS Excel software. Back up storage was done in CD and all raw data were stored safely. All analysis was done using INSTAT 3.36 version (The University of Reading, UK).

The prevalence of malaria in pregnant women who used or did not use the ITN was compared by testing the mean difference of infections using T-test, during the rainy and dry seasons. A spearman rank correlation analysis was used to show the relationship between net ownership and malaria parasitaemia during the rainy and dry seasons. It was also used to show the relationship of net ownership and the different age groups of the respondents. Chi-square test was used to test association between net retreatment and malaria parasitaemia. The General Linear Model (GLM) for analysis of linear regression and variance was used to test the effects of combined demographic factors on parasitaemia
and net ownership, while Chi-square test was used to determine the association of age and parity on parasitemia. Chi-square test was used to show the significance of net ownership and net retreatment.

3.5 Ethical considerations
All work was performed according to the guidelines for human experimentation in clinical research stated by the Ministry of Health of Kenya (National Council for Science and Technology, 2004). Signed consent was obtained from pregnant mothers attending ANC at Bumula Sub-District hospital (Appendix I). Ethical clearance was sought from the Ministry of Health and Kenyatta University (Appendix III).
CHAPTER FOUR

4.0 RESULTS

4.1 Socio-demographic characteristics of the study subjects

The respondents constituted pregnant women from 38 villages in Bumula Division of Bungoma County. A total of 228 pregnant Women were interviewed. Their ages ranged from 15 to 45 years. Pregnant women aged between 21-35 years were the majority representing 38.2% followed by those between 36 - 45 years at 36.4%, and those between 15 and 20 years at 22.8%. Women who declined to indicate their ages represented 2.6% (Table 4.1).

Most of the women interviewed (72.4%) had attained primary education, while 20.6% and 2.6% had attained secondary and post-secondary respectively. The remaining 4.8% had no formal education (Table 4.1).

Most respondents were peasant farmers representing 58.8%, while those who were self-employed formed 37.5% and 3.5% were civil servants. Only 0.4% of those interviewed were casual workers (Table 4.1). As regards marital status 92.5% were married, 7.0% were single parents while 0.4% was widowed (Table 4.1).
Table 4.1: Socio-demographic characteristics of pregnant women

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total count</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (Years)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15-20</td>
<td>52</td>
<td>22.8</td>
</tr>
<tr>
<td>21-35</td>
<td>87</td>
<td>38.2</td>
</tr>
<tr>
<td>36-45</td>
<td>83</td>
<td>36.4</td>
</tr>
<tr>
<td>Non respondents</td>
<td>6</td>
<td>2.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>228</strong></td>
<td><strong>100</strong></td>
</tr>
<tr>
<td><strong>Level of education</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No formal education at all</td>
<td>11</td>
<td>4.8</td>
</tr>
<tr>
<td>Primary education</td>
<td>165</td>
<td>72.4</td>
</tr>
<tr>
<td>Secondary education</td>
<td>47</td>
<td>20.6</td>
</tr>
<tr>
<td>Post-secondary education</td>
<td>5</td>
<td>2.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>228</strong></td>
<td><strong>100</strong></td>
</tr>
<tr>
<td><strong>Occupation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Civil servants</td>
<td>7</td>
<td>3.5</td>
</tr>
<tr>
<td>Self employed</td>
<td>86</td>
<td>37.5</td>
</tr>
<tr>
<td>Casual worker</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>Peasant farmer</td>
<td>134</td>
<td>58.8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>228</strong></td>
<td><strong>100</strong></td>
</tr>
<tr>
<td><strong>Marital status</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>211</td>
<td>92.5</td>
</tr>
<tr>
<td>Single parent</td>
<td>16</td>
<td>7</td>
</tr>
<tr>
<td>Widow</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>228</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

4.1.1 Relationship between age of the respondents and malaria infection

The highest infection rate of 24.1% was recorded from respondents above the age of 36-45 followed by those between 21-35 years who recorded 23.1% respondents testing positive for malaria parasitaemia. Respondents aged between 15-20 years had 23.0% of it’s members testing positive for malaria parasitaemia. A Regression analysis showed no significant relationship between malaria infection rate to the women’s ages ($P = 0.854; r = 0.00$).
Figure 4.1: The percentages of respondents having positive parasitaemia among different ages

4.1.2 Influence of education, occupation, age and village of residence on malaria infection

A multivariate analysis of variance, established that there was no significant relationship between the level of education and the presence of parasitaemia (P = 0.210; df = 3; F = 1.547 Table 4.4). In this study, 27.2% of respondents who had no formal education had positive parasitaemia, while 26.06% of those who attained primary education tested positive for malaria parasitaemia. 17.02% of those who had acquired secondary education and 20% of those who had post-secondary education had positive parasitaemia (Table 4.2).
Table 4.2: Percentage Respondents with positive parasitaemia in different levels of Education

<table>
<thead>
<tr>
<th>Level of education</th>
<th>No. Examined</th>
<th>No. Infected</th>
<th>% Infected</th>
</tr>
</thead>
<tbody>
<tr>
<td>No formal education</td>
<td>11</td>
<td>3</td>
<td>27.27</td>
</tr>
<tr>
<td>Primary education</td>
<td>165</td>
<td>43</td>
<td>26.06</td>
</tr>
<tr>
<td>Secondary education</td>
<td>47</td>
<td>8</td>
<td>17.02</td>
</tr>
<tr>
<td>Post secondary edu.</td>
<td>5</td>
<td>1</td>
<td>20.00</td>
</tr>
</tbody>
</table>

A multivariate analysis of variance revealed that parasitaemia was not influenced by occupation of the pregnant women (P = 0.431; df = 3; F = 0.931 Table 4.4). The representation is as follows: 28.5% of the civil servants, 12.7% of the self employed, 32.1% of the women who were peasant farmers and none of the casual workers had positive parasitaemia (Table 4.3).

Table 4.3: Respondents with positive parasitaemia in different occupations

<table>
<thead>
<tr>
<th>Occupation</th>
<th>No. Examined</th>
<th>No. Infected</th>
<th>% Infected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civil Servants</td>
<td>7</td>
<td>2</td>
<td>28.5</td>
</tr>
<tr>
<td>Self employed</td>
<td>86</td>
<td>11</td>
<td>12.7</td>
</tr>
<tr>
<td>Casual workers</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Peasant farmers</td>
<td>134</td>
<td>43</td>
<td>32.1</td>
</tr>
</tbody>
</table>

A multivariate analysis of variance showed that when socio-demographic characteristics considered jointly did not affect parasitaemia (P>0.05: Table
4.4). However, interaction between age and village of residence significantly influenced malaria infection rates (P = 0.046; df = 29; F = 1.649; Table 4.4). Meaning interaction between villages of residence of the respondents and age influenced the presence of malaria parasites in the respondents.

Table 4.4: Probability value based on the influence of socio-demographic factors on parasitaemia

<table>
<thead>
<tr>
<th>Factor</th>
<th>P value</th>
<th>DF</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Village of residence</td>
<td>0.188</td>
<td>37</td>
<td>1.278</td>
</tr>
<tr>
<td>Age</td>
<td>0.642</td>
<td>3</td>
<td>0.562</td>
</tr>
<tr>
<td>Level of education</td>
<td>0.210</td>
<td>3</td>
<td>1.547</td>
</tr>
<tr>
<td>Occupation</td>
<td>0.431</td>
<td>3</td>
<td>0.931</td>
</tr>
<tr>
<td>Marital status</td>
<td>0.848</td>
<td>1</td>
<td>0.037</td>
</tr>
<tr>
<td>Village of residence versus Age</td>
<td>0.046*</td>
<td>29</td>
<td>1.649</td>
</tr>
<tr>
<td>Village of residence versus Level of education</td>
<td>0.916</td>
<td>15</td>
<td>0.529</td>
</tr>
<tr>
<td>Village of residence versus Level of education versus Age</td>
<td>0.807</td>
<td>1</td>
<td>0.060</td>
</tr>
<tr>
<td>Village of residence versus Occupation</td>
<td>0.624</td>
<td>13</td>
<td>0.833</td>
</tr>
<tr>
<td>Age versus Occupation</td>
<td>0.550</td>
<td>3</td>
<td>0.708</td>
</tr>
<tr>
<td>Level of education versus occupiation</td>
<td>0.399</td>
<td>1</td>
<td>0.719</td>
</tr>
</tbody>
</table>

Significance according to general linear regression model (multivariate analysis of variance)

4.2 Relationship between parity and malaria infection

The highest infection rates of 27.8% was recorded from the primagravidae followed by the multigravidae at 25.2% and the least infections was recorded from secundigravidae at 20.0%. There was a significant association between malaria infection rates and the parity of respondents ($\chi^2 = 25.948$, df = 6, P < 0.05: Figure 4.2). The primagravidae were most likely to test positive for malaria parasitaemia than the other parities.
4.3 Relationship between gestation period and malaria infection

A positive correlation was observed between trimester and malaria infection rates; however, this correlation was not significant (P > 0.05; r = 0.123; Figure 4.3). Respondents in the third trimester recorded the highest infection rates of 48.4%, followed by those in the first trimester who had 26.9%. Reduced malaria infection was recorded from respondents in the second trimester who recorded 20.9%. Those who did not indicate their gestation period and had positive parasitaemia were 3.8%.
4.4 Net ownership by pregnant women

A total of 60.5% of the respondents owned nets while 36.8% did not own any net. However, 2.6% of the respondents did not indicate whether they own nets or not (Table 4.5).

Table 4.5: Percentage Net Ownership Among pregnant women

<table>
<thead>
<tr>
<th>Count</th>
<th>Ownership</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>138</td>
<td>Owned net</td>
<td>60.5</td>
</tr>
<tr>
<td>83</td>
<td>Did not own net</td>
<td>36.8</td>
</tr>
<tr>
<td>7</td>
<td>Non respondent</td>
<td>2.6</td>
</tr>
</tbody>
</table>

A portion of 26.8% of those who owned nets were found to be positive for malaria parasitaemia whereas 28.8% of those who did not own nets tested
positive for malaria parasitaemia. The non respondents 17% tested positive for malaria parasitaemia (Figure 4.4). When correlation between net ownership and malaria infection rate was calculated, it was found to be a positive correlation, which was however not significant (P > 0.05; r = 0.064).

![Figure 4.4: Malaria infection rate and net ownership](image)

### 4.5 Category of nets owned by the pregnant women

It was established that 87.8% of the respondents possessed long-lasting nets while 11.6% of the respondents had conventional nets. Furthermore 0.7% of the respondents failed to indicate the type of net owned (Figure 4.5). There was significant ownership of long lasting nets in the sampled population (P < 0.05; \(\chi^2\) = 185.870; df =2). The respondents were more likely to own a long lasting net than conventional net.
4.5.1 Net ownership in different age groups

It was observed that 48.1% of the respondents between 15-20 years of age possessed nets, followed by 60.9% of middle aged women of 21-35 years; pregnant women aged between 36 - 45 years had more net ownership (66.3%). There was a significant correlation between age of the respondents and net ownership (P = 0.024; r = -0.149; Figure 4.6). Age was a determinant factor in net ownership. Older women were likely to own a net than younger women.
Table 4.6: Net ownership by the women from various villages in Bumula Division Bungoma County

<table>
<thead>
<tr>
<th>VILLAGE OF RESIDENCE</th>
<th>NET OWNERSHIP</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>%</td>
<td>No</td>
<td>%</td>
</tr>
<tr>
<td></td>
<td>Count</td>
<td></td>
<td>Count</td>
<td></td>
</tr>
<tr>
<td>Lunakwe</td>
<td>6</td>
<td>75</td>
<td>2</td>
<td>25</td>
</tr>
<tr>
<td>Mayanja</td>
<td>1</td>
<td>33.3</td>
<td>2</td>
<td>66.7</td>
</tr>
<tr>
<td>Bwema</td>
<td>1</td>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Masuno</td>
<td>3</td>
<td>75</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mikokwe</td>
<td>1</td>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Kware</td>
<td>5</td>
<td>75.4</td>
<td>2</td>
<td>24.6</td>
</tr>
<tr>
<td>Sikinga</td>
<td>1</td>
<td>33.3</td>
<td>2</td>
<td>66.7</td>
</tr>
<tr>
<td>Tulumba</td>
<td>13</td>
<td>76.5</td>
<td>4</td>
<td>23.5</td>
</tr>
<tr>
<td>Siekumulo</td>
<td>8</td>
<td>50</td>
<td>6</td>
<td>42.9</td>
</tr>
<tr>
<td>Mateka</td>
<td>9</td>
<td>52.9</td>
<td>8</td>
<td>47.1</td>
</tr>
<tr>
<td>Tabala</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>Kibachenje</td>
<td>2</td>
<td>22.2</td>
<td>7</td>
<td>77.8</td>
</tr>
<tr>
<td>Musikoma</td>
<td>1</td>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Samoya</td>
<td>2</td>
<td>66.7</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Kimatuni</td>
<td>2</td>
<td>40</td>
<td>3</td>
<td>60</td>
</tr>
<tr>
<td>Bunambvoi</td>
<td>5</td>
<td>62.5</td>
<td>2</td>
<td>25</td>
</tr>
<tr>
<td>Khelela</td>
<td>4</td>
<td>50</td>
<td>4</td>
<td>50</td>
</tr>
<tr>
<td>Chiliba</td>
<td>1</td>
<td>25</td>
<td>3</td>
<td>75</td>
</tr>
<tr>
<td>Lunao</td>
<td>8</td>
<td>66.7</td>
<td>4</td>
<td>33.3</td>
</tr>
<tr>
<td>Kimwanga</td>
<td>1</td>
<td>50</td>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td>Mabusí</td>
<td>1</td>
<td>25</td>
<td>2</td>
<td>50</td>
</tr>
<tr>
<td>Tabuti</td>
<td>4</td>
<td>66.7</td>
<td>2</td>
<td>33.3</td>
</tr>
<tr>
<td>Burangasi</td>
<td>7</td>
<td>87.5</td>
<td>1</td>
<td>12.5</td>
</tr>
<tr>
<td>Bumula</td>
<td>19</td>
<td>65.5</td>
<td>10</td>
<td>34.5</td>
</tr>
<tr>
<td>Musia</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>Nj`oli</td>
<td>1</td>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Myanga</td>
<td>10</td>
<td>84.3</td>
<td>2</td>
<td>15.7</td>
</tr>
<tr>
<td>Lumboka</td>
<td>1</td>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Nangeni</td>
<td>5</td>
<td>62.5</td>
<td>3</td>
<td>37.5</td>
</tr>
<tr>
<td>Mwomo</td>
<td>2</td>
<td>66.7</td>
<td>1</td>
<td>33.3</td>
</tr>
<tr>
<td>Nasianda</td>
<td>2</td>
<td>66.7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Chiliba</td>
<td>2</td>
<td>66.7</td>
<td>1</td>
<td>33.3</td>
</tr>
<tr>
<td>Wekelekha</td>
<td>2</td>
<td>66.7</td>
<td>1</td>
<td>33.3</td>
</tr>
<tr>
<td>Muanda</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>Sango</td>
<td>1</td>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mungore</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>Wasimikha</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>Mikokwe</td>
<td>7</td>
<td>63.6</td>
<td>4</td>
<td>36.4</td>
</tr>
</tbody>
</table>
Among the 228 respondents drawn from 38 villages, net ownership was highest in Bumula 13.8% followed by Myanga with 7.2%. However Bumula having the highest number of respondents also recorded the highest number of those without nets. There was no significant correlation between the village of residence and net ownership ($P > 0.05; r = 0.021$; Table 4.6).

4.5.2 Relationship between net ownership and socio-demographic characteristics

The study recorded a positive correlation between net ownership and the level of education which was not significant ($P = 0.053; r = 0.036$). More of those who had post-secondary education (72.7%) owned nets whereas respondents with no formal education, 70.0% did not own nets (Table 4.7).

There was no significant association between net ownership and marital status of the respondents ($P = 0.731, \chi^2 = 2.023$). Among the respondents, 61.1% of the married women owned nets, (50.0%) of the single women owned nets while the only widow owned a net (Table 4.7).

The findings showed no significant association between net ownership and the occupation of the respondents ($P = 0.521, \chi^2 = 5.181$). In this study 87.5% of respondents who were civil servants owned nets, followed by 63.5% who were self employed, and 56.7% who were unemployed. The only recorded casual worker owned a net (Table 4.7).
Table 4.7: Relationship of net ownership with marital status, level of education and occupation

<table>
<thead>
<tr>
<th>Socio-demographic factors</th>
<th>Net ownership</th>
<th></th>
<th></th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
<td>Non respondent</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Count %</td>
<td>Count %</td>
<td>Count %</td>
<td></td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>129 61.1</td>
<td>77 36.5</td>
<td>5 2.4</td>
<td></td>
</tr>
<tr>
<td>Single parent/not married</td>
<td>8 50.0</td>
<td>7 43.8</td>
<td>1 6.3</td>
<td></td>
</tr>
<tr>
<td>Widow</td>
<td>1 100.0</td>
<td>0 0</td>
<td>0 0</td>
<td>0.731NS</td>
</tr>
<tr>
<td>Level of education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No formal education at all</td>
<td>3 30.0</td>
<td>7 70.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>primary education</td>
<td>102 61.8</td>
<td>60 36.4</td>
<td>3 1.8</td>
<td></td>
</tr>
<tr>
<td>secondary education</td>
<td>25 59.5</td>
<td>15 35.7</td>
<td>2 4.8</td>
<td></td>
</tr>
<tr>
<td>Post- secondary education</td>
<td>8 72.7</td>
<td>2 18.2</td>
<td>1 9.1</td>
<td>0.584NS</td>
</tr>
<tr>
<td>Occupation/economic activity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Civil servant</td>
<td>7 87.5</td>
<td>1 12.5</td>
<td>0 0</td>
<td></td>
</tr>
<tr>
<td>Self employed</td>
<td>54 63.5</td>
<td>30 35.3</td>
<td>1 1.2</td>
<td></td>
</tr>
<tr>
<td>Casual worker</td>
<td>1 100.0</td>
<td>0 0</td>
<td>0 0</td>
<td></td>
</tr>
<tr>
<td>Unemployed</td>
<td>76 56.7</td>
<td>53 39.6</td>
<td>5 3.7</td>
<td>0.521NS</td>
</tr>
</tbody>
</table>

Ns- Not significant at 95% CI.

4.5.3 Relationship between net ownership and malaria infection

The study established 60.5% of the respondents owned nets. There was a significant association between net ownership and malaria infection ($\chi^2=20.62$; $p < 0.05$). The study recorded 73.2% of those who owned nets testing negative for malaria parasitemia while 26.8% were positive for malaria parasitaemia.
(Figure 4.7), whereas 31.2% of respondents who did not own nets tested positive for malaria parasitaemia. Respondents who owned nets were less likely to get malaria infection.

![Figure 4.7: Relationship between net ownership and malaria infection](image)

### 4.5.4 Category of net owned and malaria infection

There was no significant association between type net and malaria infection rate ($\chi^2 = 7.060$, $P = 1.33$). Those who owned long-lasting insecticide treated nets (72.7%), tested negative for malaria parasitaemia while only 27.3% of the respondents tested positive. On the other hand 68.8% of the women who had conventional nets tested negative for malaria parasitaemia whereas (25.0%) of them tested positive (Table 4.8).
Table 4.8: Category of net owned and the presence of parasitaemia

<table>
<thead>
<tr>
<th>Type of net</th>
<th>Positive</th>
<th>Negative</th>
<th>Non respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long-lasting</td>
<td>27.3%</td>
<td>72.7%</td>
<td>0%</td>
</tr>
<tr>
<td>Conventional</td>
<td>25.0%</td>
<td>68.8%</td>
<td>6.3%</td>
</tr>
<tr>
<td>None respondents</td>
<td>0%</td>
<td>100%</td>
<td>0%</td>
</tr>
</tbody>
</table>

4.6 Conventional net retreatment

There was no significant relationship between the testing positive for malaria parasitaemia and net retreatment ($P = 0.133, \chi^2 = 7.06$). Those who retreated their nets after 6 months (10.0%) tested positive whereas 50.0% of the women who never retreated their nets tested positive for parasitaemia (Figure 4.8).

![Figure 4.8: Net retreatment against percentage respondents with positive parasitaemia](image-url)
4.7 Relationship between number of times suffered from malaria and testing positive for malaria parasitaemia

There was a significant relationship in the testing positive for malaria parasitaemia and the number of times the women had suffered from malaria ($r = 0.222, P= 0.009$). The study recorded 34.5% of the women who had suffered from malaria once, 37.5% of those who had suffered twice and 25.0% of those who had suffered thrice or more tested positive for malaria parasites (Figure 4.9).

![Figure 4.9: Percentage respondents having positive parasitaemia and the number of times the women had suffered from malaria](image)

All pregnant women who indicated to have suffered from malaria once, twice or thrice owned nets. Similarly, long-lasting nets and conventional nets owned by the women had no significant effect on malaria infection.
4.8 Net acquisition by the respondents

The study recorded 57.5% of the respondents who had acquired nets from different sources such as hospitals during antenatal care visits and supermarkets. Pregnant women who acquired nets during antenatal visits were 80.9%, while 16.8% acquired their nets from supermarkets. Those who acquired nets from other sources constituted 2.30%. The greatest source of nets was the hospital during antenatal visits by the respondents (80.9%) (Figure 4.10)

![Figure 4.10: Where the net was acquired from](image)

For the women who acquired their nets from the hospital, there was no significant correlation between the source of income and net acquisition ($P > 0.05; r = 0.213$). The study indicated 6.6% of the civil servants, 32.1% of the self employed, 0.9% casual workers and 60.4% of the unemployed women acquired nets from the hospital during ANC visits. There was a significant association between the type of net and where it was obtained from ($\chi^2 =$...
54.371, P < 0.05; Figure 4.11). The Pregnant women had higher chances of acquiring a long lasting net at the hospital during the ANC visit than the conventional net. During the ANC visit 97.8% of the respondents acquired long lasting nets compared to only 2.3% respondents who acquired conventional nets (Figure 4.11).

![Source of the nets](image)

**Figure 4.11: Category of net and source.**

### 4.8.1 Time of retiring to bed and malaria infection

The majority of the respondents (54.8%) slept between 8 to 10 pm., while 3.1% of the pregnant women slept between 6 to 7 pm. Those who slept beyond 10:00 pm were 1.8%, however 40.4% of the women declined to indicate when they went to sleep.

There were significant differences in the presence of parasitaemia and time the women slept (r = 0.198, P = 0.020). Respondents who went to sleep between 6-7pm (11.1%) tested positive for malaria parasites while 88.9% of those who...
went to sleep between 8 – 10 pm had malaria parasitemia. Those who went to sleep after 10 pm recorded no parasitaemia (Table 4.9).

Table 4.9: Malaria infection rate and the time of retiring to bed

<table>
<thead>
<tr>
<th>Parasitaemia</th>
<th>Time of going to sleep</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6 – 7 pm</td>
</tr>
<tr>
<td>Positive</td>
<td>11.1%</td>
</tr>
<tr>
<td>Negative</td>
<td>3.0%</td>
</tr>
</tbody>
</table>

4.8.2 Proper use of nets

Among the respondents that possessed nets, 89.9% of them tucked nets regularly when they slept under them; however 9.4% did not tuck in nets regularly when they slept under them. Respondents who did not indicate how often they tucked in their net constituted only 0.7% (Figure 4.12).

Figure 4.12: Regularity of tucking of nets by respondents
Young women (21-35) 92.3% used their nets regularly, as compared to 7.7% of the older women aged between 36 - 45 years and above. There was no significant correlation between age and tucking of nets (P > 0.05, P = 0.894). A representation of 88.7% of the pregnant women aged between 21 – 35 years tucked in their nets while 89.1% of the respondents above 36 years of age did so while going to sleep. Respondents who tucked in their nets regularly (71.8%) tested negative for malaria parasites while only 27.4% were positive for malaria parasites (Table 4.10). Those who did not tuck in regularly 31.2% tested positive for malaria parasitaemia while 68.8% tested negative for malaria parasitaemia.

4.8.3 Hindrances to net usage.

A large portion of the respondents (73.2%) did not experience challenge of sweating or feeling hot when using nets. However, 16.7% of the women experienced the problem of sweating when using nets. A small proportion of the respondents (2.9%) felt heat problems when using nets. There was a significant association between challenges associated with net usage and malaria infection rates ($\chi^2 = 7.533; \text{df} = 8; \text{p} = 0.048$; Figure 4.13). The pregnant women were likely to be infected with malaria when they felt hot and sweated when sleeping under bed nets.
Figure 4.13: Hindrances to net usage

4.9 Importance of owning ITNs

The respondents that owned nets stated that the nets were protecting them against malaria infection. At least 91.1% of the respondents confirmed that they were being protected by treated nets whereas 3.7% indicated that they were not being protected by the nets against malaria. An overall 5.2% were not sure whether the net conferred protection against malaria.

The respondents without nets (97.8%) indicated that they required a net to protect them against malaria. Only 1.1% was of the contrary opinion that they did not require nets to protect them against malaria. The remaining percentage (1.1%) were not aware whether they needed a net or not to protect them against malaria.

4.10 Reasons for not owning nets

The respondents listed several reasons why they did not own nets. Lack of money to buy nets accounted for 71.9% respondents. Nets of 23.6% of the
respondents had become old and torn hence they did not have any to use. The remaining portion of the respondents (4.5%) did not state why they lacked nets. Most of the respondents (93.3%) stated that the government should supply them with free nets.

4.11 Prevalence of malaria among pregnant women

A total of 57 women tested positive for malaria parasites while 168 were negative. The prevalence of malaria among pregnant women was 25%. There was a significant difference between those who tested negative and positive for malaria parasitaemia (P < 0.001; \( \chi^2 = 186.237 \), df = 2; Table 4.11).

<table>
<thead>
<tr>
<th>Parasitaemia</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>57</td>
<td>25</td>
</tr>
<tr>
<td>Negative</td>
<td>168</td>
<td>73.7</td>
</tr>
</tbody>
</table>

4.12 Differences in malaria infection rates during rainy and dry seasons

The respondents who tested positive for malaria parasitaemia were higher within the rainy season (28.8%) compared to dry season (19.0%). The differences in infection rates during rainy and dry season were significant (P<0.05; t=3.67; df =226; Figure 4.14). The pregnant women were likely to test positive for malaria parasitaemia during the rainy season than the dry season.
4.13 Relationship between fever and malaria infection

Fever of the respondents was compared with malaria infection. It was found that 20.2% of respondents had fever whereas 78.1% had normal temperature below 38°C. A correlation analysis to establish any relationship in the body temperature to the presence of parasitaemia showed that those with higher temperatures were positive for parasitaemia ($r = 0.663, P < 0.05$; Figure 4.15).
Figure 4.15: Relationship between body temperature and Malaria infections
CHAPTER FIVE

5.0 DISCUSSION, CONCLUSIONS AND RECOMMENDATION

5.1 Discussion

A larger percentage of the respondents were in the age range of 21-35 years (38.2%). A majority were married (92.5%). A big proportion of pregnant women were peasant farmers (58.8%). Those with primary education constituted the highest percentage (72.4%), while those with no formal education at all were only (4.8%). This demographic statistics are in line with the report about Bumula division by the Kenya Bureau of Statistics, (2010) which gave 72.8% of the population in Bumula division as having primary education and 60% of the members are peasant farmers growing food crops for subsistence. The highest population of women ages ranged between 21-35 years (38.2%), while on marital status the census reported by Kenya Bureau of Statistics, (2010) states 80% of women in the division are married.

These study revealed significant mean differences in parasitaemia during the dry and rainy seasons, with higher infection rates during the rainy season. This observation may be related to the availability of suitable breeding habitats for mosquitoes during the rainy season. On the other hand the findings by Lindsay et al. (1996) reported that infection rates are determined by temperature and rainfall patterns. Malaria prevalence among the pregnant women was 25%. In Western Kenya, the prevalence of malaria has been reported to be 75% (Guyatt et al., 2004). Hence the prevalence reported in this study is much
lower than the general malaria prevalence of the region. This may be related to the number of pregnant women in the study area. WHO/UNICEF, (2003) reported that approximately 14% of families in western Kenya have a pregnant woman every year. It is also reported that only 75% of the pregnant women seek antenatal care. The reduced malaria prevalence among the pregnant women might be due to the increased awareness and subsequent use of ITNs (Hawley et al., 2003). This is also supported by a report by Lengeler, (2004), stating that when large numbers of people use LLINs to protect themselves, the burden of malaria can be reduced. This study has also revealed significant correlation between the fever and malaria infection. Fever usually forms part of the symptoms of malaria, however it is not a rule. Fever, therefore, may be a symptom of many conditions of the body. Studies in Africa have also reported that infections are subject to fever (Bouyou-Akotet et al., 2003).

Women who owned nets had less parasitaemia as compared to those who did not have nets hence there were a significant differences in the infection levels between those who possessed nets and those who did not. Net ownership therefore reduced cases of malaria infection in the pregnant women. Studies in western Kenya by Hawley et al., (2003) have reported a similar reduction in cases of malaria infection with net ownership. Hawley et al., (2003) reported reduced infection in both infants and pregnant women when nets were used. Respondents were found to possess two types of nets; long lasting nets and conventional nets. Long lasting nets were associated with lower cases of malaria infection. The respondents who used this type of nets were not
expected to retreat them, while the conventional nets were either retreated occasionally or were never retreated at all. According to Jamison et al., (2006), conventional insecticide-treated nets (ITNs) need to be re-treated once per year to enhance their effectiveness, whereas long lasting nets can be used for three to five years without re-treatment. These findings are also similar to Baunes, (2004) study in Senegal, Nigeria, Zambia, Ghana and Ethiopia. It reported LLINs being more effective than conventional nets.

There was a significant relationship between the presence of parasitemia and the number of times individuals had suffered from malaria. Whereas net ownership by pregnant women had no significant effect on the number of times pregnant women had been infected by malaria, all those who suffered from malaria once, twice, thrice owned nets. Lack of significant effect between ownership of nets and number of times individuals suffered from malaria could be due to other factors like improper use of nets, or use them only at certain time of the year. This finding is in consistent with studies conducted in Ghana by Binka, et al., (1997) where people who were found to own nets did not necessarily use them for the correct purpose or used them only at certain time of the year. A study by Tsuyuoka, et al., (2002), in Zimbabwe reported that some women did not sleep under the bed nets because there were no mosquitoes during that period and only used them during rainy season.
Most of the respondents acquired their nets from the hospital during antenatal care visit. A small number of pregnant women acquired their nets from supermarkets. A study conducted by Wiseman, et al., (2007) suggested that modelling net ownership can provide useful insights into factors influencing demand, which can be used to inform public policy decisions about the universal provision of free bed nets or their targeting towards specific groups. There was a significant correlation between the economic status and the source of the net, similarly there was a significant association between the type of net and the source of the net. This implies that the individual’s economic status may play a role in determining their ability to have a mosquito net, hence most people who had low economic status preferred receiving one for free. A Study in Kilifi Kenya reported that free ITNs distribution increases area of coverage as well as use (Njoroge et al., 2009). Equally Guyatt and Snow, (2002) noted that the ability of communities to pay for ITNs is dependent upon the income of the population.

The highest parasitaemia was reported in respondents who went to sleep between 8pm and 10pm. The time of going to sleep may determine the likelihood of being bitten by mosquitoes, hence infections by malaria. People who stay awake for a long time probably expose themselves to mosquito bites whereas those who sleep early cover themselves hence reducing the chances of being bitten. These findings have not been confirmed in other studies and need further investigation, though Kline, (2006) suggested that mosquitoes become active at night.
Most of the respondents tucked in their nets before they slept. These resulted into a positive correlation between tucking of nets and parasitaemia which was however not significant. The study by Gamble et al., (2007) reported that the correct use of ITNs reduced malaria infection. There was a positive correlation between hindrances to using bed nets and malaria parasitaemia which was however not significant. Respondents cited sweating and feeling hot as the main hindrance to proper usage of the nets especially during the hot season. A study by Alaii, (1997) mentions temperature as the main reason an individual will deploy his or her bed net; people are less likely to use ITNs when it’s hot. Njoroge et al., (2009) also reported such problems where respondents claimed that it felt hot under the bed net and therefore uncomfortable especially during the hot seasons. Furthermore he reported that sleeping on the floor or outside during hot seasons made it difficult to use bed nets.

Respondents were in agreement that nets protected them against being infected by malaria. This is unlike the findings by Njoroge et al., (2009) who reported that nets do not protect against malaria infection, but instead people who have grown up without using nets avoid using ITNs even during pregnancy. Those who did not possess nets suggested that they required access to free nets for protection against mosquitoes. They cited several reasons why they did not have the nets including lack of money to buy nets, or the nets were either old or torn, consequently they requested for assistance to buy ITNs. Similar findings were reported by Hawley et al., (2003), who proposed 100% subsidy by the Government on ITNs. Socio-economic status has also been found to
influence net possession in a study conducted in African countries by Eisele *et al.*, (2009).

The study revealed no significant relationship between malaria infections rate and age of the respondents (P > 0.05). Though the older women (36-45 yrs) recorded higher malaria infections rate than the younger women (15-20 yrs). This difference could be due to increased awareness of antenatal care in the young women and the ability to use the ITNs effectively as compared to those above 36 years of age. It has been argued by Rashed *et al.*, (1999) that when women are pregnant they fall into a high-risk malaria group. In turn they receive greater exposure to health services and gain higher level of awareness of disease and ways of preventing it.

The interaction between the village of residence and age significantly determined parasitaemia (p = 0.046). This could be due to most women being aware of the importance of nets usage in the villages. Ter Kuile, *et al* (1999) reported that women in their first to third pregnancies living in insecticide treated bed net villages were significantly less likely to develop malaria parasitaemia compared to women who did not use nets.

Primigravidae recorded the highest cases of parasitaemia. There was significant association between parity and parasitaemia (P < 0.05). A study conducted by Bayoumi, *et al.*, (2009) reported increased incidences of malaria especially in primigravidae and secundigravidae. This was brought about by
the impairment of the humoral and cell mediated immunity, moreover the primagravidas could be more vulnerable due to their poorly developed anti-disease immunity against malaria parasites (Staalsoe, et al., 2004).

There was no significant correlation between parasitaemia and the gestation period. However, respondents in the third trimester had the highest cases of parasitaemia compared to the other trimesters in terms of percentage (48.4%). This is in line with studies done by Ishag et al. (2005) in pregnant women attending antenatal clinic in Eastern Sudan. Their results showed that women who attended the antenatal clinic in the third trimester had the highest malaria prevalence compared to the other trimesters. Lack of significant correlation between trimester and parasitaemia could probably be due to the increased awareness of the risk of malaria and subsequent use of control measures against the vectors of malaria in pregnancy.

There was a significant correlation between net ownership and age of the pregnant women (P = 0.024). This could be due to most women being aware of the importance of net usage through antenatal care visits. These results are consistent with another study conducted on ITNs in Kenya, which reported an increased use of ITN with increase in age and gravidity (Van Eijk et al., 2008).

Other socio-demographic factors like marital status, level of education and occupation did not show significant association with net ownership. However
there was a higher percentage of net ownership among those who had post secondary education as compared to those with no education at all. This observation concurs with a study carried out in the Democratic Republic of Congo, Kinshasa, which showed women who had secondary school or post secondary education were 3.4 times more likely to own a net compared to women with less education (Audrey et al., 2008). Similarly, a study conducted in Kilifi reported that good practice was high in the educated than the non-educated as regards to net usage (Njoroge et al., 2009). Education plays an important role in enhancing health education and awareness of health issues.

Net ownership was highest in Bumula village (13.8%). This high percentage net ownership in Bumula village probably is due to it’s proximity to the health centre hence easy access to the point of supply. In addition, this could have been due to the benefits of free supply of the nets in the village as well as campaigns for awareness by the Ministry of Public Health and Sanitation. A study by Njoroge et al., (2009) in Kilifi, reported some factors that might determine net ownership in villages. The factors include culture that leads to wrong perception towards nets with regard to some cultural beliefs as well as religion. Pregnant women from other villages might have been disadvantaged by distance covered to the point of supplying ITNs.

Long-lasting net ownership was significantly high in the sampled population and could be attributed to a shift from conventional nets to long-lasting nets. These is supported by the call made by the World Health Organization (WHO)
to its partners to distribute only LLINs (WHO, 2007). Due to increased shift to using long-lasting nets a study recommended diversion from awareness of net retreatment to adherence and net usage (Hawley et al., 2003). However, there is potential to increase the use of ITNs by providing insecticide treatment of any untreated nets already in houses.

5.2 Conclusions

i) There was high prevalence of malaria parasitaemia among pregnant women during the rainy season (77.5%) compared to dry season (22.5%).

ii) There was high adherence to net usage by pregnant women in Bumula division (89.9%). The adherence was however affected by factors such as age. Young women of the ages between 15-20 yrs adhered to net usage compared to pregnant women above 36 yrs.

iii) Factors associated with use of ITNs by pregnant women in Bumula division included age, occupation and level of education. Increased temperatures during net usage, general ignorance on net retreatment and time of going to sleep had draw backs on the effectiveness of ITNs.

5.3 Recommendation

i) The County government of Bungoma should take full advantage of devolution of health services to the county by allocating more funds to carry out campaigns to eradicate mosquito breeding grounds during the
rainy season. The county government should also Endeavour to partner with organizations interested in reproductive health to achieve full ITNs coverage particularly during the rainy season by distributing long-lasting nets through existing ANC units within the county.

ii) To increase equitable use and coverage of ITNs in all age groups the County government of Bungoma should employ more community health workers that will spearhead campaigns in villages through public Baraza’s of the importance of using ITNs to protect against mosquito bites that transmit malaria.

iii) Awareness on the retreatment of nets should be enhanced by the Ministry of Public Health and Sanitation of the county government of Bungoma. There is potential to increase more long-lasting nets by providing insecticide treatment of any untreated nets already being owned by a section of pregnant women and replacing aging ones.

iv) Time of going to sleep influenced the presence of malaria parasitemia. These apparently affect the efficiency of the ITNs. These findings have not been confirmed in other studies and need further investigation, particularly the peak biting time of mosquitoes within the Division.

v) Vector control methods like indoor residual spraying, window screens filling and leveling hollow grounds left by brick molders, clearing bushes around homesteads and eliminating incidental containers should be used along with ITNs to counter challenges posed when using ITNs. The challenges included high temperatures by some pregnant women.
REFERENCES


APPENDICES

Appendix I: Consent form

As a partial fulfilment for the award of a Master of Science degree in Medical Parasitology at Kenyatta University, I am carrying out a study to determine the impact of insecticide treated nets (ITNs) on malaria transmission among expectant mothers. I will ask you to fill the ITNs questionnaire to enable me assess the extent to which pregnant women are using ITNs, problems they encounter in the course of using the ITNs and benefits derived when using them.

I shall also ask you to allow the nurse and the laboratory technician to take a sample of your blood to determine the presence or absence of malaria parasites. The results of this investigation will be made available to you so that advice can be given on seeking appropriate treatment.

If you have understood what I have explained to you, I ask you to confirm and sign up for voluntary participation in the study.

Declaration

I understand that participation in this study is purely voluntary, and I hereby accept to fill the questionnaire and allow you to take the blood specimen for your investigation.

Interviewee’s name........................................................................

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

Interviewer’s name......................................................................

Signature....................................... Date.........................................
Appendix II: Questionnaire

1) QUESTIONNAIRE ON EFFECTIVENESS OF INSECTICIDE TREATED NETS TO PREVENT MALARIA TRANSMISSION IN EXPECTANT MOTHERS.

a) i) NAME OF HOSPITAL

ii) NAME OF PATIENT

iii) IDENTITY CARD NUMBER

iv) PLACE OF RESIDENCE/VILLAGE

v) AGE

b) LEVEL OF EDUCATION

i) No formal education

ii) Primary education

iii) Secondary education

iv) Post-secondary education

(Select your suitable option)

c) OCCUPATION/ECONOMIC ACTIVITY

i) Civil servant

ii) Self employed/business

iii) Casual worker

iv) Peasant farmer

(Select your suitable option)

d) MARITAL STATUS

i) Married

ii) Single parent/not married

iii) Widow

(Select your suitable option)
e) **PARITY**

i) Primigravidae (first pregnancy) [ ]

ii) Secundigravidae (second pregnancy) [ ]

iii) Multigravidae (third and above pregnancy) [ ]

(Select your suitable option)

g) **PARASITEMIA** (for those with malaria positive parasitemia (To be filled after a blood test)

h) **Axillary Temperature** .......................... 0°C

2) **NET OWNERSHIP AND USE QUESTIONS**

a) Do you have a mosquito net?

i) Yes [ ]

ii) No [ ]

(Tick whichever applies)

b) If yes, what type of net?

i) Long lasting insecticide treated net (lasts 3 years before treatment) [ ]

ii) Conventional net (to be treated after every six months) [ ]

(Tick whichever applies)
c) If the answer in b) above is (ii), how often is it retreated?
   i) Has never been treated since it was bought
   ii) Retreated after six months
   iii) Occasionally retreated when money is available

d) How many times have you suffered from malaria in the past six months?
   i) Once
   ii) Twice
   iii) Three or more times
   iv) None

   (Tick whichever applies)

e) Where did you acquire your net?
   i) From population services international- PSI
   ii) From hospital during Antenatal/post-natal clinics
   iii) From supermarket/retail shop
   iv) Any other source

   (Specify)..........................................................................................

f) What time of the night do you often go to sleep?
   i) Between 6 – 7 pm
   ii) Between 8 - 10 pm
   iii) Beyond 10 pm

   g) How often do you tuck in/ use your net?
   i) Every day when I go to sleep/always
   ii) Once in a while
   iii) Never used it since I bought it
h) What problems, if any do you encounter when using ITNs?

i) No problem

ii) Feel hot

iii) Sweating

i) Do you think ITN is protecting you against malaria?

i) YES

ii) No

(Tick whichever applies)

3) **TO BE ANSWERED BY THOSE WITHOUT NETS**

a) Do you believe you require a mosquito net to protect yourself from malaria?

i) Yes

ii) No

b) If YES, what are the reasons for not owning a net?

............................................................................................................................
............................................................................................................................
............................................................................................................................

(Your answer here)

b) If the answer in a) above is NO, how do you usually prevent malaria?

............................................................................................................................
............................................................................................................................

(Your answer here)

d) In your opinion how do you expect the government to assist you in acquiring one?

............................................................................................................................
............................................................................................................................
APPENDICES III - RESEARCH APPROVAL

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GRADUATE SCHOOL

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Our Ref: I56/CE/10955/06

Date: 2nd November, 2010

The Permanent Secretary,
Ministry of Higher Education, Science & Technology,
P.O. Box 30040,
NAIROBI

Dear Sir/Madam,

RE: RESEARCH AUTHORIZATION FOR MAKOKHA MARTIN MUKANDA
REG.NO I56/CE/10955/06

I write to introduce Makokha Martin Mukanda who is a Postgraduate Student of this University. He is registered for a M.Sc degree programme in the Department of Zoological Sciences in the School of Pure and Applied Sciences.

Mr. Makokha intends to conduct research for a Thesis Proposal entitled, “Effects of Insecticide Treated Nets on Prevalence of Malaria among Pregnant Women in Bumula Division of Bungoma South District”.

Any assistance given will be highly appreciated.

Yours faithfully,

GEoffrey K.KORIR
FOR: DEAN, GRADUATE SCHOOL

GKK/rm