MALARIA VECTOR CONTROL PRACTICES IN MWEA DIVISION, KIRINYAGA DISTRICT, CENTRAL KENYA

BY

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A THESIS SUBMITTED IN PARTIAL FULFILMENT FOR THE AWARD OF THE DEGREE OF MASTERS IN PUBLIC HEALTH AND EPIDEMIOLOGY OF KENYATTA UNIVERSITY

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DECLARATION

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

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This thesis is dedicated to my parents who tirelessly offered moral support throughout my academic period and also to all my relatives and friends who directly or indirectly made this study a success.
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ACRONYMS

CHW- Community Health Workers
DALYs- Disability Adjusted Life Years
DDT- Dichloro-diphenyl Trichloroethane
Epi-info- Epidemiological Information
FAO- Food and Agricultural Organization
FGD- Focus Group Discussion
GOK- Government of Kenya
IIBNs- Insecticide Impregnated bed Nets
IPT- Intermittent Preventive Therapy
ITNs- Insecticide Treated Bed Nets
JICA Japan International Cooperation Agency
MOH- Ministry of Health
NIB- National Irrigation Board
NMCC- National malaria Coordinating Committee
PSI- Population Services International
RBM- Roll Back Malaria
ROK- Republic of Kenya
SES- Socio-Economic Status
SP- Sulfadoxine-Pyrimethamine and Sulfalene Pyrimethamine
SPSS- Statistical Package for Social Sciences
UNAIDS- United Nations Programme on HIV/AIDS
UNDP- United Nations Development Programme
UNEP- United Nations Environment Programme
UNICEF- United Nations Children’s Fund
WHO- World Health Organization
ABSTRACT

Malaria continues to be an important vector-borne disease in Africa South of Sahara where the conventional treatment strategies have proved ineffective due rapid spread of drug resistance. This has generated renewed global interest in vector control with an aim of minimizing man-vector contact both at household and community level. A cross-sectional ethnographic household survey was conducted in Mwea Division, Central Kenya in April 2005. The main goal of the study was to explore and determine currently used malaria vector control practices as well as determine the level of community participation in malaria vector control. Four villages were purposefully selected to represent socio-economic and geographical diversity within the study area. A total of 400 households were randomly selected from the four villages. Both semi-structured questionnaires and focus group discussions were used to gather information on community’s biomedical knowledge of the disease including the role of the vector in malaria transmission. Results of the study showed that malaria was perceived to be a major public health problem in the study area by 93% of respondents and the role of mosquitoes in malaria transmission was recognized by 95% of respondents (n=368). However, some respondents perceived that malaria could also be caused by other factors like being rained on (13%) with significant difference between the four villages ($\chi^2=24.336; \text{df 3}; P=0.000$). Other perceived causes were wet and cold conditions (11%), taking of raw foods like mangoes and fermented porridge (5%) with significant variation between gender ($\chi^2=19.24; \text{df 3}; P=0.000$). Personal protection methods applied included; use of treated mosquito nets (57%), with significant variations among; different occupational groups ($\chi^2=7.955; \text{df 3}; P=0.047$) and education level of respondent ($\chi^2=33.622; \text{df 6}; P=0.000$). Other methods reported were: untreated bednets (35%), coils (21%), traditional methods (8%), insecticide sprays (6%), and skin repellents (2%). Main reason for using bednets was protection against mosquito bites (95%) while protection against malaria became second (54%). Source reduction methods reported at household level included clearing of bushes/vegetations (45.7%), refuse/waste disposal, (26.9%) and filling of breeding sites (13.6%). Reported environmental management practices at community level included levelling and draining areas of stagnant water (4.3%), clearing vegetations in water canals (0.3%) and destruction of discarded water receptacles (1.1%). Despite malaria being a major public health problem in the area, 39% of respondents (n=365) could not apply some of the known vector control methods. Reasons for regular non-use ranged from unaffordability (67.7%), side effects (26.6%), lack of effectiveness (21.5%), and lack time (3.5%). Methods said to be unaffordable included use of mosquito nets (91.7%) and insecticide sprays (50%), while untreated mosquito nets were ineffective (59%). Results from this study underscored the need for understanding the existing local needs during design and implementation of vector control interventions at community level. The non-scientific explanations given for malaria aetiology may have important implications on the treatment, prevention and control of malaria in irrigated ecosystems, where vectors of malaria are abundant and disease transmission stable.
CHAPTER 1: INTRODUCTION

1.1 Background information

Malaria continues to be an important vector-borne disease in the world and is the leading public health problem in most developing countries. It continues to affect the lives of almost all people living in Africa south of the Sahara where 15% of all disability life-years are lost to malaria (Chima et al., 2003). The disease makes substantial demands on Africa’s fragile health infrastructure where the conventional treatment and control strategies have proved ineffective (Morel et al., 2006). The disease is estimated to cause 300-500 million clinical attacks globally and a minimum of between 1-2 million deaths annually with one to three million children dying each year in Africa alone (WHO/UNICEF, 2003). This number is expected to double over the next two decades in communities which are normally exposed to high rates of transmission (RBM/WHO/UNICEF, 2005).

Malaria control is hampered by many factors like increasing spread of the multi-drug resistant strains of Plasmodium falciparum parasites, poverty, poor health infrastructure and ecosystem degradation (WHO/UNICEF, 2003). In Africa, control is mostly affected by rapid spread of drug and insecticide resistance coupled with periodic changes of weather patterns, civil unrest, population movements and absence of effective intervention strategies (Morel et al., 2006). The expanding human population in the continent has led to an increase in food demand. In an effort to meet this food deficit, many African governments have initiated both small scale and large-scale rice irrigation projects. This has been achieved through reclamation of arid and semi-arid areas with increased number of cropping cycles per year (Oomen et al., 1994). However, this has brought changes in the ecosystem which have affected the farmers’ health in addition to creating conducive habitats ideal for the breeding of vectors of diseases like malaria and schistosomiasis (Robert et al., 1992). Increased rice
irrigation in Africa has altered the epidemiological pattern of malaria from seasonal to perennial, leading to prolonged transmission and raised disease incidence in indigenous communities (Lindsay et al., 1991; Dolo et al., 2004).

In Kenya, Malaria is a major public health problem with its burden and transmission patterns varying across the country (ROK/MOR, 1998). Approximately 70% of Kenya’s land is prone to malaria epidemics and the disease affects millions of Kenyans each year and accounts for 30% of all outpatients’ attendance and 19% of all admissions into our health facilities (ROK/MOH, 2001). To combat this problem, the Kenya Government through the Division of Malaria Control in the Ministry of Health (MOH) has put more attention towards vector control aimed at minimizing man-vector contact both at household and community level (ROK/MOH, 2001; WHO/RBM, 2002). This study presents results of a cross-sectional household survey was conducted in a rice irrigated ecosystem in Central Kenya with an aim of investigating vector control practices and factors affecting their application both at household and community level.

1.2 Statement of the problem

Malaria control is becoming increasingly difficult particularly due to the high cost and resistance rate of the parasite to the first line antimalarial drugs (WHO/UNICEF, 2003). This has made the Kenya government to put greater attention towards malaria vector control interventions aimed at minimizing the disease burden and reducing dependency on chemotherapy at household level (ROK/MOH, 2001). However, despite these efforts by the government, vector control strategies have not been clearly recognized at community level. In Mwea Division, malaria takes precedence over all other diseases and has continued to have major impact on the economic and well being of the people. Moreover, large numbers of
bloodfed *Anopheles* mosquitoes have been collected indoors which indicates that vector control practices are either not fully utilized or are not technically sound in protecting against mosquito bites in and around human settlements (Mukiama and Mwangi, 1989; Ijumba *et al.*, 1990; Mutero *et al.*, 2000, 2004a).

### 1.3 Justification

Vector control interventions need to be set according to local needs and priorities. However, local needs and priorities are not uniform across communities and methods suitable in one place are not necessarily applicable elsewhere even if the characteristics of the disease and its vectors are unchanged. Moreover, extrapolation of results of other studies may not be possible and if done it may lead to unsustainable interventions. Therefore, integrating the local needs and priorities in malaria vector control forms an important step towards ensuring that the interventions are sustainable and socially feasible. If carefully designed and implemented, vector control interventions should minimize man-vector contact thus resulting to decreased morbidity and mortality. Findings from this study are expected to forms a benchmark for present and future community based malaria vector control interventions in Mwea Division.

### 1.4 Research questions

(a) What is the level of knowledge on malaria transmission and vector control practices in the study are?

(b) What are the currently used vector control methods in Mwea Division?

(c) Which factors determine choice and use of vector control practices both at household and community levels in Mwea Division?

(d) What is the level of community participation in vector control practices in the study area?
1.5 Null hypotheses

(a) Level of knowledge on malaria transmission does not affect use of personal protection practices among the respondents in Mwea Division.

(b) Local peoples’ perceptions on effectiveness of malaria vector control methods do not affect their use in the study area.

(c) Socio-economic factors do not affect community participation in vector control in Mwea Division.

1.6 Objectives

1.6.1 General objective

To establish malaria vector control practices and factors affecting their use in Mwea Division, Central Kenya.

1.6.2 Specific objectives

a) To establish level of knowledge on causes and transmission of malaria in Mwea Division.

b) To determine the level of participation in malaria vector control both at household and community level in Mwea Division.

c) To establish community perceptions towards effectiveness of malaria vector control practices in the study area.

d) To determine factors affecting choice and use of malaria vector control practices in Mwea Division.
CHAPTER 2: LITERATURE REVIEW

2.1 Epidemiology of malaria

During the last two decades, the epidemiological situation of malaria has changed in many
developing countries and the situation is worsening with the spread of drug resistance in the
parasite and insecticide resistance in the vector (Lindsay and Martens, 1998). More evidence
points to significantly increasing malaria morbidity and mortality in Sub-Saharan Africa due
to the development of resistance by *Plasmodium falciparum*. Changes in epidemiological
pattern of malaria has also been attributed to the expansion of agricultural areas resulting in
ecological changes favourable to mosquito breeding (Lindblade *et al.*, 2000).

For transmission of malaria to occur within a community, several conditions must be
fulfilled (Stephens, 1983). There must be:

(a) A proportion of human population which is susceptible to infection and whom
    gametocytes can develop.

(b) Sufficient number of vector(s) which have a preference for human blood or are in a
    situation where their preferred host is absent.

(c) A large proportion of the vectors which must survive long enough for the parasite to
    complete its sporogenic cycle.

(d) Environmental temperature of between 18-30°C and relative humidity of between 60-
    70% or above which must suite both the mosquito and the *Plasmodium*.

The degree and burden of illness attributed to malaria varies substantially between
communities and even between different regions of the same country. Thus, understanding of
malaria epidemiology requires advanced investigation of the complex relationships between
the malaria parasite, the vector, the host and the environment (Bloland *et al.*, 1999).
In Kenya, the pattern of malaria has been shown to vary and is generally affected by factors such as parasite species and strains (Snow et al., 1998), human population dynamics, economic conditions (Mwabu, 1993), mosquito species, climate change (environmental conditions), land-use patterns and breakdown of health services (Wang’ombe and Mwabu, 1993). The land-use pattern in the country has been associated with the provision of mosquito breeding sites resulting in increased numbers of the dominant malaria vector Anopheles arabiensis (WHO/FAO/UNEP, 1990; Githeko et al., 1993). Understanding of malaria epidemiology forms the baseline upon which integrated vector control interventions can be designed and implemented according to local environment.

### 2.2 Clinical features of malaria

Malaria is a febrile illness characterised by fever and related symptoms. However it is not a simple disease of fever, chills and rigors. The incubation period ranges from 7 to 30 days, depending on the malaria parasite (Marsh and Snow, 1999). An illness episode may start with an unspecific symptomatology, usually with an irregularly intermittent fever, accompanied by general malaise, nausea and headache. Typically, a fever phase begins with shaking chills and a rapid rise of temperature ranging from 40°C - 41°C. After a fever-free interval, the cycle of chills, fever and sweating is repeated. In vivax, malariae and ovale malaria, the cycles of chills, fever and sweating are most evident. In all three forms, the illness develops but rarely has severe or fatal consequences. Early and late reactivations of liver stage parasites are relatively common and may occur at irregular intervals up to 2 years for P. vivax and 5 years for P. ovale, respectively. The least virulent is malaria quartana (P. malariae) which shows up at a 72 hours periodicity with fever phases of 4 to 5 hours. Late recrudescence of persistent blood stage parasites is possible after 3 to 10 years, in extreme cases up to 50 years, and
causes recurrent febrile episodes. In partially immune patients and people who have been taking prophylactic drugs, the clinical manifestation for a malaria episode may easily be confused with other febrile illnesses. The most pathogenic and dangerous malaria is provoked by *P. falciparum*, often with irreversible or fatal consequences. Its symptomatology is extremely diverse and inherently ambiguous, making a differential diagnosis based on the clinical presentation difficult. Frequent signs and symptoms are fever, headache, joint pain, dizziness, nausea, vomiting and diarrhea. Irregular or continuous fevers are most usual, but occasionally fever might be absent, even in acute phases. The diffuse, varied clinical picture and rapid progress from uncomplicated to complicated malaria makes early diagnosis and prompt treatment absolutely essential (Warrell, 1993).

### 2.3 Laboratory diagnosis of malaria

The most widely used diagnostic technique is the microscopic screening of blood slides for parasites. Usually a thick and thin smear of finger-prick blood is prepared on a glass slide stained and examined. While the thick smear provides results with an increased sensitivity due to the relatively large volume of blood, the thin film permits one to quantify the blood infection rate and to determine the malaria species (Gilles, 1993). Important drawbacks of laboratory diagnosis includes the costs of the test materials, maintenance of the technical equipments and lack of skilled technicians who are able to read the slides correctly (Trape, *et al.*, 1985). Another problem is that in high transmission areas, where the development of semi-immunity among the population is significant, there is no direct association between infection and disease. Greater parts of the population can carry parasites in their blood without clinical manifestations of malaria (Gilles, 1993). Therefore, repeated examinations would be required.
2.4 Global distribution of malaria vectors

The medical importance, behaviour and distribution of malaria vectors vary depending on the geographical region. Major regions includes:

Table 1: Regional distribution of malaria vectors

<table>
<thead>
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<th>Region</th>
<th>Major species</th>
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<tbody>
<tr>
<td>a Mexico and Central America</td>
<td><em>Anopheles albimanus</em>, <em>Anopheles albitars</em>, <em>Anopheles aquasalis</em>.</td>
</tr>
<tr>
<td></td>
<td><em>Anopheles darlingi</em>, <em>Anopheles punctimacula</em> among others (Lacey &amp; Lacey, 1990).</td>
</tr>
<tr>
<td>b South America</td>
<td><em>Anopheles albimanus</em>, <em>Anopheles albitars</em>, <em>Anopheles aquasalis</em>.</td>
</tr>
<tr>
<td></td>
<td><em>Anopheles darlingi</em>, <em>Anopheles punctimacula</em>, <em>Anopheles bellator</em>,</td>
</tr>
<tr>
<td></td>
<td><em>Anopheles cruzii</em> among others (Pant et al., 1981).</td>
</tr>
<tr>
<td>c Africa south of the Sahara</td>
<td><em>Anopheles gambiae</em> complex (<em>Anopheles gambiae</em>, <em>Anopheles arabiansis</em>,</td>
</tr>
<tr>
<td></td>
<td><em>Anopheles quadriannulatus</em>, <em>Anopheles bwambae</em>, <em>Anopheles melas</em>,</td>
</tr>
<tr>
<td></td>
<td><em>Anopheles merus</em> and <em>Anopheles finestus</em> complex) (Gillies and de Meillon, 1968).</td>
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<td>d North Africa and the Middle East</td>
<td><em>Anopheles atropavus</em>, <em>Anopheles claviger</em>, <em>Anopheles pharoensis</em>,</td>
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<td></td>
<td><em>Anopheles sacharovi</em>, <em>Anopheles stephensi</em> and <em>Anopheles sergentii</em></td>
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<td></td>
<td>(Service, 1986b).</td>
</tr>
<tr>
<td>e Indian Subcontinent</td>
<td><em>Anopheles culicifacies</em>, <em>Anopheles fluviatilis</em>, <em>Anopheles minimus</em>,</td>
</tr>
<tr>
<td></td>
<td><em>Anopheles stephensis</em>, and <em>Anopheles sundaicus</em>.</td>
</tr>
<tr>
<td>f South-East Asia</td>
<td><em>Anopheles aconitus</em>, <em>Anopheles culicifacies</em>, <em>Anopheles hyrcanus</em> group,</td>
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<tr>
<td></td>
<td><em>Anopheles sinensis</em>, <em>Anopheles umbrosus</em>, <em>Anopheles maculates</em>,</td>
</tr>
<tr>
<td></td>
<td><em>Anopheles minimus</em>, <em>Anopheles subpictus</em> among others (Cowper, 1988).</td>
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</table>

Any malaria vector control program need to incorporate information of vector distribution in order to identify control techniques that would be effective, affordable, and acceptable to local communities.
2.5 **Biology and ecology of malaria vectors**

Most *Anopheles* mosquitoes are nocturnal in their bloodfeeding activities and oviposition normally occurs in the evening and at night or in the early morning (McCrae, 1984). Some species bite mainly outdoors, others bite indoors and rest in houses before and after biting whereas others will rest outdoors during which bloodmeal digestion and maturation of ovaries takes place (Pates and Curtis, 2005). A gravid *Anopheles* lays some 50-200 boat-shaped eggs which hatch within 2-3 days depending on the temperature of the day. The larvae are surface feeders and they feed on yeasts, bacteria, protozoa and numerous microorganisms found in the water (Service, 1993b). Larval habitats vary from large water bodies for example rice fields to small collections of water (Mutero *et al.*, 2004b). *Anopheles* larvae are usually absent from habitats that contain rotting vegetation or contaminated with feacal matter (Service, 1986b). A good knowledge and understanding of the characteristic feeding, resting and breeding behavior of the malaria vector forms an important background in decision making. It helps in selective application of control interventions suitable to specific characteristic in relation to time, host and place. It also helps ensuring sustainability and integration of various control methods with minimum use of available resources.

2.6 **Malaria vector control strategies**

2.6.1 **Use of bednets**

An attractive alternative option for malaria control is the use of untreated nets. It was practiced for many centuries as early as the 6th century BC in the Middle East (Lindsay and Gibson, 1988). Untreated nets have shown considerable protection provided the nets are properly tucked in, maintained in good condition and sufficiently large so that user(s) does (do) not make contact with the net (Lindsay *et al.*, 1989). Untreated nets can be enhanced by impregnating them with insecticides to improve their efficiency in killing or repelling
potential vectors. Other fabrics like curtains, hammocks, eave strips, papyrus mats and cloth can also treated with insecticides to repel and reduce human-vector contact (Curtis et al., 1990). In some previous large scale trials, insecticide-treated nets (ITNs) have been proved to have a high efficacy in reducing mortality and morbidity from malaria in African children. These studies have confirmed the efficacy of ITNs in Africa with 17%, 25% and 33% protective efficacy in Ghana, Kenya and The Gambia respectively (D’Alessandro et al., 1995; Binka et al., 1996; Nevill et al., 1996). ITNs have also been shown to reduce malarial episodes by 50% and reduce mortality from all causes by up to 20% in Africa (Lengeler and Snow, 1996). In Kenya, an intensive five-year effort by PSI program, launched in 2002 with funding from the British Department for International Development (DFID) has dramatically increased malaria awareness and net usage among pregnant women and children under five years (PSI, 2004).

2.6.2 Use of repellents

Repellents are substances applied to the skin, clothing or mosquito nets to repel and prevent mosquitoes from biting (Onari, et al., 1993). They have been widely used traditionally to keep mosquitoes and other arthropods away from homes. A number of synthetic repellents have been developed with a protection duration of 2-10 hours. Repellents are normally applied to exposed areas of the skin taking care to avoid the eyes. They are normally in the form of oils, creams or aerosols and provides temporary protection. Plant repellents exert their control influence through the potent constituents contained in their tissues especially the foliage. Such repellents include the Neem (Azadirachta indica). Some can remain effective for several hours to several weeks or even months (Service, 1986b). Repellents can help to minimize man-vector contact in the early evening before people retire to bed or the early morning
before sunrise when people are not protected by other methods like bednets (Katsuyama et al., 1997).

2.6.3 Indoor residual house spraying

This method was responsible for the success of malaria control in the 1950s and 1960s and malaria was almost eradicated in many parts of the world. It involves application of water dispersible powders or residual insecticides to the interior surface of walls (Service, 1986a). When applied in the right circumstances this method reduces the vector lifespan, vector population size and the number of human bitten thus reducing malaria transmission (Curtis and Mnazava, 2000). The duration of residual activity of insecticidal compounds and their formulations depends on the intrinsic persistence of the chemical and also on its biological action on the target insect. A residual insecticide should have; (1) high biological activity against the vector species (2) fairy rapid kill, after a brief contact with the toxic surface, (3) low acute or chronic toxicity on humans, domestic animals and environment (4) good stability on storage, easy formulations and application, and (5) low cost and economy in use. The use of residual insecticide has been successfully used in the control of malaria and mosquitoes in many parts of the world. For example: in Pare-Taveta scheme along the United Republic of Tanzania-Kenya border, and in the islands of Zanzibar and Pemba, house spraying reduced the population of Anopheles funestus to undetectable levels (Delfini, 1969). During the same spraying period, a reduction in the percentage of outpatients positive for malaria was recorded at health facility in Zanzibar (Delfini, 1969). In Kisumu, Kenya, 43.5% reduction in malaria incidence was recorded for all age groups after a WHO sponsored trial of spraying in 1970s (Bradley et al., 1991).
2.6.4 Larviciding

Larviciding involves application of chemicals to the water surface or to the breeding sites to kill mosquito larvae (Service, 1986a). They either act as stomach poisons when ingested by the larvae while feeding or as stomach contact (Rozendaal, 1997). The earliest insecticides to be used in mosquito control were essentially inorganic chemical like Paris green and petroleum oils (Service, 1986b). When applied on the water surface, oil penetrates into the trachea of the larvae and kills them either by suffocation or by poisoning. Paris green is an insoluble microcrystalline green powder which floats in water surface. It is dispersed in the form of dust and it is mixed with substances like powdered charcoal, or some other locally available materials. Currently with the development of highly effective and reasonably safe organophosphorus and other larvicidal compounds, the use of paris green has markedly reduced (WHO, 1984). Most larvicides are available in several formulations like wettable powder, suspension concentrate, emulsifiable concentrates, granules, pellets and briquettes (Rozendaal, 1997). Application of larvicide must be repeated at intervals corresponding to the development cycle of the targeted vector (WHO, 1984).

2.6.5 Housing design

Poor housing and living condition is a contributor to major vector borne diseases in most developing countries (Gamage-Mendis et al., 1991). Certain types of housing may lead to high level of exposure to infections from the disease vectors (Greenwood, 1989). Greater exposure to the outdoors due to lack of windows or screens for example, may increase contact between an individual and the mosquito vector. Similarly, the presences of particular structural features that limit contact with the mosquito vector are likely to reduce infection. Housing characteristics and the position of the house in relation to vector breeding sites influences the level to which inhabitants are exposed to infection(s) and also the degree of
effectiveness of control interventions (Schofield et al., 1991). Mosquito-proofing dwellings by covering windows, eaves, and doors with screening and repairing cracks and holes by which mosquitoes enter can reduce transmission both by protecting people from bites and by preventing the spread of the disease from infected human reservoirs. It is important, however, that such improvements do not impede ventilation unless the house is air-conditioned. Screening and general housing improvements may reduce malaria transmission while raising overall living conditions. In rural Gambia for example, Lindsay and Snow (1988), found that children sleeping in houses with closed eaves and metal roofs experienced fewer malaria infections than children sleeping in houses with open eaves. In Sri Lanka, Gamage-Mendis et al. (1991) argued that the housing type is a more important determinant of variability in malaria risk.

2.6.6 Environmental management (EM)

Environmental Management operates by regulating the general environment to ensure that production and survival of mosquitoes is controlled (WHO, 1982b). There are three major approaches of Environmental Management: (1) Environmental modification, (2) Environmental manipulation and (3) Modification of human habitations. Environmental modification includes permanent changes such as landscaping, land reclamation and other vector control activities aimed at preventing, eliminating, or reducing mosquito breeding habitats on a relatively permanent basis such as drainage and land filling (Ault, 1994). Environmental manipulation entails recurrent or periodic measures that produce temporary conditions unfavourable to larval production. These activities include regulation of water levels, intermittent irrigation (Mutero et al., 2000), and operations such as removing weeds from irrigation/drainage canals (Keisser et al., 2002), removal of vegetation, stream flushing, emptying and destruction of discarded containers in the compound. In Malaysia and Sri
Lanka, the breeding of malaria vector *Anopheles maculatus* in streams, and outbreak of malaria was effectively controlled by periodic flushing of small dams with siphons and sluice gates (Onari *et al.*, 1993), and in USA (Tennessee Valley) and Sudan (Blue Nile Project), intermittent raising of and lowering of water levels, and the use of saltwater, marsh drainage, ditch clearing and other source reduction measures have been successfully used in larval control of malaria vectors (WHO, 1995).

In Japan and Kenya, Mogi (1988) and Mutero *et al.* (2000) reported high net loss of mosquito larvae in ricefields without significantly affecting rice yields in comparison to other treatments. Environmental Management is not intended to replace other control strategies, rather it should provide a basis on which other methods can be integrated in a complementary fashion.

2.6.7 Biological control

2.6.7.1 Use of predators

Predatory fish that eat mosquito larvae have been used for mosquito control for at least 100 years (Meisch, 1985). The most commonly used larvivorous fish are species of the genera *Gambusia poecilia, Sarotherodon* (Tilapia) and *Panchax* (Rozendaal, 1997). *Gambusia affinis* has been mass produced and distributed since before the turn of the 19th century and is now considered as the most widely fish species. It has been utilized in Spain, Italy, Greece, India, Malaysia, Georgia and Africa (Zahar, 1984; Rozendaal, 1997). For example, in Somalia, the use of larvivorous fish *Oreochromis spilurus spilurus* was successfully used to eliminate breeding of *Anopheles arabiensis* in an area where a malaria epidemic occurred (WHO, 1982a; Zahar, 1984). In rural areas, fish may be appropriate components of malaria control if breeding sites are well known and limited in number, but use of fish may be less feasible
where natural breeding sites are extremely numerous. Other predators of mosquito larvae and pupae include tadpoles of frogs and toads (Service, 1986a).

2.6.7.2 Pathogens

The most promising candidates for microbial control of mosquitoes are two bacteria: *Bacillus thurigiensis* var. *israelensis* (Serotype H-14) and *Bacillus sphaericus* which are easy to mass-produce and formulate into various forms (Lacer and Lacer, 1990). *Bacillus thurigiensis* var. *israelensis* (Bti) is a potent gut poison when ingested by mosquito larvae, and are harmless to non-target organism and the environment (Onari *et al.*, 1993; Tiayun and Mulla, 1999). It can be easily and safely applied as a biological larvicide in waters for domestic supply or for irrigation of food crops (Rozendaal, 1997). *Bacillus sphaericus* also produce toxins in its spore envelopes and is more potent and more specific to various mosquito larvae and has longer action than Bti. Its formulation contains living bacteria which can multiply even in polluted waters which are preferred by *Culex* mosquitoes (WHO, 1982a). The use entomopathogenic bacteria for mosquito control has been experimented in irrigated rice fields in Kenya (Asimeng and Mutinga, 1993).

2.6.7.3 Use of aquatic fern *Azolla*

*Azolla* is a free-floating aquatic fern that lives in symbiotic association with species of blue alga, *Anabaena azolla*. In favourable conditions, this aquatic fern grows rapidly and has the ability to fix nitrogen in rice fields (Lu, 1988a). It is a useful biological control agent in a heavily managed or human-made aquatic ecosystem such as rice fields. It can provide a partial control of mosquitoes and a useful source of fertilizer or green manure (Lu, 1988b; Lacer and Lacer, 1990).
2.6.8 Zooprophylaxis

Zooprophylaxis is the use of wild or domestic animals which are not the reservoir of host of a given disease to divert the blood-seeking mosquito vectors from the human host of that disease (WHO, 1982a). There are two types of zooprophylaxis: active and passive. Active zooprophylaxis is the deliberate deployment of domestic animals as a barrier between mosquito breeding sites and human settlements, while passive zooprophylaxis is the serendipitous reduction in malaria, purported to occur when cattle density increases within a community (Bouma and Rowland, 1995). In some areas, zooprophylaxis could be an effective way for communities and individuals in reducing their exposure to biting insects and the transmission of diseases (English, 1989). However, some mosquitoes may carry the disease from animals to humans thus making the situation worse rather than better (Wada, 1989).

Both active and passive zooprophylaxis have been attributed to decline of man-biting mosquitoes as well as lowering malaria prevalence and incidences in most parts of the world (Shultz, 1989). In India, for example, malaria epidemics used to be linked with decrease of cattle as a result of severe drought in one year followed by heavy rains in the next, creating abundant mosquito breeding sites (Cragg, 1923). Also in British Guyana coastal area, Giglioli (1963) reported community sufferings from an increase in bites and disease transmission because cattle and other animals were removed and blood sucking animals were left with only people to feed on. In another study on malaria and agroecosystems, Mutero et al. (2004a), associated zooprophylaxis with low malaria prevalence rate in some villages in Mwea Irrigation Scheme. However, the interactions between the vector mosquito, man, environment and the domestic animal need to be locally studied carefully before this method can be sustainably and appropriately implemented.
2.6.9 **Health education**

Health education is a combination of learning activities that promote adaptations in health related behaviour. Its goal is to help people learn and help themselves solve health related problems. It is a combination of planned learning activities that enable people to behave in ways that promote health, prevent diseases and recover from illness (Green *et al.*, 1980). The learning strategies include social support, acquisition of knowledge, skills and resource development. Health education should aim at capacity building not only the control or elimination of a health problem. It should also not be perceived by local people as a scheme imposed from outside but as something they have helped create (El Katsha and Watts, 1994). Full and active involvement of individuals, communities and organization is required in defining needs, setting priorities, planning, implementing and evaluating programmes. The form of health education may differ according to; the specific aims of the programme, the particular characteristics of the locality and the media through which health education is disseminated. The education should demonstrate the value of learning from the people through a process that enables, encourages, supports and facilitates but does not impose (Brieger, 1996). It should provide the local people with an opportunity to experience what they can do with their own resources in order to effect change in health and health related issues. Community should be involved in all phases of planning and efforts should be made to ensure that the designed programmes fit into the local socio-cultural and economic context (Brieger, 1996).

2.7 **Challenges facing malaria vector control interventions**

2.7.1 **Community perceptions on malaria aetiology**

The perception of malaria aetiology on the part of the population is one of the most critical factors in determining if the disease will be identified early, treated promptly and effectively
prevented or controlled. Several studies have tried to explore the understanding of malaria and the vector in different parts of the world particularly in Africa and Latin America (Reubush et al., 1992; Service, 1993a; Aikins et al., 1994). They have explored the gaps in knowledge about malaria and “folk illnesses” that overlap with the biomedical definition of malaria. In many endemic areas, while the specific types of fever or malaria symptoms are known, their causes are not associated with the mosquito. A wide range of other causes of malaria are given in different areas. In The Gambia and Kenya, for example, other causes given are: colds, rains, drinking too much fresh cows’ milk in the rainy season, eating mangoes and sometimes the evil spirits, weather changes (Ongore, et al., 1989; Aikins et al., 1994; Munguti, 1998). Another study from Ghana reported that malaria is perceived as an environmentally related disease caused by excessive contact with external heat which upsets the blood equilibrium, and that many community members did not connect it with mosquitos in theory or practice (Agyepong, 1992). In Tanzania and Burkina Faso, virulent fevers with convulsions during childhood were often interpreted as resulting from attacks by spirits which assumed the form of a bird referred to as degedege in Tanzania and kono in Burkina Faso (Winch et al., 1996; Okrah et al., 2002). Malaria control interventions should be well adapted to take into account local customs, habits and beliefs.

2.7.2 Lack of technically sound vector control interventions

Malaria vector control intervention need to be technically, economically and socially sound. Technical soundness implies that the interventions should stop vector breeding while social soundness implies that they should take into account local customs and habits. Economic soundness implies that community resources can provide labour and material cost even if external financial help is received for capital costs (Stevens, 1984). Lack of economic soundness in terms of support labour, materials, and recurrent costs of any control programme
is subject to failure. However, implementing a technically and socio-economically sound control programme is expensive and requires specialized skills and efficient organization.

2.7.3 **Inadequate information on malaria prevention and control**

Knowledge and information on the part of consumers can severely influence the demand for preventive services. For instance, while in many places there is demand for untreated mosquito nets, there is not yet demand for insecticide treatment because of low level of knowledge about its effectiveness in malaria prevention (Adongo *et al*., 2005). The information problem is more pronounced for insecticide than for nets as it is not immediately obvious to consumers how the insecticide retreatment improves the effectiveness of the net. Consumers are also often unaware that pregnant women and young children are particularly vulnerable to malaria, and will therefore benefit most from using some interventions like ITNs. This lack of information, combined with the intra-household allocation of power and authority, means that the household members most in need are often least protected (Ettling, 1994). Good information on the suitability of different specific measures is often not locally available.

2.7.4 **Socio-economic factors**

Socio-Economic Status (SES) influences choice, use and coverage of any intervention. The poor, for example are less likely to use preventive measures, especially the most effective ones. When they choose to invest in malaria prevention and control, they suffer a greater relative burden of this expenditure (total household expenditure) and its opportunity cost. Generally, the level of expenditure on prevention methods is positively correlated with income, wealth or other proxy measures of SES such as occupation. Mosquito nets, for example are relatively expensive items and the average household will need to purchase more
than one net to cover all beds/sleeping mats. A study in Malawi by Ettling (1994), found that expenditure on malaria prevention was positively correlated with income. Ten percent of all households and only 4% of very low income households reported expenditure on malaria prevention in the previous month. In Malawi, Ziba et al. (1994), found that an increase in household income and men’s level of education attained was strongly correlated with the use of malaria prevention and control methods. A similar picture regarding the relationship between SES and malaria prevention was reported in Malawi by Holtz et al. (2002) where use of ITNs was found to be lower in rural (poorer) compared to urban (less poor) households. Poverty appeared to be the most important barrier to net use where more than 80% of households without a net reported "lack of money" and 13% reporting that they could not afford them. In Burkina Faso, a Focus Group Discussion (FGD) revealed that high cost was the most frequently stated reason for not owning nets (Okrah et al., 2002). And in Afghanistan, scarcity of financial resources compromised both the ability of most families to obtain preventive means (Howard et al., 2003). Seasonality of availability of financial resources can also influence spending for preventive measures. In an ITN social marketing project in Tanzania, people reported that they were obliged to wait until harvest season when cash was available to purchase nets (Hanson and Jones, 2000). These studies suggest that a threshold level of wealth exists where it becomes possible to invest in prevention to save on treatment (Howard et al., 2003).

2.7.5 Limited physical access to preventive interventions

Limited physical access to preventive interventions also restricts their demand at household level. Households may have to travel long distances to get to health facilities, incurring both time and travel costs, and the distance to places where mosquito nets are sold. Low net coverage and low retreatment rates of nets for instance may be due to the inaccessibility of
market places and retreatment points, and the inconvenience associated with communal retreatment, where villagers are asked to bring their net to a central location to be treated. There is also evidence that people are uncomfortable bringing dirty nets to a public place to be treated (Winch et al., 1997).

### 2.7.6 Insecticides resistance

One factor contributing to decreased acceptance of insecticide spraying by the community is the development of resistance by the mosquitoes (Kasap et al., 2000) and the killing of other non-target organisms. The main impact of resistance in the vector is to decrease efficacy (if the same compound is used despite resistance) or to increase the cost (if there is a switch to a more expensive compound). Vector resistance to DDT and to other residual insecticides has been a major problem in South Asia, some parts of Southeast Asia, and some parts of Latin America (WHO, 1984, 1995). Since an effective spraying programme requires strong managerial capacity, especially in relation to the timing of the spraying round relative to the transmission cycle, governments will need to be realistic about their capacity to mount an intervention of this organizational complexity.

### 2.7.7 Cost-effectiveness of control interventions

Community determines the success of any malaria control intervention by its impact in reducing the vector population or by its impact in reducing vector breeding habitats (Stephens et al., 1995). According to Last (1995), an intervention has an impact at two levels: community and individual. Community effectiveness is the impact of the intervention on the overall death rate in the community. On the other hand individual effectiveness measures the reduction in disease or death risk that a compliant can expect compared to non-compliant. There are two types of costs incurred in disease control programmes: (1) cost incurred in the planning,
implementation, monitoring and evaluation of the programmes, (2) costs which results from ill
health in areas where health services cannot provide sufficient preventive or protective
measures (WHO, 1995). A solid knowledge of the vectors and malaria epidemiology is crucial
in choosing the right intervention. Cost-Effectiveness may be diminished if interventions are
inappropriately timed in relation to the transmission season (Mills, 1992).

2.7.8 Lack of active community participation
Community participation is defined as the right of people to participate individually and
collectively in the planning and implementation of healthcare (WHO, 1978). The declaration
conceptualised a community to be a cohesive unit of individuals bound by characteristic
economic, socio-cultural and political relationship (Jewkes and Murcott, 1996). Community
participation is a means by which people meaningfully participate in different levels of
development and are empowered to have autonomy over their health care (Woelk, 1992; Zakus
and Lysack, 1998). Integrating community participation into vector control programmes is
complex because social, political, economic, cultural factors among others vary across the
community. People and communities are not the same everywhere and the understanding
people have for a particular community may not be applicable to other communities elsewhere.
In most times, communities are compelled to implement poorly designed and socially
unacceptable strategies, which are determined independently of them. Such control
interventions normally results to lack of community rapport and trust (WHO, 1987; 1995). The
level of community participation is sometimes determined by, the community level of
knowledge, time, financial support, leadership structure, availability of resources and
compatibility with the local customs and beliefs (Pinikahana, 1992; Winch et al., 1997).
Therefore, interests and concerns of all members of the community need to be addressed
properly and incorporated during design and implementation of malaria control programmes.
CHAPTER 3: MATERIALS AND METHODS

3.1 Study area

3.1.1 Mwea Division

The study was conducted in Mwea Division, Kirinyaga District, Central Kenya. The Division is located approximately 100 km North East of Nairobi in a riverine plain several kilometers South East of Mt Kenya, at an altitude of about 1159 m above sea level (Fig 1). During the 1999 census, the division had a population density of 246 persons per square kilometre and a total area of 581Km$^2$ consisting of gently rolling plains and isolated hills which forms part of Tana river basin (ROK, 2002). The low-lying landscape in the southern side provides a gentle slope that facilitates rice irrigation by gravity flow in Mwea irrigation scheme (Plates 1). The scheme was started in 1954 and gradually expanded to about 5,830 hectares in 1973 and 13,640 hectares in early 1990s, and became the largest rice growing scheme in Kenya. On average, it contributes about 75%-80% of Kenya's rice production annually (Wanjogu et al., 1995).

Plate 1: Low-lying landscape of Mwea scheme facilitates rice irrigation by gravity flow.
Fig 1: Map of Mwea Division in Central Kenya. The arrows show the four villages selected for the study.
Source: Mutero et al., 2004a.
Mwea Division has scattered homesteads with high concentration of villages in the rice growing schemes leaving large tracks of land for rice growing. It has the highest poverty prevalence in Kirinyaga District which is attributed to the characteristic semi-arid conditions of the area and the land tenure system which renders many people landless in rice growing areas in the scheme.

3.1.2 Climatic conditions of the study area

Mwea division has tropical type of climate with two rainfall seasons. The long rains occurs from March to May and the short rains occurs from October to November. The amount of rainfall declines from the high altitude towards the semi-arid zones in the eastern part of the division which is a low potential area. Evapotraspiration is highest in the lower zone of the division which has resulted to low food production. The annual rainfall varies from a maximum of 1,625 mm to a minimum of 356 mm, averanging 950 mm/year. The highest recorded temperatures ranges between 28-29°C which occurs during the hottest season of the year ie between January-February and August-September. Average temperatures are in the range of 16-26.5°C and the relative humidity varies from 52-67% (Asimeng and Mutinga, 1993). The above combinations of temperature and humidity provides suitable and ideal conditions for rapid development and survival of both the malaria vector and *Plasmodium* parasite in the division.

3.1.3 Agricultural activities

The main economic activity in Mwea division is rice growing and horticultural farming. Most of the incomes are earned from agricultural production and wage employment in both informal and formal sectors (ROK, 2002). Most of the land is covered by black cotton soils
which is suitable for rice irrigation (Plate 2). The main food crops grown in the division includes maize, beans, potatoes, and bananas while rice, tobacco, cotton and horticulture (Tomatoes and french beans) forms the main cash crops. Indigenous cattle are kept mainly for beef production and draught power during ploughing and levelling of flooded rice paddies before transplanting. Due to the fast growing human population and the ever increasing demand for food in the division, rice production has become increasingly important. As a consequence, the heceterage under rice cultivation and numbers of cropping cycles have increased tremedously. There are concerns that the increased introduction and expansion of irrigated rice in the division would enhance favourable conditions for propagation and development of vector mosquitoes. Cattle keeping and rice irrigation has been identified as the key agroecosystem factors determining local variations in Malaria prevalence (Mutero et al., 2004a). The potential mosquito breeding habitats in the area are; rice fields, feeder canals (Plate 2), temporary pools formed from rain, runoffs, overflowing canals, wheel ruts and puddles resulting from footprints of the workforce (Asimeng and Mutinga, 1993; Mutero et al., 2000).

Plate 2: Rice paddies and feeder canals which are potential breeding habitats for Anopheles mosquitoes in Mwea irrigation scheme.
3.2 Study population

The study subjects comprised of males and females heads of households and key informants from selected villages. Most of the inhabitants in the study area live mainly in traditional style houses with mud walls, corrugated iron roofs and unscreened windows and eaves. The unscreened windows and large open unscreened eaves provide easy access for the *Anopheles* mosquitoes (Mukiama and Mwangi, 1989).

3.3 Inclusion criteria

The study included male or female heads of households/representatives aged 18 years and above from the selected households in the study villages.

3.4 Exclusion criteria

Persons outside the study villages were excluded from the study. Also, all persons who were not head of household/spouse and were below eighteen years old were excluded from the study because they were assumed not to be responsible for making final judgements for the treatment and prevention of malaria in the households.

3.5 Study design

The study involved a combination of both qualitative and quantitative cross-sectional survey conducted in April 2005. This method was chosen because it costs less and was regarded as more feasible in the relatively short time available for the survey than other study designs.

3.6 Sampling procedure

Mwea Division was conveniently selected because of its high burden of malaria in Kirinyaga District. The four study villages were purposefully selected in order to represent the socio-
economic and geographical diversity within irrigated and non-irrigated areas. A standard sample size of 100 individual households was randomly selected from each village. This was meant to compensate for any nonresponse from some residents/individuals households. To create a framework of gender integration, at least 20% of the randomly selected sample comprised of female-headed households from each village.

3.7 Sample size determination

The study sample size was determined by use of Fisher et al. (1998) formula because the study population in Mwea division exceeds 10,000:

\[
\begin{align*}
\text{n} &= \frac{Z^2 pq D}{d^2} \\
\text{n} &= \text{Sample size} \\
Z &= \text{Standard normal deviation which corresponds to 95% confidence interval.} \\
P &= \text{Proportion of target population estimated to have malaria} = 0.24 \text{ (Mutero et al., 2004a)} \\
q &= 1-p = 0.76 \\
D &= \text{Design effect} = 1 \\
d &= \text{Degree of accuracy desired} = 0.05
\end{align*}
\]

Therefore:

\[
\text{n} = \frac{1.96^2 \times 0.24 \times 0.76 \times 1}{0.05^2} = 280 \text{ (Minimum sample 280)}
\]

3.8 Data collection techniques

Interviews using structured questionnaire were held in April 2005, with randomly selected individual heads of households (or spouse) from the four study villages (Plate 3). The
questions focused on various sub-themes (Appendix II). Direct observation of the home and the surrounding environment was made during interview time in order to gather information on housing design and place of residence in relation to the major mosquito breeding sites like rice paddies and rainwater puddles. Questionnaires were prepared in English and verbally translated into the local language (Kikuyu) during interview time. Thirteen field assistants were trained on questionnaire administration for two days (Plate 4). During the training, each part of the questionnaire was interpreted into the local language and corrections were made accordingly. Pre-testing was done in a non-study village and adjustments were made before administration.

Plate 3: A research assistant administering questionnaire in one of the study villages.

Two focus group discussions were held in each village with randomly selected individual household members. The purpose of this was to compare and gather more descriptive information on community's knowledge, attitudes and practices towards malaria.
3.9 Knowledge and perception indices

Levels of knowledge of the respondents on various sub themes were developed. Sub themes included; symptoms and signs of malaria, breeding places of the vector, prevention and control of the disease. Respondents who scored more than 70% on each sub-theme were classified as having high level of knowledge. Those who scored between 40-60 percent were classified as having average level of knowledge while scores below 40 percent were classified as low. Respondents’ perceptions on effectiveness of various control practices were determined by prompting the respondent to classify each of the practiced method as; effective, not so effective or not effective at all.

3.10 Ethical consideration

Clearance for the study was obtained from Kenyatta University, Ministry of Education and Ministry of Health. The questionnaire was administered after explaining purpose of the study and criteria used to select each respondent. Informed verbal and written consents were obtained from the focus group participants and the household heads. Confidentiality of information was maintained during the whole study.

3.11 Data management and analysis

Data was recorded and processed using Statistical Package for Social Science (SPSS) version 11.5 for windows, MS Access and MS Excel. Association between dependent variables (Knowledge, Attitudes and Practices) and independent variables (Socio-demographic and socio-economic factors) were measured by use of Cross Tabulation and Chi-square test. Data was summarized using measures of central tendency (frequency mean, mode and median).
CHAPTER 4: RESULTS

4.1 Demographic characteristic of the respondents

During the cross-sectional survey, 368 respondents were successfully interviewed. They consisted of 127 (34.5%) males and 241 (65.5%) females. The ages of the respondents ranged from 18 to 92 years. Majority of the respondents were protestants and formed 55% of the total sample followed by catholic (44%; Figure 2).

![Fig. 2: Religion of the respondents]

Sixty five percent (65%) of the respondents were married, 17.1% widowed, 8.2% single and 6.3% were separated at the time of interview. In terms of occupation, 74.5% of the respondents were farmers, 7.3% were in self business, 4.9% in formal employment and 13.3% in other minor occupations like casual labour (Fig 3). Murinduko village reported the highest number of respondents with other occupations like casual labour.
Forty percent (40%) of the respondents had only completed primary education and 18.2% had dropped out at primary school level with 19.8% having informal education (Fig 4). There was significant difference in the level of education of the respondents between the four study villages ($\chi^2 = 38.3; \text{df } 18; P=0.004$).
4.2 Respondents' perception on common illnesses

Malaria was perceived to be a major public health problem in the study area. In total, 92.9% of respondents rated malaria as one of the most frequently occurring disease among all other ailments. In order of priority, typhoid was rated second (38%) and bilharzia third (10.3%). However, there was an observed variation between irrigated and non-irrigated villages in ranking the third-most frequent occurring disease (bilharzia) in the study area (Table 2).

Table 2: Respondent’s ranking of common illnesses

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<thead>
<tr>
<th>Ranking</th>
<th>All villages (n=368)</th>
<th>Irrigated Villages (n=185)</th>
<th>Non-irrigated Villages (n=183)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>Malaria 92.9</td>
<td>Malaria 88.6</td>
<td>Malaria 97.3</td>
</tr>
<tr>
<td>2nd</td>
<td>Typhoid 38</td>
<td>Typhoid 55.7</td>
<td>Typhoid 20.2</td>
</tr>
<tr>
<td>3rd</td>
<td>Bilhazia 10.3</td>
<td>Bilhazia 20</td>
<td>Common colds 11.5</td>
</tr>
</tbody>
</table>

4.3 Perceived causes of malaria

Mosquito bite was mentioned to be the main cause of malaria by 95% of the respondents. Other non-biological causes mentioned by some respondents were; long rains /being rained on (12.5%), which had a significant difference between the four villages ($\chi^2=24.336$; df 3; $P=0.000$), stagnant water (16%), dirty home surroundings (4.6%), wet and cold conditions (10.6%), eating raw of food/mangoes (5.2%) and taking of dirty or polluted water (4.1%). Significantly, more males (10.5%) compared to females (2.5%) believed that malaria could also be caused by eating of raw food/mangoes ($\chi^2=10.19$; df 1; $P=0.001$). There was no significant difference in the responses between different levels of education of the respondents (Table 3).
Table 3: Perceived causes of malaria

<table>
<thead>
<tr>
<th>Cause</th>
<th>% responses (n=368)</th>
<th>Village</th>
<th>Age</th>
<th>Gender</th>
<th>Education</th>
<th>Occupation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working in the sun</td>
<td>0.8</td>
<td>0.225</td>
<td>0.911</td>
<td>0.966</td>
<td>0.143</td>
<td>0.227</td>
</tr>
<tr>
<td>Long rains/Being rained on</td>
<td>12.5</td>
<td>0.000</td>
<td>0.908</td>
<td>0.709</td>
<td>0.093</td>
<td>0.061</td>
</tr>
<tr>
<td>Wet and cold condition</td>
<td>10.6</td>
<td>0.363</td>
<td>0.715</td>
<td>0.870</td>
<td>0.942</td>
<td>0.275</td>
</tr>
<tr>
<td>Working in rice paddies</td>
<td>3</td>
<td>0.451</td>
<td>0.174</td>
<td>0.930</td>
<td>0.083</td>
<td>0.255</td>
</tr>
<tr>
<td>Mosquito bite</td>
<td>94.6</td>
<td>0.154</td>
<td>0.000</td>
<td>0.914</td>
<td>0.850</td>
<td>0.973</td>
</tr>
<tr>
<td>Eating raw foods/mangoes</td>
<td>5.2</td>
<td>0.000</td>
<td>0.804</td>
<td>0.001</td>
<td>0.443</td>
<td>0.204</td>
</tr>
<tr>
<td>Evil spirit/Demons/Witchcraft</td>
<td>0.3</td>
<td>0.127</td>
<td>0.981</td>
<td>0.644</td>
<td>0.626</td>
<td>0.953</td>
</tr>
<tr>
<td>Taking dirty/Polluted water</td>
<td>4.1</td>
<td>0.081</td>
<td>0.009</td>
<td>0.648</td>
<td>0.210</td>
<td>0.850</td>
</tr>
<tr>
<td>From another person with malaria</td>
<td>0.8</td>
<td>0.479</td>
<td>1</td>
<td>0.687</td>
<td>0.805</td>
<td>0.382</td>
</tr>
<tr>
<td>Stagnant water</td>
<td>16</td>
<td>0.467</td>
<td>0.532</td>
<td>0.430</td>
<td>0.122</td>
<td>0.113</td>
</tr>
<tr>
<td>Dirty home surroundings/Environment</td>
<td>4.6</td>
<td>0.019</td>
<td>0.699</td>
<td>0.689</td>
<td>0.316</td>
<td>0.283</td>
</tr>
<tr>
<td>Don’t know</td>
<td>1.1</td>
<td>0.532</td>
<td>0.000</td>
<td>0.687</td>
<td>0.135</td>
<td>0.846</td>
</tr>
<tr>
<td>Others</td>
<td>2.4</td>
<td>0.001</td>
<td>0.002</td>
<td>0.432</td>
<td>0.404</td>
<td>0.620</td>
</tr>
</tbody>
</table>

The link between malaria and non-biomedical causes was expressed during men and women focus group discussions in all the four villages.

"Fruits like mangoes and tomatoes are bitten by mosquitoes and this cause malaria when eaten by people" (Kagio, Women FGD). "Mosquitoes bite mangoes and injects the germs and when one eats the mangoes s/he gets malaria" (Murinduko Women FGD). "Some people become sick after eating raw food like tomatoes, mangoes and fermented porridge. I think it is the sourness, which makes the germs to become active in the body" (Murinduko and Mbui Njeru Men and Women FGDs).

4.4 Knowledge of signs and symptoms of malaria

The most featured signs and symptoms were headache (70%), feeling cold (65%), with the tendency to bask in the sun or sit near the fire, fever (57%), general body weakness (57%), body/joint pains and vomiting. The level of knowledge on common signs and symptoms of
malaria was average in all the villages. There was no significant difference in the percentage score between the villages \( (\chi^2=6.509; \text{df 6; } P=0.369; \text{ Table 4}) \).

**Table 4: Knowledge score on signs and symptoms of malaria**

<table>
<thead>
<tr>
<th>Village</th>
<th>Scores in percentages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low &lt;40%</td>
</tr>
<tr>
<td>Ciagi-ni (n=96)</td>
<td>29.2</td>
</tr>
<tr>
<td>Kagio (n=103)</td>
<td>35.9</td>
</tr>
<tr>
<td>Mbu-Njeru (n=89)</td>
<td>30.3</td>
</tr>
<tr>
<td>Murinduko (n=80)</td>
<td>38.8</td>
</tr>
<tr>
<td>Total (n=368)</td>
<td>123</td>
</tr>
</tbody>
</table>

**4.5 Perceived group of people at risk of getting malaria**

Malaria was perceived to affect all people in the area irrespective of age, however, 59% and 41.3% of the respondents reported that children under the age of five years and pregnant women respectively are at greater risk. Comparatively, adult men were perceived to be at lower risk than adult women and children (Fig 5).

![Fig 5: Perceived group of people at risk of getting malaria](image-url)
Participants in the FGDs gave various reasons as to why children and pregnant women were perceived to be at a more risk;

"Children are not strong enough and have low resistance (Hawana nguvu)," (Men FGD in Mbui-Njeru). "For pregnant women the treatment given is not strong enough to completely fight the disease. Preventive medicine is also not allowed which puts them at a more risk" (One women FGD participant in Mbui Njeru).

4.6 Problems caused by mosquitoes

In total, 98% of the respondents said that mosquitoes caused trouble in one way or another to their households. Mosquitoes were reported to cause trouble by their nuisance bites by 75.3% of the respondents, while disease transmission was rated second by 64.4% of the respondents (Fig 6). The biting nuisance of the vector was elaborated during the FGDs where the participants said the vectors bite through the clothes;

"It is very hard to escape their bites unless we all fail to go to work and this one cannot be possible because people will get hungry" (Ciagi-ini Women FGD).

![Fig 6: Problems caused by mosquitoes](image-url)
4.7 Knowledge of vector breeding habitats

Presumably as a result of their personal experience with the vector over a longer period of time, 83% of the respondents were aware of at least a major breeding habitat. They said that mosquito breeds in stagnant water found in swamps, hoof prints, wheel ruts and pods. Other mentioned breeding places were; vegetation outside houses (51%), rice paddies (37%), rubbish/latrines pits (16%), water canals (11%) and animal pens (101%). Responses varied significantly between the study villages (Table 5).

Table 5: Knowledge of mosquito breeding places

<table>
<thead>
<tr>
<th>Breeding places</th>
<th>Responses n=366</th>
<th>Village</th>
<th>Age</th>
<th>Gender</th>
<th>Education</th>
<th>Occupation</th>
</tr>
</thead>
<tbody>
<tr>
<td>In stagnant water</td>
<td>83.1</td>
<td>0.233</td>
<td>0.782</td>
<td>0.320</td>
<td>0.054</td>
<td>0.104</td>
</tr>
<tr>
<td>In vegetations outside the house</td>
<td>50.5</td>
<td>0.030*</td>
<td>0.796</td>
<td>0.060</td>
<td>0.042*</td>
<td>0.191</td>
</tr>
<tr>
<td>In rice paddies</td>
<td>37.4</td>
<td>0.000*</td>
<td>0.945</td>
<td>0.016</td>
<td>0.351</td>
<td>0.158</td>
</tr>
<tr>
<td>In water canals</td>
<td>10.9</td>
<td>0.006*</td>
<td>0.345</td>
<td>0.228</td>
<td>0.140</td>
<td>0.235</td>
</tr>
<tr>
<td>In animal pens</td>
<td>10.7</td>
<td>0.001*</td>
<td>0.763</td>
<td>0.381</td>
<td>0.851</td>
<td>0.026*</td>
</tr>
<tr>
<td>Rubbish Pits/Latrines/Cess pits</td>
<td>16.1</td>
<td>0.000*</td>
<td>0.763</td>
<td>0.381</td>
<td>0.851</td>
<td>0.026*</td>
</tr>
<tr>
<td>In dark places</td>
<td>23.2</td>
<td>0.006*</td>
<td>0.727</td>
<td>0.601</td>
<td>0.693</td>
<td>0.535</td>
</tr>
<tr>
<td>Don’t know</td>
<td>1.6</td>
<td>0.673</td>
<td>0.009*</td>
<td>0.567</td>
<td>0.116</td>
<td>0.641</td>
</tr>
<tr>
<td>Others</td>
<td>3.8</td>
<td>0.378</td>
<td>0.056</td>
<td>0.922</td>
<td>0.758</td>
<td>0.699</td>
</tr>
</tbody>
</table>

*Significant

4.8 Personal protection methods known

Ninety three percent (93%) of all the respondents claimed to be aware of at least one method of controlling or protecting against mosquito bite (n=368). Among the personal protection methods known were; use of treated mosquito nets (79%), use of untreated nets (52%), lighting of fire/coils (43%), insecticide sprays (40%) taking preventive medicine (30%), use of traditional methods (18.6%), application of skin repellents (11.9%) and screening windows and doors (5.4%; Table 6).
<table>
<thead>
<tr>
<th>Method</th>
<th>% Known n=354</th>
<th>Village</th>
<th>Age</th>
<th>Gender</th>
<th>Education</th>
<th>Occupation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated mosquito net</td>
<td>52.3</td>
<td>0.000</td>
<td>0.411</td>
<td>0.205</td>
<td>0.725</td>
<td>0.001</td>
</tr>
<tr>
<td>Treated Mosquito net</td>
<td>79.7</td>
<td>0.882</td>
<td>0.006</td>
<td>0.295</td>
<td>0.046</td>
<td>0.729</td>
</tr>
<tr>
<td>Insecticide spray</td>
<td>39.5</td>
<td>0.000</td>
<td>0.869</td>
<td>0.083</td>
<td>0.088</td>
<td>0.699</td>
</tr>
<tr>
<td>Preventive medicine</td>
<td>29.9</td>
<td>0.000</td>
<td>0.749</td>
<td>0.458</td>
<td>0.319</td>
<td>0.169</td>
</tr>
<tr>
<td>Screen windows &amp; doors</td>
<td>5.4</td>
<td>0.017</td>
<td>0.701</td>
<td>0.900</td>
<td>0.335</td>
<td>0.739</td>
</tr>
<tr>
<td>Light fire/Coils</td>
<td>42.9</td>
<td>0.000</td>
<td>0.798</td>
<td>0.430</td>
<td>0.657</td>
<td>0.560</td>
</tr>
<tr>
<td>Skin repellents</td>
<td>11.9</td>
<td>0.000</td>
<td>0.892</td>
<td>0.540</td>
<td>0.068</td>
<td>0.174</td>
</tr>
<tr>
<td>Traditional methods</td>
<td>18.6</td>
<td>0.000</td>
<td>0.345</td>
<td>0.166</td>
<td>0.776</td>
<td>0.100</td>
</tr>
</tbody>
</table>

Table 6: Personal protection methods known

4.9 Personal protection methods applied

4.9.1 Use of bednets

Seventy five per cent (75%) of the respondents reported to own a bednet during the time of the interview. Of these, 62% were insecticide treated and the remaining 38% were untreated (Fig 7).

![Bednets Condition](image)

Fig. 7: Condition of bednets used in the study area

There were significance differences in reported use of treated mosquito nets between different socio-demographic profiles of the respondents like occupation ($\chi^2 = 7.955; df 3; P=0.047$),
gender ($\chi^2=4.254; \text{df 1; } P=0.039$), levels of education ($\chi^2=33.622; \text{df 6; } P=0.000$) and marital status ($\chi^2=19.593; \text{df 3; } P=0.000$).

### 4.9.1.1 Perceived benefits of bednet use

Among the respondents who reported bednets use, 95% cited protection against mosquito bite as the main reason for sleeping under bednets. Protection against malaria was mentioned second by 54% of the respondents ($n=300$). Other reported benefits of using bednet were protection from other nuisance insects (25%) while 11% of the respondents acknowledged that the nets offered warmth at night (Fig 8).

Fig 8: Perceived benefits of sleeping under a bednet

#### 4.9.2 Use of insecticide sprays

Use of insecticide sprays was reported by 7.1% of respondents ($n=368$). Among those who reported use of the method during interview time included, 4.4% of the farmers, 3.7% of
business people, and 27.8% of the respondents with formal employment (Fig 9). There was a significant difference in use of insecticide sprays among different occupational groups ($\chi^2=23.023; \text{df} 3; P=0.000$) and also between the villages ($\chi^2=7.159; \text{df} 3; P=0.067$).

![Graph showing occupation vs insecticide use](image)

Fig 9: Use of insecticide sprays among different occupational groups

4.9.3 Screening of windows and doors

In total, screening of windows and doors was reported to be in use by 3% of the respondents (n=304) who happened to be from two villages i.e. Ciagi-ini and Mbu-njeru. There was significant difference in the use of this method between the villages ($\chi^2=10.198; \text{df} 3; P=0.017$).

4.9.4 Lighting of fire and coils

Seventeen percent (17%) of respondents acknowledged lighting fire and mosquito coils for personal protection against mosquito bites at night (n=368). This consisted of 17.2% of the farmers, 25.9% of the business people, 33.3% of those with formal employment and 8.2% of respondents with other minor occupations like casual labours (Fig 10). Application of fires
and mosquito coils among different occupational groups showed significance variation between the four study villages ($\chi^2=45.276; \text{df } 3; P=0.000$).

![Graph showing use of fires and mosquito coils among different occupational groups.](image)

**Fig 10:** Use of fires and mosquito coils among different occupational groups

### 4.9.5 Use of skin repellents

Skin repellents were used by 2% of the respondents (n=304). This consisted 2% of males against 1% of the females. There was no significant differences in application of this method between the two sexes ($\chi^2=0.068; \text{df } 1; P=0.795$).

### 4.9.6 Traditional methods

Traditional methods (burning of cow dung and local herbs) were used by 7.9% of the respondents. They were reported in small percentages in the study area but with a significant variation in their use between the four villages ($\chi^2=10.129; \text{df } 3; P=0.018$; Fig 11).
4.10 Environmental management practices

4.10.1 Environmental management practices at household level

Environmental management practices at household level were; clearing household refuse/proper waste disposal (26.9%), filling/leveling of breeding sites around houses (13.6%), clearing of vegetations in canals (0.5%) and clearing of bushes and vegetations around houses (45.7%), $n=368$ (Fig 12). There was significant differences between different occupational groups ($\chi^2=10.138; df 3; P=0.017$) and also between gender ($\chi^2=4.401; df 1; P=0.036$) which acknowledged clearing household refuse/proper waste disposal.
4.10.2 Environmental management practices at community level

At community level, environmental management practices were reported by 6.5% of the respondents. Methods practiced reported were; levelling and draining areas of stagnant water (4.3%), clearing vegetations in water canals (0.3%) and destruction of discarded water receptacles in the village (1.1%), n=368, (Fig 13). Levelling and draining areas of stagnant water varied significantly between the four villages ($\chi^2=11.943$; df 3; P=0.008), with Kagio reporting the highest percentage (9.7%) compared to Murinduko village which had the lowest percentage (0%).

![Fig 13: Environmental management practices at community level](image)

4.11 Perceived effectiveness of personal protection methods

Among the respondents using various personal protection methods, 77.6% said that the methods were effective. However, 21.9% believed that some of the methods were not quite effective in protecting them against mosquito bite. Untreated mosquito nets were reported to be effective by 84% of the users. Other methods said to be effective were; treated mosquito nets (94%), insecticide sprays (74%), house screening (70%), skin repellents (83%) and traditional methods (58%; Fig 14). 60% of respondents using fire/coils said that they were
not so quite effective. Respondent’s perception on effectiveness of fire/coils varied significantly between the villages ($\chi^2=49.993; \text{df } 6; P=0.000$). During Focus group discussions, the participants said that untreated nets have to be sufficiently large enough to prevent sleepers who make contact with the nets from receiving infective bites. However, treated nets were said to offer maximum protection by killing and repelling mosquitoes even when shared by several people.

![Graph](image)

Fig. 14: Perceived effectiveness of personal protection methods

### 4.12 Perceived effectiveness of environmental management practices at household level

Environmental management practices at household level were reported to be effective by 49.8% of the users while 47.9% of the practices in use were said to be not so quite effective. Methods said to be effective by most respondents were; clearing of household/proper waste disposal (53%) and clearing bushes or vegetations around houses (49%). draining/levelling of breeding sites was said not to be so effective by 50% against 46% of the respondents who said that the method was effective (Fig 15). Respondent’s perception on the effectiveness of clearing bushes and vegetations around houses varied significantly between villages
(\chi^2=79.553; \text{df } 9; P=0.000), gender (\chi^2=9.310; \text{df } 3; P=0.025) and education level of the respondents (\chi^2=29.991; \text{df } 18; P=0.038).

![Bar chart showing perceived effectiveness of environmental management practices at household level.]

Fig 15: Perceived effectiveness of environmental management practices at household level

4.13 Perceived effectiveness of environmental management practices at community level

Among the respondents using environmental management practices at community level (n=25), 60% reported that the methods were not so quite effective. The remaining 40% of the practices were said to be effective. Method said not to be so effective by most respondents were; levelling/draining areas of stagnant water (61%) and clearing of vegetations in water canals (67%; Fig 16). There were significant differences between villages (\chi^2=27.646; \text{df } 6; P=0.000) in the respondent’s responses on the perceived effectiveness of levelling/draining areas of stagnant water at community level. Respondent’s perceptions on the effectiveness of clearing of vegetations in water canals also varied significantly between different occupational groups (\chi^2=18.244; \text{df } 8; P=0.019).
Fig 16: Perceived effectiveness of environmental management practices at community level

4.14 Reasons for not regularly using some personal protection methods

Despite malaria being reported as one of the most frequently occurring diseases in the area, most respondents could not apply regularly some of the available personal protection methods. Unaffordability was the main reason cited for regularly non-use. Other reasons mostly given for non-use were; side effects (26.6%), lack of effectiveness (21.5%), low mosquito density and lack of application know how with 6.5% each, (n=368). Major reasons cited for non-use varied depending on the type of the practice. Methods, which most respondents said they could not afford to apply regularly were; use of treated nets (91.7%), use of; insecticide sprays (50%) and use of skin repellents (36%; Table 7). The socio-economic issue was clarified during FGDs. It was emphasized that household had other daily responsibilities like paying school fees and feeding the family in addition to protecting the household against other common diseases. Other reasons cited included lack of effectiveness of some practices like untreated nets (59.7%) and side effects of some methods like use of fire/coils (50%) and traditional methods like burning local herbs and cow dung (78.6%).
Table 7: Reasons for regular non-use of available personal protection methods

<table>
<thead>
<tr>
<th>Method</th>
<th>Not effective</th>
<th>Can't afford</th>
<th>Low mosq. Density</th>
<th>Hot weather</th>
<th>Applictn Problem</th>
<th>Side effects</th>
<th>Lack time</th>
<th>Spouse denial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated nets n=62</td>
<td>59.7</td>
<td>32.3</td>
<td>4.8</td>
<td>1.6</td>
<td>0</td>
<td>0</td>
<td>1.6</td>
<td>0</td>
</tr>
<tr>
<td>Treated nets n=121</td>
<td>3.3</td>
<td>91.7</td>
<td>0.1</td>
<td>1</td>
<td>1</td>
<td>1.7</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Insecticide sprays n=108</td>
<td>14.8</td>
<td>50</td>
<td>4.6</td>
<td>0</td>
<td>18.5</td>
<td>10.1</td>
<td>1.8</td>
<td>0</td>
</tr>
<tr>
<td>Preventive medicines n=51</td>
<td>7.8</td>
<td>68.6</td>
<td>2</td>
<td>0</td>
<td>5.8</td>
<td>11.7</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Screen windows &amp; doors n=3</td>
<td>33.3</td>
<td>33.3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>33.3</td>
<td>0</td>
</tr>
<tr>
<td>Light fire/Coils n=84</td>
<td>9.5</td>
<td>23.8</td>
<td>13</td>
<td>0</td>
<td>0</td>
<td>50</td>
<td>3.6</td>
<td>0</td>
</tr>
<tr>
<td>Skin repellents n=22</td>
<td>22.7</td>
<td>36</td>
<td>9</td>
<td>9</td>
<td>0</td>
<td>18</td>
<td>4.5</td>
<td>0</td>
</tr>
<tr>
<td>Traditional methods n=42</td>
<td>9.5</td>
<td>0</td>
<td>2.4</td>
<td>0</td>
<td>0</td>
<td>78.6</td>
<td>7.1</td>
<td>2.4</td>
</tr>
</tbody>
</table>

Traditional methods like use of cow dung and burning of local herbs were reported to have side effects ranging from respiratory/breathing problems, eye irritation, coughing, colds and flu. Cow dung was said to releases too much smokes in the house, leaving everything in the house smelling smoke.

4.15 Reasons for not regularly using environmental management practices

Lack of time was the major cited reason for not using regularly most of the environmental management practices both at household and community level. 21.7% of the respondents said that they did not have time to apply these practices. Other cited reasons cited for non-use were presence of low mosquito densities (5.2%) and lack of effectiveness (3.8%), n=368. Methods that most users said they could not apply them regularly due to lack of time to were; levelling/filling breeding sites (77.4%) clearing of vegetations in canals (66.7%), clearing bushes/vegetations around houses (57.6%). At community level, levelling/filling stagnant water (50%) and clearing of vegetations in water canals (66.7%) were the most
cited measures which majority of respondents said they could not get time to regularly apply. Another frequently cited reason for non-use was low mosquito density which was the main reason given for not regularly destroying discarded receptacles by all the applicants (100%). During FGDs, participants said that most people in the villages were always busy in search of daily bread and therefore, they were left with little time to engage in environmental management activities at the end of the day. In Murinduko, FG participants said that household heads and their spouse left the village very early in the morning in search of “Kibarua” (Casual labour) and returns late in the evening already exhausted.
CHAPTER 5: DISCUSSION

5.1 Knowledge of causes and transmission of malaria

Results from this cross-sectional household survey showed that malaria was perceived to be an important health problem in most households. The responses corresponded well with the hospital data collected from the nearest sub-District hospital in a previous study between 2001 and 2002 (Mutero et al., 2004a). However, unlike other related studies in East and West Africa (Agyepong, 1992; Winch et al., 1996; Binka and Adongo, 1997; Okrah, et al., 2002), the disease was reported to have no vernacular name and was locally referred to as “mareria” which is a coined English name for the biomedical term malaria. It was noted that 95% of the respondents recognized the role of mosquitoes in malaria transmission and this was confirmed during the focus group discussions in all the villages. However, the study also showed that like in other areas in Sub-Saharan Africa where malaria is endemic, respondents held a variety of other beliefs about the causes, and transmission of malaria. They believed in non-biomedical causes like eating of raw food and exposure to rains and cold conditions. This multiple perception on malaria aetiology among the respondents was similar to other related studies conducted in sub Saharan Africa (Ongore et al., 1989; Aikins et al., 1994; Ahorlu et al., 1997; Munguti, 1998). Such beliefs could adversely influence acceptance of and adherence malaria control interventions in the community. Other health implications of such a misconception is that if a section of people in the community do not fully associate the vector to malaria transmission, they may not take significant measures to protect themselves against the malaria vector. Belief in non-biomedical causes can also be attributed to low level of formal education in the study area where 78% had either informal or only primary school education. This could also impact negatively towards implementations of previously
perceived simple control measures making it difficult to motivate the community to maintain continuous use of the interventions.

5.2 Community participation in vector control practices

Both traditional and orthodox methods of controlling mosquitoes were used in the study area. In total, 95% of the respondents in the study area used bednets though mainly for protection against the nuisance adult biting mosquitoes. They valued bednet use mainly for affording them good sleep free from nuisance biting mosquitoes, which were reported to cause trouble by their nuisance biting at night. The link between bednet use and malaria control was only reported second by 54% of the respondents. The use of bednets by Mwea residents for personal protection against nuisance biting mosquitoes and other nuisance insects can be used as a promotion tool for bednet use. However, this approach can have limitations in that the users may only use bednets when the mosquito density is high and may also view the risk of disease as being directly proportional to mosquito population. During seasons when nuisance adult biting mosquito densities are low, the rate of bednet use may decrease which may put local people at more risk of malaria infection. This is mainly because the relatively perceived low vector density may be efficient enough in infecting people and transmitting the plasmodium parasites in the community (Winch et al., 1994). Another important implication is that people from areas with low mosquito densities especially those outside irrigated areas may be less concerned in taking preventive action against the vectors, thus putting them at a high risk of infection. The combinations of the above social issues could considerably explain the previously reported concept of “paddies paradox” in Mwea where irrigated areas have been shown to experiences low prevalence of malaria parasites in the population despite having significantly higher vector population (Mutero et al., 2004a).
Most respondents reported non regular application of available personal protection methods. For example, screening of windows and doors which was used by only 3% of the respondents. Use of proper housing and screening of windows, doors and eaves in mitigating malaria transmission was also less mentioned in the study area. The Mwea situation depicts a typical tropical African rural setup which is mostly epitomized by overcrowding and poor ventilation. The flimsy, open-walled traditional style houses made of mud walls, corrugated iron roofs and unscreened windows provide little protection from insects that spread diseases like malaria (Gamage-Mendis et al., 1991). Evidences from previous researches (Service, 1986a, b; Lindsay and Snow, 1988) have proved that these unscreened openings provide easy access to insects especially the mosquitoes (Schofield and White, 1994). Therefore, improving the design of these traditional dwellings and educating the community on the significance of this approach could significantly reduce the number of infective bites, resulting into reduced disease transmission in the study area. Moreover, integration of the approach with Primary Health Care (PHC) could also make it sustainable, locally acceptable and compatible with the local customs and beliefs.

Use of traditional methods (Burning plants leaves and cow dung) was reported in all the four villages but in small percentages. Though their efficacy has not been elucidated, their use for personal protection can be a valuable investment. They can be applied in situations where use of other personal protection measures is impractical particularly for people who work outdoors at night when the insect-biting rate is high, and when people sleep outside to flood rice paddies, water horticultural crops or guard rice crops during harvesting time (Winch et al., 1994). They can also be used indoors in combination with other personal protection methods especially in the early evening before people retire to bed or in the early morning.
before sunrise when people are not protected by other methods like bednets (Katsuyama et al., 1997).

On community participation in environmental management, 57.8% of the respondents claimed to use at least a method of environmental management at household level while only 7% participated on the same at community level. This depicted the level of community in organized community efforts in malaria control practices in the study area. The low level of community participation was revealed during one of the focus group discussions, when the participants contrasted current situation with what used to happen some few years back when the public health officers and local administration used to enforce measures of environmental management, sanitation and overall health education. Currently, there is no such enforcement and everything has returned to normal. This was a clear indication that respondents cooperated with such practices because they were enforced by the local administration and people cooperated for fear of legal action. People perceived it to be a government policy that had to be obeyed without any question. If well formulated and implemented, community participation in vector control can have a significant and sustainable impact on vector density. However, this is rarely achieved because most interventions are vertically structured and community members are not involved in the design and implementation stages (Service, 1993a; Rifkin, 1996).

5.3 Perceived effectiveness of malaria prevention and control practices

Contrary to the epidemiological or scientific indicators of effectiveness as described by Lengeler and Snow (1996), local people mostly determine the effectiveness of a vector control intervention by its immediate or noticeable potential in either reducing adult mosquito population, stopping the nuisance biting or reducing the breeding habitats. Failure to satisfy these conditions, the intervention may be deemed ineffective and this can either wane
community support, develop negative perception or the community may become reluctant or uncooperative in participating actively in malaria control strategies (Karanja et al., 1999). Untreated bednets in the study area were reported to be ineffective in reducing the nuisance biting. The low reported effectiveness of untreated bednets was mainly due to the ability of the mosquitoes to bite when the bed net user(s) makes contact with the net during sleeping time (Lindsay et al., 1989; Takken 2002). This was the main reason given for their reported non-use by most respondents. Treated bednets were said to offer better protection against mosquito bites in all the four study villages. This was through the killing and excito-repellent effects of pyrethroids which causes the mosquitoes to leave rooms for the outdoors, resulting to observed reduction in indoor biting. Moreover, mosquitoes, which make contact with the net are knocked down and killed in sufficient numbers (Mbogo et al., 1996; Pates and Curtis 2005). Both traditional methods and environmental management practices were said to be partially effective in reducing man-vector contact. Environmental management practices are normally not very effective by themselves and need to be integrated with other control measures. They do not have immediate effect in reducing the number of biting vectors and may take several days or weeks before reduction in their numbers can be achieved. They can have significant large scale impact only if they cover relatively high proportions of breeding sites within vector flight range and large proportion of community members actively participate.

5.4 Factors affecting choice and use of malaria vector control practices

For any vector control intervention to be sustainable in the community, it has to be technically, economically and socially sound. This implies that it must be effective, affordable, acceptable and compatible with the local customs attitudes and beliefs (Rozendaal, 1997). Generally, people opt to choose actions that are less expensive, save, simple and easier
to administer (Stevens, 1984). In the case of Mwea, despite, majority of the respondents reporting that most of the methods were effective, unaffordability (Socio-economic status) was the main reason for not using regularly some of the available vector control interventions like treated mosquito net, insecticide spray and lighting of coils in Mwea. During FGDs in one of the non-irrigated village, (Murinduko) which was relatively poorer socio-economically, it was revealed that insecticide treated bednets were unaffordable and their ownership and use was viewed to be a preserve for the rich. In comparison, large scale rice cultivation and sales in irrigated areas provides the farmers with disposable incomes which they invest in personal protection measures like insecticide treated bednets among others thus resulting into reduction in malaria incidences as a result of better protection against anthropophilic mosquitoes (Ijumba and Lindsay, 2001). In most cases, what may appear affordable to the outside through socio-economic based measurement (e.g. household income, house design, among others) might not be affordable to many households. During the focus group discussion, it was recognized that households have many competing needs (e.g. food and education) and tradeoffs. Therefore, households without sustainable money upfront may result to other perceived less expensive traditional methods like burning local herbs, cow dung, and wood fires, which actually may not be effective in the long run. Besides being not well known, greater part of the respondents said that they never had time to apply most of the environmental management practice both at household and community level.
CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

This study has provided relevant information that is crucial for the long-term success of community based malaria control strategies. It has provided a number of issues that need to be considered and integrated during design and implementation of malaria control interventions in order to make them sustainable. In conclusion;

a) The role of vector (mosquito) in malaria transmission was recognised in the study area though some respondents acknowledged some non-biomedical causes.

b) Malaria was perceived to be a major public health disease in the study area.

c) Mosquitoes were reported to cause trouble in most households mostly by their nuisance biting (98%) and secondly by their disease transmission (64%).

d) There was little integration of various vector control practices both at household and community level. Only bednet use was reported in most households in the study area.

e) Personal protection methods were reported to be effective by atleast 58% of respondents except use of fire/coils which had 40%.

f) Community participation in environmental management was low.

g) Major reasons cited for regular non-use of most vector control practices included, unaffordability, perceived lack of effectiveness and lack of time to apply particularly for environmental management.
6.2 Recommendations

From the above conclusion there is need to:

a) Develop sustainable information education and communication (IEC) programmes/campaigns as well as raise education standards in the study area so as to educate the residents on the role of the vector in malaria transmission.

b) Promote active community participation in vector control practices especially on environmental management. Attempts could be made to link control interventions with income generating activities, which are socially, culturally and economically appropriate.

c) Educate the community on importance of integrating other vector control options (IVM). These include use of biological control, zooprophylaxis, house design and alternation of rice cultivation with soya beans. This should be done in collaboration with other sectors and stakeholders like Ministry of Health in consideration to socio-economic, cultural and technical factors.
REFERENCES


Gillies, M.T. and De Meillon, B. (1968) The Anophelinae of Africa south of the Sahara (Ethiopian zoogeographical region), second ed. South African Institute of Medical Research.


DEFINITION OF SOME TERMS USED IN THE QUESTIONNAIRE

Homestead: Several houses occupying the same compound. The houses may be under the same or different household heads.

Concept of a household:

a) A person living alone, or a group of persons (who may or may not be related), living at the same address with common housekeeping. This implied that more than one household may occupy one structural or separate housing unit.

b) A person or group of related or unrelated persons who live together in the same dwelling unit(s), who acknowledge one adult male/female as head of household who share the same housekeeping arrangements and are considered as a unit. A member of the household is any person who usually lives in the household.

c) A basic unit of society. It consists of one or more persons and may occupy a whole building or part of a building in the same compound. It may also consist of a person or group of persons who live and eat together in the same dwelling unit or homestead.

A household head: Master or head of the family.

A house is the structure used for human habitation or building that serves as one's residence or domicile. It also means a building containing living quarters for one or a few families.

A family refers to a group of persons sharing a common dwelling and living under one household. It includes parents, children, servants or employees living and eating together. Body of persons (parents, children servants etc) who live in one house and under one head is considered a family.

A household was used as the main sampling unit for the Mwea cross sectional household survey. People cooking, eating and living together under the same housekeeping address and under one household head were referred to as a household. Enquiries were made to distinguish existing households in a multi-occupied dwellings or homesteads. Differences between household, homestead, housing unit or the house were clearly defined before questionnaire administration.
Appendix II:

HOUSEHOLD QUESTIONNAIRE ON MALARIA VECTOR CONTROL

INTRODUCTION

“Hello, my name is Mr. Ng’ang’a P from Kenyatta University/ICIPE. I/we are carrying out a study on malaria in this community. I hope you can help us by answering some questions. Your participation will enable us to better understand the malaria situation and ways of controlling it in this area. I hope that you will feel free to discuss with me about malaria and other issues that involve your household. You are not under obligation to participate in the study, but it is my desire that you do so. Do you agree?

Yes__________  No__________

(If yes, thank the respondent and proceed to the rest of the questionnaire).

NB: In the event that information is not made available after repeated visits please fill the box below and return the questionnaire.

SECTION 1: IDENTIFICATION

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Serial number of questionnaire</td>
</tr>
<tr>
<td>2</td>
<td>Name of interviewer</td>
</tr>
<tr>
<td>3</td>
<td>Village code (see below)</td>
</tr>
<tr>
<td>4</td>
<td>Homestead Number</td>
</tr>
<tr>
<td>5</td>
<td>Household number (list provided)</td>
</tr>
<tr>
<td>6</td>
<td>Name of respondent</td>
</tr>
<tr>
<td>7</td>
<td>Date of interview (or Date of visit)</td>
</tr>
<tr>
<td>8</td>
<td>Type of visit (see below)</td>
</tr>
</tbody>
</table>


Type of Visit: 1. Successful 2. Unavailable 3. Unwilling
SECTION 2: SOCIO-DEMOGRAPHIC PROFILE OF RESPONDENT (Tick Accordingly)

1. Relationship to Head of Household

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Head</td>
</tr>
<tr>
<td>2</td>
<td>Wife</td>
</tr>
<tr>
<td>3</td>
<td>Husband</td>
</tr>
<tr>
<td>4</td>
<td>Son</td>
</tr>
<tr>
<td>5</td>
<td>Daughter</td>
</tr>
<tr>
<td>6</td>
<td>Relative</td>
</tr>
<tr>
<td>7</td>
<td>Employee</td>
</tr>
<tr>
<td>8</td>
<td>Others (Specify)</td>
</tr>
</tbody>
</table>

2. Sex of respondent

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Male</td>
</tr>
<tr>
<td>2</td>
<td>Female</td>
</tr>
</tbody>
</table>

3. Highest level of education attained

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Primary school (Not completed)</td>
</tr>
<tr>
<td>2</td>
<td>Primary school (Completed)</td>
</tr>
<tr>
<td>3</td>
<td>Secondary school (Not completed)</td>
</tr>
<tr>
<td>4</td>
<td>Secondary school (Completed)</td>
</tr>
<tr>
<td>5</td>
<td>University/ college</td>
</tr>
<tr>
<td>6</td>
<td>Informal</td>
</tr>
</tbody>
</table>

4. Marital status

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Married</td>
</tr>
<tr>
<td>2</td>
<td>Single</td>
</tr>
<tr>
<td>3</td>
<td>Separated</td>
</tr>
<tr>
<td>4</td>
<td>Widowed</td>
</tr>
<tr>
<td>5</td>
<td>Divorced</td>
</tr>
<tr>
<td>6</td>
<td>Others (Specify)</td>
</tr>
</tbody>
</table>

5. Religion

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Catholics</td>
</tr>
<tr>
<td>2</td>
<td>Protestants</td>
</tr>
<tr>
<td>3</td>
<td>Others (Specify)</td>
</tr>
</tbody>
</table>

6. Main Occupation

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Student</td>
</tr>
<tr>
<td>2</td>
<td>Farming</td>
</tr>
<tr>
<td>3</td>
<td>Self business</td>
</tr>
<tr>
<td>4</td>
<td>Salaried Employment</td>
</tr>
<tr>
<td>5</td>
<td>Unemployed</td>
</tr>
<tr>
<td>6</td>
<td>Others (Specify)</td>
</tr>
</tbody>
</table>
SECTION 3: KNOWLEDGE OF MALARIA

7. What are the three most frequently occurring diseases in your household?
   1. -----------------------------
   2. -----------------------------
   3. -----------------------------

8. When was the last time a member in your household had malaria?  

9. What do you perceive as the causes (s) of malaria in this area? (Multiple answers possible)

<table>
<thead>
<tr>
<th>Perceived causes</th>
<th>Tick</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Working in the sun</td>
<td></td>
</tr>
<tr>
<td>2 Long rains/Being rained on</td>
<td></td>
</tr>
<tr>
<td>3 Wet and cold condition</td>
<td></td>
</tr>
<tr>
<td>4 Working in rice paddies</td>
<td></td>
</tr>
<tr>
<td>5 Mosquito bite</td>
<td></td>
</tr>
<tr>
<td>6 Eating raw food/mangoes</td>
<td></td>
</tr>
<tr>
<td>7 Evil spirit/demons/witchcraft</td>
<td></td>
</tr>
<tr>
<td>8 Taking dirty/polluted water</td>
<td></td>
</tr>
<tr>
<td>9 From another person with malaria (specify how)</td>
<td></td>
</tr>
<tr>
<td>10 Stagnant water</td>
<td></td>
</tr>
<tr>
<td>11 Dirty home surroundings/Environment</td>
<td></td>
</tr>
<tr>
<td>12 Don’t know</td>
<td></td>
</tr>
<tr>
<td>13 Others (Specify)</td>
<td></td>
</tr>
</tbody>
</table>

10. What are the symptoms and signs of malaria you are aware of? (Multiple answers possible)

<table>
<thead>
<tr>
<th>Symptoms/ signs</th>
<th>Tick</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Fever</td>
<td></td>
</tr>
<tr>
<td>2 Feeling cold</td>
<td></td>
</tr>
<tr>
<td>3 Headache</td>
<td></td>
</tr>
<tr>
<td>4 Vomiting</td>
<td></td>
</tr>
<tr>
<td>5 Diarrhoea</td>
<td></td>
</tr>
<tr>
<td>6 General body weakness</td>
<td></td>
</tr>
<tr>
<td>7 Loss of appetite</td>
<td></td>
</tr>
<tr>
<td>8 Body pain/joint pain</td>
<td></td>
</tr>
<tr>
<td>9 Convulsion</td>
<td></td>
</tr>
<tr>
<td>10 Eyes become yellow</td>
<td></td>
</tr>
<tr>
<td>11 Cough</td>
<td></td>
</tr>
<tr>
<td>12 Don’t know</td>
<td></td>
</tr>
<tr>
<td>13 Others (Specify)</td>
<td></td>
</tr>
</tbody>
</table>
11. Which categories/groups of people do you think are most affected by malaria? (Prompt; multiple answers)

<table>
<thead>
<tr>
<th>Category</th>
<th>Tick</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults women</td>
<td></td>
</tr>
<tr>
<td>Children under five years</td>
<td></td>
</tr>
<tr>
<td>All children</td>
<td></td>
</tr>
<tr>
<td>Elderly people only</td>
<td></td>
</tr>
<tr>
<td>Pregnant women</td>
<td></td>
</tr>
<tr>
<td>Adult men</td>
<td></td>
</tr>
<tr>
<td>Don’t know</td>
<td></td>
</tr>
<tr>
<td>Others (Specify)</td>
<td></td>
</tr>
</tbody>
</table>

SECTION 4: VECTOR BIOLOGY

12. Do mosquitoes cause any trouble to you or your family?
   1. Yes ☐
   2. No ☐ (If No go to Qn. 14)

13. In what ways do they cause you trouble? (Do not prompt)

<table>
<thead>
<tr>
<th>Cause you trouble</th>
<th>Tick</th>
</tr>
</thead>
<tbody>
<tr>
<td>They bite</td>
<td></td>
</tr>
<tr>
<td>Their bites are itchy</td>
<td></td>
</tr>
<tr>
<td>They carry and cause diseases</td>
<td></td>
</tr>
<tr>
<td>They make noise</td>
<td></td>
</tr>
<tr>
<td>They finish our blood</td>
<td></td>
</tr>
<tr>
<td>Can’t sleep at night</td>
<td></td>
</tr>
<tr>
<td>Others (specify)</td>
<td></td>
</tr>
</tbody>
</table>

14. In this area where do you think mosquito breeds? (Do not prompt, multiple answers)

<table>
<thead>
<tr>
<th>Breeding places</th>
<th>Tick</th>
</tr>
</thead>
<tbody>
<tr>
<td>In stagnant water (ponds, swamps, hoofprints, wheel ruts etc)</td>
<td></td>
</tr>
<tr>
<td>In vegetations outside the house</td>
<td></td>
</tr>
<tr>
<td>In rice paddies</td>
<td></td>
</tr>
<tr>
<td>In water canals</td>
<td></td>
</tr>
<tr>
<td>In animal pens</td>
<td></td>
</tr>
<tr>
<td>Rubbish pits/Latrines/Cess pits</td>
<td></td>
</tr>
<tr>
<td>In dark places</td>
<td></td>
</tr>
<tr>
<td>Don’t know</td>
<td></td>
</tr>
<tr>
<td>Others (Specify)</td>
<td></td>
</tr>
</tbody>
</table>
15. Where do mosquitoes’ stay/hide before biting? (Multiple responses)

<table>
<thead>
<tr>
<th>Places</th>
<th>Tick</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  In dark places inside houses</td>
<td></td>
</tr>
<tr>
<td>2  On walls and roofs</td>
<td></td>
</tr>
<tr>
<td>3  In vegetations outside the house</td>
<td></td>
</tr>
<tr>
<td>4  At edges of streams and canals</td>
<td></td>
</tr>
<tr>
<td>5  Don’t know</td>
<td></td>
</tr>
<tr>
<td>6  Others (specify)</td>
<td></td>
</tr>
</tbody>
</table>

**SECTION 5: VECTOR CONTROL PRACTICES**

16. Are you aware of any method(s) of controlling or protecting you and your family from malaria/mosquito bite?

<p>| | |</p>
<table>
<thead>
<tr>
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<th></th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Yes</td>
</tr>
<tr>
<td>2</td>
<td>No</td>
</tr>
</tbody>
</table>
17. What are some of the ways of controlling or preventing your household/family from malaria/Mosquito bite? Indicate how often you apply the methods and rank the order of effectiveness (Tick accordingly as they are mentioned).

<table>
<thead>
<tr>
<th>Method</th>
<th>Methods Known to you (tick)</th>
<th>Methods Currently Applying (tick)</th>
<th>Application frequency (Prompt)</th>
<th>Effectiveness (Prompt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Use of mosquito net-untreated</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Use of treated mosquito net</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Use of insecticide spray</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Taking preventive medicine</td>
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<td>5. Screen windows and doors</td>
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<td>6. Light the fire/coils</td>
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<tr>
<td>7. Apply mosquito repellents to the skin</td>
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<tr>
<td>8. Use traditional Methods (Specify)</td>
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<tr>
<td>9. Environmental Management (Household level):</td>
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<tr>
<td>Clearing HH refuse/proper waste disposal</td>
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<tr>
<td>Draining/Levelling breeding sites</td>
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<tr>
<td>Clearing vegetation in canals</td>
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<tr>
<td>Clearing bushes/vegetations around houses</td>
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<tr>
<td>Others (Specify)</td>
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<tr>
<td>10. Environmental Management (Community level):</td>
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<tr>
<td>Leveling/Draining areas of stagnant water</td>
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<tr>
<td>Clearing vegetation in water canals</td>
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<tr>
<td>Destroying discarded receptacles</td>
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<tr>
<td>Others (Specify)</td>
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</tbody>
</table>
18. Please give reasons why you don’t apply regularly or at all some of the methods known to you (Mentioned above) for control or self-protection against mosquitoes/malaria.

<table>
<thead>
<tr>
<th>Reason for non-use</th>
<th>Examples of the methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Not effective</td>
<td></td>
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<tr>
<td>2. Cannot afford</td>
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<tr>
<td>3. Don’t know how to apply</td>
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<td>4. Low mosquito density</td>
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<td>5. Hot weather</td>
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<td>6. Denied by my spouse</td>
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<td>7. Not culturally accepted</td>
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<td>8. Side effects e.g. eye irritation, sneezing etc</td>
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<tr>
<td>9. Don’t have time to apply</td>
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<tr>
<td>10. Others (Specify)</td>
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</tr>
</tbody>
</table>

19. Do you have a Bed net in your household? (Should be asked only if Bednets have not been mentioned before)

1. Yes
2. No

20. What do you think are the benefits of sleeping under a bednet? *(Multiple answers, don’t prompt)*

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Tick</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Don’t get bitten by Mosquitoes</td>
<td></td>
</tr>
<tr>
<td>2. Don’t get malaria</td>
<td></td>
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<tr>
<td>3. Don’t get bothered by other insects</td>
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<tr>
<td>4. Its warmer</td>
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<tr>
<td>5. None</td>
<td></td>
</tr>
<tr>
<td>6. Don’t know</td>
<td></td>
</tr>
<tr>
<td>7. Others (Specify)</td>
<td></td>
</tr>
</tbody>
</table>

21. What do you think can be done to improve malaria/mosquito control in this area?

1.
2.
3.
4.
5.
6.

End of the interview
Thank the respondent for his/her participation and spending time with you.
Appendix III

FOCUS GROUP DISCUSSIONS INTERVIEW GUIDELINE

Introduction

"Hello, my name is Mr. P. Ng‘ang‘a from Kenyatta University/ICIPE. I/we are carrying out a study on malaria control in this community. I hope you can help us by participating in some focused discussions on selected topics. Your participation will enable us to better understand the malaria situation and ways of controlling it in this area. I hope that you will feel free to participate and discuss with me about malaria and other issues that involve your village. You are not under obligation to participate in the discussion, but it is my desire that you do so.

Questions for discussion

1. (a) What activities contribute to making malaria to be one of the most frequently occurring disease in this area?

   (b) How do these activities expose people to mosquitoes and do they hamper utilisation of available personal protection measures against the vector.

2. Which categories /groups of people are most affected (at higher risk) by malaria in this area/village? And what makes this categories to be at a high risk?

3. (a) What are the most common symptoms associated with malaria in this area and how do local people differentiate malaria symptoms with those of other illnesses?

   (b) How do malaria symptoms present/manifest in a patient? Do you have any local name for malaria?

4. What are the main causes of malaria in this area? What is the relationship between malaria and other non-biomedical causes like eating raw foods/mangoes, etc

5. How do the local people in the village participate in environmental management practices aimed at vector control both at individual and community level? If any what are the advantages and disadvantages of community participation in vector control in your area?

6. (a) Are there any traditional methods for protection against mosquito bites in this area?

   (b) Do people use these methods and how are they used?

   (c) What are peoples perception on their effectiveness?

   (d) What are the problems faced and their side effects if any?

End of the discussion.

Thank all the participants for their contribution and spending their precious time with you.