LONG-LASTING INSECTICIDAL NET USE AND ASYMPTOMATIC MALARIA PARASITAEMIA AMONG HOUSEHOLD MEMBERS OF LABORATORY-CONFIRMED MALARIA PATIENTS ATTENDING HEALTH FACILITIES IN ABUJA, NIGERIA

BY

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Abstract

Nigeria accounts for about 25% of malaria cases that occur globally. The north central zone has the second highest malaria prevalence in the country and low utilization of long-lasting insecticidal nets (LLIN). However, there is paucity of information on household dynamics that influence malaria transmission in all age groups. The objective of this study was to determine prevalence of malaria parasitaemia, identify exposure factors for infection, and factors associated with long-lasting insecticidal net use among households of confirmed malaria patients in Abuja, Nigeria. The rationale for selecting households where one was already diagnosed for malaria was to establish possible common exposure.

A cross-sectional study was conducted using multi-stage sampling technique. Malaria patients were identified from selected health facilities in Abuja. Their homes were visited within seven days and all their household members were enrolled into the study. Overall, we recruited 602 participants from 107 households linked to 107 malaria patients. Interviewer-administered pre-tested questionnaires were used to get information on house characteristics, LLIN ownership and utilization, and knowledge of LLIN and other prevention measures. Blood samples were collected from the household members for laboratory diagnosis of malaria parasitaemia using rapid diagnostic test kits in the field and microscopy in the laboratory. Individuals who tested positive were treated with artemether-lumefantrine. Frequencies and proportions were calculated for all study variables. Association between LLIN use and malaria parasite density were determined using Kruskal-Wallis test while association between participants' characteristics and presence of parasitaemia were examined using Chi-square test and logistic regression models. Level of significance was set at 5%.

Of all participants, 331 (55.0%) were female while 271 (45.0%) were male. The median age of respondents was 16.5 years (Interquartile range (IQR): 23 years). Proportion of households that owned and used LLINs were 44.8% and 33.6%, respectively. Malaria parasitaemia was detected in at least one family member of 102 index patients. Proportion of LLIN use and prevalence of asymptomatic malaria parasitaemia among study participants were 17.8% and 69.9%, respectively. Living in houses with uncovered water receptacles around the house (AOR: 2.3, 95% CI:1.29-4.00) was associated with LLIN use in study participants. Individuals with bushes around their homes had increased odds (AOR:2.1, 95% CI: 1.37-3.27) of having malaria parasitaemia.

High prevalence of asymptomatic malaria parasitaemia and low use of LLIN among household members of malaria patients portend the risk of intra-household common source of malaria transmission. Study to explore the role of preventive treatment of household members of confirmed malaria patient in curbing transmission is suggested. It is recommended that all age groups use LLINs and that environmental management is conducted regularly.

Keywords: Malaria, Parasite, Households, Insecticide-treated bednets, Nigeria

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Certification

I certify that this work was carried out by Miss A.P. Onyiah in the Department of Epidemiology and Medical Statistics, University of Ibadan.

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Abbreviations

AC	area council
ACT	artemisinin-based combination therapies
AOR	adjusted odds ratio
CDC	US Centers for Disease Control and prevention
CI	confidence interval
DHIS	Demographic and Health Information Survey
FCT	Federal Capital Territory
IPTp	intermittent preventive treatment in pregnancy
IQR	interquartile range
ITN	insecticide-treated net
IVM	Integrated Vector Management
LLIN	long-lasting insecticidal net
MIP	malaria in pregnancy
NFELTP	Nigeria Field Epidemiology and Laboratory Training Programme
NMIS	National Malaria Indicator Survey
OR	Odds Ratio
RDT	rapid diagnostic test kit
WBC	white blood cell
WHO	World Health Organization

CHAPTER ONE

1.0. Introduction

1.1. Background

Malaria is an acute febrile illness caused by the protozoan parasite *Plasmodium*. There are five species of *Plasmodium* that can infect humans: *P. falciparum*, *P. malariae*, *P. ovale*, *P. vivax* and *P. knowlesi*. *P. falciparum* is predominant in Africa while *P. vivax* has a wider geographical distribution (WHO, 2015b). However, *P. falciparum* is responsible for most malaria deaths. Transmission of the parasite to humans is via bite from infected female anopheles mosquito. Over 400 anopheles species exist but only about 30 are capable of transmitting the parasite (WHO, 2016). Occasionally, transmission occurs by blood transfusion, organ transplantation, needle sharing, or congenitally from mother to fetus. *P. knowlesi* is still considered zoonotic malaria as direct transmission from human to human via mosquito, without the natural intermediate host (macaque monkey), has not been determined. Malaria incubation period is from 7 days to 3 months. Malaria is characterized by fever and other symptoms such as chills, headache, myalgia, and malaise. In severe disease, impaired consciousness, prostration, multiple convulsions, acidosis, hypoglycaemia, severe malarial anaemia, jaundice, renal impairment, pulmonary oedema, and significant bleeding may occur (WHO, 2015a). Partial immunity to malaria may develop in malaria endemic regions from repeated exposure to the parasites resulting in asymptomatic malaria.

The categories most at risk of infection include pregnant women, children less than five years, visitors from non-malaria regions, those with sickle-cell anemia, and those with compromised immunity (Federal Ministry of Health [Nigeria], 2007). Malaria is one of the leading causes of child mortality (UNICEF, 2014). In pregnancy, malaria infection is associated with maternal anemia and low birth weight in newborns (Ogbu *et al.*, 2015).

Over half of the world's population are at risk of malaria. However, the burden of malaria is greatest in fifteen countries in sub-Saharan Africa which account for an estimated 78% of all malaria deaths (WHO, 2015b). Ninety-seven percent of Nigerians are at risk of malaria infection (Federal Ministry of Health [Nigeria], 2011a). In 2015, Nigeria accounted for 29% of the global burden of malaria infections and mortality (WHO, 2016b). Approximately 110 million cases of malaria are diagnosed yearly (Federal Ministry of Health [Nigeria], 2010a). Malaria reportedly accounts for 60% of outpatient visits, 30% of childhood deaths, 25% of deaths in children under 1 year and up to 11% mortality in pregnant women (Federal Ministry of Health [Nigeria], 2010a). It is the leading cause of child mortality in Nigeria.

Strategic interventions for malaria control in Nigeria include case management of malaria using artemisinin-based combination therapies (ACTs), integrated vector management including insecticide treated nets (IVM/ITNs), IPTp for malaria control in pregnancy (MIP) and other health-system strengthening (cross-cutting) intervention strategies. Artemisinin combination therapies were introduced in Nigeria in 2005 for treatment of uncomplicated malaria as a result of failure of monotherapies such as chloroquine and sulfadoxine-pyrimethamine (Roll Back Malaria, 2015). Parasitological confirmation of all patients suspected to have malaria using light microscopy or rapid diagnostic test kits is recommended prior to treatment to ensure rational use of ACTs as well as delay subsequent development of drug resistance by malaria parasite (Djallé *et al.*, 2014; Federal Ministry of Health [Nigeria], 2011b; WHO, 2015a). This is because malaria signs and symptoms are non-specific. However, treatment based on clinical diagnosis alone may be done where parasitological confirmation is not available (Federal Ministry of Health [Nigeria], 2011b; WHO, 2009).

1.2. Problem Statement

Malaria is a major public health problem which causes an estimated 215 million infections worldwide and 655,000 deaths annually (Arguin and Tan, 2015). In 2015, there were about 214 million cases of malaria and an estimated 438 000 deaths (WHO, 2015b). Sub-Saharan Africa accounts for 85% of all malaria cases and 90% of all malaria deaths (WHO Regional office for Africa, 2015). In Nigeria, according to the Global burden of disease study of 2010, malaria was ranked the number one cause of years of lives lost (YLL) at 23.2% (Institute for Health Metrics and Evaluation, 2010). Malaria is responsible for over 300,000 deaths annually in Nigeria (Roll Back Malaria, 2015).

Malaria cases can be severe, uncomplicated, or asymptomatic. Asymptomatic malaria influences transmission dynamics. Asymptomatic malaria remains a challenge to malaria elimination as asymptomatic gametocyte carriers contribute to persistence of malaria transmission (Laishram *et al.*, 2012). World Health Organization (WHO) recommends that people of all ages sleep under an ITN to prevent continued transmission of malaria by mosquitoes (World Health Organization, 2015). In a bid to achieve universal coverage in Nigeria, a strategy of scaled-up mass distribution of free long-lasting insecticidal nets (LLIN) across the 36 states and Federal Capital Territory, representing 90.2% of the national target was embarked upon in 2009 (Federal Ministry of Health [Nigeria], 2010b). LLINs are promoted as they are durable, do not require retreatment and can be used for up to 4 years as well as can stand up to 20 washes (Federal Ministry of Health [Nigeria], 2010b). The proportion of households owning one or more ITNs has risen steadily over the years; from 8% in the Demographic Health Survey (DHS) 2008 to 42% in the Malaria Indicator Survey (MIS) 2010 and to 69% in Malaria Indicator Survey (MIS) 2015 (National Malaria Elimination Programme (NMEP), National Population Commission (NPopC) National Bureau of Statistics (NBS), 2015; National Population Commission (NPC) [Nigeria] *et al.*, 2012; National Population Commission (NPC) [Nigeria] and International, 2009). The proportion of household members reported to have slept under an ITN the night before the survey increased from 29% in the MIS 2010 to 37% in the MIS 2015 (National Population Commission (NPC) [Nigeria] and ICF International, 2014; National Population Commission (NPC) [Nigeria] *et al.*, 2012). However, LLIN utilization remains sub-optimal. Abuja, the Federal Capital Territory (FCT), is located in the North Central region which had the second highest malaria prevalence among children under five in the entire country in 2015 (National Malaria Elimination Programme (NMEP), National Population Commission (NPopC) National Bureau of Statistics (NBS), 2015). A study in FCT found low utilization of long-lasting insecticidal nets of 7.6% and 19.2% among children under five and pregnant women respectively (Otsemobor *et al.*, 2013). There is paucity of information in Abuja on the factors associated with ITN use in other age groups as well as their malaria parasitaemia prevalence. Further research is needed to determine household dynamics that influence malaria transmission.

1.3. Justification

It is estimated that 42% of malaria infections in sub-Saharan Africa is attributable to modifiable environmental risk factors (Prüss-Üstün and Corvalán, 2006). People living in the same household are exposed to similar environmental conditions. A household where one individual has been diagnosed for malaria is more likely to have a cluster of infected individuals (Lawpoolsri *et al.*, 2010). Use of LLIN is both a means of environmental management and chemical control (Prüss-Üstün and Corvalán, 2006). Studies in Nigeria have focused on assessing malaria prevalence, coverage and use of ITN/LLINs among specific at-risk groups such as pregnant women and under five children (Aderibigbe *et al.*, 2014; Okafor and Odeyemi, 2012; Egbuche *et al.*, 2013; Ojo *et al.*, 2014). However, there is paucity of data on malaria parasitaemia prevalence among all age groups in Nigeria, particularly in the Federal Capital Territory. The asymptomatic population can serve as reservoir for silent malaria transmission.

This study is expected to provide information towards malaria control in Nigeria related to all age groups while comparing with patterns of LLIN use among household members of malaria patients. The rationale for selecting households where one was already diagnosed for malaria is to establish possible common exposure. The study will be carried out in Abuja, located in the North Central region which has the 2nd highest malaria prevalence in the country (NMIS, 2010)

1.4. Research Questions

1. What is the prevalence of asymptomatic malaria parasitaemia among household members of patients with acute malaria in Abuja, Nigeria?
2. What is the relationship between LLIN use and malaria parasite density in household members?
3. What factors are associated with LLIN use among household members?
4. What are the contributing factors to malaria infection in individuals in the household?

1.5. General and Specific Objectives

1.5.1. General Objective

To determine the prevalence of asymptomatic malaria parasitaemia, and determine factors associated with LLIN use among households of confirmed malaria patients in Abuja, Nigeria.

1.5.2. Specific Objectives

1. To determine the prevalence of asymptomatic malaria parasitaemia among household members of confirmed malaria patients in Abuja, Nigeria
2. To determine the relationship between LLIN use and malaria parasite density in household members
3. To identify factors associated with LLIN use among household members of confirmed malaria patients in Abuja
4. To determine factors contributing to malaria infection in individuals in a household

1.6. Operational definitions

LLIN: A factory-treated mosquito net made with netting material that has insecticide incorporated within or bound around the fibers. The net is able to retain its effective biological activity without re-treatment for at least 20 WHO standard washes under laboratory conditions and three years of recommended use under field conditions (WHO, 2007).

Household: A group of people living together, eating from the same pot and having one person as head (Federal Ministry of Health [Nigeria], 2007)

LLIN use: Sleeping under an LLIN the night prior to the survey/interview/visit (Otsemobor *et al.*, 2013)

CHAPTER TWO

2.0. Literature Review

2.1. Plasmodium species and the vector

According to the 2015 World Malaria Report, *P. falciparum* is the predominant malaria specie in Africa (WHO, 2015b). In Nigeria, this is substantiated by studies conducted in Abuja, Kaduna, and Port Harcourt where *P. falciparum* infections account for roughly 99% of all malaria infections (Erhabor and Azuonwu, 2012; Peletrici and Ibecheozor, 2013; Umaru and Uyaiabasi, 2015). *P. falciparum* is transmitted by *Anopheles(An.) gambiae* and *An. funestus* (PMI, 2015). The parasite develops optimally in the female anopheles mosquito in temperatures ranging from 25 to 30°C and ceases to develop below 16°C.

2.2. Clinical presentation of malaria

The clinical presentation of malaria ranges from asymptomatic to uncomplicated to severe forms. Uncomplicated malaria is symptomatic infection with malaria parasitaemia without signs of severity and/or evidence of vital organ dysfunction. Severe malaria involves presence of asexual parasitaemia and life-threatening clinical or laboratory features without other confirmed cause of their symptoms (Federal Ministry of Health [Nigeria], 2011b). Uncomplicated malaria can progress rapidly to the severe form, particularly in people with low or no immunity (WHO, 2015a) such as children because they have not acquired immunity to the disease. However, a large number of malaria infections, including gametocyte carriers are asymptomatic (Bousema *et al.*, 2004; Laishram *et al.*, 2012). Children with asymptomatic *P. falciparum* infection are prone to increased morbidity due to anemia and reduced cognitive development (Kurtzhals *et al.*, 1999; Kern *et al.*, 2011). Malaria parasite characteristics may be involved in explaining why some individuals come down with symptomatic malaria while others are asymptomatic (Miller *et al.*, 2002; Laishram *et al.*, 2012). Malaria parasites characteristics such as parasite density, resetting and sequestration, toxin production, and genetic diversity may favor the asymptomatic state (Laishram *et al.*, 2012). To target this asymptomatic pool that contributes to malaria transmission, certain countries in the elimination phase have adopted active case detection and treatment strategies as recommended by WHO.

2.3. Malaria prevalence

Approximately 3.2 billion people are at risk of malaria infection globally (WHO, 2016). From 2000 to 2015, 57 of the 106 countries that had ongoing malaria transmission had reduced their malaria incidence by >75%, while 18 countries reduced their incidence by 50-75% (WHO, 2015b). The burden is greatest in Africa with fifteen countries in sub-Saharan Africa accounting for about 80% of malaria cases globally (WHO, 2015b).

Malaria prevalence in Africa varies and ranges from as high as 42% in Nigeria, to as low as 4.1% in Ethiopia and 0.07% in Swaziland (National Population Commission (NPC) [Nigeria] *et al.*, 2012; Graves *et al.*, 2009; Hsiang *et al.*, 2012). Swaziland, Botswana, South Africa, Sao Tome and Principe, Cape Verde, Eritrea, Rwanda, Algeria, Namibia, Mauritania and Guinea Bissau have been able to reduce malaria incidence by >75% from 2000 to 2015 with a few of them working towards malaria elimination by/in 2020 (WHO, 2015b). Malaria prevalence varies as well across the different zones of Nigeria even though 97% of the population are at risk of the disease.

Malaria prevalence in children under 5 years was estimated at 52% for the entire country in the 2010 national malaria indicator survey (National Population Commission (NPC) [Nigeria], 2010). Across the country, South West zone was highest with 50.3%, North Central had 49.4%, North West had 48.2%, South South had 32.2% and South East was lowest with 27.6%. Kenya reported an 8% malaria prevalence in children under five for the same year (Division of Malaria Control Ministry of Public Health and Sanitation [Kenya], 2010). However, the results in Kenya varied greatly based on endemicity of zones, ranging from as high as 38% in lake endemic zone to 1% in a zone of low endemicity.

Some community-based cross-sectional studies found malaria prevalence of 60.6% in Kano state (North west zone), 36.6% in Plateau state (North central zone), and 36.1% in Abia state (South east zone) among all age groups (Dawaki *et al.*, 2016; Noland *et al.*, 2014).

Malaria in pregnancy poses considerable risks to the mother, her foetus, and the newborn. It is estimated that 11% of maternal mortality in Nigeria is due to malaria (Federal Ministry of Health [Nigeria], 2011a). Malaria prevalence studies conducted among pregnant women in the North Central, North East, North West zones of Nigeria estimated 13.8%, 60.3%, and 41.6%, respectively (Omalu *et al.*, 2012; Bako *et al.*, 2007; Fana *et al.*, 2015). In South East Nigeria, Nwonwu *et al.* (2009) found 29% malaria prevalence while it was 99% the study by Gunn *et al.* (2015). However, the study by Gunn *et al.* (2015) was community-based, and may give a truer picture of the prevalence in pregnant women as not all pregnant women attend ante-natal care clinics in health facilities. Low malaria prevalence were recorded in the South West by Agomo *et al.* (2009) who found prevalence of 7.7% in Lagos and Falade *et al.* (2013) who found a prevalence of 8.4% in Ibadan.

2.4. Factors associated with malaria infection and transmission

Some studies have tried to identify the age groups that are most affected by malaria to provide data that will aid malaria control. A survey in Kenya found a higher prevalence in children aged 5 to 14 years compared to children below 5 years (Division of Malaria Control Ministry of Public Health and Sanitation [Kenya], 2010). Another study in Malawi that found a significantly higher malaria prevalence in school age children, 6 to 15 years, than all other age groups (Walldorf *et al.*, 2015). The study by Noland *et al.* (2014) in Abia and Plateau states of Nigeria and Loha and Tefera (2013) in Ethiopia corroborates the findings in the above-mentioned studies. Ani *et al.* (2015) found higher malaria prevalence among children 10 to 16 years and Dawaki *et al.* (2016) found a higher prevalence in participants 12 to 17years. Hassan (2012) and Babamale & Ugbomoiko (2016), on the other hand, found a higher malaria prevalence among participants less than 10 years and significant decrease with increasing age groups. The findings of Hassan (2012) may be as a result of the very low number of participants in the older age groups enrolled. The decrease with age may also indicate acquired immunity with age. This finding was similar to that of a study in Ethiopia (Ayele *et al.*, 2012). A household cross-sectional study done in Kisumu County, Kenya (an area which has a holo-endemic malaria transmission pattern similar to Nigeria) found 28% malaria prevalence among adults. This indicates the need for further research in malaria prevalence among all groups in Nigeria to identify other sub-groups that have received less of malaria interventions and who may serve as community reservoir of infection.

No association between sex and malaria infection were found in studies by Noland *et al.* (2014) in North Central and South east zones, Ani *et al.* (2015) in the South East zone, Dawaki *et al.* (2016) in the North West zone, and Babamale and Ugbomoiko (2016) in North central zone. This finding is similar to studies done in Eritrea, Ethiopia (Sintasath *et al.*, 2005; Graves *et al.*, 2009). This suggests equal distribution of risk to both sexes. However, Dougnon *et al.* (2015) and Umaru and Uyaiabasi (2015) found a higher malaria prevalence in males than females.

Households in lowest wealth quintile were found to have higher malaria prevalence than those in higher wealth quintiles and this was corroborated in studies carried out in Nigeria, Ethiopia, and Kenya (National Population Commission (NPC) [Nigeria] *et al.*, 2012; Graves *et al.*, 2009; Division of Malaria Control Ministry of Public Health and Sanitation [Kenya], 2010).

National surveys conducted across Nigeria in West Africa, Kenya and Malawi in East Africa, found higher malaria prevalence in rural than urban areas (Meshnick *et al.*, 2015; Division of Malaria Control Ministry of Public Health and Sanitation [Kenya], 2010; National Population Commission (NPC) [Nigeria] *et al.*, 2012). This supports the findings from studies in rural communities in Anambra and Kano states that found 67.7% and 60% malaria prevalence respectively, which is much higher than the zonal prevalence of 27.6% in the South East and 48.2% in the North West, respectively (Egbuche *et al.*, 2013; Dawaki *et al.*, 2016). This suggests that rural areas may have increased mosquito breeding sites than urban areas.

Religious affiliation was not found to be associated with malaria infection in studies conducted in Tanzania (Abdulla *et al.*, 2002) and Ghana (Dako-Gyeke and Kofie, 2015). This contrasts with findings from a study in Nigeria where the highest malaria prevalence rate of 89.3% was found among participants that refused to take malaria medication due to religious beliefs (Adefioye *et al.*, 2007). The religious affiliation however, was not stated.

Household construction types such as walls made with earth or dung, presence of open eaves, earth roof or lacking roof have been found to be associated with increased malaria parasitaemia risk in individuals living in those households (Sintasath *et al.*, 2005; Graves *et al.*, 2009; Chirebvu *et al.*, 2014; Sharma *et al.*, 2015; Babamale and Ugbomoiko, 2016). Households with source of drinking water within the house had minimized risk of malaria in a study in India (Sharma *et al.*, 2015). Other factors such as presence of bushes around the house and proximity to dumpsite and vector breeding sites have also been found to be associated with malaria transmission (Babamale and Ugbomoiko, 2016; Nasir *et al.*, 2015). The study by Nasir *et al.* (2015) was a comparative study and found a prevalence of 82% among those living between 100 and 500m from a dumpsite compared to 26% among the control group that were living beyond 500m from the dumpsite.

Another study in Ethiopia found a relationship between malaria prevalence in children below 17 and distance from mosquito breeding sites (Peterson *et al.*, 2009). Children who lived within 350m of breeding sites were at higher risk of malaria than children who lived further away.

Malaria transmission dynamics are complex. Factors such as climate, rainfall, presence of mosquito breeding sites, and areas of clustered human habitation are correlated with malaria transmission (Wiwanitkit, 2006; Graves *et al.*, 2009; Peterson *et al.*, 2009; Alemu *et al.*, 2011; Laishram *et al.*, 2012). Increased malaria intensity and transmission has been linked to decreasing altitude in several studies (Sintasath *et al.*, 2005; Chukwuocha and Dozie, 2011; Graves *et al.*, 2009). This may be due to ease of mosquitoes to reach human populations from their resting habitat. Anopheles mosquito growth and survival has been linked to climatic conditions such as temperature, humidity, and rainfall. (Sintasath et al. 2005; Alemu *et al.*, 2011; Onyiri, 2015). Seasonal variations of malaria intensity have been recorded in some studies, with wet season linked to higher transmission of malaria (Koram *et al.*, 2003; Alemu *et al.*, 2011; Okwa, 2003).This may explain why a study carried out in South East Nigeria showed a 55% prevalence of malaria parasitaemia in rainy season (April to October) and 26.92% in the dry season (November to March) (Okocha *et al.*, 2005). *An. gambiae* is acknowledged to be less common in central urban areas compared to peri-urban and rural areas as a result of fewer appropriate breeding sites (Klinkenberg *et al.*, 2008; Snow and Omumbo, 2010; De Silva and Marshall, 2012). *An. funestus* flourishes in dry and peri-urban environments (De Silva and Marshall, 2012). However, malaria transmission has been found to be more focal in urban areas as mosquito dispersal is more limited due to higher housing density (Byrne, 2007; De Silva and Marshall, 2012).

2.5. Malaria parasitaemia among household members of malaria positive patients

Researchers in Zambia found higher malaria prevalence of 8.0% in households where an index acute malaria case resided in comparison to prevalence of 0.7% in randomly selected households (Stresman *et al.*, 2010). Targeting those with clinical malaria and presumptively treating their relatives and nearest neighbors is a practical way to clear infection and diminish the local reservoir (Smith *et al.*, 2007). This is the principle of reactive case detection, a form of active case detection recommended for countries in the malaria elimination phase (Sturrock, Hsiang, *et al.*, 2013). A reactive case detection study conducted in Swaziland found that the odds of detecting secondary cases is significantly higher within the index households when compared to households less or greater than 100m from the index household (Sturrock, Novotny, *et al.*, 2013).

2.6. Knowledge, attitude, and practices towards malaria prevention/control

Knowledge of malaria, its signs & symptoms, mode of transmission, prevention techniques are expected to improve the ability to take appropriate prevention measures to protect oneself and others from the disease. The key interventions for malaria transmission prevention and reduction is vector control (WHO, 2016). The vector control strategies adopted in Nigeria include indoor residual spraying, use of ITNs/LLINs, and environmental management (Federal Ministry of Health [Nigeria], 2010b). In Nigeria, distrribution of LLINs has been through mass distribution campaigns and routine channels such as antenatal care clinics, immunization clinics, schools,and the commercial sector (Noland *et al.*, 2014). The strategy for prevention of malaria in pregnancy is intermittent preventive therapy with sulfadoxine-pyrimethamine (Federal Ministry of Health [Nigeria], 2011a).

In malaria-endemic countries, knowledge of malaria is high (>80%) as evidenced by studies conducted in several endemic african countries (Atieli *et al.*, 2009; Kimbi *et al.*, 2014; Pettifor *et al.*, 2008). In Nigeria, proportion of women with knowledge of malaria was found to be over 90% in the different zones with the exception of North Central zone which was 88% in 2010 (National Population Commission (NPC) [Nigeria] *et al.*, 2012). This is consistent with findings from another study conducted in Kano state of Nigera among individuals 10 years and above that found over 90% of respondents had heard of malaria (Dawaki *et al.*, 2016).

Knowledge of the mode of transmission was equally high in the 2010 malaria indicator survey in Nigeria with 82% of women recognising that mosquitoes spread malaria and the most common symptom recognised by the women was fever (National Population Commission (NPC) [Nigeria] *et al.*, 2012). This is similar to findings from studies in Kenya and Swaziland that had fever ranked as most common symptom, closely followed by headache and chills (Kimbi *et al.*, 2014; Hlongwana *et al.*, 2009).

Knowledge of effects of malaria on vulnerable groups was good in a study in Cameroon (Kimbi *et al.*, 2014). A study in Ethiopia found that most respondents believed children under 5years should be given priority to sleep under a net, but few respondents had inadequate knowledge on vulnerability of pregnant women to malaria with regards to prioritizing them for use of ITNs/LLINs (Tomass *et al.*, 2008).

Sixty-two percent of women in Nigeria correctly identified use of mosquito nets as a way of preventing malaria while 31% identified keeping the environment clean (National Population Commission (NPC) [Nigeria] *et al.*, 2012). Eductional level was found to be associated with good knowledge of vector and malaria prevention. Heads of households with at least a primary education had knowledge of mosquito as a vector and were more likely to acquire and use mosquito nets for themselves as well as their children (Atieli *et al.*, 2011).

One of the key strategies for malaria control is case management. The recommended medication for malaria case management are ACTs which have contributed to reduction of global malaria morbidity mortality (WHO, 2015a). This comes following the development of resistance to monotherapies such as chloroquine, amodiaquine, and sulfadoxine-pyrimethamine. Home-based treatment is very common in endemic countries. However, the recommendation by WHO is the parasitological confirmation before treatment and clinical diagnosis where this is not available. Studies have found that knowledge of ACTs increased significantly with education and wealth of the woman in the household (Division of Malaria Control Ministry of Public Health and Sanitation [Kenya], 2010; National Population Commission (NPC) [Nigeria] *et al.*, 2012). Walldorf *et al.*, (2015) found that school age children were brought less often for treatment than younger children and were less exposed to malaria interventions.

2.7. ITN/LLIN ownership and utilization

Insecticide treated nets are useful in malaria prevention because they serve as a physical barrier between the host and the vector which is the mosquito. An advantage of ITNs over untreated bed nets is that the insecticide in ITNs irritates mosquitoes and at a lethal dose, kills them. Regular ITNs, however, need to be re-treated with insecticide after 6 months. This led to the introduction of long-lasting insecticidal nets (LLIN) which is a special type of ITN that does not need re-treatment for at least 3 years and it is recommended for full coverage of population at-risk of malaria by WHO (WHO, 2007). Use of ITNs has been found to contribute to reduction in malaria mortality in children under 5years by an estimated 55% (WHO, 2015b). Of 663 million malaria cases averted by malaria control interventions from 2001 to 2015 in sub-Saharan Africa, an estimated 69% were due to use of ITNs (WHO, 2015b). Controlled trials conducted in Western Kenya and Sierra Leone demonstrated the impact of ITNs on mosquitoes and substantial reduction in malaria morbidity in infants (Marbiah *et al.*, 1998; Ter Kuile *et al.*, 2003). Resistance of vectors to pyrethroids, which is a class of insecticide recommended for manufacture of ITNs due to its low mammalian toxicity and long residual activity, has become a concern as mass distribution of ITNs carry on. A study in Malawi was able to detect a 30% reduction in malaria incidence as a result of ITN use despite moderate pyrethroid resistance in the area (Lindblade *et al.*, 2015). ITN use was found to be protective against malaria whether used on its own or in addition to indoor residual spraying in an area of high pyrethroid resistance in Malawi (West *et al.*, 2015). Other studies conducted in Anambra, Calabar, and Kano in Nigeria also found associations between malaria prevalence increase and non-use of ITN (Egbuche *et al.*, 2013; Iwuafor *et al.*, 2016; Dawaki *et al.*, 2016).

Use of ITNs is considered one of the most cost-effective interventions against malaria in highly endemic areas (WHO, 2007). An analysis of cost of ITN and indoor residual spraying (IRS) programmes in Sub-Saharan Africa revealed that ITNs which last 3 years, and when effectively targeted at children less than 5 years who account for high malaria burden in high transmission areas, were four to five times cheaper than IRS which would not target that particular age group (Lengeler *et al.*, 2007; WHO, 2007). Another study carried out in Jigawa state did not find a significant cost effectiveness ratio between the two, however, it found that use of ITNs effectively lead to a 0.042 reduction in malaria incidence compared to 0.028 reduction by IRS (Uneze and Nwadike, 2013).

Over 900 million ITNs have been delivered to endemic countries in sub-Saharan African countries from 2004 to 2014 (United Nations, 2015). Data from 2012 across Africa showed that ITN ownership ranged from as high as 82% in Rwanda to as low as 10% in Swaziland (Atta and Reeder, 2014). However, use of ITNs is a small proportion of vector control interventions in Swaziland, which is one of the low-transmission countries in Southern Africa. The National Demographic Health survey conducted in Nigeria in 2013 estimated a 50% and 48% household ownership of ITNs and LLINs, respectively (National Population Commission (NPC) [Nigeria] and ICF International, 2014). In countries like Malawi, Benin, Ethiopia, Rwanda, Tanzania, urban households were more likely to own ITNs than rural households (Khan *et al.*, 2008; Holtz, 2002). Also, households in highest wealth quintiles were more likely to own mosquito nets in Kenya and Ethiopia (Division of Malaria Control Ministry of Public Health and Sanitation [Kenya], 2010; Sena *et al.*, 2013). This contradicts the situation in Nigeria where households in the highest wealth index were least likely to own or sleep under a mosquito net (National Population Commission (NPC) [Nigeria] *et al.*, 2012). Other factors that affected ITN ownership included living in rural areas, living in areas where LLIN campaigns had been carried out, living in North East zone (National Population Commission (NPC) [Nigeria] *et al.*, 2012). In Abuja, the Federal Capital Territory of Nigeria, rural settlements were 2 times more likely to own ITNs compared to urban settlements and average net ownership was less than 1 net per household (Otsemobor *et al.*, 2013). A study conducted in Kano, northwestern region of Nigeria, found households with more than five members were less likely to own ITNs than those with one member and that women and under five children were more likely to sleep under ITNs (Ye *et al.*, 2012).

In Kenya, households with no education were less likely to own ITNs than households with at least a member having primary or secondary education (Atieli *et al.*, 2011). A study done across the 6 geopolitical zones of Nigeria found that level of education raised the odds of owning a net by 42% in the urban region in Northern Nigeria (Oresanya *et al.*, 2008) and this is supported by Iwuafor *et al.* (2016) in a study conducted in Southern Nigeria, where those with higher education were less likely to own ITNs. Those who had at least secondary education were more likely to sleep under mosquito nets than those who did not have (Pettifor *et al.*, 2008; Atieli *et al.*, 2011; Okafor and Odeyemi, 2012; Onyido *et al.*, 2015).

Religious affiliation has been linked to ownership of ITNs in a study in Nigeria that found more Christians likely to own ITN/LLINs compared to Muslims (Oresanya *et al.*, 2008). This contrasts with findings from a study in Uganda where Muslims were more likely to use ITN/LLINs than Christians (Ndugga, 2013).

According to the 2015 World Malaria Report, 68% of children under five and 55% of all age groups sleep under insecticide treated mosquito nets in sub-Saharan Africa (WHO, 2015b). This is still below the 100% target for universal coverage. Among those surveyed in the Nigeria malaria indicator survey in 2010, only 24% slept under an ITN the net before the survey (National

Population Commission (NPC) [Nigeria] *et al.*, 2012). In Kenya, 40% slept under an ITN in the same year (Division of Malaria Control Ministry of Public Health and Sanitation [Kenya], 2010).

The 2015 World Malaria Report also estimates that 82% of those with access to ITN in 2015 sleep under it (WHO, 2015b). This indicates a disparity in ownership and utilization with net usage being lower than possession. In 2010, 49% of population in Nigerian households with at least one ITN slept under it the night before the malaria indicator survey was conducted (National Population Commission (NPC) [Nigeria] *et al.*, 2012). These statistics decreased in the 2013 Demographic and health survey, which saw only 13% of population in households with at least one ITN sleeping under a net the night before the survey. This finding of low utilization among ITN owners is consistent in community-based studies across the country (Egbuche *et al.*, 2013; Noland *et al.*, 2014; Dawaki *et al.*, 2016).

Many studies have been carried out to determine reasons for low ITN utilization. Findings from a data survey across seven African countries showed that urban residents were significantly more likely to use ITNs than rural residents in Benin, Senegal, Tanzania, and Rwanda (Khan *et al.*, 2008). It also revealed that the odds of using an ITN increases significantly with increase in number of ITNs in the house and decreases as the household size increases. This is similar to findings from another study in northeastern Nigeria where households in which the ratio of one ITN for two members is met were more likely to use ITNs (Ye *et al.*, 2012).

Age and sex have been found to significantly affect use of ITNs. A study conducted across five African countries including Nigeria found that females of reproductive age and children less than 5 years were more likely to sleep under a net (Baume and Marin, 2007; National Population Commission (NPC) [Nigeria] *et al.*, 2012; Division of Malaria Control Ministry of Public Health and Sanitation [Kenya], 2010). This is similar to findings in Kano (Ye *et al.*, 2012). Pregnant women and children under 5years have been targeted for malaria interventions in Nigeria because they are considered most vulnerable for malaria interventions. However, there is concern as school age children make up the largest parasite reservoir and may continue the spread of malaria by mosquitoes (WHO, 2015a). School age children, between the ages of 6 to 15 years, in Malawi were less likely to sleep under ITNs compared to all other age groups (Walldorf *et al.*, 2015). This is similar to findings from a study carried out in Plateau and Abia states in Nigeria that found higher net use among children below 5years and adults above 20 years (Noland *et al.*, 2014).

However, the same study was unable to detect significant difference in net use between males and females.

Married women were also more likely to own and use mosquito nets for themselves and their children than their unmarried counterparts as found in several studies (Pettifor *et al.*, 2008; Okafor and Odeyemi, 2012; Malusha *et al.*, 2009).

A study in Ethiopia found that, of all the respondents who owned ITNs, only 12% hung and used the nets in the study area (Tomass *et al.*, 2008). Most of the nets were either stored in a box or used for other purposes. In Kenya, a survey carried out found 19% of respondents reported that insecticides in ITN/LLINs may be harmful to net users (Malusha *et al.*, 2009). Some reasons given by respondents in some studies for low utilization of ITNs include no mosquitoes (when it is not the high transmission season) (Tomass *et al.*, 2008), heat (Kimbi *et al.*, 2014), difficulty in hanging (Noland *et al.*, 2014; Baume and Marin, 2007), and cost (Pettifor *et al.*, 2008).

Studies conducted across sub-Saharan Africa have found that health education is effective and impacts positively on ITN utilization (Owusu-Addo and Owusu-Addo, 2014). The low utilization of ITNs in Nigeria may be due to poor knowledge of ITN benefits, hanging, or handling.

2.8. Conceptual framework

The conceptual framework for malaria burden is shown in figure 2.1. The external factors that are associated with malaria infection include the socio-demographic and socio-economic characteristics of individuals as well as environmental factors such as climate and ecological factors. Program factors such as a national malaria control program with adequate national and international support, partnerships with stakeholders and other agencies, antimalarial drug policy and a health policy, help to build a strong health care system. This health care system in turn provides adequate prevention services (indoor residual spraying, intermittent preventive treatment, long-lasting insecticidal nets, and environmental management) which help to prevent malaria infection or development of malaria infection to morbidity. Coupled with early diagnosis and treatment of malaria morbidity, this will have a significant impact on malaria morbidity and mortality. Another important component in this framework is the individual's knowledge of malaria causation, prevention, and treatment, which will enable their participation in prevention and control of malaria.

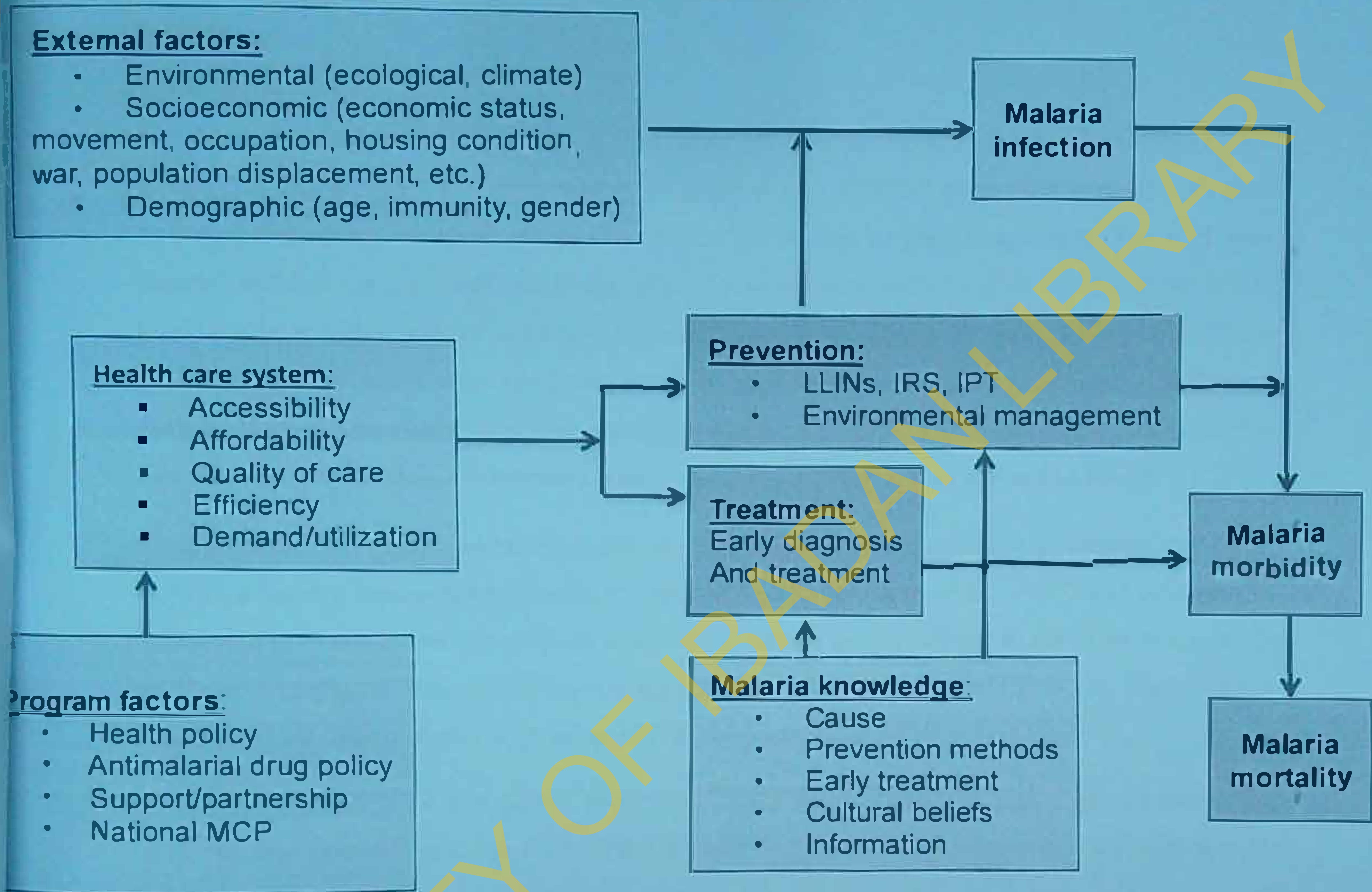

Figure 2.1 Conceptual framework of malaria burden

Source: Monitoring and evaluation of malaria control programmes; A brief overview. Presented by Jui Shah, MEASURE Evaluation/ICF International, as part of a symposium organized by MEASURE Evaluation and MEASURE DHS at the 6th MIM Pan-African Malaria Conference 2013.

CHAPTER THREE

3.0. Methods

3.1.Study area

The study was conducted from March to August 2016 in the Federal Capital Territory (FCT), Abuja, the capital city of Nigeria with a population of 1,406,239 as at 2006 census and total projected population of 2,238,751 in 2011 (National Bureau of Statistics, 2010). The FCT was planned and built in the 1980s but Abuja officially became the capital city on 12 December 1991, replacing Lagos. It is located in the north-central geopolitical zone and covers an area of 7,753.9 sq. km. It shares borders in the north with Kaduna state, south-east with Nasarawa state, south-west with Kogi state, and Niger state in the west (Appendix 3). The FCT is made up of six area councils namely Kuje, Bwari, Abaji, Gwagwalada, Kwali, and Abuja Municipal Area Council (AMAC).

Usually in the FCT, there is a humid rainy season from April to September with temperature of 22 – 30°C, a hot dry season from October to March with a temperature of 12 – 40°C and brief period of harmattan in December. The annual total rainfall ranges from 1100mm to 1600mm and altitude is 476m. Malaria transmission is intense during the rainy season compared to low transmission during the dry season (Federal Ministry of Health [Nigeria], 2011a).

There are 3 tertiary, 14 secondary, and 179 primary public health facilities spread across the different area councils in in the FCT. There are also 673 registered private health facilities and 81 laboratories.

Majority of the inhabitants are either Christian or Muslim, although few traditional religious worshippers are still present. As a rapidly growing capital city, almost all tribes in Nigeria are represented in Abuja.

The Malaria Indicator Survey (MIS) conducted in 2015 in all 36 states of Nigeria and FCT showed that North Central region had the second highest malaria prevalence of 32.0% by microscopy among children aged 6 to 59 months.

3.2. Study design

Household cross-sectional study was conducted.

3.3. Study population

The study population were all household members of laboratory-confirmed malaria patients presenting at selected hospitals in Abuja.

3.3.1. Inclusion criteria

Household members (all ages) of laboratory confirmed malaria-positive individuals residing in Abuja who consented to participate in the study.

3.3.2. Exclusion criteria

- Individuals who had not lived in the house for more than 7 days (minimum incubation period of malaria)
- Individuals who took anti-malarial drugs two weeks prior to the study
- Individuals with blood dyscrasias (such as haemophilia and sickle cell disease)
- Critically ill individuals

3.4. Sample size

The sample size was calculated using the following formula (David, 1999).

$$n = \frac{{Z_{1-\alpha/2}}^2 P(1-P)}{d^2}$$

Where:

n = minimum sample size

Z= standard normal deviate corresponding to 2-sided level of significance at 5% = 1.96

p = To obtain the prevalence, p, based on stated objectives: A study carried out in FCT found 19.2% LLIN use (Otsemobor et al., 2013) and the malaria parasitaemia prevalence of 36.6% was found from a previous community-based study in Plateau state, North Central Nigeria (Noland *et al.*, 2014). Therefore. the prevalence of 36.6% was used as 'p' to obtain a larger sample size.

d = level of precision, d (how close to the proportion of interest the estimate is desired to be (within 5%)

The sample size used was calculated thus:

$$n = \frac{z^2\ P(1-P)}{d^2} = \frac{(1.96)^2 * .366 * .634}{(0.05)^2} = 356$$

Factoring in design effect of 1.5 to take care of clustering effect in households and enable us detect any variability,

Sample size $n = 1.5 * 356 = 534$

Factoring in anticipated non-response rate (NRR) of 10%,

Final sample size $N = \frac{n}{(1-NRR)}$

Therefore, $n = \frac{534}{(1-0.1)}$ and the final calculated sample size is **593 household members.**

3.5. Sampling technique

Multi-stage sampling technique was used.

Stage 1: Three of the six area councils in the FCT were randomly selected

Stage 2: Four health facilities were randomly selected from each of the three selected area councils. Laboratory-confirmed malaria patients presenting in the selected health facilities and residing in Abuja were identified as they came for their results and recruited consecutively

Stage 3: The houses of the identified individuals were visited in the community within 7 days and all eligible household members were enrolled into the study.

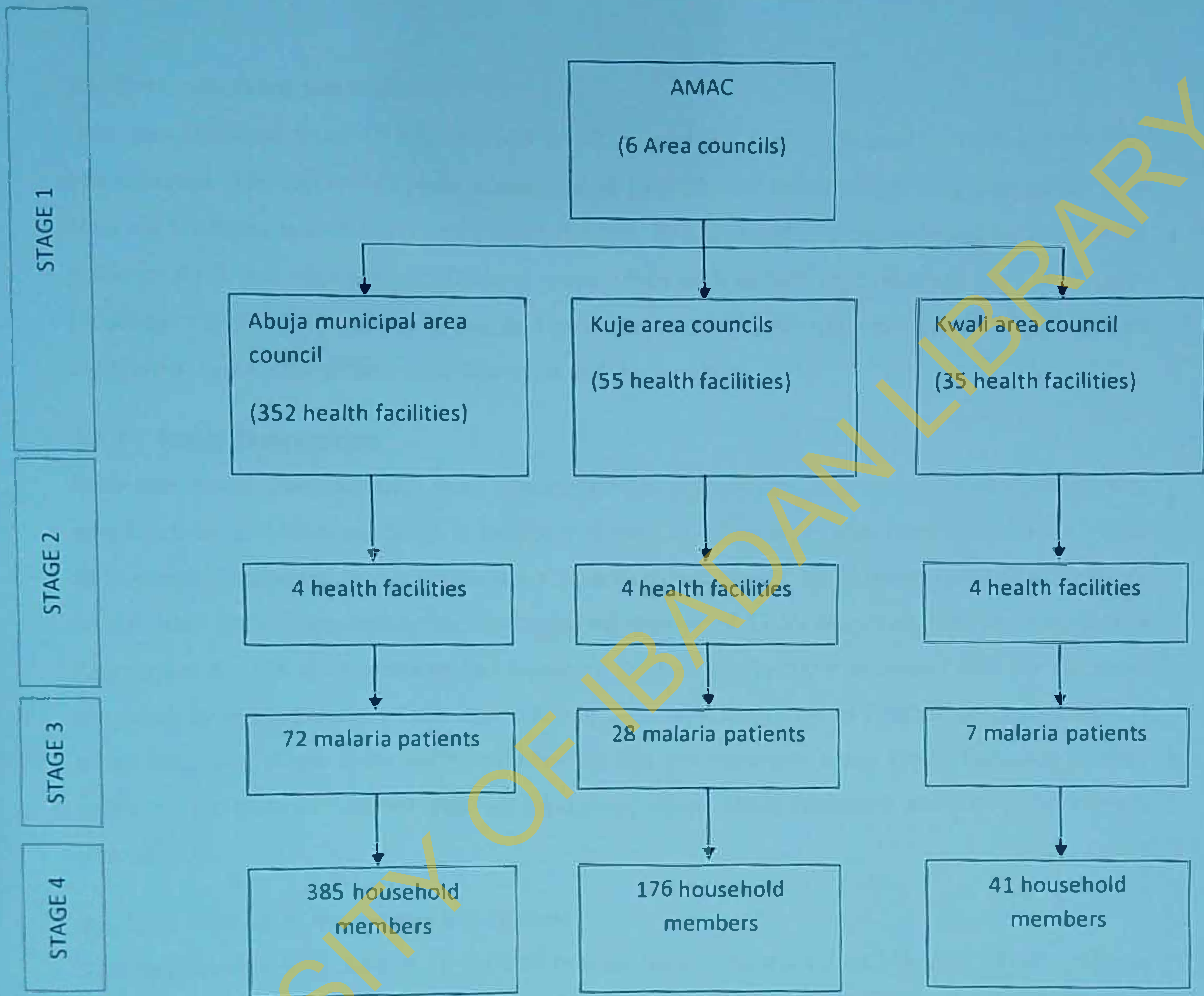

Figure 3.1 Flow diagram of sampling technique

3.6. Data collection methods

Data was collected from 1st March 2015 to 5th August 2015. Questionnaires were interviewer-administered. The interviews were conducted in English and the common language in the area councils for those who did not understand English. Blood samples were collected by finger/heel prick for RDT and microscopy. House characteristics such as roof type, window type, wall type, presence of bushes around the house, and presence of uncovered water receptacles such as open containers, tyres, and gutters were observed and documented.

3.6.1. Study Instruments

Semi-structured questionnaires were administered to respondents. The questionnaire, which was adapted from the National Malaria Indicator Survey questionnaire, contained sections on socio-demographic and economic characteristics, house characteristics, LLIN ownership and utilization, use of other malaria preventive measures and knowledge of LLIN and other prevention measures (Appendix 2). The questionnaire and informed consent forms were translated into the common language of respondents in each area council and back translated to English to ensure correct translation was done. Data were collected on the questionnaire using Open Data Kit (ODK) software on android phones and on hard copy questionnaires where android phones were unavailable.

3.6.2. Training of the research assistants

The interviewers were trained on the survey objectives to enhance understanding of their roles in the survey as well as the need for good, quality data and use of the ODK phones for data collection. They were also trained by a laboratory scientist with field expertise on preparation of thick films for uniformity.

3.6.3. Pre-test of study instruments

Questionnaire was pre-tested prior to initiation of fieldwork on 30 respondents in Lugbe, AMAC, who were comparable to the study participants and was corrected based on observations prior to final use.

3.6.4. Field work

Blood samples were collected by finger-prick of all participants above 6 months and heel-prick for participants below 6 months using sterile non-reusable lancet. Standard diagnostic (SD) Bioline malaria rapid diagnostic test (RDT) kits were used for on-site diagnosis and blood films were prepared on-site for microscopy. The thick blood films were prepared by laboratory technologists on a single slide, air dried and stained with Giemsa on the day of collection. Blood films were read by trained medical laboratory scientists (experience of 10 years or more of malaria microscopy) using x100 oil immersion objective to determine malaria parasitaemia status and density. The number of parasites per microlitre of blood in a thick film were counted against a standard number of white blood cells (WBCs) (8000 WBCs). Parasite quantitation was performed against 200 or 500. If, after counting 200 WBC, 100 or more parasites were found, the results were recorded against number of parasites/200 WBC. If fewer than 100 parasites were found after counting 200 WBCs, parasite quantification was continued until 500 WBCs were counted. All parasites in the final field were counted even if the count exceeded 500 WBCs. In each case, the number of parasites relative to the leukocyte count were converted to parasites per microlitre of blood by the simple mathematical formula:

$$\frac{\text{Number of parasites} \times 8{,}000 \text{ WBCs}}{\text{Number of leukocytes}} = \text{parasites per microlitre}$$

This means that if 200 WBCs were counted, the number of parasites was multiplied by 40 and if 500 WBCs were counted the number of parasites was multiplied by 16 (Federal Ministry of Health [Nigeria], 2011b).

Ten percent of the household sample slides and index case slides were rechecked by a second reader, who is also a trained medical laboratory scientist, for quality assurance.

3.7. Data analysis

Regular supervision was provided by the principal investigator during data collection process. Data collected were reviewed for completeness and cleaned for inaccuracies on the field and affected questionnaires were corrected. Data were cleaned and checked for outliers, inconsistencies and missing values. Quantitative data collected were analyzed using Microsoft Excel, Epi-info 7 software package, and statistical package for social sciences (SPSS)16.0.

3.7.1. Dependent variables

The major outcomes or dependent variables are malaria parasitaemia, malaria parasite density, and LLIN use.

3.7.2. Independent variables

The measurement /explanatory variables included demographic variables, socio-economic variables, house characteristics, ownership and use of LLINs, use of other malaria preventive measures and knowledge of LLINs and other malaria prevention measures.

3.7.3. Analysis methods

Descriptive analysis

The prevalence of asymptomatic malaria parasitaemia, proportion of those who own and use LLINs, and knowledge of LLINs were calculated.

Bivariate analysis

Factors associated with LLIN use, and factors responsible for malaria transmission in a household were determined using chi square test. Variables from the bivariate analysis significant at $p<0.25$ were selected for inclusion in a logistic regression model.

Multivariate analysis

Binary logistic regression analysis was done using SPSS Generalized Estimating Equations (GEE) to assess independent predictors of malaria transmission and LLIN use. Codes for area council, health facility, and household levels were used as within-subject variables to account for the intra-cluster correlation in the data. The level of significance was set at $p<0.05$.

3.8. Ethical approval

The proposal was submitted for ethical review and approval by the FCT Ethical review board (Appendix 3). Written informed consent was obtained from each participant ≥18 years or from parents of minors (0-17 years), as well as additional verbal assent from minors over the age of 6 years prior to the interview. All the interviews were conducted with no names recorded on the questionnaire but codes were used to represent the names. There was minimal risk involved in participating in the study, which was in the collection of capillary blood by finger or heel prick. However, the risk was lessened by employing competent hands in the collection as well as following the standard operating procedure and safety practices. Participation of respondents was strictly voluntary, and they could withdraw any time after they got involved in the study. Individuals with positive RDT results were offered on-site treatment according to national guidelines: artemether-lumefantrine for non-pregnant individuals older than twelve months of age. Individuals younger than twelve months and pregnant women with a positive RDT test were referred to the nearest health facility for evaluation and care, as well as RDT-negative individuals with self-reported fever or other overt signs of clinical illness.

Measures were taken to ensure that the respect, dignity, non-maleficence and freedom of each individual participating in the study was maintained.

3.9. Dissemination plan

Upon completion, the dissertation will be presented to the University of Ibadan for approval; then it will be disseminated to National Malaria Elimination Programme. Feedback will be provided to the study participants. An abstract will be prepared and presented in different Scientific Communities such as Epidemiological Society of Nigeria (EPiSON) annual scientific conferences, Epidemic Intelligence Service (EIS) annual scientific conference, European Scientific Conference on Applied Infectious Disease Epidemiology (ESCAIDE), African Field Epidemiology Network (AFENET) annual scientific conference, Training Programs in Epidemiology and Public Health Interventions Network (TEPHINET) annual scientific conference, and other regional and global conferences after which manuscripts will finally be submitted to journal for publication. The documentation of this study result through publication will be of value to understanding household dynamics that affect LLIN use and malaria parasitaemia and may inspire further studies.

CHAPTER FOUR

4.0. Results

4.1. Demographic and socio-economic characteristics of respondents

Overall, 602 study participants linked to 107 malaria patients were recruited from 107 households (median: 4.5 household members/household, range: 1 to 20 household members/household). Of all the participants, 331 (55.0%) were female while 271 (45.0%) were male (Table 4.1.1). Of all the female participants, only 5 (1.5%) were pregnant. The median age of respondents was 16.5 years (Interquartile range (IQR): 23 years).

Approximately 78% of the study participants were Christians while 22% were Muslims (Table 4.1.1). Most were of Igbo tribe (30.2%), followed by Hausa tribe (19.6%). The study participants had varying levels of education. One hundred and twenty-seven (21.1%) study participants had no formal education, 164 (27.2%) had primary education, 182 (30.2%) had secondary education, while 129 (21.4%) had tertiary education (Table 4.1.1.). Two hundred and twenty-two (36.9%) of the study participants were students, 210 (34.9%) were unemployed, 55 (9.1%) were civil servants, 43 (7.4%) were traders/ business men, while only 16 (2.7%) were farmers.

Table 4.1.1 Socio-demographic characteristics of study participants [N=602]

Characteristics	Frequency (%)
Age-group of respondents (years)	
<5	91 (15.1)
5-9	112 (18.6)
10-19	136 (22.6)
20-24	50 (8.3)
25-34	111 (18.4)
≥35	102 (16.9)
Sex	
Male	271 (45.0)
Female	331 (55.0)
Religion	
Christian	471 (78.2)
Muslim	131 (21.8)
Ethnicity	
Igbo	182 (30.2)
Hausa	118 (19.6)
Yoruba	73 (12.1)
Others	229 (38.1)
Educational level	
None	127 (21.1)
Primary	164 (27.2)
Secondary	182 (30.2)
Tertiary	129 (21.4)
Occupation	
Student	222 (36.9)
Unemployed	210 (34.9)
Civil servant	55 (9.1)
Trader/businessman	43 (7.1)
Farmer	16 (2.6)
Others	56 (9.3)

Table 4.1.2 shows the characteristics of houses of study participants. Four hundred and forty (73.1) participants resided in flats, 77 (12.9%) in huts, 30 (5.0%) in duplexes, and 25 (4.2%) in bungalows. Four hundred and seventy-six (79.1%) participants lived in houses with cement plastered walls while 126 (20.9%) lived in houses with mud walls. Approximately seventy-seven percent of study participants resided in houses that had glass windows (louvers/sliding windows), 82 (13.6%) lived in houses with open windows (opening in wall area as windows), 44 (7.3%) in houses with wooden shutters, and 11 (1.8%) in houses with metal shutters. The most common roof type was metal (zinc/aluminum/asbestos) at 62.6%, followed by roof shingles at 21.6%, and wood planks at 15.8%. Seventy-eight (13.0%) participants lived in houses with floors that were carpeted, 183 (30.4%) in houses with cement floors, and 341 (56.6%) in houses with ceramic tiles.

Individuals residing in houses with bushes around were 34.9% while those residing in houses without bushes were 65.1%. Only 12.6% of the study participants resided in houses found to have uncovered water receptacles.

Table 4.1.2 Characteristics of residences of study participants [N=602]

Characteristics	Frequency (%)
House types	
Flat	440 (73.1)
Hut	77 (12.9)
Duplex	30 (5.0)
Bungalow	25 (4.1)
Others[a]	30 (4.9)
Wall types	
Cement-plastered	476 (79.1)
Mud	126 (20.9)
Window types	
Glass windows	465 (77.3)
Open windows	82 (13.6)
Wooden shutters	44 (7.3)
Metal shutters	11 (1.8)
Roof types	
Metal	377 (62.6)
Roof shingles	130 (21.6)
Wood planks	95 (15.8)
Floor types	
Carpet	78 (13.0)
Cement	183 (30.4)
Ceramic tiles	341 (56.6)
Bushes around the house	
Yes	210 (34.9)
No	392 (65.1)
Uncovered water receptacles around house	
Yes	76 (12.6)
No	526 (87.4)

[a]self-contained room, 1 room and parlour

4.1.1. Ownership and use of LLINs

Of the 107 households visited, 48 (44.8%) households owned at least one LLIN while 36 (33.6%) had at least one household member who used the LLIN the night prior to the survey. Of the 602 study participants, only 148 (24.6%) owned LLINs. Net ownership was highest in Kwali (70.7%), while Abuja municipal and Kuje area councils were 20.3% and 23.3%, respectively. Only 107 (17.8% of all study participants and 72.3% of all those who owned LLINs) study participants slept under LLINs the night before the survey. Long-lasting insecticidal net use among all study participants in Abuja municipal, Kuje, and Kwali area councils was 16.9%, 19.9%, and 17.1%, respectively. Among study participants who owned nets, LLIN use was lowest in Kwali area council at 26.1% while Abuja municipal and Kuje area councils were 83.3% and 85.3% respectively (Table 4.1.3)

Table 4.1.3 Ownership and use of LLINs by study participants

Characteristics	LLIN ownership N=602 n (%)	LLIN use among all participants N=602 n (%)	LLIN use among participants who owned nets N=148 n (%)
Abuja municipal	78 (20.3)	65 (16.9)	65 (83.3)
Kuje	41 (23.3)	35 (19.9)	35 (85.3)
Kwali	29 (70.7)	7 (17.1)	7 (26.1)
Total	148 (24.6)	107 (17.8)	107 (72.3)

Among those who owned LLINs, 65 (43.9%) of them had their LLINs for more/greater than 12 months to 3 years, 51 (34.4%) had their LLINs between 1 to 12 months, and 28 (18.9%) had theirs for longer than 3 years (Table 4.1.4). Most (53.4%) of the participants got their LLINs from super markets /open markets/ street hawkers. Eighty-one (54.7%) of the study participants purchased their nets. The most common net type was permanet® at 33.8%. Fifty-one (34.5%) participants did not know the trade name of the type of net they owned. About 96 % of the nets were rectangular while 3.4% of the nets were conical. One hundred and three (69.6%) participants had nets which had never been mended and which had no holes. Information on net sizes were collected and 51.4% were single, 42.6% were double, and 2.0% were triple. Of all the net owners, 15 (10.1%) said they dipped or soaked their nets in liquid to repel mosquitoes, 125 (84.5%) did not, 8 (5.4%) did not know if their nets had been dipped or not. Almost 96% of all the nets owners had their nets hanging.

Table 4.1.4 Characteristics of LLINs by participants who owned one [N=148]

Characteristics	Frequency (%)
Duration of ownership of ITN	
<1 month	2 (1.4)
1 to 12 months	51 (34.4)
>12months to 3 years	65 (43.9)
>3 years	28 (18.9)
Don't know	2 (1.4)
Source of LLINs	
Supermarket/Open market/Hawker	79 (53.4)
Mass distribution campaign	30 (20.3)
Immunization clinic	19 (12.8)
Gift	9 (6.1)
Ante-natal clinic	9 (6.1)
Don't remember	2 (1.4)
Net purchased	
Yes	81 (54.7)
No	67 (45.3)
Net type	
Permanet	50 (33.8)
Olyset net	26 (17.6)
Duranet	18 (12.2)
Netprotect	3 (2.0)
Don't know	51 (34.5)
Net shape	
Rectangular	143 (96.6)
Conical	5 (3.4)
Net size	
Single	76 (51.4)
Double	63 (42.6)
Triple	3 (2.0)
Don't know	6 (4.0)
Net condition	
Never mended, no holes	103 (69.6)
Never mended, holes	33 (22.3)
Mended, holes	7 (4.7)
Mended, no holes	5 (3.4)
Net dipped in liquid	
Yes	15 (10.1)
No	125 (84.5)
Don't know	8 (5.4)
Net hanging	
Yes	141 (95.3)
No	7 (4.7)

Among those who did not own LLINs, 173 (39%) said they did not like sleeping under them, while 138 (31%) claimed they did not know where to get them from (Fig. 4.2.1). Some participants had no reason (9%) for not owning LLINs, some said they use insecticide sprays (9%), some said they had window nets (2%), while some claimed there are no mosquitoes in their area (2%).

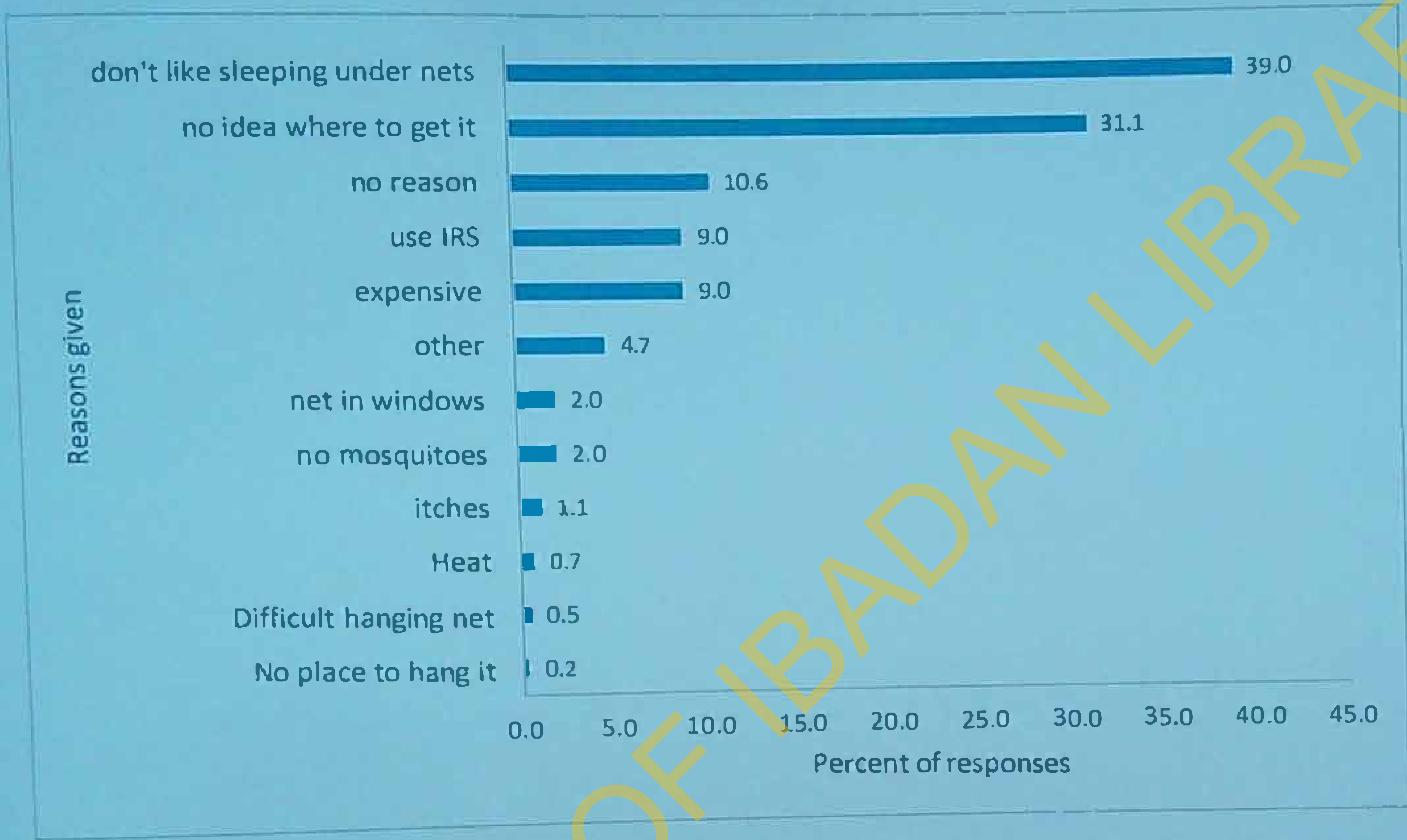

Figure 4.1.1 Reasons given by study participants for not owning LLINs

The most common reason given for not using LLIN by study participants who owned but did not use the LLIN was that the weather was too hot (68.3%). This was followed by participants who said "net is too old" (4.9%), and "there are no mosquitoes" (4.9%) (Fig 4.1.2).

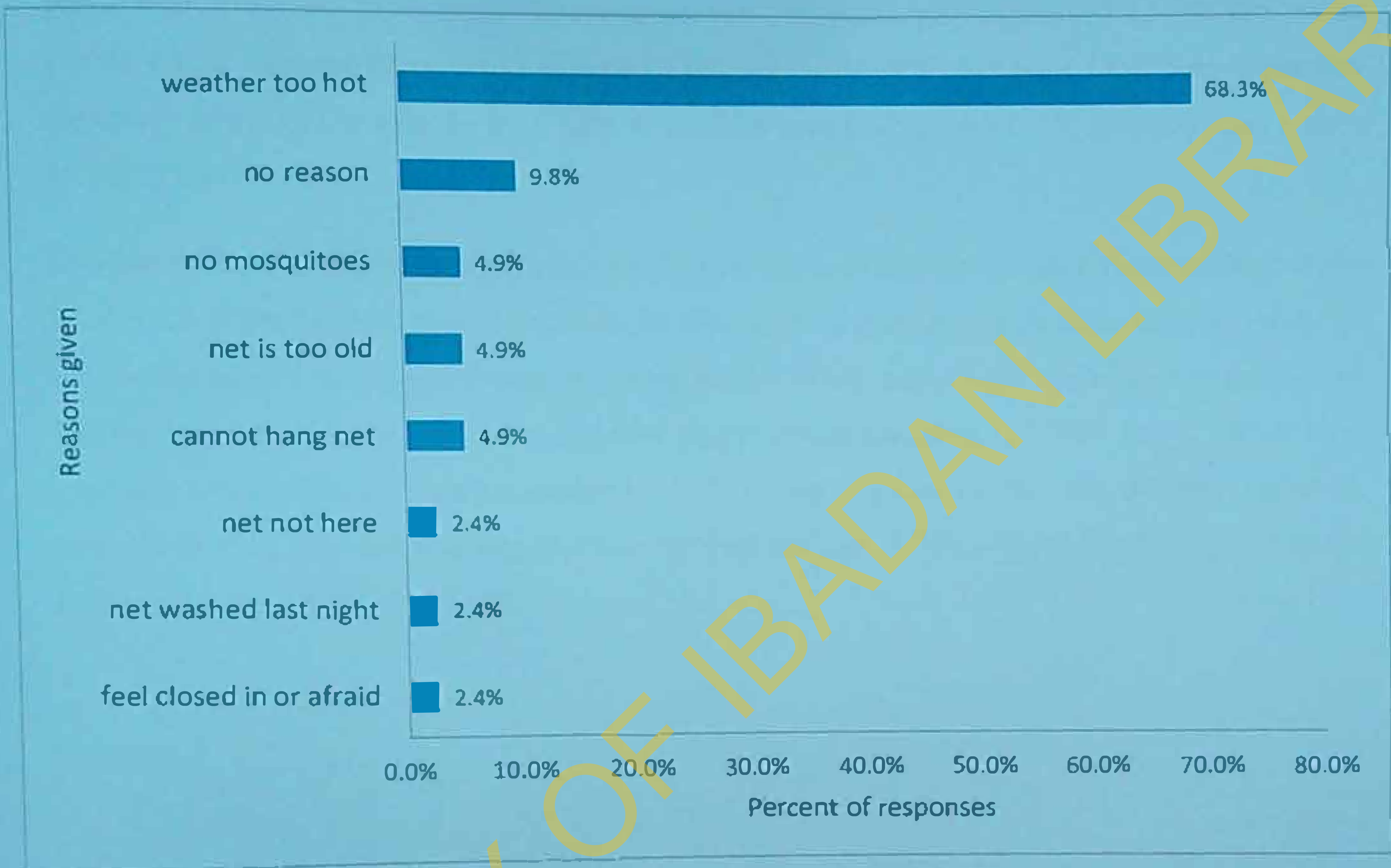

Figure 4.1.2 Reasons given by study participants who own LLINs for not using them the night prior to visit

4.1.2. Knowledge of and attitude of study participants to malaria prevention

Adults and children above 3 years were asked about their knowledge of LLINs and other malaria prevention measures. Five hundred and seven (96.8%) participants believed LLINs are useful (Table 4.1.5). Among those who believed LLINs are useful, 82% believe LLINs help to prevent mosquito bites, 14.6% believe they help to prevent insect bites, and 0.2% have no idea how it works (Table 4.1.5).

Over half (62%) of the study participants believed everyone should be given priority to sleep under LLINs, 13.9% believed it should be adults, 10.9% believed it should be children <5year, and 6.3% believed it should be pregnant women (Table 4.1.5). When asked what could lead to damage of LLINs in the house, the responses included inappropriate handling (27.5%), fire (21.9%), long exposure to sun while drying after washing (16.0%), sharp objects (16.0%), rats and other domestic animals (6.4%), frequent washing (2.6%), and dust and dirt (1.5%). About 26.4% of participants believed LLINs have side effects.

Table 4.1.5 Knowledge of and attitude of household members of malaria positive individuals to LLIN [N=524]

Characteristics	Frequency (%)
Believe LLINs are useful	
Yes	507 (96.8)
No	17 (3.2)
Mode of protection by LLIN*	
By preventing mosquito bites	474 (82.3)
By preventing insect bites	84 (14.6)
By avoiding dust and dirt	15 (2.6)
Chemicals repel mosquitoes	2 (0.3)
Don't know	1 (0.2)
Priority groups to sleep under LLINs in the household*	
Everyone	422 (62.1)
>18 years	95 (13.9)
Children <5 years	74 (10.9)
Pregnant women	43 (6.3)
Elderly	27 (4.0)
Guests	12 (1.8)
Don't know	7 (1.0)
Believe LLINs have side effects	
Yes	136 (26.4)
No	336 (64.7)
Don't know	46 (8.9)
Factors that damage LLINs in the household*	
Inappropriate handling	226 (27.5)
Fire	180 (21.9)
Long exposure to sun while drying after washing	132 (16.0)
Sharp objects	132 (16.0)
Rats and other domestic animals	53 (6.4)
Using LLIN for other purposes	47 (5.7)
Frequent washing	21 (2.6)
Don't know	20 (2.4)
Dust and dirt	12 (1.5)

*Multiple responses were given

Among those who did not believe that LLINs are useful, 2 (40%) said mosquitoes enter the nets with you as you go in, 2 (40%) said mosquito bites can happen outside, and 1 (20%) said mosquitoes penetrate holes in the net (Fig. 4.1.3).

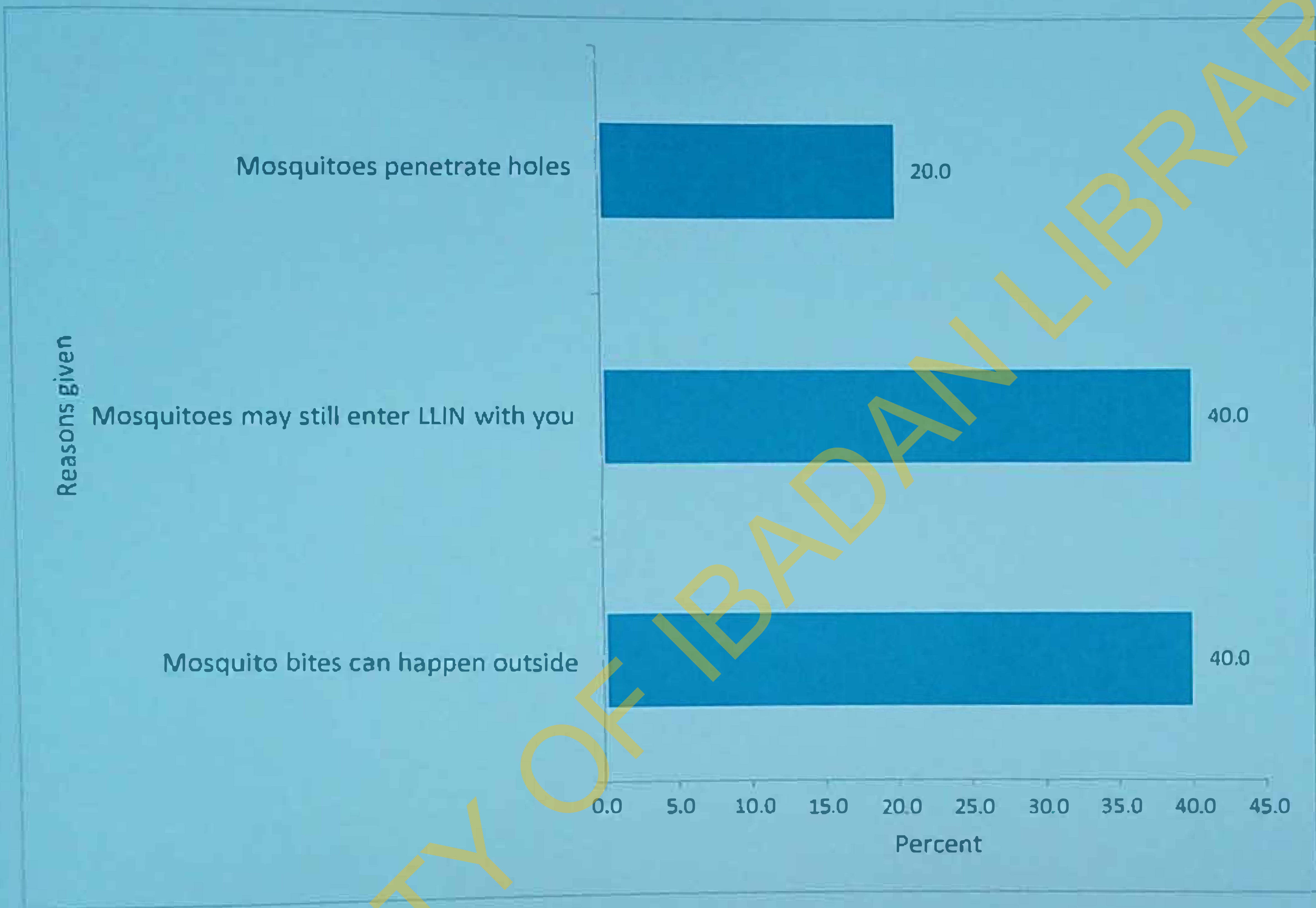

Figure 4.1.3 Reasons given by study participants for believing LLINs are not useful

The most common side effect stated was heat rashes (55.1%), followed by itching (25.2%) (Fig 4.1.4).

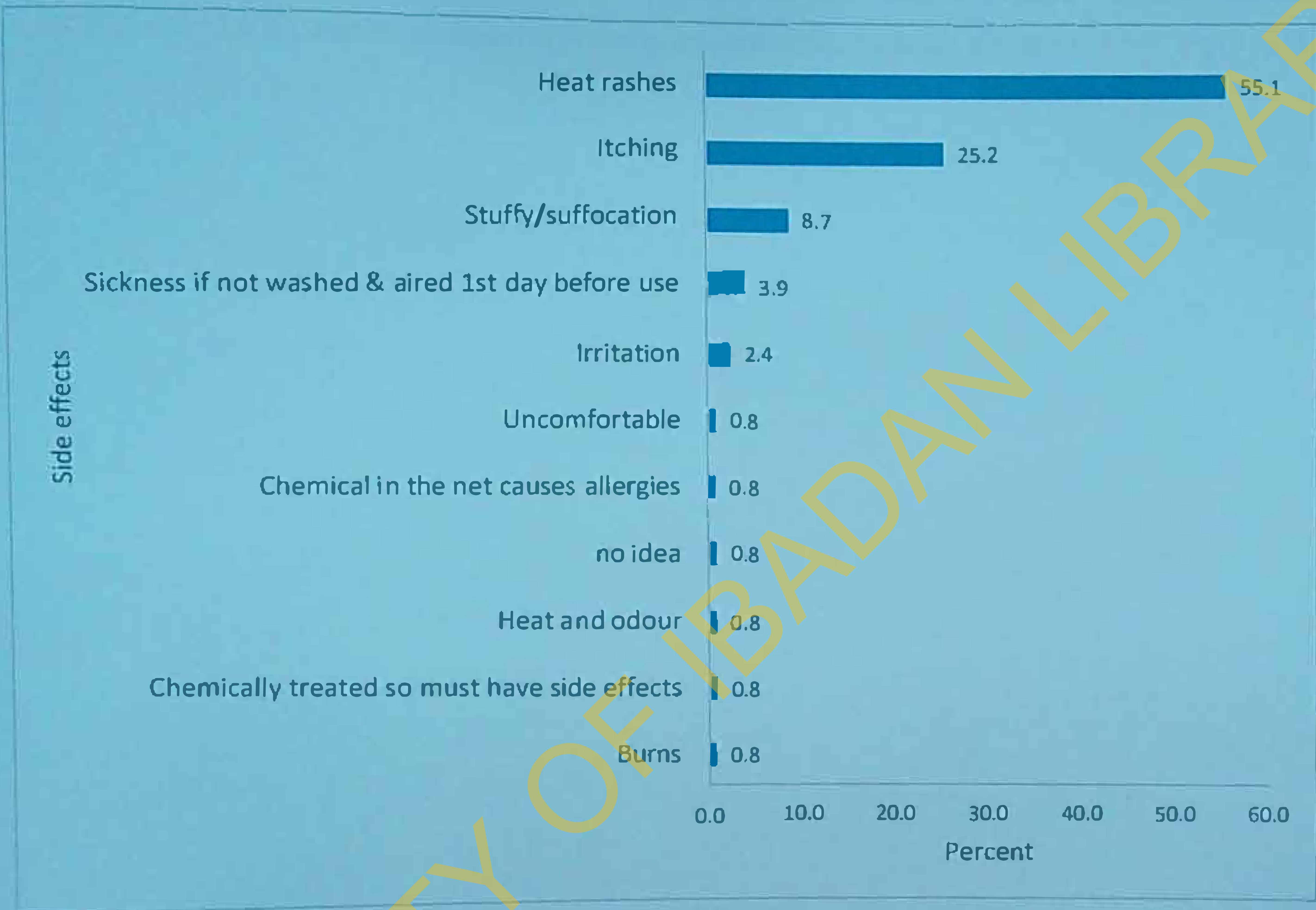

Figure 4.1.4 Perceived Side effects of LLIN among participants

Participants were assessed on their knowledge of other malaria prevention measures. Over two-thirds of them mentioned closing doors in the evening (44.2%) and use of insecticides (36.2%). Others mentioned keeping a clean environment (8.5%), use of insect repellent (6.3%), malaria prophylaxis (3.6%), and intermittent preventive treatment for pregnant women (0.7%) (Fig. 4.1.5).

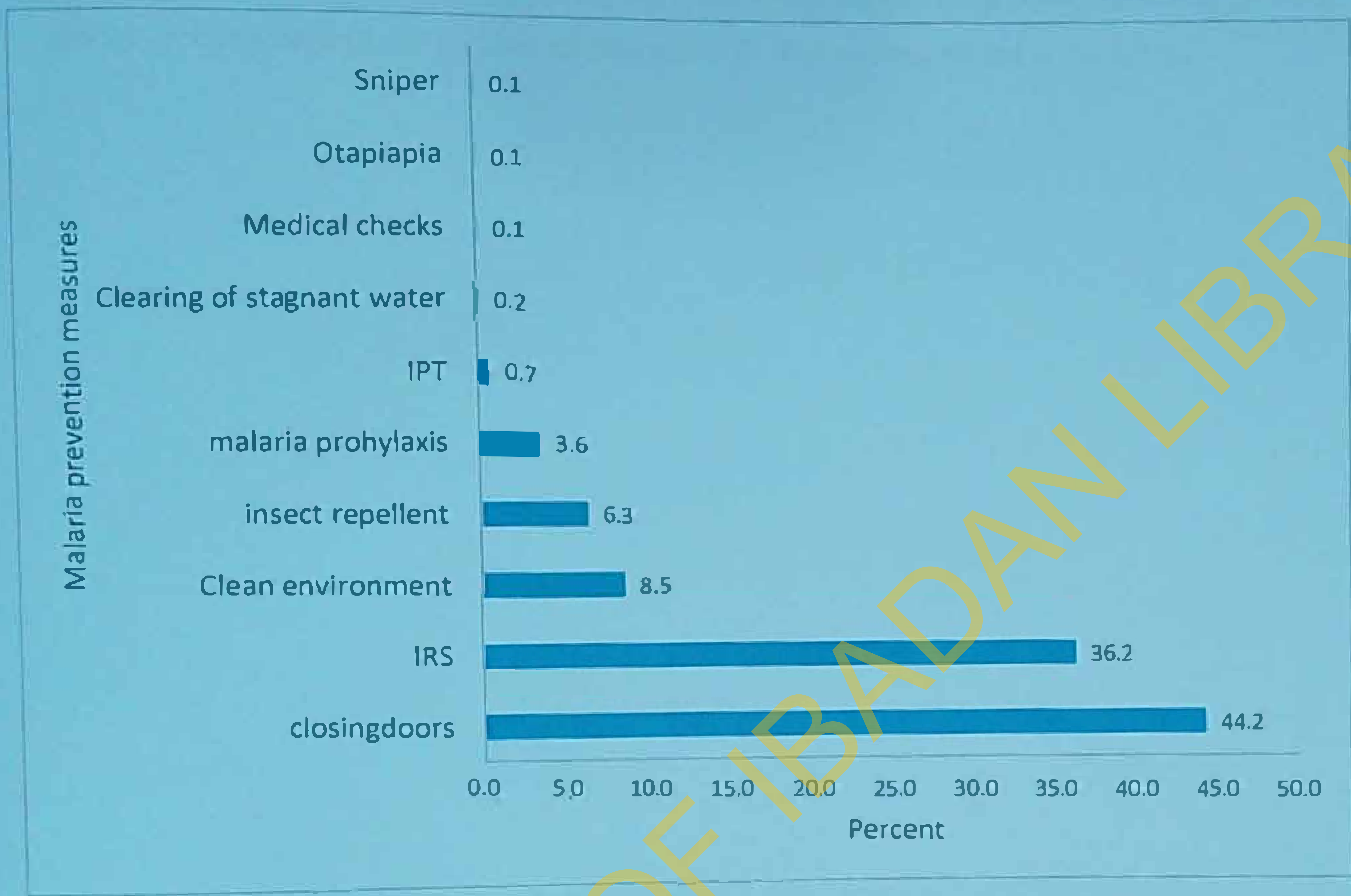

Figure 4.1.5 Study participants' knowledge of other malaria prevention measures

When participants were asked about what they do/use to prevent malaria asides use of LLINs, they mentioned closing doors (43.8%), use of insecticides (39.5%), insect repellent (9.4%), malaria prophylaxis (4.4%), clean environment (1.4%) among others (Fig. 4.1.6).

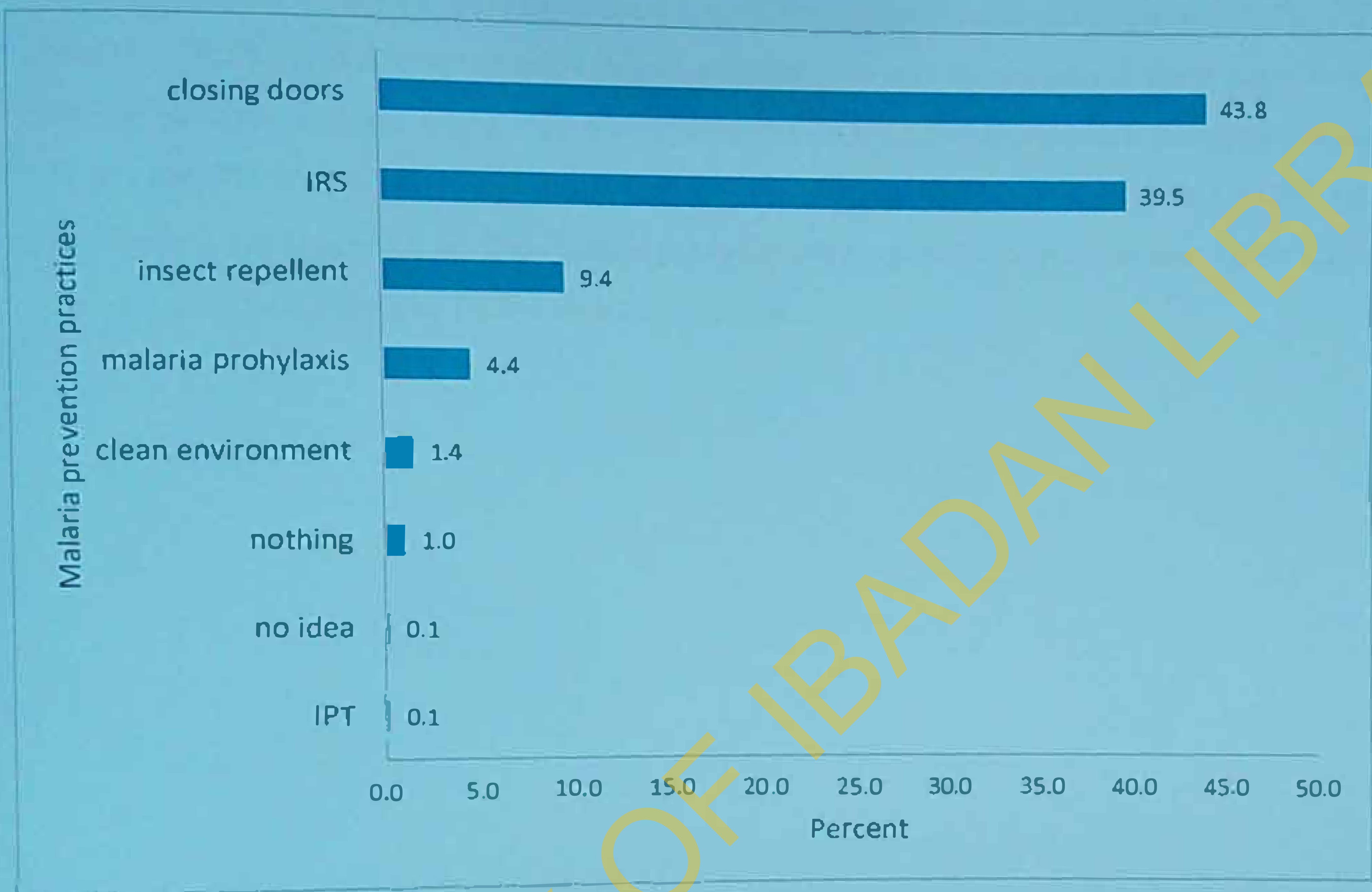

Figure 4.1.6 Other malaria prevention measures used by study participants

4.1.3. Prevalence of asymptomatic malaria parasitaemia

Of the 107 households, 102 (95.3%) had at least one household member with asymptomatic malaria parasitaemia. As shown in Table 4.1.6, 421 out of 602 study participants (69.9%, 95% CI: 66.2% – 73.5%) had asymptomatic malaria parasitaemia and the median malaria parasite density for the positive malaria cases was 64 parasites/µl (IQR:208 parasites/µl). The prevalence was 71.4% (66.7%-75.7%) in Abuja municipal, 63.4% (46.9%-77.9%) in Kwali, and 68.2% (60.8%-75.0%) in Kuje area council. The malaria prevalence by rapid diagnostic test was much lower than that of light microscopy at 13.8% overall prevalence.

Table 4.1.6 Malaria prevalence and malaria parasite densities of study participants

Variables	No. infected by RDT n (%)	No. infected by microscopy n (%)	95% CI (%) of microscopy result	Median Parasite density (IQR) (parasites/µl)
Abuja municipal	35 (9.1)	275 (71.4)	66.7-75.7	48 (64)
Kwali	8 (19.5)	26 (63.4)	46.9-77.9	184 (3168)
Kuje	40 (22.7)	120 (68.2)	60.8-75.0	1304 (3872)
Total	83 (13.8)	421 (69.9)	66.2-73.5	64 (208)

4.2. Bivariate analysis

4.2.1. Factors associated with LLIN use

Table 4.2.1 compares socio-demographic and socio-economic factors with LLIN use among study participants. Males who used LLINs (18.4%) were slightly more than females who used LLINs (17.2%). More of children less than five years (22.0%) slept under an LLIN the night before the survey, followed by 21.4% of those 50 years or older. Children between the ages of 10 and 14 years (10.6%) appeared to be least likely to sleep under LLINs. Having uncovered water receptacles around the house (p = 0.10) was the only factor significantly associated with LLIN use among all the study participants.

Table 4.2.1 Reported LLIN use by socio-demographic characteristics of all study participants [N=602]

Characteristics	Used LLIN N= 107 n (%)	Did not use LLIN N= 495 n (%)	X^2	p-value
Sex				
Female	57 (17.2)	274 (82.8)	0.08	0.775
Male	50 (18.4)	221 (81.6)		
Age group (years)				
0-4	20 (22.0)	71 (78.0)	9.5	0.090
5-9	22 (19.6)	90 (80.4)		
10-19	20 (14.7)	116 (85.3)		
20-24	4 (8.0)	46 (92.0)		
25-34	16 (14.4)	95 (85.6)		
≥35	25 (24.5)	77 (75.5)		
Ethnicity				
Igbo	39 (21.4)	106 (89.8)	6.7	0.081
Yoruba	15 (20.6)	143 (78.6)		
Hausa	12 (10.2)	58 (79.4)		
Others	41 (17.9)	188 (82.1)		
Religion				
Christians	91 (19.3)	380 (80.7)	3.1	0.080
Muslims	16 (12.2)	115 (87.8)		
Area council				
Abuja Municipal	65 (16.9)	320 (83.1)	0.76	0.683
Kuje	35 (19.9)	141 (80.1)		
Kwali	7 (17.1)	34 (82.9)		
Educational level				
None	22 (17.3)	105 (82.7)	1.0	0.809
Primary	30 (18.3)	134 (81.7)		
Secondary	29 (15.9)	153 (84.1)		
Tertiary	26 (20.2)	103 (79.8)		
Slept in the same room with patient				
Yes	59 (20.9)	224 (79.1)	3.07	0.080
No	48 (15.1)	271 (84.9)		
Bushes around the house				
Yes	34 (16.2)	176 (83.8)	0.4	0.527
No	73 (18.6)	319 (81.4)		
Uncovered water receptacles around the house				
Yes	22 (29.0)	54 (71.0)	6.6	*0.010
No	85 (16.2)	441 (83.8)		

* : Significant at $p<0.05$

Among study participants who owned LLINs, the factors found to be significantly associated with LLIN use were ethnicity ($p=0.032$) and area council ($p<0.001$) (Table 4.2.2).

Table 4.2.2 Reported LLIN use by socio-demographic characteristics of study participants who owned LLINs [N=148]

Characteristics	Used LLIN N=107 n (%)	Did not use LLIN N=41 n (%)	X^2	p-value
Sex				
Female	57 (75.0)	19 (25.0)	0.3	0.568
Male	50 (69.4)	22 (30.6)		
Age group (years)				
0-4	20 (74.1)	7 (25.9)	1.4	0.920
5-9	22 (75.9)	7 (24.1)		
10-19	20 (64.5)	11 (35.5)		
20-24	4 (66.7)	2 (33.3)		
25-34	16 (76.2)	5 (23.8)		
≥35	25 (73.5)	9 (26.5)		
Ethnicity				
Igbo	39 (84.8)	7 (15.2)	8.8	*0.032
Yoruba	15 (57.7)	11 (42.3)		
Hausa	12 (85.7)	2 (14.3)		
Others	41 (66.1)	21 (33.9)		
Religion				
Christians	91 (70.5)	38 (29.5)	0.9	0.333
Muslims	16 (84.2)	3 (15.8)		
Area council				
Abuja Municipal	65 (83.3)	13 (16.7)	41.8	*<0.001
Kuje	35 (85.4)	6 (14.6)		
Kwali	7 (24.1)	22 (75.9)		
Educational level				
None	22 (81.5)	5 (18.5)	5.1	0.167
Primary	30 (71.4)	12 (28.6)		
Secondary	29 (61.7)	18 (38.3)		
Tertiary	26 (81.3)	6 (18.7)		
Slept in the same room with patient				
Yes	59 (70.2)	25 (29.8)	0.21	0.648
No	48 (75.0)	16 (25.0)		
Bushes around the house				
Yes	34 (63.0)	20 (37.0)	0.49	0.083
No	73 (77.7)	21 (22.3)		
Uncovered water receptacles around the house				
Yes	22 (84.6)	4 (15.4)	1.7	0.192
No	85 (69.7)	37 (30.3)		

* : Significant at p<0.05

4.2.2. Factors associated with malaria parasitaemia

More males (74.2%) than females (66.5) had malaria parasitemia (Table 4.2.3). Malaria parasite infection cut across all age groups. However, children below 10 years appeared to be most affected. Those who lived in houses with roof shingles (58.5%) were least likely ($p = 0.005$) to have malaria parasite infection than those living in houses with other roof types. There was no significant difference ($p = 0.588$) in malaria parasitaemia between those who used LLINs the night before the survey and those who did not ($p=0.588$). Even among LLIN owners, no association was found between LLIN use and malaria parasitaemia ($p = 0.837$) (Table 4.3.2).

Overall, the factors that achieved statistical significance for malaria parasitaemia were ethnicity ($p < 0.001$), religion ($p < 0.001$), house roof ($p = 0.005$), and bushes around the house ($p < 0.001$).

Table 4.2.3 Bivariate analysis of factors associated with malaria parasitaemia among study participants [N=602]

Variable(s)	Malaria parasite present N= 421 n (%)	Malaria parasite absent N=181 n (%)	X^2	p-value
Age group (years)				
0-4	67 (73.6)	24 (26.4)	10.6	0.059
5-9	90 (80.4)	22 (19.6)		
10-19	90 (66.2)	46 (33.8)		
20-24	35 (70.0)	15 (30.0)		
25-34	76 (68.5)	35 (31.5)		
≥35	63 (61.8)	39 (38.2)		
Sex				
Female	220 (66.5)	111 (33.5)	3.8	0.050
Male	201 (74.2)	70 (25.8)		
Ethnicity				
Hausa	98 (83.1)	20 (16.9)	18.5	*<0.001
Yoruba	53 (72.6)	20 (27.4)		
Igbo	130 (71.4)	52 (28.6)		
Others	140 (61.1)	89 (38.9)		
Religion				
Christian	313 (66.5)	158 (33.5)	11.7	*<0.001
Islam	108 (82.4)	23 (17.6)		
Slept in same room with index patient				
Yes	190 (67.1)	93 (32.9)	1.7	0.187
No	231 (72.4)	88 (27.6)		
LLIN use among all study participants				
Yes	146 (29.5)	349 (70.5)	0.29	0.588
No	35 (32.7)	72 (67.3)		
LLIN use among participants who owned LLINs				
Yes	35 (32.7)	72 (67.3)	0.04	0.837
No	12 (29.3)	29 (70.7)		
Area Council				
Abuja Municipal	275 (71.4)	110 (28.6)	1.49	0.474
Kuje	120 (68.2)	56 (31.8)		
Kwali	26 (63.4)	15 (36.6)		
House wall				
Mud	86 (68.3)	40 (31.7)	0.1	0.724
Cement plastered walls	335 (70.4)	141 (29.6)		

Table 4.2.3 Bivariate analysis of factors associated with malaria parasitaemia among study participants [N=602]

Variable(s)	Malaria parasite present n (%)	Malaria parasite absent n (%)	X^2	p-value
Window type				
Open windows	59 (72.0)	23 (28.0)	0.58	0.901
Wooden shutters	39 (70.9)	16 (29.1)		
Metal shutters	7 (63.6)	4 (36.4)		
Glass windows	323 (69.5)	142 (30.5)		
House roof				
Wood planks	67 (70.5)	28 (29.5)	10.8	*0.005
Metal	278 (73.7)	99 (26.3)		
Roof shingles	76 (58.5)	54 (41.5)		
Bushes around the house				
Yes	169 (80.5)	41 (19.5)	16.3	*<0.001
No	252 (64.3)	140 (35.7)		
Uncovered water receptacles around house				
Yes	52 (68.4)	24 (31.6)	0.03	0.862
No	369 (70.2)	157 (29.8)		

* : Significant at $p<0.05$

Malaria parasite densities of study participants are shown in table 4.2.4. Individuals without malaria parasitaemia were excluded. Kruskal Wallis test was used to compare the median parasite densities of the different groups as the data was found to be positively skewed.

The median parasite density was highest in children below 5 years (80 parasites/µl, IQR: 1376 parasites/µl). Males (64 parasites/µl, IQR: 240 parasites/µl) had a slightly higher median parasite density than females (56 parasites/µl, IQR: 160 parasites/µl) but this was not statistically significant (p=0.45). Muslims had significantly higher median parasite densities than Christians (p<0.01), and those with no formal education had higher median parasite densities than those who had formal education. Those living in Kwali area council had significantly higher median parasite densities than those living in Abuja municipal area council (p<0.01). The same was observed for ethnicity where those of Hausa ethnicity were found to have significantly higher median parasite density than Igbo ethnicity (p<0.01).

Those living in houses with mud walls (104 parasites/µl, IQR: 1466 parasites/µl), those in houses with cement roofs (80 parasites/µl, IQR: 2320 parasites/µl), and those in houses without windows (240 parasites/µl, IQR: 4656 parasites/µl) had the highest parasite densities among the different wall, roof, and window types. Those with bushes around their homes had significantly higher parasite densities (80 parasites/µl, IQR: 416 parasites/µl) than those who did not (p<0.01). There was no significant difference in malaria parasite densities of those who had uncovered water receptacles around their homes and those who did not (p<0.01).

There was no significant difference in parasite densities between those who used LLINs the night before the survey and those who did not (p=0.52). Among those who own nets, there was no significant difference in parasite densities between those who used LLINs the night before the survey and those who did not (p=0.53).

Table 4.2.4 Malaria parasite density by independent variables among study participants [n=421]

Variables	Parasite density (parasites/µl) median (IQR)	df	z statistic	p-value
Sex				
Female	56 (160)	1	0.6	0.45
Male	64 (240)			
Age group (years)				
<5	80 (1376)	5	8.1	0.15
5-9	64 (480)			
10-14	80 (640)			
15-19	64 (128)			
20-49	48 (128)			
≥50	40 (64)			
Age group (years)				
<10	64 (480)	1	3.0	0.08
≥10	48 (128)			
Area council				
AMAC	48 (64)	2	43.4	<0.01
Kuje	184 (3168)			
Kwali	1304 (3872)			
Ethnicity				
Hausa	128 (1072)	4	24.6	<0.01
Yoruba	64 (240)			
Igbo	48 (96)			
Others	48 (112)			
Gbagyi	48 (1440)			
Religion				
Christian	48 (128)	1	19.6	<0.01
Muslim	128 (1099)			
Educational level				
None	80 (832)	3	9.4	0.02
Primary	64 (144)			
Secondary	48 (240)			
Tertiary	48 (64)			
Slept in same room with index patient				
Yes	48 (160)	1	3.5	0.06
No	64 (240)			
Location of water source				
Own dwelling	64 (128)	2	1.5	0.47
Own yard	48 (288)			
Elsewhere	64 (1168)			

Table 4.2.4 Malaria parasite density by independent variables among study participants [n=421]….2/2

Variables	Parasite density (parasites/µl) median (IQR)	df	z statistic	p-value
Window type				
No windows	240 (4656)	4	21.6	*<0.01
Open windows	80 (1677)			
Metal windows	1216 (2368)			
Wooden shutters	48 (1408)			
Glass windows	48 (128)			
House wall				
Brick/concrete	48 (128)	1	8.7	*<0.01
Mud	104 (1466)			
House roof				
Wood planks	80 (2320)	3	14.0	*<0.01
Cement	112 (288)			
Metal	64 (160)			
Roof shingles	32 (80)			
Bushes around the house				
Yes	80 (416)	1	7.6	*<0.01
No	48 (128)			
Uncovered water receptacles around house				
Yes	48 (723)	1	0.46	0.50
No	64 (160)			
LLIN use				
Yes	64 (232)	1	0.4	0.52
No	48 (176)			
LLIN use among those who own LLINs				
Yes	64 (232)	1	0.4	0.53
No	64 (3168)			

* - significant at $p<0.05$

4.3. Multivariate analysis

Variables from the bivariate analysis significant at $p<0.25$, age, and sex were selected for inclusion in a logistic regression model. Three separate models were prepared for the outcome variables (LLIN use among all study participants, LLIN use among study participants who owned nets, and malaria parasitaemia) and significance level was set at 5%.

4.3.1. Predictors of LLIN use among all study participants

As shown in Table 4.3.1 the predictor of LLIN use in this study among all participants was having uncovered water receptacles around the house. Those who lived in houses that had uncovered water receptacles (AOR: 2.28, 95% CI: 1.28-4.04) around had 2 times the odds of using LLINs than those who did not have.

Table 4.3.1 Predictors of LLIN use among all study participants [N=602]

Variables	AOR	95% CI	p-value
Age group (years)			
<5 (ref)	1		
5-9	0.92	0.46-1.84	0.814
10-19	0.61	0.30-1.22	0.164
20-24	0.31	0.10-1.00	0.050
25-34	0.59	0.28-1.23	0.156
≥35	1.06	0.53-2.11	0.869
Sex			
Male (ref)	1		
Female	0.99	0.64-1.53	0.960
Religion			
Christians	1.28	0.56-2.93	0.565
Muslims (ref)	1		
Ethnicity			
Yoruba (ref)	1		
Igbo	1.0	0.49-2.01	0.991
Hausa	0.51	0.20-1.35	0.176
Others	0.90	0.45-1.76	0.749
Uncovered water receptacles			
Yes	2.28	1.28-4.04	*0.005
No (ref)			

* - significant at $p<0.05$

4.3.2. Predictors of LLIN use among study participants who own LLINs

As shown in Table 4.3.2, the predictors of LLIN use among study participants who own LLINs were area council and bushes around the house. Living in Kwali area council (AOR: 0.04, 95% CI: 0.01-0.20) and having bushes around the house (AOR: 0.33, 95% CI: 0.13-0.84) were negatively associated with LLIN use.

Table 4.3.2 Predictors of LLIN use among participants who owned LLINs [N=148]

Variables	AOR	95% CI	p-value
Age group (years)			
<5 (ref)	1		
5-9	0.84	0.16-4.44	0.837
10-19	0.22	0.04-1.11	0.066
20-24	0.23	0.02-2.59	0.232
25-34	0.40	0.08-2.08	0.273
≥35	0.31	0.07-1.37	0.121
Sex			
Males (ref)	1		
Females	1.27	0.54-2.99	0.587
Ethnicity			
Yoruba (ref)	1		
Igbo	2.80	0.77-10.14	0.117
Hausa	1.55	0.16-15.30	0.710
Others	3.75	0.78-17.96	0.099
Area Council			
Abuja Municipal (ref)	1		
Kuje	1.10	0.30-4.12	0.884
Kwali	0.04	0.01-0.20	*<0.001
Bushes around the house			
Yes	0.33	0.13-0.84	*0.020
No (ref)	1		
Uncovered water receptacles			
Yes	1.97	0.49-7.90	0.340
No (ref)	1		

* - significant at $p<0.05$

4.3.3. Predictors of malaria parasitaemia among all study participants

As shown in Table 4.3.3 the only factor that was significantly associated with malaria parasitemia in this study was having bushes around the house. Study participants who lived in houses with bushes around (AOR: 2.13, 95% CI: 1.37-3.32) had 2 times the odds of having malaria parasitemia compared to those who did not have bushes around.

Table 4.3.3 Predictors of malaria parasitaemia among study participants [N=602]

Variables	Adjusted OR	95% CI	p-value
Age group (years)			
<5 (ref)	1		
5-9	1.44	0.73-2.84	0.290
10-19	0.79	0.43-1.47	0.455
20-24	1.03	0.47-2.31	0.924
25-34	0.97	0.52-1.82	0.936
≥35	0.59	0.31-1.12	0.106
Sex			
Male (ref)	1		
Female	0.73	0.50-1.05	0.960
Religion			
Christians	0.64	0.30-1.37	0.245
Muslims (ref)	1		
Ethnicity			
Yoruba (ref)	1		
Igbo	0.93	0.49-1.80	0.819
Hausa	1.02	0.42-2.51	0.960
Others	0.56	0.30-1.03	0.063
Bushes around the house			
Yes	2.13	1.37-3.32	*0.001
No (ref)	1		
House roof			
Wood planks (ref)	1		
Metal	1.35	0.80-2.29	0.256
Roof shingles	0.96	0.51-1.80	0.897

* - significant at $p<0.05$

CHAPTER FIVE

5.0. Discussion, conclusion and recommendations

5.1. Discussion

Prevalence of asymptomatic malaria parasitaemia among household of confirmed malaria patients

This study investigates asymptomatic malaria parasitaemia prevalence and LLIN use among household members of malaria patients attending health facilities in FCT Abuja. Similar studies have found that parasitaemia clusters around homes of index cases of malaria (Stresman *et al.*, 2010; Bousema *et al.*, 2010; Sturrock, Novotny, *et al.*, 2013). A study done in Zambia found that targeting homes of index cases identified higher proportion of malaria cases when compared to randomly selected households (Stresman *et al.*, 2010). Another study carried out in Swaziland found increased odds of detecting a case in an index household compared to neighboring households (Sturrock *et al.*, 2013b). As this population are targeted in this study, it may explain the high prevalence of malaria parasitaemia found. However, the estimates from this study, carried out in a malaria-endemic setting, are not comparable to other studies specifically targeting this population as most of them are carried out in pre-elimination settings. The prevalence of 69.9% found in this study is higher than the prevalence of 36.6% found by Noland *et al.* (2014) in Plateau state, 63.7% found by Babamale and Ugbomoiko (2016) in a peri-urban community in Kwara state, and 60.7% found by Dawaki *et al.* (2016) in rural communities Kano state. It is, however, similar to malaria prevalence of 67% found by Egbuche *et al.* (2013) in Anambra state.

Relationship between LLIN use and malaria parasite density

Unlike other studies that have documented negative association between LLIN use and malaria parasitaemia (Egbuche *et al.*, 2013; Iwuafor *et al.*, 2016; Dawaki *et al.*, 2016), there was no statistically significant difference in the parasite density of LLIN users versus non-users in this study. This may be because the study only took into account use of LLINs the night prior to the survey and did not consider frequency of use. Over half of those who owned LLINs but did not use it the night prior to the survey mentioned that the weather influenced their use of the net. This suggests that frequency of use may have been more informative in establishing the association between LLIN use and malaria parasitaemia.

Factors associated with LLIN use

Long-lasting insecticidal nets have been found to be effective in preventing malaria (Ter Kuile *et al*., 2003; Marbiah *et al*., 1998; Lindblade *et al*., 2015; West *et al*., 2015) and cost-effective compared to other malaria prevention measures (Lengeler *et al*., 2007; Uneze and Nwadike, 2013). Approximately three-quarters of the study participants did not own LLINs even though 97% of them believed they are useful. Most of the individuals who owned LLINs bought them and surprisingly, thirty-one percent of those who did not own them said they did not know where to get them from. About 305,000 LLINs were mass distributed in the rural areas of FCT and seven other states by NetMark, an international non-governmental organization (NGO) supported by USAID, in collaboration with the National Malaria Elimination Programme and three local NGOs from 2002 to 2009 (Otsemobor *et al*., 2013). Other distribution channels included antenatal clinics, immunization and schools. Despite this, ownership of LLIN in this area was still low, as evidenced by the results, and most of the owned nets were purchased. This presents a need for increased awareness through the media or other channels on availability of LLINs and where to get them from.

Long-lasting insecticidal net use the night prior to the survey among household members of malaria positive individuals in Abuja was low at 17.8%. This estimate is similar to the estimate by Noland *et al*. (2014) in a survey carried out in Plateau state. Findings from the National Malaria Indicator survey carried out in 2015 show that FCT Abuja had the lowest proportion of LLIN use in the North central region. The estimate from this study is similar to the FCT estimate from the National Malaria Indicator survey carried out in 2015 as well as and North Central Nigeria estimate from the National Malaria Indicator survey carried out in 2010 (National Malaria Elimination Programme (NMEP), National Population Commission (NPopC) National Bureau of Statistics (NBS), 2015; National Population Commission (NPC) [Nigeria] *et al*., 2012).

The proportion of children under 5 years who slept under an LLIN the night before the survey (22%) is lower than the estimate for North Central region from the 2015 National malaria indicator survey (National Malaria Elimination Programme (NMEP), National Population Commission (NPopC) National Bureau of Statistics (NBS), 2015). As state by state estimates were not provided for this category, we may assume that the peculiarity of low LLIN use found in FCT among all household members applies in this category as well. There was no statistically significant difference between LLIN use of males and females. This is similar to findings by Noland *et al.* (2014) in Nigeria but contrary to Baume and Marin (2007) that found higher net use among women of reproductive age.

Those who had uncovered water receptacles around their homes were more likely to use LLINs. Pools of water in gutters, waste tins, and containers serve as breeding ground for mosquitoes (Dzinjalamala, 2009; Peterson *et al.*, 2009) and the abundance of mosquitoes in these areas may explain why these set of people use LLINs more than others. This is similar to findings from other studies in Nigeria (Nasir *et al.*, 2015; Babamale and Ugbomoiko, 2016) and Yemen (Bamaga *et al.*, 2014) that found higher malaria prevalence in homes close to mosquito breeding sites.

Despite having the highest proportion of LLIN owners, Kwali area council had the lowest proportion of LLIN users among those who owned LLINs. Further studies looking at temperatures and mosquito intensity in the different area councils may be needed to support and explain this finding. Also, having bushes around the house increased the odds of using LLINs in this subgroup.

Factors associated with malaria parasitaemia

All age groups had malaria parasite infection although the parasite density was significantly higher among children less than 10 years. This finding is similar to findings in studies done in Kwara state (Babamale and Ugbomoiko, 2016) and Ibadan (Hassan, 2012) that suggest an inverse relationship between malaria prevalence and age. This shows there may be a level of acquired immunity to malaria infection with age. It however contradicts findings in some other studies done in Kano (Dawaki *et al.*, 2016) and Anambra states (Ani *et al.*, 2015) in Nigeria and Malawi (Walldorf *et al.*, 2015) that found higher malaria parasitaemia prevalence in older children. The study by Dawaki *et al.* (2016) found that children younger than 12 years were less likely to have malaria parasitaemia than children 12 to 17 years. However, in their study, they also found a significantly higher use of ITN/LLIN among younger children which was not found in this study. Children below 5 years are at increased risk of severe malaria due to no or low immunity (Baume and Marin, 2007; Ayoola *et al.*, 2005; WHO, 2015a), and presence of malaria parasites in other age groups can still fuel transmission and this indicates the need for malaria control in all ages.

The prevalence of 68.1% found in children below 5 years is higher than the estimate from the 2015 national malaria indicator survey of 32.0% in the north central zone and 20.2% in FCT (National Malaria Elimination Programme (NMEP), National Population Commission (NPopC) National Bureau of Statistics (NBS), 2015). However, the study design and time frame during which both studies were conducted varies. This study was conducted from March to August (end of dry season to rainy season), while the national survey was conducted from October to December (dry to harmattan season).

Males had higher parasite density than females in this study although there was no significant difference in malaria infection between both sexes. This finding is similar to findings from various studies in Nigeria (Noland *et al.*, 2014; Ani *et al.*, 2015; Dawaki *et al.*, 2016; Babamale and Ugbomoiko, 2016). It is also similar to findings from studies done in Ethiopia (Graves *et al.*, 2009) and Eritrea (Sintasath *et al.*, 2005). This higher density in males is probably because males tend to spend more time outdoors than females. Some studies have found that some endophagic mosquitoes such as Anopheles have modified their biting behavior as a result of indoor interventions such as use of LLINs and IRS, to biting outdoors early in the evening (Russell *et al.*, 2013, 2011; Sougoufara *et al.*, 2014).

Individuals residing in houses that had bushes around had higher parasitaemia than those who lived in houses that did not have. This finding was statistically significant and is corroborated by findings in studies done in Nigeria and Indonesia (Arsunan and Situmorang, 2015; Babamale and Ugbomoiko, 2016; Peterson *et al.*, 2009).

Study limitations

The cross-sectional nature of this study may limit the causal and effect interpretation of the factors that are observed in the study. It should be noted also that information on LLIN use was self-reported and could not be verified. In interpreting the results, outdoor behavior of study participants was not taken into account. Also, information on frequency of use of LLIN was not captured. This information would have been useful in determining the association between LLIN use and malaria parasitaemia among the study participants. Finally, malaria parasitaemia was determined by microscopy which, despite being the gold standard, is subjective and is unable to detect subpatent levels of parasitaemia. Polymerase chain reaction (PCR) which gives more accurate results was not used in this study due to cost.

5.2. Conclusion

High prevalence of asymptomatic malaria parasitaemia and low use of LLIN among household members of malaria patients portend the risk of intra-household common source of malaria transmission. Predictors of LLIN use included having uncovered receptacles in surroundings, while among those who owned LLINs, living in Kwali area council was found to be a predictor for its' use. Having bushes around the house was an important predictor of malaria parasitaemia.

Environmental sanitation, clearing of bushes and uncovered water receptacles around the house, and use of LLIN by all age groups will likely reduce malaria transmission. Study to explore the role of preventive treatment of household members of confirmed malaria patient in curbing transmission is suggested. Malaria transmission may not be broken if these asymptomatic population are not identified and treated.

5.3. Recommendations

Based on the findings of this study, we recommend the following:

1. National Malaria Elimination Programme should administer prophylaxis to household members of confirmed malaria patients to reduce parasitaemia and latent recycling of the disease
2. FCT Abuja public health department in the State Ministry of Health should increase awareness through various channels to inform the general public about availability of LLINs and where to get them from. They should also emphasis use of the LLIN.
3. Health workers in health facilities should encourage the frequent use of LLINs for all age groups and other malaria prevention measures through increased awareness on dangers of malaria

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Appendices

Appendix 1: Informed Consent sheet

LLIN use and malaria parasitaemia among household members of laboratory-confirmed malaria patients attending health facilities in Abuja, Nigeria

The content of this INFORMATION SHEET will be explained to each prospective participant in the language understood by him/her.

Introduction: Good day, my name is________________________ and I am part of a team carrying out a study on LLIN use and malaria parasitaemia among household members of laboratory-confirmed malaria patients in Abuja, Nigeria.

Purpose: We believe that the study findings will enable us determine factors that may be associated with malaria parasitaemia. It will give information on current dynamics of LLIN use in households, whether current strategies targeting use of LLINs among pregnant and children under five years is effective and the need to promote LLIN use among other groups.

Procedure of the research and what shall be required of each participant: We will ask you some questions after which we will collect your blood sample (finger or heel prick) which will be used for malaria diagnosis.

Expected duration of participant(s)' involvement: Participation in this study will take about __ minutes.

Risk(s): You may experience discomfort during finger prick for collection of blood

Benefit(s): You will be provided with malaria test results. You may be given medication if you are positive for malaria.

Costs to the participants, if any, of joining the research: Your participation in this research will not cost you anything.

Confidentiality: All information collected in this study will be given code numbers and no name will be recorded in the questionnaire. This cannot be linked to you in anyway and your name or any identifier will not be used in any publication or reports from this study.

Voluntariness: Your participation in this research is entirely voluntary and you can withdraw at any time. However, we hope that you will participate since your views are important.

If you have any question you can contact the principal investigator at any convenient time at the following address: Name of principal Investigator- Onyiah Amaka

Phone number/Email address- 08034954861/aonyiah@gmail.com

II. Consent form

Research title: Malaria parasitaemia among household members of laboratory-confirmed malaria positive individuals in Abuja, Nigeria, 2016

Ethics approval number: FHREC/2015/01/65/09-11-15

I, the selected participant, have read/listened to the information in the consent sheet and understood what is required of me if I participate in the study. I understand that my participation is voluntary. I know enough about the purpose, methods, risks and benefits of the research study to judge that I want to take part in it. I have received a copy of this consent form and additional information sheet to keep for myself. I understand that my name will not be recorded but codes will be used instead. I also understand that I can withdraw from the study at any time without giving a reason.

I consent to participate and have a sample of my blood taken for the purpose of the study.

______________________	______________	______________
Name of participant (block capitals)	Date	Signature

______________________	______________	______________
Witness name (if applicable, block capitals)	Date	Signature

The Participant:

1. Agreed ☐
2. Did not agree ☐ → End the interview and thank the respondent.

Appendix 2: Questionnaire

LLIN use and malaria parasitaemia among household members of laboratory-confirmed malaria patients attending health facilities in Abuja, Nigeria

I Interviewer name: ____________

II Time of interview: ____________

III Index case code: ____________

IV Questionnaire code: ____________

V Area council

1 AMAC 2 Kuje 3 Kwali

A: SOCIO-DEMOGRAPHIC & SOCIO-ECONOMIC INFORMATION

A1 What is your relationship to (III)?

1 son/ daughter
2 Parent
3 wife/ husband
4 brother/sister
5 grandparent
6 parent-in-law
7 son-in-law/daughter-in law
8 other relative
9 adopted/foster/stepchild
10 not related
99 Don't know

A2 Sex of respondent- *to be filled by interviewer*

1 Male 2 Female

A3 If female, are you currently pregnant? 1 Yes 2 No

A4 What is your date of birth? __/__/____

A5 How old were you on your last birthday (in years)? ____________

A6 What is your ethnicity?

1 Hausa
2 Yoruba
3 Igbo
4 Other *(please specify)* ____

A7 What is your religion?

1 Islam
2 Christianity
3 Traditionalist
4 Other *(please specify)* ____

A8 What is your highest educational level attained?

1 None
2 Primary
3 Secondary
4 Tertiary
5 Other *(please specify)* ____

A9 What is your occupation?

1 Unemployed
2 Student
3 Fisherman
4 Farmer
5 Teacher
6 Civil servant
7 Driver
8 Labourer
9 Law enforcement agent
10 Health worker
11 Lawyer
12 Accountant
13 Engineer
14 Banker
15 Journalist
16 Security officer
17 Trader/business man
18 child
Other *(please specify)* ____

A10 If working, how much money (in naira) do you make per month at your current job? ____

A11 Are you the household head?

1 Yes 2 No

B: HOUSE CHARACTERISTICS

B1 Type of house- *to be filled by interviewer*

1 Hut
2 Bungalow
3 Flat
4 Duplex
5 Other *(please specify)* ____

B2 Type of exterior walls- *to be filled by interviewer*

1 Mud
2 Wood
3 Brick
4 Concrete
5 Other *(please specify)* ____

B3 Type of roof- *to be filled by interviewer*

1 No roof
2 Thatch
3 Sod
4 Bamboo
5 Wood planks
6 Rustic mat
7 Cardboard
8 Metal
9 Cement
10 Ceramic tiles
11 Roof shingles
12 Calamine
13 Other *(please specify)* ____

B4 Type of windows- *to be filled by interviewer*

1 No windows
2 Open windows
3 Wooden shutters
4 Glass windows
5 Other *(please specify)* ____

B5 Main material of the floor?- *to be filled by interviewer*

1 Earth/sand
2 Dung
3 Palm/bamboo
4 Wood planks
5 Parquet or polished floor
6 Vinyl or asphalt strips
7 Cement
8 Ceramic tiles
9 Carpet
10 Other *(please specify)* ____

B6 Are there bushes around the house?

1 Yes 2 No

B7 Are there uncovered water receptacles arund the house?

1 Yes 2 No

B8 What is your main source of drinking water?

1 Water piped into dwelling
2 Water piped to yard/plot
3 Water piped to neigbour
4 Public tap or standpipe
5 Borehole
6 Protected well
7 Unprotected well
8 Protected spring water
9 Unprotected spring water
10 Rain water
11 Cart with small tank
12 Tanker truck
7 Surface water (river/lake/stream)
8 Sachet water
9 Bottled water
10 Other *(please specify)* ____

B9 What is you main source of water used for other household purposes such as cooking and hand washing?

1 Water piped into dwelling
2 Water piped to yard/plot
3 Water piped to neigbour
4 Public tap or standpipe
5 Borehole
6 Protected well
7 Unprotected well
8 Protected spring water
9 Unprotected spring water
10 Rain water
11 Cart with small tank
12 Tanker truck
7 Surface water (river/lake/stream)
8 Sachet water
9 Bottled water
10 Other *(please specify)* ____

B10 Where is that source located?
1 In own dwelling 2 In own yard/plot 3 Elsewhere

B11 How long does it take to go there, get water, and come back (in mins)? ____

C: LLIN OWNERSHIP & UTILIZATION INFORMATION

C1 Do you usually live in this house? 1 Yes 2 No

C2 Did you sleep here last night? 1 Yes 2 No

C3 Do you own a mosquito net? 1 Yes 2 No

C4 If no, why? *(check all that apply)*
Skip to question C21
☐ I don't like sleeping under nets
☐ It is expensive
☐ No idea where to get it
☐ No mosquitoes
☐ Other *(please specify)* ____

C5 If yes, how did you get it?
(check all that apply)
☐ Mass distribution campaign
☐ Ante-natal clinic
☐ Immunization
☐ Other *(please specify)* ____

C6 Did you buy the net(s) or were you given free of charge?
1 Bought 2 Free
If bought, how much (in naira)? ____

C7 What type & brand of net do you use? *(observe or ask)*
1 Permanet
2 Olyset
3 Iconlife
4 Duranet
5 Netprotect
6 Basf interceptor
7 Don't know
8 Other

C8 How many do you own?
1 One 2 Two or more

C9 How long have you had it/them?
1 less than a month
2 1-12 months
3 12months-3years
4 greater than 3 years
4 Don't know
5 Not sure

C10 How many of you sleep under the net that you have?
1 One
2 Two
3 More than two

C11 Did you sleep under the net last night? 1 Yes 2 No

C12 If no, why? *(check all that apply)*

- ☐ Net is too old
- ☐ Cannot hang net
- ☐ Net was washed last night
- ☐ Net is too dirty
- ☐ Weather too hot
- ☐ Feel closed in or afraid
- ☐ No mosquitoes
- ☐ No reason
- ☐ Other *(please specify)* ____

C13 What would encourage you to sleep under a mosquito net? *(check all that apply)*

- ☐ If net did not smell
- ☐ Had a different shape or size
- ☐ Did not smell
- ☐ If net were not itchy/irritating
- ☐ If net were bigger/not claustrophobic
- ☐ Don't know
- ☐ Other *(please specify)* ____

C14 Is the net hanging? *(observe or ask)*

1 Yes 2 No

C15 Condition of net(s) *(observe or ask)*

1 no holes observed 2 hole(s) observed

C16 Shape of net(s) *(observe or ask)*

1 Rectangular 2 Conical 3 Other *(please specify)* ____

C17 Size of net(s) *(observe or ask)*

1 Cot/crib 3 Double
2 Single 4 Triple 5 Other *(please specify)* ____

C18 Color of net(s) *(observe or ask)*

1 Green 3 Light blue 5 White
2 Dark blue 4 Red 6 Other *(please specify)* ____

C19 Has the net ever been mended? *(observe or ask)*

1 Yes 2 No

Has the net ever been dipped or soaked in a liquid to kill or repel mosquitoes?

1 Yes 2 No 3 Don't know

C20 If yes, how many months ago was the net last dipped or soaked in liquid?

- ☐ 0-12 months
- ☐ 12-24 months
- ☐ more than 24 months ago
- ☐ Not sure
- ☐ Don't know

C21 Do you sleep in the same room with (II) above?

2 Yes 3 No

D: KNOWLEDGE OF LLIN AND OTHER MALARIA PREVENTION MEASURES

D1 Do you believe that LLINs help to prevent malaria? *(check all that apply)*

1 Yes 2 No

D2 If yes, how? *(check all that apply)*

- ☐ By preventing mosquito bites
- ☐ By preventing insect bites

- [ ] By avoiding dust and dirt
- [ ] Other *(please specify)* ______________

D3 In which rooms do you think LLIN should be used?
(check all that apply)

- [ ] Living room
- [ ] Kitchen
- [ ] Sleeping room
- [ ] Don't know
- [ ] Other *(please specify)* ______________

D4 Which group of people should be given priority for sleeping under the LLIN?
(check all that apply)

- [ ] Children <5 years
- [ ] Adults >18 years
- [ ] Pregnant women
- [ ] Elderly
- [ ] Guests
- [ ] None
- [ ] No idea
- [ ] Everyone
- [ ] Other *(please specify)* ______________

D5 Do you think there are any side effects associated with using LLINs?

1 No side effects
2 Minor side effects
3 Yes, there are side effects
Don't know

D6 If yes, please explain ______________

D7 What do you think can lead to damage of LLIN in the household?
(check all that apply)

- [ ] Long exposure to sunlight while drying, after washing
- [ ] Inappropriate handling
- [ ] Rats and other domestic animals
- [ ] Dust and dirt
- [ ] Fire
- [ ] Frequent washing
- [ ] Sharp objects
- [ ] Using it for other purposes
- [ ] Don't know
- [ ] Other *(please specify)* ______________

D8 In what other way can malaria be prevented?
(check all that apply)

- [ ] Indoor residual spraying (insecticides)
- [ ] Closing doors in the evenings

☐ Insect/mosquito repellent
☐ Intermittent preventive treatment
☐ Malaria prohylaxis
☐ Other *(please specify)* ____________

D9 What do you do to prevent malaria? *(check all that apply)*

☐ Indoor residual spraying (insecticides)
☐ Closing doors in the evenings
☐ Insect/mosquito repellent
☐ Intermittent preventive treatment
☐ Malaria prohylaxis
☐ Other *(please specify)* ____________

D10 When last did you use the mentioned preventive measure? (in weeks) ____________

D11 When last did you take malaria medication? (in weeks) ____________

D12 What type of malaria medication do you take? ____________

D9 In the last 12 months, has anyone come into your dwelling to spray the interior walls against mosquitoes?

1 Yes 2 No

D10 If yes, who sprayed the dwelling?

Government worker/program
Non-governmental organisation (NGO)
Private company
Other *(please specify)* ____________

E: MALARIA PARASITAEMIA INFORMATION

RDT results

E1 Malaria parasite present? 1 Yes 2 No

Microscopy results

E2 Number of parasites per µl of blood ____________

E3 Treatment administered? 1 Yes 2 No

Appendix 3: Map of Nigeria and FCT showing the six area councils

Appendix 4: Ethical approval

FEDERAL CAPITAL TERRITORY
HEALTH RESEARCH ETHICS COMMITTEE

Research Unit, Room 10, Block A Annex, HHSS
FCT Secretariat No. 1 Kapital Street Area II, Garki, Abuja - Nigeria

Name of Principal Investigator	Onyiah Amaka Pamela
Address of Principal Investigator	Nigeria Field Epidemiology and Laboratory Training Programme, University of Ibadan, Ibadan, Oyo State
Date of receipt of valid application	15/10/2015

Notice of Research Approval

Protocol Approval Number: FHREC/2015/01/65/09-11-15

Study Title: Malaria Parasitaemia and Long Lasting Insecticidal Net Use among Household Members of Laboratory Confirmed Malaria Positive Individuals in Abuja, Nigeria

This is to certify that the FCT Health Research Ethics Committee (FCT HREC) has fully approved the research described in the above stated protocol

Approval Date - 09/11/2015
Expiration Date - 08/11/2016

Note that no activity related to this research may be conducted outside of these dates. Only the FCT HREC approved informed consent forms may be used when written informed consent is required. They must carry FCT HREC assigned protocol approval number and duration of approval of the study.

The National Code of Health Research Ethics requires you to comply with all institutional guidelines, rules and regulations, and with the tenets of the code. The FCT HREC reserves the right to conduct compliance visit to your research site without prior notification.

Modifications: Subsequent changes are not permitted in this research without prior approval by the FCT HREC.

Problems: All adverse events or unexpected side effects arising from this project must be reported promptly to FCT HREC.

Renewal: This approval is valid until the expiration date. If you are continuing your project beyond the expiration date, endeavor to submit your annual report to FCT HREC early, and request for renewal of your approval to avoid disruption of your project.

Closure of Study: At the end of the project, a copy of the final report of the research should be forwarded to FCT HREC for record purposes, and to enable us close the project.

Desmond Ezhereonyeokwe
For: Secretary, FCT HREC
November 09, 2015