ADHERENCE TO THE USE OF INSECTICIDE-TREATED BED NETS BY NIGERIAN CHILDREN

by

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Dedication

This dissertation is dedicated to the memory of two special people I met during this journey who were big impacts in my life: Imade Asemota and Tunji Okusanya. Thank you for showing me the importance of making the most of every day.

To my mother, Dr. Naomi Ovadje, who inspired me to be the woman I am today.

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List of Acronyms

ACT	Artemisinin-based Combination Therapy
ANC	Antenatal Care
DHS	Demographic Health Survey
DRC	Democratic Republic of the Congo
EM	Environmental Management
EPI	Expanded Program on Immunization
GFATM	Global Fund to fight AIDs, Tuberculosis and Malaria
IEC/BCC	Information, Education, Communication/Behavior Change Communication
IRB	Institutional Review Board
IRS	Indoor Residual Spraying
ITN	Insecticide Treated Net
IVM	Integrated Vector Management
LGA	Local Government Area
LLIN	Long-Lasting Insecticide Treated Net
KAP	Knowledge, Attitudes, and Practice
MDG	Millennium Development Goal
MICS	Multiple Indicator Cluster Survey
MIS	Malaria Indicator Survey

NDHS	Nigerian Demographic Health Survey
NMIS	Nigerian Malaria Indicator Survey
PMI	President's Malaria Initiative
PMV	Patent Medicine Vendors
RBM	Roll Back Malaria
SES	Socio-Economic Status
SSA	Sub-Saharan Africa
WHO	World Health Organization

Abstract

Background: As access to insecticide-treated bed nets (ITNs) increases, it becomes important to understand factors associated with regular and proper use of ITNs (here termed as "adherence"). This research was undertaken to fill the gap in knowledge and has four main objectives: 1. Evaluate malaria knowledge of caregivers and its association with adherence to children's ITN use; 2. Determine the associations between use of other mosquito avoidance methods and adherence to ITN use; 3. Evaluate the relationships between people's perceptions of ITNs and adherence to their use; and 4. Determine how the characteristics of ITNs and the areas where children sleep are associated with adherence to ITN use.

Methods: Caregivers (N=1,939) of young children were recruited through a random school-based survey in two states (Lagos and Oyo) in Nigeria. There were 927 ITN owners in the sample. Data were collected from caregivers using a pre-piloted, self-administered questionnaire. Logistic regression models were used to estimate the relationships between the cofactors, confounding variables, and adherence to ITN use by children.

Results: Level of malaria knowledge had no significant relationship with adherence to ITN use. Furthermore, a majority (60%) of participants reported using other methods for avoiding mosquitoes. Children of caregivers who used insecticide sprays and window screens were less

likely to adhere to ITN use. While negative perceptions of ITNs were not predictors of consistent use, positive perceptions were. Characteristics of nets such as color, shape, size, age, deployment method, and how they were obtained were not associated with adherence to ITN use. However, ownership of more than one ITN, regular sharing of ITN, education on hanging the net, and sleeping on a bed with a frame were positively associated with use.

Conclusions: Educational activities around the hanging and use of nets should be incorporated into ITN distribution activities. Locally appropriate educational messages should be developed to discredit misinformation and encourage integration of other mosquito avoidance methods to complement ITN use. This study suggests that positive messages may help promote consistent ITN use, and if reinforced, could become an important component of the efforts to reduce the malaria burden in African countries.

Chapter 1

Introduction

In 2010, there were estimated to be about 219 million malaria cases in the world (with estimates ranging from 154 million to 289 million) and 660, 000 deaths (with estimates ranging from 610,000 to 971,000). The countries contributing the most malaria cases were the Democratic Republic of the Congo (DRC), Nigeria, and India, with the DRC and Nigeria accounting for >40% of deaths (World Health Organization (WHO), 2012). Until substantial progress is made in these countries, the millennium development goal (MDG) of halting and reversing the incidence of malaria by 2015 will not be achieved. With a population of 162 million people (WHO, 2012), Nigeria has the largest population in Africa at risk for acquiring malaria. In 2008, the country accounted for a quarter of all malaria cases on the African continent (WHO, 2008). Malaria is therefore a huge burden on the Nigerian health system; it is also a cause and consequence of poverty, which has important implications for the economic development of the country.

Recognizing the morbidity and mortality from malaria in African countries such as Nigeria led to the formation of the roll back malaria (RBM) global partnership in 1998 (WHO RBM, 2002). The current goal of RBM is to reduce malaria incidence by 75% by the end of 2015 compared to levels in the year 2000 (WHO, 2012). The last decade has witnessed a large

increase in the amount of resources dedicated to fighting malaria (Sarbib et al., 2006; Snow and Marsh, 2010; Snow et al., 2010). Institutions such as the Global Fund to fight AIDS, Tuberculosis and Malaria (GFATM), the World Bank, and the US President's Malaria Initiative (PMI) have more than doubled funding for malaria control, especially in Sub-Saharan Africa (SSA) (Grabowsky, 2008; Pigott et al., 2012). This increase in funding has allowed for measures to prevent and control malaria such as universal free bed net distributions in many SSA countries.

Malaria is caused by one of four species of *Plasmodium* parasites that are transmitted by various species of mosquitoes in the genus *Anopheles*. One of the major ways to control malaria is through the use of insecticide treated bed nets (ITNs) that prevent these mosquitoes from feeding on people. ITN use has been shown to reduce illness and death drastically from malaria across a range of transmission environments (Lengeler, 2004). Overall, despite the high one-off cost for procuring ITNs, they have been demonstrated by various studies to be both cost-effective and sustainable in the long run (WHO, 2006). As part of a larger preventive program, they aid in the reduction of malaria episodes in malaria endemic regions. When the use of ITNs is high in a community, studies have shown that there is not only large-scale reduction of mosquitoes, but also a protective effect on surrounding compounds without ITNs, thereby leading to an increase in health and survival overall (Binka et al., 1998, Hawley et al., 2003; Howard et al., 2000). Untreated nets provide some protection to people sleeping under them, but ITNs are approximately twice as effective as untreated nets in reducing successful mosquito feeding (D'Alessandro et al., 1995). Consistent use of ITNs can cause up to a 90% reduction in malaria incidence, and also reduce malaria-related mortality by about 44% in children under five years of age (Lengeler, 2004). In a review of studies conducted in various

malaria settings, Lengeler (2004) showed an overall reduction of 17% in mortality demonstrated in five randomized control trials, with six lives saved per 1000 children protected by ITNs. In areas of endemic malaria, incidence of uncomplicated malaria was reduced by 50% when compared to areas using no nets, and by 39% when compared to areas using untreated nets. The use of ITNs also reduced the prevalence of severe malaria, parasitaemia, splenomegaly, and improved hemoglobin levels of children (Lengeler, 2004). This evidence of the efficacy of ITNs is the major reason for ITNs being adopted as one of the four RBM strategies for control (Oresanya et al., 2008). Previously, targeted distribution of ITNs to vulnerable groups, e.g. children under five years and pregnant women, was the focus of malaria control programs in endemic countries (Nafo-Traore et al., 2005). However, based on the evidence that when community access to nets is high, there are residual protective effects for people not covered by nets, the WHO recommended in 2007 that all members of a population at risk be covered with insecticide treated nets i.e. universal access (WHO, 2007).

While ITN distribution campaigns increase ownership of an ITN, there seems to be a discrepancy between ownership and actual use of an ITN (Korenromp et al., 2003; Pulford et al., 2011). Increasing access to ITNs is necessary but not sufficient to increase their use. Also important are people and their behavior once they possess the nets. For ITNs to have an epidemiological impact on the burden of malaria, those who receive them have to use them consistently and properly by sleeping under them as recommended. There is a growing body of literature that has evaluated community beliefs and behaviors concerning malaria prevention and control (Agyepong, 1992; Ahorlu et al., 1997; Aikins et al., 1993; Aikins et al., 1994; Alilio and Bammek, 1998; Esse et al., 2008; Hassan, 2012; Hlongwana et al., 2009; Ndo et al.. 2011;

Opiyo et al., 2007; Yeneneh et al., 1993). Results from these studies underscore the importance of socio-cultural factors, knowledge, beliefs, and perceptions of malaria and its control. For malaria control programs to be effective, the myriad of complex factors which influence the use of interventions like ITNs have to be addressed.

Technical issues or practical barriers associated with erecting a net (Baume et al. 2009; Das et al., 2007; Pettifor et al., 2009), temporary unavailability of a net that is normally available (Alaii et al., 2003b; Pettifor et al., 2009), or an array of social factors that cause net use to be impractical in the short term (Alaii et al., 2003b; Das et al., 2007; Brieger et al., 1996) are all associated with non-use of an ITN. Other reasons reported in the literature for non-use of nets include personal discomfort or net being too hot (Agyepong and Manderson, 1999; Binka and Adongo, 2005; Frey et al., 2006), perceived low mosquito density (Alaii et al., 2003a; Atkinson et al., 2009; Binka and Adongo, 2005; Hlongwana et al., 2009; Howard et al., 2010; Thwing et al., 2008; Toe et al., 2009), and sleeping arrangements (Alaii et al., 2003b; Frey et al., 2009; Iwashita et al., 2010). These challenges for bed net use are also compounded by poor local knowledge of malaria (Adongo et al., 2005; Agyepong, 1992; Aikins et al., 1994; Chuma et al., 2010; Okrah et al., 2002) and perceptions of the measures to control it (Galvin et al., 2011; Sampath et al., 1998). Perceptions of net efficacy may also influence its use (Baume et al., 2009; Lover et al., 2011; Opiyo et al., 2007; Toe et al., 2009). For effective malaria control to work towards interrupting malaria transmission in endemic areas, country-specific research is needed to inform strategies that promote the use of bed nets.

Research presented in this dissertation, therefore, aims to assess factors, which might be barriers or impediments to consistent ITN use in the southwestern part of Nigeria, and

hopefully produce results that are generalizable to other parts of Nigeria and similar countries. While several studies have been conducted elsewhere in SSA on perceptions and other sociocultural factors that influence ITN use as discussed above, these issues remain important and timely as Nigeria has embarked on the largest scale-up of treated nets in Africa (Galvin et al., 2011). As mentioned, Nigeria contributes a huge percentage of the malaria burden in Africa. Hence, we posit that until the burden of malaria is significantly reduced in Nigeria, the overall burden of malaria on the continent will not decrease. It is therefore necessary to understand why there is a discrepancy between ownership and use (especially consistent use - hereafter termed 'adherence') of ITNs in Nigeria. This is important for helping malaria control programs refine their ITN distribution programs and refine effective information, education, communication/behavior change communication (IEC/BCC) activities so that the impact of ITNs can be capitalized on to reduce malaria-related morbidity and mortality. It is also necessary to understand the determinants of reduced adherence to ITN use in order to educate and encourage individuals to maintain their use of ITNs. Lack of knowledge and awareness of malaria risk has been associated with reduced use or non-use of ITNs (Adongo et al., 2005; Arogundade et al., 2011; De la Cruz et al., 2006). We therefore aim to evaluate overall malaria knowledge of Nigerian caregivers and investigate how this might influence adherence to the use of an ITN by young children. A second objective of this dissertation is to determine what characteristics of both the ITN and sleeping area may influence use and also adherence to the use of a net. The third objective is to evaluate how the use of methods to protect against nuisance mosquitoes is associated with ownership and use of ITNs. Lastly, this dissertation aims to evaluate the association between caregivers' perceptions of ITNs and their use by children.

To assess the use of ITNs, most studies ask questions about use of an ITN the night before the survey. This is limited in assessing long-term compliance with the use of ITNs. The study on which this dissertation is based collected data on not just ITN use the night preceding the survey, but also the week before the survey. These questions allowed us to evaluate if there is a difference in risk factors associated with individuals who used a net the night before the survey, individuals who sometimes used a net, individuals who usually used a net but did not do so the night before the survey, and individuals who used a net every night.

Beyond this introductory Chapter 1, the remainder of the dissertation is structured into five additional chapters. Chapter 2, **Poor multi-dimensional malaria knowledge of Nigerian caregivers: implications for ownership and use of Insecticide-treated bed nets by children**, evaluates the malaria knowledge of caregivers in the sample. We assess how this knowledge is distributed in the different domains of malaria – cause, transmission, symptoms, risk perception, and treatment. We analyze the associations between correct malaria knowledge and ownership and use of an ITN. We also discuss the implications of the knowledge in the different domains for ownership and use of an ITN.

Chapter 3, **Mosquito avoidance methods and adherence to insecticide treated bed net use**, aims to evaluate if the use of other methods for controlling nuisance mosquitoes acts as an impediment to the ownership and use of an ITN in Nigeria. The primary objective is to assess if the use of other methods to reduce mosquito nuisance reduces ownership of ITNs. Secondly, we examine whether use of these methods also influences the use of ITNs by children.

Chapter 4, **Perceptions of insecticide treated bed nets: implications for promoting net use in Nigeria**, evaluates perceptions of ITNs in Nigeria. The objectives of this chapter are to

assess the relationship between negative perceptions of a caregiver and use of an ITN by children. The association between positive perceptions of an ITN and its use are also examined. We assess how these perceptions influence adherence to the use of an ITN.

Chapter 5, **Influence of treated bed nets and children's sleeping areas on adherence to ITN use among Nigerian children**, evaluates the associations between characteristics of the ITN and the use of an ITN. We also examine characteristics of the child's sleeping area and how they influence the use of an ITN. The association between both net and sleeping area characteristics is also analyzed with respect to consistent use of an ITN the week before the survey.

Chapter 6, **Conclusion**, summarizes and highlights important research findings. It makes recommendations for malaria control policy makers and also suggests future research directions building on this body of knowledge.

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Chapter 2

Poor Multi-dimensional Malaria Knowledge of Nigerian Caregivers: Implications for Ownership and Use of Insecticide Treated Bed Nets by Children

Abstract

Objectives: Misperceptions about the cause, transmission, symptoms, and treatment of malaria can have a negative impact on the success and sustainability of malaria control programs. This study evaluates the distribution of knowledge in the different domains of cause, transmission, risk perception, symptoms, and treatment of malaria. It also assesses the association between a caregiver's correct malaria knowledge and ownership and use of insecticide treated nets (ITNs) to protect children.

Methods: 1,939 caregivers of young children were recruited through a random school-based survey in two states (Lagos and Oyo) of Nigeria. The self-administered questionnaire had 20 questions on the cause, transmission, prevention, symptoms, and treatment of malaria, which were used to create a malaria knowledge score for each caregiver. Data was also collected on ITN ownership and use during the week before the survey. Caregivers with a score greater than or equal to the 95th percentile score were compared to caregivers with lower scores.

Results: Malaria risk perception and knowledge of malaria transmission were the domains with the highest and lowest average scores, respectively. After adjusting for state of residence, gender, age, educational level, and income in multivariate regression analyses, high correct knowledge was not significantly associated with ownership or use of an ITN.

Conclusions: The study reveals that a lot of misperceptions still exist about malaria in Nigeria. We conclude that a locally appropriate educational intervention (covering such dimensions as cause, transmission, prevention, symptoms, and treatment) needs to become a more important component of current efforts to reduce the burden of malaria in African countries.

2.1 Introduction

Access to and proper use of insecticide treated bed nets (ITNs) are a main component of effective malaria control in sub-Saharan Africa (Aikins et al., 1994). The World Health Organization (WHO) currently recommends that all members of a population at risk of malaria (WHO, 2007) have access to bed nets in regions where malaria is endemic. This recommendation has led many countries to recently scale up free or subsidized provision of bed nets, especially the long lasting insecticide treated nets (LLINs). Nigeria, which has the highest number of childhood deaths from malaria in Africa (WHO, 2012), has used several strategies to make ITNs available to its population including free public sector campaigns as "stand alone" or integrated with other health activities (e.g. Immunizations); free public sector routine distributions through antenatal care (ANC) and expanded program on immunization

(EPI) services; and subsidized and at cost sales through the commercial sector (National Malaria Control Strategic Plan, 2008). While access to ITNs (including LLINs) in Nigeria has increased, the use of these preventive measures remains stubbornly low (Ankomah et al., 2012; Idowu et al., 2011; Ordinioha, 2007; Ye et al., 2012). As more and more resources are targeted to scale up ownership of ITNs in Nigeria, it is imperative that the proper use of this intervention is maintained so that the 2015 MDG of reducing the burden of malaria may be attained.

A number of studies have identified factors that could aid and improve decisions and health behaviors related to ownership and use of ITNs including cost, education, household income, malaria knowledge, negative perceptions about the effects of insecticides, age of child, access to health care, and location of residence (Agyepong and Manderson, 1999; Ankomah et al., 2012; Chuma et al., 2010; Esse et al., 2008; Matovu et al., 2009; Pettifor et al., 2008; Wiseman et al., 2006). Among the multi-factorial determinants of ITN ownership and use, many people have singled out understanding local knowledge, attitudes, and practice (KAP) as vital to designing and implementing this particular malaria control program if it were to have a chance of being sustainable and successful (Adongo et al., 2005; Agyepong, 1992; Agyepong and Manderson, 1999; Aikins et al., 1994; Binka and Adongo, 1997; Okrah et al., 2002; Rashed et al., 1999; Uza et al., 2002; Winch et al., 1994). Determining the modifiable factors that might drive ITN ownership and use is essential for building sustained action against malaria.

The potential implication of misperceptions about malaria cause and transmission on malaria prevention behavior has not been adequately addressed in malaria control programs in African communities (Aikins et al., 1993; Alilio et al., 1998; Cham et al., 1996; Einterz et al., 2003; Akaba et al., 2013; Arogundade et al., 2011; Hlongwana et al., 2009; Iriemenam et al.,

2011). Erroneous perceptions of malaria as “ordinary fever” that is caused by “too much work” or “too much sun” have been reported across various cultural sub-groups in Nigeria and are believed to significantly influence treatment-seeking behavior (Falade et al., 2005); these misperceptions have been associated with the belief that ITNs might not be fully effective at preventing malaria (Alaii et al., 2003; Atkinson et al., 2010; Toe et al., 2009). This study focuses on domains of malaria knowledge (in terms of cause, transmission, prevention, symptoms, and treatment) as predictors of ownership and use of ITN. We hypothesize that high correct knowledge of Nigerian caregivers would predict ITN ownership and use by children. Specifically, the questions being asked are: 1. What is the distribution of correct knowledge in the different domains of malaria knowledge? 2. Does high correct malaria knowledge in particular domains predict ownership of ITNs? 3. Does high correct malaria knowledge of caregivers translate into increased use of an ITN by their children? Previous studies have relied on the use of an ITN the night before the survey as the outcome. In this study, we collected data on the use of the ITN the week prior to the survey so as to gain a better handle on the regularity of ITN use by study participants.

2.2 Methods

Study Area

The study was conducted in the southwestern part of Nigeria. Four local government areas (LGAs) were selected based on whether they had participated in ITN distribution campaigns – two LGAs were in Lagos State (Lagos Mainland and Ikorodu) and two in Oyo State (Ibadan North and Akinyele). This information was obtained from the malaria control programs in these states. Malaria transmission occurs throughout the year in these areas but becomes

more frequent during the rainy season, which is generally between April and November. The majority of malaria cases are due to *Plasmodium falciparum* (WHO, 2008) with the predominant malaria mosquito vector being *Anopheles gambiae* (FMOH, 2008).

Survey procedures and sample population

This was a cross-sectional school-based survey. Young children 4-14 years in primary school were the population of interest not only because they are more susceptible to malaria than adults but also for logistic (data collection) purposes. Primary schools were a convenient setting to recruit study subjects with low cost and high efficiency. A pre-piloted self-administered questionnaire was used for collection of data from caregivers.

The questionnaire was created by adapting questions from previous KAP studies (Rashed et al., 1999; Deressa et al., 2009; Brieger et al., 1996), and a multiple indicator cluster survey questionnaire (MICS round 4). Additional questions of interest were added and a pre-test of the survey instrument conducted for construct validity in June 2011.

For the survey, which was conducted in July and December 2011, 15 public and 21 private primary (elementary) schools were randomly identified from the list of accredited schools in the four LGAs visited. All of the approached schools agreed to participate with all children in grades one to three being eligible. Where a family had more than one child in the target grades, only one of the children was allowed to participate in the study. The first child who received the questionnaire was asked to take it home for the caregiver to complete. Each questionnaire had an informed consent form attached and instructions on how to complete the survey.

To achieve a margin of error of 3% with 95% confidence interval and using an assumed percentage of 50% ITN owners in each state, final sample size was calculated to be 1,200 caregivers/children. 2,400 questionnaires were given out to account for a minimum participation rate of 50%. 1,939 questionnaires were returned (actual participation rate of 80%).

Predictor Variables

The survey included a set of 20 questions on the cause, transmission, prevention, symptoms, and treatment of malaria. Socio-demographic variables such as age and gender of both the child and caregiver were collected. Other information gathered were location of residence, educational level of caregiver, and income range.

Outcome Variables

There were two outcomes in this study. **ITN ownership** was measured using the question "Do you own a treated bed net?" The answer categories were "Yes" or "No." **ITN use** was measured using the question "How often did your child sleep under a treated bed net in the past one week?" The response categories were "Never", "Partial" (i.e. the child used an ITN at least once during the week but less than every day), and "Every day."

Statistical analysis

All data were entered and cleaned using Microsoft Access and analyzed using SPSS version 20. Descriptive statistics were computed for all relevant data. Quantitative variables were summarized using mean, standard deviation, and range while frequency tables were created for categorical variables.

Since there were both correct and incorrect statements, the answers were coded so that respondents who agreed with an incorrect statement were given a '0' and respondents who agreed with a correct statement were given a '1'. Disagreeing with an incorrect statement was given a '1' and disagreeing with a correct statement was also given a '0'. 'Don't know' and no answer responses were treated as inaccurate and coded as a '0'.

A knowledge score was created according to the following formula:

$$\frac{\textit{the number of correct statements for each respondent}}{\textit{total number of questions}} \times 100$$

This was so that the total knowledge scale ranged theoretically from 0 to 100% and reflected the percent of knowledge items answered correctly. Hence, higher scores reflected more correct total malaria knowledge. The knowledge score was divided into three categories: 0-50% (low), 51-74% (fair), 75-100% (Good). Bivariate analyses of the score and socio-demographic variables were conducted using chi-square tests. A p-value of 0.05 or less was considered significant.

Binary logistic regression was used to evaluate the association between malaria knowledge and ownership of an ITN. Also, multinomial logistic regression was used to assess the use of an ITN by children in the sample the week before the survey with respect to their caregiver's malaria knowledge scores. Caregivers with a score at or greater than the 95th percentile (i.e. a score of 75% or more) were compared against caregivers with lower scores. The regression models were adjusted for the following variables: location (urban or rural), gender, age, educational level, and income range of caregiver. In addition, the number of times the child had malaria in the six months preceding the survey were adjusted for in multinomial logistic regression models. 95% confidence intervals (CI) and p-values were reported.

Differences between urban and rural locations were evaluated using appropriate interaction terms in the logistic regression models.

Ethical Considerations

This project was determined to be exempt from institutional review board (IRB) review by the University of Michigan Health Sciences and Behavioral Sciences IRB because participants were not required to provide their names and home addresses. Excluding the identifying information ensured that all primary schools that were approached participated. In both Lagos and Oyo States, permission to involve both public and private primary schools in the selected LGAs was obtained from the appropriate ministry and local government authorities. The principals (of the selected public schools) and owners (of the selected private schools) were given details about the study and permission was received before questionnaires were given out to the children to take home to their caregivers.

2.3 Results

Table 1 shows the socio-demographic characteristics of the 1939 respondents in the study. Due to missing data for some questions, the sample sizes vary. A majority (55%) of the children in the sample attended public primary schools and the caregivers were predominant (59%) female. There were more male caregivers in rural areas when compared to urban areas ($p=0.02$). About 80% of the caregivers were older than 30 years old, reflecting the fact that nearly 60% of them had post-secondary education and did not have children until they were in their 20's and 30's. There were significantly more university-educated caregivers in urban areas

than in rural areas (p=0.001). Children in this sample ranged from 4-14 years with a mean age of 7.1 years (±1.8). The majority (71%) of the children were 4-7 years old and about half of them were female. A majority of the participants (58%) were renters and over 60% had an income over 20,000 Naira/month (about $126/month, equivalent to minimum wage in the country). A large percentage of the caregivers (56%) were self-employed, which may explain the self-reported low monthly income.

The average malaria knowledge score for all respondents was 53.8% (95% CI: 53.1-54.4%) and there was no difference between those that owned ITNs (53.5%; 95% CI: 52.6-54.5) and those that did not (Table 2). Only 164 of the 1892 participants (8.7%) had total knowledge scores greater than 75% (95th percentile); 45% of participants had knowledge scores of 50% or less (Table 3).

Knowledge of Cause of Malaria

Figure 1 shows the percent of correct responses to the malaria knowledge statements. 50% of the respondents knew that female mosquitoes transmit malaria. 66% of respondents thought that too much exposure to the sun causes malaria while approximately 50% agreed with the statement "overworking yourself causes malaria." Approximately 80% thought that malaria has more than one cause. Most people (74%) knew that malaria is not transmitted by physical contact with a malaria patient.

Knowledge of Malaria Transmission

Knowledge in this domain was poor since less than half of the respondents (47%) knew that malaria could be transmitted during the dry season. Only 16% and 38% of the caregivers knew that mosquitoes were likely to bite at any time and during the daytime, respectively.

Knowledge of Malaria Risk

Participants scored the highest in the domain of knowledge of malaria risk. Average score in each of the three items in this domain was over 75%. Over 90% knew that malaria is a preventable disease while 91% knew that malaria affects all age groups.

Knowledge of Malaria Symptoms

Most caregivers had good knowledge about some symptoms for malaria. About 85% knew that fever has more than one cause while 79% knew that vomiting is a symptom of malaria. Over 60% knew that convulsions were a symptom of severe malaria but only 53% knew that anemia is also a symptom of malaria. Most (78%), however, did not know that sweating is not a sign of recovery from malaria.

Knowledge of Treatment of Malaria

While 95% of the caregivers agreed that malaria needs to be treated immediately, 86% thought malaria can be treated effectively with chloroquine and 66% agreed that traditional medicine/herbs are a good way to treat malaria. About 70% of the participants knew that Coartem® is effective against malaria in children.

Bivariate analysis of socio-demographic variables and ITN ownership and use

The survey showed that 58% of the caregivers owned ITNs in Lagos State while only 40% owned ITNs in Oyo State (Table 4). The association between state and ownership was different between urban and rural locations (interaction term p-value=0.001). Female caregivers were more likely to own ITNs compared to male caregivers (p=0.03); however, this association was not significant between both states (interaction term p-value>0.05). There was a significant difference in age range category with respect to ownership of an ITN ($p < 0.001$). As caregiver's

age increased, the proportion of ITN ownership rates decreased. There was also an association between educational level and ownership of ITN ($p < 0.001$). As the level of education increased, the percentage of caregivers owning an ITN increased. The same trend was seen with income of caregiver, with the rates of ownership of an ITN increasing as income increased ($p < 0.001$). However, these associations were not different in both urban and rural locations (interaction term p-value >0.05).

There was a weak association between the states where a caregiver resides and the use of ITN by children the week before the survey ($p=0.09$). The gender of the caregiver was only marginally associated with ITN use by the child ($p=0.09$). Children of caregivers who were younger than 30 years old had a higher frequency of ITN use during the week when compared to older caregivers. This was not different between urban and rural locations (interaction term p-value >0.05). As educational level of the caregiver increased, children were more likely to use an ITN during the week ($p=0.04$). This finding was similar between both locations (interaction term p-value >0.05). There was no significant association between income of the caregiver and the use of the ITN by children ($p=0.14$); no difference was seen between locations (interaction term p-value >0.05).

Malaria Knowledge, Ownership, and Use of ITNs

A binary logistic regression model was used to evaluate the relationship between the correct knowledge score and ownership of ITN. There was no significant association between correct knowledge of malaria and ownership of ITNs (Table 5).

The results of the multinomial logistic regression were not significant either. Correct knowledge was not associated with every day ITN use (OR: 1.11 times; 95% CI: 0.61-2.01) (Table

6). Both the binary and multinomial logistic regression models were adjusted for location (urban or rural), income range, educational level, age and gender of caregiver. The multinomial logistic regression model also included the number of times the child had malaria in the six months before the survey as a confounder.

2.4 Discussion

This study shows that there still exist limited knowledge and a lot of misconceptions about the cause, transmission, symptoms, and treatment of malaria in Nigeria. Wrong beliefs with respect to malaria will have negative impacts on malaria control programs, as people may be unwilling to embrace effective preventive practices such as use of ITNs. Our study shows that malaria risk perception and knowledge of malaria transmission were the domains with the highest and lowest average scores, respectively. However, high correct knowledge was not significantly associated with ownership or use of an ITN in this sample of caregivers and children.

Malaria risk perception was the one domain of knowledge where average knowledge was very high. Over 90% of the caregivers knew that malaria can be prevented and affects all age groups. Other studies show similar rates of people having a high sense of malaria as a preventable disease. Previous studies in Ghana and Nigeria likewise found that over 90% of the respondents knew that malaria was preventable (Adongo et al., 2005; Akaba et al., 2012). Although a majority of participants knew that “malaria is more serious for children than adults” there is still a need to increase the awareness that children are more vulnerable to the effects of malaria than adults.

Risk perception of malaria has been shown to influence ownership and use of ITN (Ankomah et al., 2012), and a lack of fear of personal malaria infection due to lived experience may be a major factor in regular use or non-use of nets (Okwa, 2003). While this study shows that people generally have a high perception of the risk of malaria, high infection rates may lead to apathy and contextualization of the disease as normal and unavoidable. Indifference to the disease can have a determining influence on use of control methods such as ITNs. This may explain why this knowledge dimension (high risk perception) is not strongly associated with ITN use.

The knowledge measured by items in the malaria cause domain was poor with the average score being 44% (Table 2). The score was highly skewed by the fact that a majority of the caregivers believe that malaria has more than one cause. Attributions of disease causation in Nigerian communities are deeply rooted in cultural beliefs and are multifarious: some are personal (such as bad habits or negative emotional states); some are ecologic (e.g., pollution and germs); some are interpersonal (e.g., actions of others); and some are supernatural factors including God, destiny, and indigenous beliefs such as witchcraft or voodoo (Feyisetan et al., 1997; Helman, 2001; Vaughan et al., 2009). Minor ailments such as mild cases of malaria usually are not considered to even have any particular significant cause. From the confused prisms through which participants view malaria causation, it should not be surprising that this knowledge domain (based primarily on biologic origin of malaria) is not associated with ITN use. Although health attributions influence health beliefs and subsequent health behaviors (Adongo et al., 2005; Deressa et al., 2009; Arogundade et al., 2011), this may be a difficult attribute to change with an educational intervention aimed at increasing ITN use in Nigeria.

Participants had the lowest score (average of 32%) in the malaria transmission sub-scale (Table 2). The majority knew that mosquitoes are likely to bite at any time while over 40% believed that mosquitoes can also bite during the day time (Figure 1). This could be as a result of the activities of nuisance *Culex* mosquitoes, which have a different biting pattern from *Anopheles* mosquitoes that are mostly active from dusk till dawn (Lindsay et al., 1989). Again, this has implications for ITN use as it has been suggested that people who believed that they had been exposed to malaria already (i.e. had been bitten during the day by mosquitoes) might be less likely to use an ITN at night (Kudom et al., 2010). Also, less than half of the caregivers knew that malaria is transmitted during the dry season. Malaria is endemic in Nigeria which means that the disease can be transmitted throughout the year and is not only restricted to being transmitted during the rainy season. Educational programs should be developed to increase knowledge and awareness about the difference between the types of mosquitoes, biting patterns and times of anopheles mosquitoes, and year round risk of contracting malaria. There is also the need to encourage people to use nets throughout the year since there can be a substantial risk of transmission even when there is low vector density (Craig et al., 1999; Thomson et al., 1994).

The ability of a caregiver to identify symptoms of malaria is crucial to their being able to manage the disease among their children (Iriemenam et al., 2011). Knowledge of malaria symptoms was average with the majority of respondents knowing that fever and vomiting are associated with the disease. The responses to the statement that "sweating is a sign of recovery from malaria" suggest that participants might be confusing recovery and actual illness. Approximately 21% knew that it is not a sign of recovery but a symptom of malaria. The

proportion of respondents who knew that anemia (53%) and convulsions (62%) are symptoms of malaria is less than adequate. Linking malaria to life-threatening complications such as anemia and convulsions is vital information that can goad a caregiver to use mosquito control measures for protecting children, especially ITNs (Adongo et al., 2005).

While the great majority of participants (over 95%) knew that malaria needs to be treated immediately, the overall score for malaria treatment domain was only 50%. This shows that most people are still not sure what to use for treatment of childhood malaria. In this study, over 60% of the caregivers believed that traditional herbs/medicine are a good way to treat malaria. Similar findings from northeastern Nigeria and Cote d'ivoire show that paradoxically, people with sound knowledge of malaria cause and symptoms are still likely to use traditional medicine (Esse et al., 2008; Akogun and John, 2005). Another study in Nigeria, in fact, found that the use of traditional herbal preparations was a preferred method for malaria treatment with majority of the respondents believing that malaria could be prevented with a combination of traditional medicaments and drug prescriptions (Iriemenam et al., 2011). Apparently, a substantial number of the participants are exposed to the use of traditional herbal medicine in the treatment of malaria. The efficacy of these traditional medicaments is basically unknown. On the other hand, 30% of the caregivers did not even know that Coartem®, which is one of the most popular artemisinin-based combination therapy (ACTs) drugs being used in Nigeria, is effective against malaria (Figure 1). It would appear that the right drugs are not being used for treating malaria and this can be a contributing factor to drug resistance of the disease vectors in Nigeria.

ACTs are recommended by the WHO as the first line antimalarial drug in the treatment of malaria. In Nigeria, they were adopted in 2004 (WHO, 2008). Based on this policy, ACTs are meant to have been in circulation and use for about seven years at the time of this study. It is noteworthy that a significant proportion of caregivers (86%) still think that chloroquine is an effective drug for treatment of malaria. Chloroquine was withdrawn in 2005 in Nigeria as first line malaria treatment because of a widespread and high-level clinical failure rate across the country (Efunshile et al., 2011). This drug, however, has remained in use because many health care practitioners do not adhere to national and WHO guidelines for treating malaria cases (Meremikwu et al., 2007; Umar et al., 2011). Also, a large portion of the Nigerian populace gets its drugs from patent medicine vendors (PMVs) who are poorly regulated (Nriagu et al., 2009). Although more than 200 brands of ACTs can be bought over the counter in Nigeria (Palafox et al., 2009), many people apparently have refused to give up chloroquine.

Caregivers with the highest malaria knowledge scores (≥75%) were compared to caregivers with lower scores with respect to their children using an ITN during the week before the survey because we hypothesized that having high correct knowledge was going to be associated with both ITN ownership and use. However, we found no association between caregiver's high correct knowledge and ITN use by children. There were not a lot of caregivers with high correct knowledge of malaria across all the different domains (only 164 caregivers had a score of 75% or greater across all sub-scales). Aikins et al. (1994) reported no correlation between malaria knowledge and the use of bed nets in several countries that they investigated. Other investigators that have also reported no association between knowledge and ITN use include Agyepong and Manderson (1999) and Arogundade et al. (2011). By contrast, several

studies have found significant associations between measures of malaria knowledge and ITN use (Bennett et al., 2012; Biswas et al., 2010; Graves et al., 2011; Hwang et al., 2010; Paulander et al., 2009). The fact that the results of previous studies are contradictory should not be surprising. These studies have all used different metrics to evaluate malaria knowledge. However, our study shows that malaria knowledge is multi-dimensional and the results of previous studies obtained with blunt measurement instruments have not provided much insight on the moderating effects of malaria knowledge on ITN use. This study emphasizes the need for measuring the important domains of knowledge in any effort to develop an effective educational intervention that is currently needed in the global effort to eradicate malaria (WHO, 2012).

Our finding that 48% of the caregivers owned ITNs is not very different from the overall ownership level in the 2010 Nigerian malaria indicator survey of 42% (NMIS, 2010). The low ownership rate is quite surprising considering that Nigeria is supposedly committed to increasing access to ITNs and has spent millions of dollars distributing free bed nets in the country. Apparently the program is not working well, at least in the two states surveyed in this study. Reasons mentioned by participants for not owning nets include not knowing where to get the nets, inability to get the nets during distribution activities, never heard about the free net program, and even affordability.

Caregivers who lived in Lagos State and were female were more likely to own ITNs when compared to caregivers in Oyo. Respondents with more education (university education versus secondary school educational level) were generally more likely to own ITNs. A corollary observation that caregivers with primary school education or less were also likely to own ITNs is

likely related to the targeting of this population during the distribution activities of malaria control programs. Another study in Nigeria also found that educational level was associated with ownership of ITN (Jombo et al., 2010). The same study also reported that people with higher socioeconomic status (SES) were more likely to own nets but those in lower quartiles of the wealth index were more likely to have more than one ITN (Jombo et al., 2010). Ownership of ITNs has also been linked to high household income by Biswas et al. (2010), which is consistent with our results. The association of ITN ownership with income in Nigeria is unusual considering that the government is giving them away free of charge. One suspects that some people may be selling their nets or that government supplies of ITNs destined for free distribution are being diverted to the retail sector.

We found that age was associated with net ownership (Table 3). A similar observation was made in a previous study in Nigeria (Arogundade et al., 2011), and elsewhere (Biswas et al., 2010). The theory of adaptation to innovations of social psychology which maintains that younger people are more likely to be innovators and early adaptors of new technology (Kok et al., 1997) may be at work here. Since younger caregivers owned and used nets for their children, current educational intervention appears to be resonating with them. On the other hand, health education messages targeting older caregivers would seem to be called for.

There are a few limitations of this study. First, the study was based on self-interview; we were not able to validate reported ownership and use of ITNs with actual observation. Second, the cross-sectional nature of this study is limited in its ability to establish a cause and effect relationship between predictors and outcomes. Third, the information collected on the use of the ITN was based on a recall period of the week preceding the survey (i.e. seven days) so the

data could be subject to recall bias and social desirability bias where caregivers might have reported more use by children than their actual use. The major strength of this study is that it confirms that there is the need to develop effective means of continuously communicating information about the cause, transmission, prevention, symptoms, and treatment to people living in malaria endemic areas like Nigeria. Telling people that malaria is caused by mosquitoes may not be the only thing that needs to be done. Health communication can be used not only to provide scientific evidence/knowledge but also address incorrect information about the different knowledge domains of malaria. Health educators can also be used to discredit the belief in alternative causes of malaria and other incorrect malaria knowledge.

Conclusion

This study documents a lot of misperceptions about malaria among the Nigerian population, both urban and rural. The elements of knowledge chosen for evaluation in this study are important because they are related to the use of nets and can be targeted for modification through specific communication for behavior change. Few of the participants, however, got high scores across all domains of the measurement instrument used, indicating that knowledge about malaria is very limited in the two states surveyed which is surprising considering that Nigeria is spending a lot of money on the effort to eradicate this disease. Respondents' knowledge of malaria does not translate into increased ITN use, which has implications for malaria control in Nigeria. While knowledge is just one of a complex interplay of factors that drive malaria-related behaviors, it affects attitudes towards malaria control and is an important prerequisite for influencing behavior change. The ongoing efforts to reduce the burden of malaria through use of ITNs in the country should focus not only on their delivery but

should also be complemented with programs on caregiver behavioral change to ensure that when nets are available in the home, they are used properly and effectively to protect children. This study has identified an important need to add more targeted educational and behavioral change intervention to help make the current malarial control programs sustainable. The fact that years after the roll out of free distribution of bed nets in the country, less than 50% of the population currently owns ITNs is a clear indication that the malaria control program might need to reevaluate its priorities.

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Tables

Table.2.1: Socio-demographic characteristics of the children and caregivers in the sample

Variable	All		Urban		Rural		p-value
	Valid N	Frequency (%)	Valid N	Frequency (%)	Valid N	Frequency (%)	
Type of School	1939		937		1002		0.09
Private		878 (45)		443 (47)		435 (43)	
Public		1061 (55)		494 (53)		567 (57)	
Gender of caregiver	1915		926		989		0.02
Male		776 (41)		349 (38)		427 (43)	
Female		1139 (59)		577 (62)		562 (57)	
Gender of child	1915		924		991		0.93
Male		919 (48)		442 (48)		477 (48)	
Female		996 (52)		482 (52)		514 (52)	
Age of child	1775		857		918		0.64
4-7 years		1253 (71)		600 (70)		653 (71)	
8-14 years		522 (29)		257 (30)		265 (29)	
Age range of caregiver	1841		880		961		0.05
<=30 years		334 (18)		145 (16)		189 (20)	
31-40 years		784 (43)		366 (42)		418 (43)	
>40 years		723 (39)		369 (42)		354 (37)	

Table 2.1: Socio-demographic characteristics of the children and caregivers in the sample (continued)

Variable	All		Urban		Rural		p-value
	Valid N	Frequency (%)	Valid N	Frequency (%)	Valid N	Frequency (%)	
Educational level	1901		920		981		0.001
Primary school or less		345 (18)		155 (17)		190 (19)	
Secondary school		434 (23)		216 (23)		218 (22)	
Polytechnic/vocational/ technical college		498 (26)		211 (23)		287 (29)	
University		624 (33)		338 (37)		286 (29)	
Ownership of home	1900		917		983		<0.001
Rent		1108 (58)		639 (70)		469 (48)	
Own		792 (42)		278 (30)		514 (52)	
Income range	1618		759		859		0.02
< 20,000 Naira/month		612 (38)		266 (35)		346 (40)	
20,000-100,000 Naira/month		715 (44)		338 (45)		377 (44)	
> 100,000 Naira/month		291 (18)		155 (20)		136 (16)	
Employment	1820		888		932		0.02
Self-employed		1015 (56)		471 (53)		544 (58)	
Formal employment		805 (44)		417 (47)		388 (42)	

Table 2.2: Descriptives of malaria knowledge scores

	Mean	95% CI	SD	Range
All respondents (N=1892)	54	(53, 54)	14	0 to 100
ITN owners (N=898)	54	(53, 55)	15	5 to 95
<u>Sub-domains of malaria knowledge</u>				
Knowledge of malaria cause	44	(43, 45)	28	
Knowledge of malaria transmission	32	(30, 33)	26	
Knowledge of malaria risk	83	(82, 85)	27	0 to 100
Knowledge of malaria symptoms	57	(56, 58)	25	
Knowledge of malaria treatment	50	(49, 51)	22	

Table 2.3: Distribution of total knowledge scores for all caregivers (N=1892)

Total knowledge score (%)	Frequency	Percentage
75-100	164	8.7
51-74	884	47
0-50	844	45

Table 2.4: Bivariate associations between selected socio-demographic variables and ITN ownership and use (N's for ITN ownership and use are different because the analyses were run among all caregivers and ITN owners, respectively)

Variable	ITN ownership			ITN use the week before the survey				
					Frequency (%)			
	N	Frequency (%)	p-value	N	Never	Partial	Every day	p-value
Location			<0.001					0.09
Lagos	813	474 (58)		460	94 (20)	169 (37)	197 (43)	
Oyo	1126	453 (40)		447	113 (25)	171 (38)	163 (37)	
Gender of Caregiver			0.03					0.09
Male	776	345 (45)		341	67 (20)	125 (37)	149 (44)	
Female	1139	565 (50)		550	137 (25)	208 (38)	205 (37)	
Gender of child								0.5
Male	919	420 (46)	0.13	413	88 (21)	156 (38)	169 (41)	
Female	996	490 (49)		478	117 (25)	178 (37)	183 (38)	
Age range of caregiver			<0.001					<0.001
<=30 years	334	189 (57)		184	22 (12)	89 (48)	73 (40)	
31-40 years	784	361 (46)		355	91 (26)	127 (36)	137 (38)	
> 40 years	723	312 (43)		305	87 (29)	103 (34)	115 (38)	
Age range of child								0.57
4-7 years	1253	579 (46)	0.23	570	138 (24)	206 (36)	226 (40)	
8-14 years	522	258 (49)		251	55 (22)	100 (40)	96 (38)	

Table 2.4: Bivariate associations between selected socio-demographic variables and ITN ownership and use (N's for ITN ownership and use are different because the analyses were run among all caregivers and ITN owners, respectively - continued)

Variable	ITN ownership			ITN use the week before the survey				
					Frequency (%)			
	N	Frequency (%)	p-value	N	Never	Partial	Every day	p-value
Level of Education			<0.001					0.04
Primary school or less	345	191 (55)		185	28 (15)	80 (43)	77 (42)	
Secondary school	434	169 (39)		168	41 (24)	57 (34)	70 (42)	
Polytechnic/vocational/technical college	498	212 (43)		206	43 (21)	81 (39)	82 (40)	
University	624	333 (53)		328	92 (28)	117 (36)	119 (36)	
Income range			<0.001					0.14
<20,000 Naira/month	612	262 (43)		259	46 (18)	113 (44)	100 (39)	
20,000 to 100,000 Naira/month	715	342 (48)		334	86 (26)	119 (36)	129 (39)	
> 100,000 Naira/month	291	167 (57)		163	40 (25)	62 (38)	61 (37)	

Table 2.5: Binary logistic regression of the adjusted association between malaria knowledge scores and ITN ownership

		ITN ownership (N=1514)	
Total Knowledge Score (%)	**N**	**OR (95% CI)**	**p-value**
75-100	148	1.23 (0.86-1.76)	0.24
<75	1366	Reference	

Adjusted for income, educational level, state of residence, gender, and age of caregiver

Reference category for ITN ownership: "Yes"

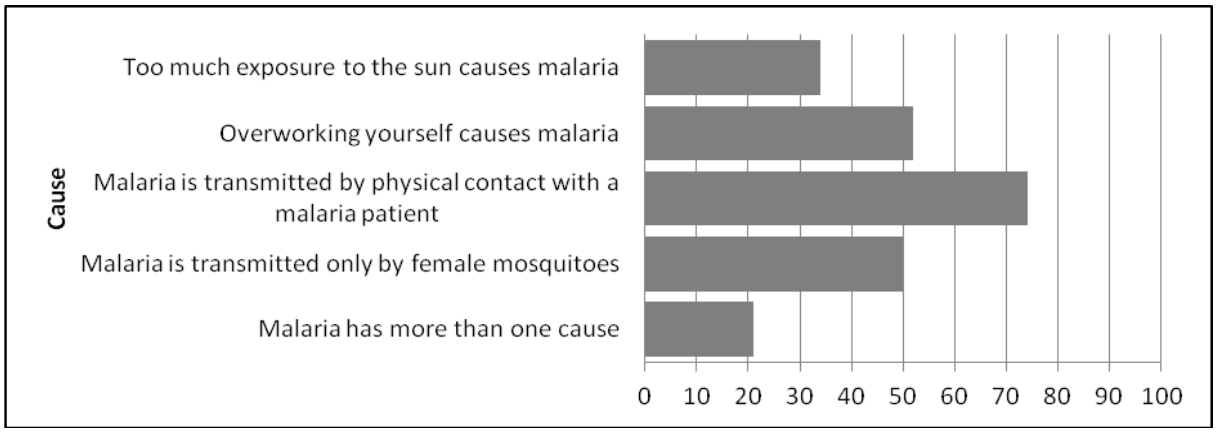
Table 2.6: Binary logistic regression of the adjusted association between malaria knowledge scores and use of ITNs

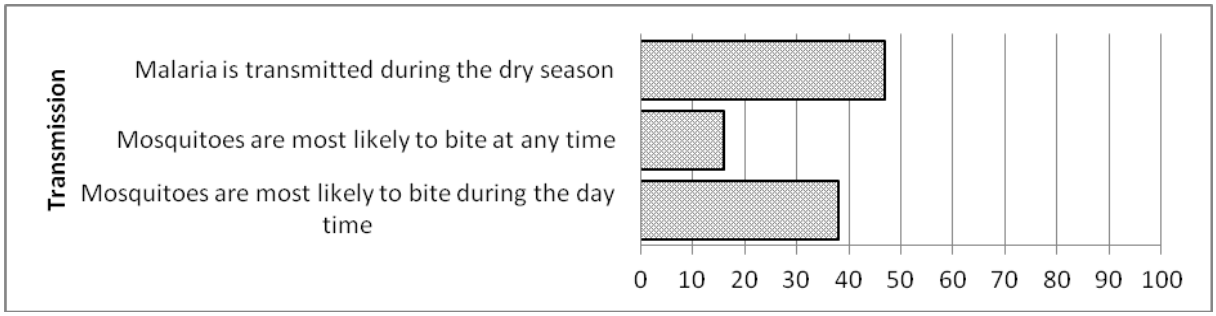
Total Knowledge Score (%)		**ITN use during the week (N=694)**			
		OR (95% CI)		**OR (95% CI)**	
	N	**Partial**	**p-value**	**Every day**	**p-value**
75-100	76	0.64 (0.33-1.24)	0.18	1.11 (0.61-2.01)	0.73
<75	618	Reference			

Adjusted for income, educational level, state of residence, gender, and age of caregiver

Reference category for ITN use: "Never"

Figure





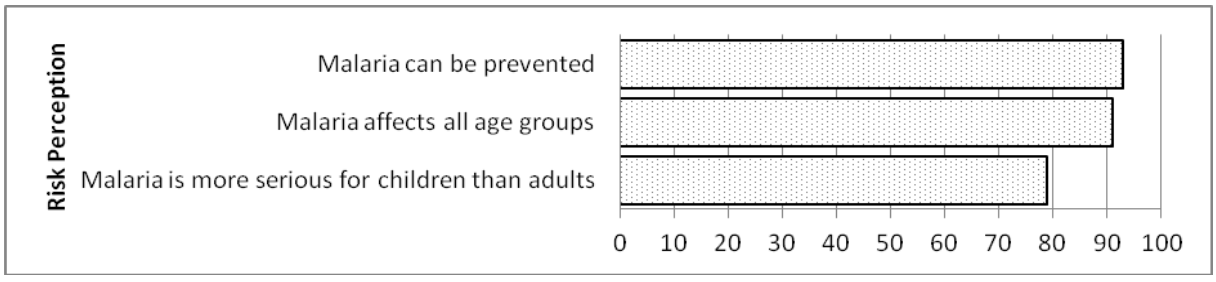


Figure 2.1: Percentage of correct answers to the malaria knowledge statements

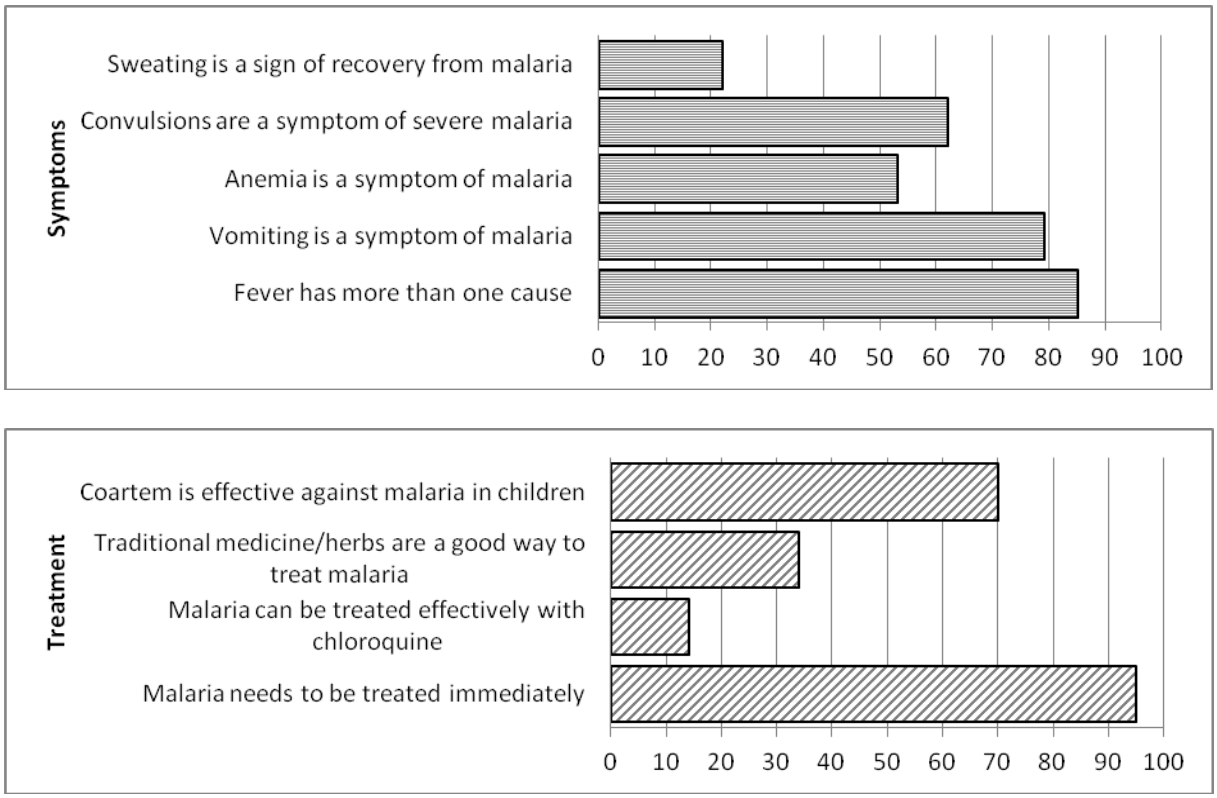


Figure 2.1: Percentage of correct answers to the malaria knowledge statements (continued)

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Chapter 3

Mosquito Avoidance Methods and Adherence to Insecticide Treated Bed Net Use

Abstract

Background: Little attention has been given to alternate methods used to protect against nuisance mosquitoes and how they might influence insecticide treated net (ITN) ownership and use. This chapter presents the results of the investigation into the association between use of methods for mosquito avoidance and the use of ITNs by Nigerian children.

Methods: 1,939 caregivers of children aged 4-14 years were recruited through a random primary school-based survey in four local government areas of Lagos and Oyo States of Nigeria. The pre-piloted self-administered questionnaire collected data on the use of the following methods for avoidance of nuisance mosquitoes by the caregiver: ITNs, insecticide sprays, mosquito coils, door and window screening, and cleaning of drains. Data on children's use of ITNs were also collected, as was socio-demographic information of both child and caregiver.

Results: The most common methods used for mosquito avoidance were insecticide sprays (60%), followed by ITNs (44%). Caregivers who used insecticide sprays were 0.5 times less likely to own an ITN (95% CI: 0.44-0.63). Children whose caregivers used sprays and screens were less

likely to sleep under an ITN the night before the survey. They were also less likely to use an ITN the week prior to the survey. Results were similar in urban and rural locations.

Conclusion: The results of this study suggest that caregivers use other mosquito nuisance protection methods as alternatives to ITNs. Health messages should be developed to encourage integration of these methods instead to complement use of ITNs. Benefits of using the ITN apart from mosquito reduction should also be promoted.

3.1 Introduction

The impact of malaria can be reduced by several methods, which include eliminating breeding sites of the *anopheline* mosquitoes, utilizing insecticide treated bed nets (ITNs), using insecticide sprays and other repellant methods, screening doors and windows, and promptly treating the illness (Agyepong and Manderson, 1999; Onyeneho, 2013). However, compliance with any intervention is influenced by people's acceptance of the intervention, their understanding of the relationship between the vector and infection, and other social, economic, and cultural factors (Agyepong and Manderson, 1999).

The evidence of the efficacy of ITNs was the basis for their adoption as a key strategy for malaria control (Oresanya et al., 2008). This has led to the call for access to ITNs for all people at risk in malaria endemic countries (WHO, 2007). Yet ITNs are just one form of prevention being used by households to protect against mosquitoes, especially during the day when nets may be of little value (Ageypong and Manderson, 1999). Due to the biting nuisance of mosquitoes, household use of insecticides has been shown to be on the increase (Achmadi and Pauluhn, 1998; Samuelson et al., 2004). The evidence exists that there is widespread use of

mosquito nuisance products -- such as mosquito coils, insecticide sprays, and smoking of herbs -- in malaria endemic countries (Agyepong and Manderson, 1999; Boakye et al., 2009; Frey et al., 2006; Samuelson et al., 2004; Stephens et al., 1995). The potential problem, however, is that while ITNs actually repel and kill malaria-causing mosquitoes, these other methods may not be as effective against malaria. In this context, very little attention has been given to how use of these other control methods might influence ITN ownership and use.

Studies show that ITN use is motivated by factors other than fear of malaria, such as nuisance mosquitoes (Baume et al., 2009; Loha et al., 2013; Moiroux et al., 2012). Indeed, community adherence to the use of any malaria control measure has been seen to be higher if the strategy is also effective against nuisance mosquitoes (Aikins et al., 1994; Samuelson et al., 2004). In addition, several studies have shown that people are much more likely to use ITNs against nuisance mosquitoes than in malaria prevention (Atkinson et al., 2010; Basseri et al., 2012; Okrah, 2002; Okwa, 2013; Yohannes et al., 2000).

If nets are used as a nuisance reduction tool, changes in temperature, season, and the corresponding mosquito density will affect their use, especially throughout the year (Agyepong and Manderson, 1999; Aikins et al., 1993; Alaii et al., 2003; Thomson et al., 1996). Moreover, even though ITNs can combat the nuisance factor of mosquitoes, this can also be achieved by the use of other mosquito repellants such as insecticide sprays and mosquito coils. It is therefore unclear whether people view these methods as alternatives to the use of an ITN.

Based on a review of the existing literature, the aim of this study therefore is to evaluate whether the use of other methods for controlling nuisance mosquitoes acts as an impediment to the ownership and use of an ITN in Nigeria. We hypothesize that mosquito avoidance

methods would decrease the odds of ITN ownership and also children's ITN use. Study specific questions therefore are: 1. Is caregivers' use of other methods for controlling mosquitoes associated with reduced ownership of an ITN? 2. Is caregivers' use of other methods for controlling mosquitoes associated with reduced use of an ITN by Nigerian children?

3.2 Methods

Study Area

The study was conducted in four local government areas (LGAs) of the southwestern part of Nigeria. The LGAs were selected based on if they had participated in ITN distribution campaigns mounted by their states (Lagos and Oyo). ITNs had either been distributed to households through stand-alone campaigns or from health care centers in the selected areas. This information was gotten from the malaria control programs in these states. Lagos Mainland and Ikorodu were the LGAs visited in Lagos State, while Ibadan North and Akinyele were the LGAs visited in Oyo State. Malaria transmission occurs throughout the year in these areas but becomes more frequent during the rainy season, which is generally between April and November. The majority of malaria cases are due to *Plasmodium falciparum* (WHO, 2008) with the predominant malaria mosquito vector being *Anopheles gambiae* (FMOH, 2008).

Survey procedures and sample population

This was a cross-sectional school-based survey. Young children 4-14 years in primary school were the population of interest not only because they are more susceptible to malaria than adults but also for logistic (data collection) purposes. Primary schools were a convenient

setting to recruit study subjects with low cost and high efficiency. A pre-piloted self-administered questionnaire was used for collection of data from caregivers.

The questionnaire was developed using other studies (Brieger et al., 1996; Deressa et al., 2009; Rashed et al., 1999; Uzochukwu et al., 2008). A pre-test was conducted for construct validity and changes to the questionnaire were then made.

The survey was conducted in July and December 2011 in Lagos and Oyo States, respectively. 15 public and 21 private primary schools were randomly identified from the list of accredited schools in the four LGAs visited. All approached schools agreed to participate. Children in Grades 1 to 3 in each school were given a questionnaire to take home to their caregivers. Where a family had more than one child in the target grades, only one of the children was allowed to participate in the study. The first child who received the questionnaire was asked to take it home for the caregiver to complete. Each questionnaire had an informed consent form attached and instructions on how to complete the survey.

To achieve a margin of error of 3% with 95% confidence interval and using an assumed percentage of 50% ITN owners in each state, final sample size was calculated to be 1,200 caregivers and children. 2,400 questionnaires were given out to account for a minimum participation rate of 50%. 1,939 questionnaires were returned (actual participation rate of 80%).

Predictor Variables

Data was collected on the methods for mosquito avoidance that caregivers practiced. The caregivers were asked how they prevented mosquitoes from biting them and a list of choices (ITNs, insecticide sprays, mosquito coils, etc.) with answer categories of “yes” or “no”

followed. The caregivers were allowed to choose as many methods that applied to them. Socio-demographic data such as age and gender of the child and caregiver were also collected. Others included: location of residence (urban or rural), type of school the child attends, educational level of caregiver, income range, ownership of home, and employment status.

Outcome Variables

There were three outcomes in this study. **ITN ownership** was measured using the question "Do you own a treated bed net?" The answer categories were "Yes" or "No." **ITN use** was defined as the child using the net the night before the survey (Yes/No). This was defined as short-term use. The last outcome (**adherence to ITN use**) was measured based on the question "How often did your child sleep under a treated bed net in the past one week?" The response categories were "Never", "Partial" (i.e. the child used an ITN at least once during the week but less than every day), and "Every day." This was defined as consistent use.

Statistical analysis

All data were entered and cleaned using Microsoft Access and analyzed using SPSS version 20. Frequencies were run and chi-square tests were used to test differences between the socio-demographic characteristics of caregivers and children by state of residence. Analyses of the variables were performed excluding non-responders or missing data points which resulted in the total number of respondents (n) varying between questions.

Binary logistic regression models were used to assess the association between each reported method of mosquito avoidance and caregivers' ownership of an ITN. This was also repeated to look at the relationship between the methods and the child's use of the ITN the night before the survey. The following variables were adjusted for in each regression model:

location (urban or rural), educational level, income range, age range, and gender of the caregiver. The number of times the child had malaria in the six months before the survey was also included in each model.

For the outcome *adherence to the use of an ITN the week preceding the survey*, multinomial logistic regression was used to assess its relationship with each reported method of mosquito avoidance. This variable was divided into three adherence category levels: never, less than every day (partial), and every day. Again, the number of times the child had malaria in the six months before the survey, location (urban or rural), educational level, income range, age range, and gender of the caregiver were adjusted for in each regression model. 95% confidence intervals (CI) and p-values are reported. Where applicable, differences between urban and rural locations were assessed using appropriate interaction terms in logistic regression models.

Ethical Considerations

This project was determined to be exempt from institutional review board (IRB) review by the University of Michigan Health Sciences and Behavioral Sciences IRB. In both Lagos and Oyo States, permission to visit both public and private primary schools in the selected LGAs was gotten from the appropriate ministry and local government authorities. The principals of the selected public and private schools and owners (of the private schools) were given details about the study and permission was received before questionnaires were given out to the children to take home to their caregivers.

3.3 Results

Socio-demographic characteristics of sample population

Table 1 shows the socio-demographic characteristics of the 1,939 respondents in the study. Due to missing data, sample sizes for variables are different. Majority of the children attended public primary schools (55%) and were 4- 7 years (71%). Children in this sample ranged from 4-14 years with a mean age of 7.1 years (±1.8). There were similar proportions of male and female children in the sample. Majority of the caregivers were female (59%). About 80% of the caregivers were older than 30 years and had more than a primary school education. There were more university-educated caregivers in urban areas when compared to rural areas ($p=0.001$). Overall, 58% of the respondents rented their homes; however, there were more renters in urban areas than in rural areas ($p<0.001$). 38% of the respondents had an income less than 20,000 Naira/month (about $126/month, equivalent to the minimum wage in Nigeria). Over half of the caregivers (56%) were self-employed.

Reasons for not owning/using an ITN

1,398 respondents (72% of the sample) gave reasons for non-ownership or non-use of an ITN (Table 2). 15% indicated that they had no interest in ITNs. A small percentage believed that the nets do not work (4%). Majority of the respondents reported that they used other methods for preventing malaria (60%) and 20% of the caregivers said the ITNs were expensive.

Use of methods to prevent nuisance mosquitoes

The caregivers were asked how they prevented mosquitoes from biting themselves and their children. Table 3 shows the frequency of methods used by caregivers for protection against nuisance mosquitoes. The caregivers could use more than one method. 44% said they used ITNs, 60% used insecticide sprays, 30% used mosquito coils, 29% mentioned window/door screens while 34% indicated that they cleaned their drains. There were more caregivers who

reported use of insecticide sprays in urban areas than in rural areas (p=0.003). However, more caregivers in rural areas reported use of mosquito coils as methods for mosquito avoidance methods when compared to caregivers who lived in urban areas (p=0.001).

Ownership of an ITN and use of other mosquito avoidance methods

Binary logistic regression was used to evaluate the association between use of mosquito avoidance methods by caregivers in the sample and ITN ownership (Table 4).

Use of insecticide spray was significantly associated with the ownership of an ITN in this sample. Caregivers who reported use of insecticide sprays were 0.47 times less likely to own an ITN (95% CI: 0.37-0.59; p-value <0.001). While caregivers who used insecticide sprays had lower odds of owning ITNs in both urban and rural areas, there was a significant difference between both locations (interaction term p-value <0.01). Caregivers who reported use of window/door screens also had lower odds of owning an ITN (OR: 0.78; 95% CI: 0.62-0.98). This association was significant in rural areas but not in urban areas. There was no difference between locations (interaction term p-value >0.05). We did not find any significant association between use of the following methods by caregivers and their ownership of an ITN: mosquito coils, or clean drains.

Use of nets by children in the sample

Of those whose caregivers owned an ITN, 59% of the children slept under one the night before the survey (Table 5). The week before the survey, 23% of the children did not use an ITN at any time while 37% used it less than every day. 40% used an ITN every day. There were more children who adhered to ITN use every day during the week in urban areas when compared to rural areas (p<0.001).

Socio-demographic variables and short term use

There was no significant association between gender of both the caregiver and child and the use of an ITN the night before the survey (Table 6). Overall, use of an ITN the night before the survey was similar between children aged 4-7 years and 8-14 years. No difference was seen between locations (interaction term p-value >0.5). We found a significant association between age of the caregiver and ITN use (p=0.01). 68% of the children of caregivers who were aged 30 years or younger slept under an ITN the night before the survey when compared to 56% of the children of caregivers aged 31-40 years and 54% of the children of caregivers aged 40 years or older. This association was also significant in rural areas (p=0.02) but not in urban areas (p=0.11). There was a significant difference between caregivers older than 30 years in both locations (interaction term p =0.05); however, no difference was found between younger caregivers (interaction term p>0.05). Overall, there was a significant association between a caregiver's income and use of an ITN the night before the survey (p=0.01). Caregivers who had an income of ₦20,000/month or less were more likely to have children who slept under an ITN (65%) while 53% of those whose income was between ₦20,000 and ₦100,000/month and 58% of those whose income was greater than ₦100,000/month used an ITN the night before the survey, respectively. There was no significant association between educational level of the caregiver and ITN use the night before the survey (p=0.18). However, there was a significant difference with respect to ITN use by children of university-educated caregivers between both locations (interaction term p-value <0.05).

Socio-demographic variables and adherence to ITN use

The results of the bivariate analysis of the socio-demographic variables and how often the child used a net the week before the survey (adherence to ITN use) are shown in Table 7.

There was no significant difference between adherence to net use in both states ($p=0.09$). Neither gender of caregiver nor child was a significant predictor of adherence to net use by the child. We also did not find any association between age of the child and adherence to net use.

The age of the caregiver was a significant predictor of adherence to the use of a net by a child in the week before the survey ($p<0.001$). Overall, as caregiver's age increased, there was a decrease in adherence to net use by children. None of the findings were different between urban and rural locations (interaction term p-value >0.05).

There was a significant association between educational level of the caregiver and adherence to the use of a net during the week before the survey ($p=0.04$). As educational level increased, there was a decrease in the percentage of children who used a net at all the week preceding the survey. 42% of caregivers who had primary school or secondary school education had children that adhered to the use of a net every day while 40% of caregivers with polytechnic/vocational/technical college background had a child who used a net every day. 36% of caregivers with university education had children who used a net every day. This association was different between urban and rural locations (interaction term p-value = 0.05).

Reported methods for mosquito avoidance and child's short-term use

The associations between the method used for mosquito avoidance or protection by caregivers and ITN use the night preceding the survey by children was evaluated using binary logistic regression models (Table 8). Using insecticide sprays was associated with significantly

lower odds of the child using the ITN the night before the survey (OR: 0.62, 95% CI: 0.45-0.86). A weak association was found for caregivers who indicated that they used window/door screens for mosquito avoidance (p=0.06). They were less likely to have children who slept under the ITN the night before the survey (OR: 0.71, 95% CI: 0.50-1.01). There was no significant difference in use the night before the survey for caregivers who reported use of mosquito coils and cleaned their drainage.

Reported methods for mosquito avoidance and child's adherence to ITN use

Multinomial logistic regression was used to assess the association between the methods used for protection from nuisance mosquitoes among ITN owners and adherence to the use of an ITN by their children (Table 9). Children of caregivers who used insecticide sprays were less likely to adhere to the use of an ITN the week before the survey. Partial users (children who used an ITN less than every day and at least once in the week prior to the survey) were 0.62 times less likely to use the ITN (95% CI: 0.39-0.98). Children who used an ITN every day were 0.43 times less likely to use an ITN if their caregiver indicated that they used an insecticide spray to control mosquitoes (95% CI: 0.27-0.67). There was no difference in adherence to the use of an ITN by children whose caregivers used mosquito coils and children of caregivers who did not use mosquito coils. Caregivers who reported use of window/door screens had lower odds of children adhere to sleeping under an ITN whether they were partial users (OR: 0.53; 95% CI: 0.33-0.84) or every day users (OR: 0.63; 95% CI: 0.41-0.99) of an ITN. There was no difference seen in adherence to the use of an ITN by children whose caregivers indicated that cleaning their drains was their method of mosquito avoidance.

3.4 Discussion

The efficacy of ITNs as physical and chemical barriers to malaria-causing mosquitoes has led to their recommended use by the World Health Organization (WHO) and the subsequent increase in access, often through the commercial market and targeted distribution activities. However, the epidemiological success of ITNs in the control of malaria depends on both their ownership and proper and consistent use. Our findings uncovered some risk factors that affect ITN ownership and use of ITNs by Nigerian children. First, in this sample, a large proportion of caregivers reported using alternate methods apart from ITNs for protecting themselves and their children from nuisance mosquitoes. Second, the use of these methods was associated with reduced likelihood of ownership of an ITN. Finally, the use of these methods was also associated with a reduced likelihood that a child would use an ITN.

By far the most common method for protection against mosquitoes was insecticide sprays (60%). Only 30% of the caregivers used mosquito coils. Caregivers who reported using insecticide sprays and screening were significantly less likely to own an ITN. A study from the Gambia similarly reported that people who used other control methods were less likely to own an ITN (Wiseman et al., 2006). While households in the study spent a lot on malaria prevention methods, only a small proportion (about 10%) was spent on bed nets (Wiseman et al., 2006). Use of nets might not be a priority due to the easy availability of other anti-insect tools like insecticide sprays and mosquito coils. An explanation for the popularity of these methods is that generally, people tend to choose actions that are seen as less expensive, save money, are simple, and are easy to use (Stevens, 1984). Multiple studies have shown that cost is a barrier to ownership and use of ITNs (Beer et al., 2012; Chuma et al., 2010; Matovu et al., 2009; Okrah

et al., 2002; Wiseman et al., 2007); households without a lot of disposable income (i.e. of lower socio-economic status) may resort to buying perceived less expensive tools which may not be as effective, especially in the long term. The popularity of insecticide sprays and mosquito coils may be because they are easily available and do not require a lot of investment to get them. Furthermore, while they may be cheaper initially, the use of these methods becomes expensive relative to the cost of ITNs. The one time cost for the ITNs (especially long-lasting insecticide treated nets (LLINs)) may seem more expensive. However, they last at least three years in the field (WHO, 2007). Hence, these nets are more cost-effective in the long term when compared to insecticide sprays and mosquito coils (Aikins et al., 1994; Boakye et al., 2009). Public education campaigns should stress this point.

While the most common method used for protection from mosquitoes was insecticide sprays, only 34% of the caregivers in the sample reported that they cleaned their drains to reduce mosquito populations. This low number may be due to either lack of drains around a caregiver's home or for those with drains, not understanding the relationship between polluted drainage and malaria transmission. Another explanation could be that having clean drains is not a priority with the myriad of problems Nigerians face on a daily basis. Information, education, and communication (IEC) messages need to be developed to target people that have drains around their homes to increase awareness of the link between polluted drains, mosquito breeding, and malaria transmission. This increase in awareness will facilitate the cleaning of drains and therefore reduce habitats for mosquito breeding.

Another finding was that use of screens was low in this population (30%). Unscreened windows and doors provide easy access for malaria vectors and other insects (Lindsay and

Snow, 1986); this could lead to increased malaria transmission and prevalence. The low use of screening may be due to the way the question was framed i.e. the question asked had to do with how caregivers protected themselves from mosquitoes. It is possible that more caregivers live in homes with screens, but they either did not attribute this benefit to screens, or caregivers did not use them as nuisance mosquito reduction methods even if the screens were available in their homes.

Regarding the association of other mosquito avoidance methods with the use of ITNs, children whose caregivers reported that they used insecticide sprays and screening (for windows and/or doors) were significantly less likely to use an ITN the night before the survey. Similarly, we found a significant negative association between caregivers using these two methods and the child's use of an ITN the week prior to the survey. Another study conducted in the same region of Nigeria found the use of insecticide sprays, mosquito coils, screened doors and windows and topical creams was a reason for non-use of an ITN (Oyedeji et al., 2009). Moreover, parents in the same study who felt the nets were unnecessary felt so because they lived in homes with screening, which they believed to be as effective as nets (Oyedeji et al., 2009). Additional findings from Sierra Leone showed low bed net use was associated with high use of local herbal repellants, aerosol insecticide sprays, and mosquito coils (Aikins et al., 1994).

A weighty contributor to ITN use is a high perception of mosquito nuisance (Beer et al., 2012; Yohannes et al., 2000). People are concerned with the irritation caused by mosquitoes, especially when it comes to disturbing their sleep (Aikins et al., 1994; Dye et al., 2010; Ng'ang'a et al., 2008, Ng'ang' a et al., 2009); hence, the main reason people spend money on personal protection methods has been attributed to the biting or nuisance role of mosquitoes

(Agyepong, 1992; Ng'ang'a et al., 2008). This point suggests that people use an intervention to eliminate mosquitoes as a biting nuisance, but not for the prevention of malaria. While there is not enough information from this study to determine if respondents also associate the use of nets with malaria prevention, this finding has implications for malaria control. If the major benefits perceived by users of nets are that they prevent and reduce nuisance mosquitoes, but not for malaria prevention, people are less likely to use them when they have a low perception of mosquito density (Binka and Adongo, 2005; Aikins et al., 1993; Yohannes et al., 2000). However, this may put them at risk since the low vector population may still be efficient enough for malaria transmission (Craig et al., 1999; Thomson et al., 1994). In the Solomon Islands, a study observed that children whose caregivers used the net for malaria protection were more likely to use the net even when perception of mosquitoes was low (Yohannes et al., 2000). The same study observed that children of respondents who used the nets as protection against mosquito nuisance had a lower likelihood of using them when compared to children of respondents who used the nets for protecting against malaria (Yohannes et al., 2000). Similarly, a Ghanaian study found that the local community acknowledged a role for ITNs in nuisance reduction but not malaria prevention (Adongo et al., 2005). An implication of this is that when the nets are seen as a nuisance reduction tool, they may be seen as the preserve of adults instead of children primarily because of the idea that adults need a good night's sleep to prepare for work the next day (Adongo et al., 2005; Alaii et al., 2003; Esse et al., 2008).

Our results show that most caregivers may use the nets for protection from nuisance mosquitoes. It might therefore be inappropriate to rely on the benefit of nuisance protection as the main message for promoting ITNs because caregivers will be less likely to use them when

they do not perceive mosquitoes in their vicinity. This perception has negative implications for the efficacy of ITNs on the burden of malaria. We suggest that malaria prevention and other benefits of using an ITN be stressed using health messages. Moreover, household insecticide use has been associated with resistant mosquito strains in Ghana (Boakye et al., 2009). Potentially, wide spread use of other insecticide-based products and tools in Nigeria may contribute to increased resistance to pyrethroids by *anopheline* mosquitoes, which could lead to decreased susceptibility of these mosquitoes to ITNs. This could impact the malaria burden by increasing the ability of the vector to transmit the illness.

People's perceptions of the efficacy of ITNs on malaria prevention may also need to be addressed. Our findings that 66% of caregivers who owned ITNs used them for protection from mosquitoes suggests that if caregivers are using nets for nuisance protection, then they might not be using them for malaria prevention. This might mean they deal with malaria in alternate ways. People generally determine the effectiveness of a vector control intervention by its immediate effect on the vector (Kroeger et al., 1995), i.e. either by stopping nuisance biting or reducing the mosquito population in their vicinity. Failure to show noticeable benefits against malaria may cause a method to be deemed ineffective and its use reduced (Baume et al., 2009; Lover et al., 2011; Ng'anga et al. 2008; Toe et al., 2009). Bed net promotion campaigns should adopt a balanced view on the usefulness of ITNs for protection against malaria and protection against nuisance mosquitoes. It should also be emphasized that these nets can only reduce and not eliminate the risk of getting malaria (Killeen et al., 2006).

Another issue raised by our finding that most caregivers seem to use nets for nuisance protection is that people's misperception of the role of mosquitoes in malaria transmission and

attributing the cause of malaria to multiple causes needs to be addressed as these could affect ITN use. Indeed, using the net for nuisance prevention and not malaria prevention has been correlated with a lack of understanding of the association between mosquitoes and malaria (Agyepong and Manderson, 1999). A study conducted in five African countries found little correlation between the perceived role of mosquitoes in the transmission of malaria and the use of bed nets. In countries where only a small proportion of respondents said mosquitoes were a cause of malaria, over 80% used a bed net while the reverse was seen in countries where over half of the respondents knew mosquitoes caused malaria but only a few used nets (Aikins et al., 1994). In addition to our results, findings such as this confirm that nets are used majorly as a mosquito nuisance reduction tool, which raises the concerns discussed above (intermittent use of ITNs, use of mosquito repellants, and other alternative methods). Health messages targeting cause and transmission of malaria should be developed and incorporated into campaigns that promote ITN use.

The results of this study may be limited by the fact that it is based on self-reported information and not observations. In addition, no information was collected on the frequency of use of the selected methods for protection from nuisance mosquitoes. Last but not least, the cross-sectional nature of the study limits causal inference. Nonetheless, to our knowledge, this is the first study to look at how reported use of several mosquito avoidance methods are associated with ITN ownership and use. Another strength of these analyses is that detailed information was collected on variables that might confound the relationship between the reported methods and ITN use. These results have real implications for public health in Nigeria and malaria control programs that have ITNs as a backbone of the program.

Tables

Table 3.1: Socio-demographic characteristics of the children and caregivers in the sample

Variable	All		Urban		Rural		p-value
	Valid N	Frequency (%)	Valid N	Frequency (%)	Valid N	Frequency (%)	
Type of School	1939		937		1002		0.09
Private		878 (45)		443 (47)		435 (43)	
Public		1061 (55)		494 (53)		567 (57)	
Gender of caregiver	1915		926		989		0.02
Male		776 (41)		349 (38)		427 (43)	
Female		1139 (59)		577 (62)		562 (57)	
Gender of child	1915		924		991		0.93
Male		919 (48)		442 (48)		477 (48)	
Female		996 (52)		482 (52)		514 (52)	
Age of child	1775		857		918		0.64
4-7 years		1253 (71)		600 (70)		653 (71)	
8-14 years		522 (29)		257 (30)		265 (29)	
Age range of caregiver	1841		880		961		0.05
<=30 years		334 (18)		145 (16)		189 (20)	
31-40 years		784 (43)		366 (42)		418 (43)	
>40 years		723 (39)		369 (42)		354 (37)	

Table 3.1: Socio-demographic characteristics of the children and caregivers in the sample (continued)

Variable	All		Urban		Rural		p-value
	Valid N	Frequency (%)	Valid N	Frequency (%)	Valid N	Frequency (%)	
Educational level	1901		920		981		0.001
Primary school or less		345 (18)		155 (17)		190 (19)	
Secondary school		434 (23)		216 (23)		218 (22)	
Polytechnic/vocational/ technical college		498 (26)		211 (23)		287 (29)	
University		624 (33)		338 (37)		286 (29)	
Ownership of home	1900		917		983		<0.001
Rent		1108 (58)		639 (70)		469 (48)	
Own		792 (42)		278 (30)		514 (52)	
Income range	1618		759		859		0.02
< 20,000 Naira/month		612 (38)		266 (35)		346 (40)	
20,000-100,000 Naira/month		715 (44)		338 (45)		377 (44)	
> 100,000 Naira/month		291 (18)		155 (20)		136 (16)	
Employment	1820		888		932		0.02
Self-employed		1015 (56)		471 (53)		544 (58)	
Formal employment		805 (44)		417 (47)		388 (42)	

Table 3.2: Reasons for non-ownership/non-use of ITNs by caregivers in the sample

Variable	Frequency (%) All (N=1398)	Urban (N=661)	Rural (N=737)
No interest	208 (15)	113 (17)	95 (13)
They do not work	62 (4)	22 (3)	40 (5)
Use other method for preventing malaria	842 (60)	397 (60)	445 (60)
Expensive	286 (20)	129 (20)	157 (21)

Table 3.3: Mosquito avoidance methods used by caregivers in sample

Mosquito avoidance method	All Subjects (N=1939) Frequency (%)	Urban (N=937) Frequency (%)	Rural (N=1002) Frequency (%)	p-value
ITN	859 (44)	410 (44)	449 (45)	0.65
Insecticide sprays	1167 (60)	596 (64)	571 (57)	0.003
Mosquito coils	585 (30)	250 (27)	335 (33)	0.001
Window/door screens	554 (29)	276 (30)	278 (28)	0.42
Clean drainage	653 (34)	313 (33)	340 (34)	0.81

Table 3.4: Binary logistic regression of the adjusted associations between different methods of avoiding mosquitoes and caregivers ownership of an ITN (adjusted for number of times child had malaria, location, educational level, income range, age range and gender of caregiver)

Variable	All Subjects		Urban		Rural	
	N (%)	OR (95% CI)	N (%)	OR (95% CI)	N (%)	OR (95% CI)
Insecticide spray						
Yes	954	0.47 (0.37-0.59)	475	0.71 (0.50-1.00)	479	0.36 (0.27-0.49)
No	554		227		327	
p-value		*<0.001*		*0.05*		*<0.001*
Mosquito coils						
Yes	475	0.94 (0.75-1.18)	192	1.28 (0.91-1.79)	283	0.74 (0.54-1.00)
No	1033		510		523	
p-value		*0.59*		*0.16*		*0.05*
Window/door screens						
Yes	473	0.78 (0.62-0.98)	231	1.36 (0.97-1.92)	242	0.49 (0.36-0.68)
No	1035		471		564	
p-value		*0.04*		*0.08*		*<0.001*
Clean drainage						
Yes	554	0.94 (0.75-1.17)	262	1.47 (1.05-2.06)	219	0.71 (0.52-0.96)
No	954		440		514	
p-value		*0.57*		*0.03*		*0.02*

Table 3.5: ITN use by children in the sample

Variable	All N	All Frequency (%)	Urban N	Urban Frequency (%)	Rural N	Rural Frequency (%)
Use the night before the survey-Yes	911	542 (59)	437	251 (57)	474	291 (61)
Use the week before the survey	907		431		476	
Never		207 (23)		115 (27)		92 (19)
Less than every day		340 (37)		130 (30)		210 (44)
Every day		360 (40)		186 (43)		174 (37)

Table 3.6: Chi-square associations between selected socio-demographic variables and ITN use by child the night before the survey

Variable	Did the child sleep under the ITN the night before the survey?					
	All		Urban		Rural	
	Valid N	Frequency (%)	Valid N	Frequency (%)	Valid N	Frequency (%)
Gender of Caregiver						
Male	336	207 (62)	152	94 (62)	184	113 (61)
Female	558	322 (58)	277	151 (55)	281	171 (61)
p-value		*0.26*		*0.15*		*0.92*
Gender of Child						
Male	413	237 (57)	200	117 (59)	213	120 (56)
Female	481	293 (61)	229	129 (56)	252	164 (65)
p-value		*0.31*		*0.7*		*0.06*
Age of child						
4-7 years	574	333 (58)	267	150 (56)	307	183 (60)
8-14 years	248	148 (60)	127	70 (55)	121	78 (65)
p-value		*0.7*		*0.91*		*0.38*
Age Range of Caregiver						
<=30 years	182	124 (68)	79	51 (65)	103	73 (71)
31-40 years	354	197 (56)	165	83 (50)	189	114 (60)
>40 years	310	167 (54)	154	84 (55)	156	83 (53)
p-value		*0.01*		*0.11*		*0.02*
Income Range						
< ₦20,000/month	257	167 (65)	127	83 (65)	130	84 (65)
₦20,000 - ₦100,000/month	335	177 (53)	142	69 (49)	193	108 (56)
>₦100,000/month	165	96 (58)	81	41 (51)	84	55 (66)
p-value		*0.01*		*0.01*		*0.18*

Table 3.6: Chi-square associations between selected socio-demographic variables and ITN use by child the night before the survey (continued)

Variable	Did the child sleep under the ITN the night before the survey?					
	All		Urban		Rural	
	Valid N	Frequency (%)	Valid N	Frequency (%)	Valid N	Frequency (%)
Educational level						
Primary school or less	182	119 (65)	76	53 (70)	106	66 (62)
Secondary school	166	99 (60)	90	52 (58)	76	47 (62)
Polytechnic/ vocational/ technical college	209	125 (60)	93	55 (59)	116	70 (60)
University	332	184 (55)	166	84 (51)	166	100 (60)
p-value		*0.18*		*0.05*		*0.99*

Table 3.7: Chi-square associations between socio-demographic variables and children's adherence to ITN use

		Frequency (%)			
Variable	**N**	**Never**	**Partial**	**Every day**	**p-value**
State					0.09
Lagos	460	94 (20)	169 (37)	197 (43)	
Oyo	447	113 (25)	171 (38)	163 (37)	
Gender of caregiver					0.09
Male	341	67 (20)	125 (37)	149 (44)	
Female	550	137 (25)	208 (38)	205 (37)	
Gender of child					0.50
Male	413	88 (21)	156 (38)	169 (41)	
Female	478	117 (25)	178 (37)	183 (38)	
Age of child					0.57
4-7 years	570	138 (24)	206 (36)	226 (40)	
8-14 years	251	55 (22)	100 (40)	96 (38)	
Age range of caregiver					<0.001
<=30 years	184	22 (12)	89 (48)	73 (40)	
31-40 years	355	91 (26)	127 (36)	137 (38)	
>40 years	305	87 (29)	103 (34)	115 (38)	
Income range					0.14
< 20,000 Naira/month	259	46 (18)	113 (44)	100 (39)	
20,000-100,000 Naira/month	334	86 (26)	119 (36)	129 (39)	
> 100,000 Naira/month	163	40 (25)	62 (38)	61 (37)	

Table 3.7: Chi-square associations between socio-demographic variables and children's adherence to ITN use (continued)

		Frequency (%)			
Variable	**N**	**Never**	**Partial**	**Every day**	**p-value**
Educational level					0.04
Primary school or less	185	28 (15)	80 (43)	77 (42)	
Secondary school	168	41 (24)	57 (34)	70 (42)	
Polytechnic/vocational/ technical college	206	43 (21)	81 (39)	82 (40)	
University	328	92 (28)	117 (36)	119 (36)	

Table 3.8: Binary logistic regression of the associations between methods used for mosquito avoidance by caregivers and ITN use the night before the survey by children

Reported mosquito avoidance method	N=717 Frequency (%)	Night before survey OR	(95% CI), *p-value*
Insecticide spray	392 (55)	0.62	(0.45-0.86) *0.004*
Mosquito coils	213 (30)	0.91	(0.65-1.26) *0.56*
Window/door screens	207 (29)	0.71	(0.50-1.01) *0.06*
Clean drainage	257 (36)	1.19	(0.85-1.66) *0.31*

Adjusted for location, age range, income, and educational level of caregiver

Table 3.9: Multinomial logistic regression of methods used for mosquito avoidance by a caregiver and child's adherence to ITN use

Mosquito avoidance method	N=694 Frequency (%)	Partial adherence OR	Partial adherence (95% CI), *p-value*	Every day OR	Every day (95% CI), *p-value*
Insecticide spray	384 (55)	0.62	(0.39-0.98) *0.04*	0.43	(0.27-0.67) *<0.001*
Mosquito coils	208 (30)	0.79	(0.51-1.24) *0.3*	0.9	(0.58-1.40) *0.65*
Window/door screens	202 (29)	0.53	(0.33-0.84) *0.01*	0.63	(0.41-0.99) *0.04*
Clean drainage	252 (36)	1.01	(0.64-1.58) *0.97*	1.27	(0.82-1.96) *0.28*

Reference category for adherence outcome: "Never"

Adjusted for location, age range, income, and educational level of caregiver, and 6-month malaria prevalence of child

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Chapter 4

Perceptions of Insecticide Treated Nets: Implications for Promoting Bed Net Use in Nigeria

Abstract

Background: The use of insecticide treated nets (ITNs) is an important tool in the roll back malaria strategy. However, there is little knowledge on how perceptions of ITNs affect their use. The goal of this study was to evaluate both positive and negative perceptions of ITNs held by Nigerian caregivers and their association with children's ITN use.

Methods: Data on 7 negative and 17 positive perception statements were collected using a self-administered questionnaire from 927 caregivers of children aged 4-14 years. The caregivers were recruited through private and public primary schools located in four local government areas of two states (Lagos and Oyo) in Nigeria. Logistic regression was used to determine which perceptions were associated with ITN use. The perception statements were added up to create a negative and positive perception score for each caregiver, respectively. Logistic regression was then used to evaluate the relationship between each score and ITN use.

Results: After adjusting for state of residence, gender, age, educational level, and income in logistic regression analyses, negative perceptions were not associated with ITN use. Positive perceptions like reduction of mosquitoes and other insects were strong predictors of ITN use. Children who liked sleeping under ITNs were more likely to use an ITN. In addition, caregivers with higher positive perception scores were more likely to have children who slept under an ITN.

Conclusions: Our results suggest that positive perceptions drive ITN use and adherence to ITN use. Malaria control programs should focus on the positive aspects of ITNs and other benefits of the nets to encourage people to maintain their use of ITNs.

4.1 Introduction

Despite recent advances made in malaria control, malaria still remains a major health concern in sub-Saharan Africa with high morbidity and mortality rates especially among children. Globally, ITNs have been shown to substantially decrease morbidity and mortality from malaria in various transmission settings (Lengeler, 2004). Hence, they are currently deployed on a large scale in many malaria-endemic countries such as Nigeria. Despite evidence demonstrating that the use of ITNs decreases malaria-related morbidity and mortality, a review of the literature shows a discrepancy between ownership and actual use of an ITN (Korenromp et al., 2003; Pulford et al., 2011).

The effectiveness of malaria control programs in reducing the burden of malaria is influenced not only by ownership of an ITN but also by a range of complex factors which include

local perceptions and how these affect sustained use of ITNs. We define perceptions in this study as the value ascribed to an object as a result of direct experience. As it is based on one's personal experience, perceptions can be seen as subjective. Significant resources are being used to address affordability barriers by provision of free or subsidized nets, but the epidemiological success of this intervention in reducing malaria is also dependent on how other barriers are addressed. Studies show that when people have negative perceptions of ITNs and the insecticide used in treating the nets, they are less likely to use this tool (Alaii et al., 2003a; Atkinson et al., 2009). Conversely, advantages and benefits of using the nets have been associated with their use (Brieger et al., 1996; Dye et al., 2010).

Many of the reported benefits of ITNs apart from malaria reduction and prevention include reduction in burden of disease co-morbidity (Frey et al., 2006); reduction of nuisance mosquitoes and subsequent protection from mosquito bites (Ng'ang'a et al., 2009; Sampath et al., 1998; Sharma et al., 2009); reduction of other insects (Dye et al., 2010) and household pests such as bedbugs, houseflies, ants, and cockroaches (Alaii et al., 2003a; Sharma et al., 2009); protection from larger animals such as rats and snakes (Alaii et al., 2003a; Frey et al., 2006); privacy; aesthetics (Aikins et al., 1993; Brieger et al., 1996; Harvey et al., 2008); provision of warmth at night (Ng'ang'a et al., 2009); prevention of dirt falling on bed (Aikins et al., 1993; Brieger et al., 1996); and non-health benefits such as reduction in malaria-related expenses due to lowered need for malaria drugs and insecticides (Frey et al., 2006). Having a sense of these aforementioned benefits will impact the perceptions one has towards ITNs and therefore, can have an impact on how consistently ITNs are used (adherence).

A limited number of studies have been conducted regarding perceptions of ITNs especially in Nigeria. Hence, the purpose of this study was to assess negative and positive perceptions about the ITNs and evaluate how they are associated with ITN use the night before the survey (short-term). Data was also collected on how often the child adhered to ITN use during the week (consistent use) prior to the survey as a second time point. This question is important because determinants of ITN use the night before a survey may not be the same as determinants of adherence to ITN use (i.e. consistent use over a period of time). Understanding what perceptions a community holds about ITNs is necessary so that negative perceptions can be overcome, positive perceptions can be enhanced, and net use can be promoted, especially as a long-term malaria control intervention. There is not much known about such mediating factors for ITN use and this study is designed to fill the critical gap in knowledge. We hypothesize that negative perceptions would be associated with decreased adherence to ITN use and that positive perceptions would be associated with increased adherence to ITN use. The study has the following specific goals: (1) Do negative perceptions influence short-term ITN use; (2) Do negative perceptions influence adherence to ITN use; (3) Do positive perceptions influence short-term ITN use; and (4) Do positive perceptions influence adherence to ITN use? We also evaluated which negative and positive perceptions might facilitate or be barriers to the use of ITNs.

4.2 Methods

Study Area

The study was conducted in the southwestern part of Nigeria. Four local government areas (LGAs) were selected based on whether they had participated in ITN distribution

campaigns – two LGAs were in Lagos State (Lagos Mainland and Ikorodu) and two in Oyo State (Ibadan North and Akinyele). This information was obtained from the malaria control programs in these states. Malaria transmission occurs throughout the year in these areas, but becomes more frequent during the rainy season, which is generally between April and November. Our data was collected in July and December. The majority of malaria cases are due to *Plasmodium falciparum* (WHO, 2008) with the predominant malaria mosquito vector being *Anopheles gambiae* (FMOH, 2008).

Survey procedures and sample population

This was a cross-sectional school-based survey. Young children in primary school (age 4-14) were the population of interest not only because they are more susceptible to malaria than adults, but also for logistic (data collection) purposes. Primary schools were a convenient setting to recruit study subjects with low cost and high efficiency. A self-administered questionnaire was used for collection of data from caregivers.

The questionnaire was developed using questions from previous studies (Aikins et al., 1993; Brieger et al., 1996; Frey et al., 2006; Sharma et al., 2009; NetMark, 2001) and pilot tested for construct validity in June 2011.

For the survey which was conducted during the months of July (in Lagos) and December (in Oyo) 2011, 15 public and 21 private primary (elementary) schools were randomly identified from the list of accredited schools in the four LGAs visited. All of the approached schools agreed to participate. Children in Grades 1 to 3 of these schools were given a questionnaire to take home to their caregivers. Where a family had more than one child in the target grades, only one of the children was allowed to participate in the study. The first child who received the

questionnaire was asked to take it home for the caregiver to complete. Each questionnaire had an informed consent form attached and instructions on how to complete the survey.

Sample Size

This study was part of a larger survey to assess factors associated with adherence to ITN use. To achieve a margin of error of 3% with 95% confidence interval and using an assumed percentage of 50% ITN owners in each state, final sample size was calculated to be 1,200 caregivers and children. To account for a minimum participation rate of 50%, 2,400 questionnaires were given out to children in the target grades. 1,939 questionnaires were returned (participation rate of 80%) and there were 927 ITN owners in the sample.

Predictor Variables

The survey included a set of 17 positive perception and seven negative perception statements. A Likert scale with the following answer categories was used: “strongly agree,” “agree,” “disagree,” “strongly disagree,” and “don’t know.” Socio-demographic variables such as age and gender of both the child and caregiver were collected. Other information gathered included location of residence, educational level of caregiver, ownership of home, occupation, and income range.

Outcome Variables

There were two outcomes in this study. **ITN use** was measured based on the question, “Did your child sleep under any treated bed net last night?” This was defined as short-term use. The answer categories were “Yes” or “No.” **Adherence to ITN use** was measured based on the question, “How often did your child sleep under a treated bed net at night in the past one week?” The response categories were “Never,” “Partial” (i.e. the child used an ITN at least once

during the week but less than every day), and “Every day.” Adherence was defined as consistent use.

Statistical analysis

All data were entered and cleaned using Microsoft Access and analyzed using SPSS version 20. Descriptive statistics were computed for all relevant data. Quantitative variables were summarized using the mean and standard deviation while frequency tables were created for categorical variables. Bivariate analyses of associations between the socio-demographic data and each outcome were conducted using chi-square tests.

The negative and positive perceptions statements had five answer categories which were coded as follows: “strongly agree”=1, “agree”=2, “disagree”=3, “strongly disagree”=4, and “don’t know”=5. For the logistic regression models, each statement was dichotomized by merging “strongly agree” and “agree” to create “agree” while “strongly disagree” and “disagree” were combined to create “disagree.” Each single item statement was run against both the ITN use and adherence to ITN use outcomes in binary and multinomial logistic regression models, respectively.

Both negative and positive perception scores were created by adding the scaled score for each statement to give a summed score for each caregiver. The Likert scale answer categories were recoded so that “strongly agree” was given the highest score of 4, “agree” was 3, “disagree” was a 2 while “strongly disagree” was coded as 1. The answer category “don’t know” was treated as a zero. The scores were then added so that a caregiver who agreed with a negative statement was given a higher score and was said to have a high negative perception of ITNs. The same procedure was conducted for positive perceptions so that a caregiver who

agreed with a positive statement was given a higher score and was said to have a high positive perception of ITNs. Those who disagreed with both types of statements received lower scores and were categorized as having lower perceptions of an ITN on both scales.

Cronbach's alpha was used to test the reliability of the statements used to create each score. Bivariate analyses were done to test the associations between each socio-demographic variable and both outcomes using chi-square tests. Each negative and positive perception statement was run against both outcomes using binary logistic (ITN use the night before – Yes/No) and multinomial logistic regression (adherence to ITN use the week before – Never, Partial, and Every day) models, respectively. The association between each summed score and the outcomes were also evaluated using binary and multinomial logistic regression models. Each regression model was adjusted for the following variables: location (urban or rural), gender, age, educational level, and income range of caregiver. In addition, the number of times the child had malaria in the six months prior to the survey was included in the multinomial logistic regression models. 95% confidence intervals (CI) and p-values are reported. Where applicable, differences between urban and rural locations were assessed using appropriate interaction terms in logistic regression models.

Ethical Considerations

This project was determined to be exempt from institutional review board (IRB) review by the University of Michigan Health Sciences and Behavioral Sciences IRB because participants were not required to provide sensitive information such as names and home addresses. In both Lagos and Oyo states, permission to involve both public and private primary schools in the selected LGAs was obtained from the appropriate ministry and local government authorities.

The principals (of the selected public schools) and owners (of the selected private schools) were provided details about the study, and permission was received before questionnaires were given out to the children to take home to their caregivers.

4.3 Results

Table 1 shows the socio-demographic characteristics of the respondents in the study. The sample size (n) is different for each question due to missing data. The caregivers were predominantly female (62%). Approximately 80% of the caregivers were more than 30 years old with 60% having post-secondary education. Majority of the children were females (54%) and aged 4-7 years old (69%). Children in this sample ranged from 4-14 years with a mean age of 7.2 years (±1.9). A majority of the participants (55%) were renters with more renters in urban areas; the converse was seen in rural areas. A large percentage of the caregivers (52%) were self-employed and over 60% had an income over 20,000 Naira/month (exchange rate of approximately 160 Naira to 1 US Dollar; about $125/month, equivalent to minimum wage in the country).

ITN Use

59% of the children slept under an ITN the night before the survey. The proportions of ITN use the night before the survey were similar between the two locations (Table 2). The week before the survey, 23% of the children did not use an ITN at any time while 37% used it less than every day. 40% used the ITN every day with more children using it in urban areas than in rural areas ($p<0.001$).

Socio-demographic variables and short-term ITN use

No significant associations were found between the following variables and a child's use of an ITN the night before the survey: gender of the caregiver, child's gender, and child's age (Table 3). This finding was similar between locations (interaction term p-value >0.05).

We found an inverse association between the age range of a caregiver and the likelihood that a child would use the net the night before. As the age range of a caregiver increased, the proportions of children using an ITN decreased. There was a significant difference in rural areas (p=0.02) but not in urban areas (p=0.11) with the interactions showing a difference between caregivers older than 30 years old (interaction term p-value=0.05) in both locations. There was also an inverse significant relationship between the income of the caregiver and the child's use of an ITN overall in the sample (p=0.01). This association was significantly different for caregivers who had income greater than 20,000 to 100,000 Naira in rural locations compared to urban locations (interaction term p-value =0.03). No association was observed between educational level of the caregiver and child's use of ITN the night before (p=0.18).

Socio-demographic variables and adherence to ITN use

Table 4 shows the bivariate associations between the socio-demographic variables and adherence to ITN use by children. There was a weak association between the state where a caregiver resided and the use of ITN by children the week before the survey (p=0.09). The gender of the caregiver was only marginally associated with ITN use by the child (p=0.09). Children of caregivers who were younger than 30 years old had a higher frequency of ITN use during the week when compared to older caregivers (p<0.001). There was no significant

association between income of the caregiver and the use of the ITN by children the week prior to the survey (p=0.14). There were no differences in associations for the aforementioned factors found between locations (interaction term p-value>0.05). However, an inverse association was observed between the educational level of the caregiver and the child's use of an ITN during the week (p=0.04) and this association was different between both locations (interaction term p-value=0.05).

Perceptions of the ITN

Negative perceptions: short-term ITN use

Table 5 shows the results of the binary logistic regression models of the association between each single negative statement and the use of an ITN the night before the survey. There was a weak association found for the statement "insecticide may make treated bed nets unfit for young children." Caregivers who agreed with this statement were less likely to have children that used an ITN the previous night (OR: 0.74; 95% CI: 0.52-1.04; p=0.08). None of the other statements were predictive of short-term use.

Negative perceptions: adherence to ITN use

After adjusting for location (urban or rural), gender, age range, educational level, income range of the caregiver, and number of times the child had malaria, none of the negative perception statements were associated with the child's adherence to the use of an ITN during the week at p<0.05 (Table 6).

Positive Perceptions: short-term ITN use

The results of the binary logistic regression evaluating the relationship between each positive statement and ITN use are shown in Table 7. Each regression was adjusted for

location, gender, age range, educational level, and income range of the caregivers. Multinomial logistic regression models were additionally adjusted for 6-month malaria prevalence of the children. There was no difference in ITN use the night before for children of caregivers who agreed with the following statements about malaria and mosquitoes and those who disagreed: treated bed nets prevent mosquito bites (p=0.14), treated bed nets kill mosquitoes (p=0.88), treated bed nets reduce malaria (p=0.29), and treated bed nets prevent malaria (p=0.23). Children of caregivers who agreed that treated bed nets reduced mosquito bites were 2.25 (95% CI: 1.50-3.37; p-value <0.001) times more likely to have used a net the night before the survey.

When caregivers were asked about other diseases, we found no association between the statement that treated bed nets prevent other diseases and child's ITN use the night prior to the survey (p=0.77). However, the positive perception statement "treated bed nets reduce other insects" was significantly associated with child's use of an ITN the night before (OR: 1.72; 95% CI: 1.19-2.50; p=0.004). There was no association between the statement "treated bed nets kill other insects" and ITN use (p=0.64). Neither was caregiver agreement with any of the following statements predictive of ITN use by the child the night before the survey: treated bed nets protect against animals (p=0.15), treated bed nets make your home beautiful (p=0.44), treated bed nets prevent dirt falling on your bed (p=0.25), and treated bed nets provide privacy (p=0.08).

The following items were significantly associated with ITN use the night before the survey: treated bed nets help you sleep better (OR: 2.41; 95% CI: 1.49-3.91), it is easy to hang your treated bed net (OR: 2.38; 95% CI: 1.58-3.58), it is easy to use your treated bed net every

day (OR: 3.24; 95% CI: 1.95-5.39), and treated bed nets do not wear and tear easily (OR: 1.55; 95% CI: 1.08-2.23). A very strong predictor of ITN use the night before the survey was the statement "my child likes to sleep under the treated bed net." Children of caregivers who agreed with this positive perception were 9.51 (95% CI: 5.36-16.9, $p<0.001$) times more likely to have used an ITN the night preceding the survey.

Positive perceptions: adherence to ITN use

Table 8 shows the results of the bivariate analyses between each positive perception statement and how often children used an ITN the week before the survey. The following statements were not predictors of adherence to ITN use the week prior to the survey: treated bed nets prevent mosquito bites, treated bed nets reduce mosquito bites, treated bed nets kill mosquitoes, treated bed nets reduce malaria, and treated bed nets prevent malaria.

Children whose caregivers agreed that treated bed nets prevent other diseases were 2.19 (95% CI: 1.33-3.62) times more likely to adhere to the use of an ITN partially when compared to children whose caregivers disagreed and did not use the net at all during the week. The perception that ITNs reduce other insects was significantly associated with partial adherence to ITN use (OR: 1.79; 95% CI: 1.10-2.94) and every day (OR: 2.28; 95% CI: 1.38-3.75), but the perception that ITNs kill other insects was not associated with either category of adherence to ITN the preceding week.

Positive perceptions that the ITNs make you home beautiful, prevent dirt from falling on your bed, and provide privacy were not significant predictors of adherence to ITN use. Children of caregivers who agreed that treated bed nets protect against animals were more likely to sleep under an ITN 1.88 times (95% CI: 1.11-3.16) every day when compared to children whose

caregivers disagreed and did not use nets at any time during the week. While the perception that treated bed nets help you sleep better was not significantly associated with partial adherence to ITN use, it was a significant predictor of everyday use the week before (OR: 3.95; 95% CI: 1.96-7.94).

Perceptions that it is easy to hang your treated bed net and to use the treated bed net every day were significantly associated with adherence to ITN use every day (OR's: 3.04 (95% CI: 1.81-5.10) and 5.16 (95% CI: 2.57-10.3) respectively). Children of caregivers who agreed that the treated bed nets do not wear and tear easily were also more likely to adhere to use of an ITN partially (OR: 1.78; 95% CI: 1.10-2.88) and every day (OR: 1.71; 95% CI: 1.07-2.74). Caregivers who agreed with the statement "my child likes to sleep under the treated bed net" had children who were 22 times more likely to have used an ITN every day the week before the survey (95% CI: 8.80-53.6).

Perception scores

The negative and positive perception items were added to create negative and positive perception scores, respectively. Due to missing data for the items used to create both scores, they have different sample sizes (Table 9). Cronbach's alpha for the negative and positive perception items used to create the scores were 0.71 and 0.81, respectively. The range of negative perception scores was from 7 to 28 while for positive perceptions, the range was from 28 to 68. The mean negative perception score was 17 (±3.3) while the mean positive perception score was 50 (±7.04). Both scores were similar between urban and rural areas.

Caregiver perception scores and child's short-term ITN use

After adjusting for location, educational level, caregiver's age, income, and gender in a binary logistic regression model, the negative perception score was not associated with the child using an ITN the night before the survey (p=0.34). On the other hand, a higher positive perception score was associated significantly with the child using the ITN the prior night (p=0.003) (Table 10).

Caregiver's perception scores and child's adherence to ITN use

Table 11 shows the results of the multinomial logistic regression model. After adjusting for 6-month malaria prevalence, location, caregiver's age range, income, gender and educational level, we found no difference in negative perception scores between the caregiver of a child who used the net every day and the scores of a caregiver whose child did not use the net at any time during the week before the survey (p=0.13). Conversely, there was an association between positive perception scores and children's every day adherence (p=0.001). As a caregiver's positive perception score increased, the child was more likely to adhere to use of an ITN every day.

4.4 Discussion

Understanding people's perceptions of ITNs is an important determinant of success in malaria control programs that have ITN use as their central focus. Therefore, the goal of this study was to identify how caregiver's negative perceptions are associated with the use of an ITN by their children. We also wanted to assess the relationship between positive perceptions of an ITN and its use by children.

First, we found that negative perceptions do not seem to translate well in this region of the world. In this sample of caregivers and children, there were no associations between any of the negative perception items and use of an ITN. Whether they agreed with the negative perception statements or not, caregivers seemed to be indifferent to the negative statements. Hence, none of the negative statements were predictors of ITN use the night before the survey nor did they predict adherence to the use of an ITN the week before the survey. This finding is supported by another study from Nigeria, which compared the efficacy of ITNs to other insecticide-impregnated materials and observed that very few negative comments were made about nets (Brieger et al., 1996). This finding has implications for the development of questions for measuring negative statements. People might be more likely to view ITNs positively, so questions or statements should emphasize the benefits of products and not dwell on the negative aspects.

One of the reasons for non-use of ITNs has been the perception that the insecticide on the net can be harmful (Brieger et al., 1996; Onwujekwe et al., 2005; Pettifor et al., 2008). Caregivers who agreed with the statement "insecticide may make treated bed nets unfit for young children" were significantly less likely to have had children in the four to seven year age range using the net during the preceding night (results not shown). However, there was no difference in use for children in the 8 – 14 year age range. These results are in line with other studies that show that bed nets are less likely to be used (especially for children) when parents and other adults believe that the insecticide used to treat the nets is harmful (Atkinson et al., 2009; Prakash et al., 2008). Our results indicate that some targeting of health messages about

the insecticides used to treat nets needs to be carried out in Nigeria to dispel the belief that the insecticide on the net is harmful so it is not a barrier to ITN use by young children.

Regarding malaria prevention, none of the statements about malaria such as “treated bed nets reduce malaria” and “treated bed nets prevent malaria” were associated with either ITN use the night before or the week before the survey. This suggests that malaria prevention might not be a strong factor driving for use of ITNs and that there might be other additional factors driving the use of these nets.

The positive perception that “treated bed nets reduce mosquitoes” was a significant predictor of child’s ITN use the night before the survey; however, it was not associated with adherence to ITN use. This finding is interesting considering the evidence that the nuisance of mosquitoes is a strong driver of ITN use (which most studies typically define as the night before the survey or interview) (De la Cruz et al., 2006; Pettifor et al., 2008; Tsuang et al., 2010). The fact that children were not likely to adhere to the use of an ITN in this study when their caregivers believe that it reduces mosquitoes suggests the downfall of marketing these tools as nuisance avoidance methods. This has been suggested by Alaii and colleagues (2003a) and Binka and Adongo (1997). Our study results are evidence that nuisance avoidance is not likely to cause people to maintain their use of an ITN over time as observed in the Solomon Islands (Atkinson et al., 2009) and Burkina Faso (Toe et al., 2009). This finding has also been tied to seasonality i.e. the rainy season and the resulting mosquito density causes people to perceive more nuisance biting which motivates them to use ITNs (Agyepong and Manderson, 1999; Beer et al., 2012; Frey et al., 2006; Okrah et al., 2002). Another study from the Solomon Islands noted that there were two levels of use: for adults, net use was for protection from nuisance

mosquitoes while for children, net use was for malaria prevention (Yohannes et al., 2000). The present study suggests that protection from nuisance mosquitoes is a risk factor for increased use of an ITN for children in Nigeria and not necessarily malaria prevention. In the same vein, the caregivers' perception that ITNs reduce other household insects was associated with increased likelihood that their child would use an ITN the night before the survey. This perception was also associated with adherence to ITN use. This suggests that protection from not only mosquitoes but other household insects is a driving factor for ITN use in Nigeria. It might be necessary for messages to be disseminated that mosquitoes transmit malaria when they bite; therefore, proper use of nets would not only protect from mosquito bites but also prevent malaria infection as a result of the bites.

Presumed benefits such as killing other insects, making a home beautiful, providing privacy, and preventing dirt from falling on one's bed were not predictors of ITN use in this study. This contrasts with reports from other studies (Aikins et al., 1993; Aikins et al., 1994; Brieger et al., 1996). In this study, the perception that the nets do not wear and tear easily however, was significantly associated with ITN use the night and week before the survey. We also found that perceptions of ease of use were significant predictors of short-term and consistent ITN use. Similar findings from Tanzania showed that perceived ease of ITN use (self-efficacy) was high when respondents had mastery and control of the activity of putting up the bed net. It had therefore become part of the caretaker's routine to use nets for their children (Beer et al., 2012). In our study, children of caregivers who believed that it was easy to use the net every day were more likely to have used an ITN the night before and adhered to its use every day the week before the survey. For caregivers who have figured out a way to deal with

the inconvenience of hanging a net, these results suggest that having a sense of control and making the nets easy to use will encourage adherence to use.

Our results showing that children whose caregivers agreed that treated bed nets help you sleep better were more likely to have used an ITN the night before the survey are consistent with studies from Tanzania and India that reported that the perception of sleeping better can be related to protection from nuisance mosquitoes and other insects; this may motivate people to use nets (Beer et al., 2012; Gunasekeran et al., 2009). In our study, children whose caregivers agreed that "treated bed nets help you sleep better" were also more likely to have used an ITN every day when compared to those who did not use an ITN at any time the week before. This shows that Nigerian caregivers are not likely to use the ITNs themselves at the detriment of their children as has been reported from studies in other sub-Saharan countries (Alaii et al., 2003b; Adongo et al., 2005). It also points again to the fact that these nets are being used as nuisance avoidance tools, to reduce the nuisance of mosquitoes and other insects that might make noise and disturb one's sleep.

One surprising finding is that children of caregivers who agreed with the statement "my child likes sleeping under the treated bed net" had children who were approximately 10 times more likely to have used an ITN the night before the survey and 22 times more likely to have used an ITN every day during the preceding week. It is logical to assume that it is easy for children who like to sleep under the net to use it consistently. This suggests that children might need to be targeted as health messengers. The formal education sector can also be included in promoting ITN use as most children in primary school are at an age where behavior is easy to influence.

The negative perception scores of caregivers did not predict either ITN use or adherence to ITN use. The mean negative perception score was 17 out of a maximum score of 28 and the proportion of caregivers who had a score greater than 17 was 40%. This seems to suggest that not a lot of people have high negative perceptions of the ITNs. On the other hand, positive perception scores were significant predictors of both use and adherence to use of an ITN by children. The mean positive perception score was 50 out of a maximum score of 68. Approximately 51% of the sample had a score of 50 or greater showing that people have pretty high perceptions of ITNs. Social desirability is possible where caregivers might not want to report negatively about ITNs but since the survey was self-administered and not interviewer-administered, we believe the bias due to this issue to be very low.

A major strength of this study is that it has led to a more nuanced assessment of the perceptions that are associated with and therefore motivate ITN use. Additional strengths are the large sample size, high participation rate, and good representation of caregivers of children in both private and public primary schools. The limitations of this study include its cross-sectional nature, which limits causal inference. It was based on self-interview and not observations. Lastly, the information collected on the use of the ITN was based on a recall period of the week preceding the survey (i.e. seven days) so the data could be subject to recall bias and social desirability bias where caregivers might have reported more use by children than their actual use.

Tables

Table 4.1: Socio-demographic characteristics of the children and caregivers in the sample

Variable	All		Urban		Rural		p-value
	Valid N	Frequency (%)	Valid N	Frequency (%)	Valid N	Frequency (%)	
Gender of caregiver	910		433		477		0.17
Male		345 (38)		154 (36)		191 (40)	
Female		565 (62)		279 (64)		286 (60)	
Gender of child	910		433		477		0.79
Male		420 (46)		202 (47)		218 (46)	
Female		490 (54)		231 (53)		259 (54)	
Age of child	837		397		440		0.33
4-7 years		579 (69)		268 (68)		311 (71)	
8-14 years		258 (31)		129 (32)		129 (29)	
Age range of caregiver	862		402		460		0.31
<=30 years		189 (22)		80 (20)		109 (24)	
31-40 years		361 (42)		168 (42)		193 (42)	
>40 years		312 (36)		154 (38)		158 (34)	

Table 4.1: Socio-demographic characteristics of the children and caregivers in the sample (continued)

Variable	All		Urban		Rural		p-value
	Valid N	Frequency (%)	Valid N	Frequency (%)	Valid N	Frequency (%)	
Educational level	905		429		476		0.03
Primary school or less		191 (21)		77 (18)		114 (24)	
Secondary school		169 (19)		92 (21)		77 (16)	
Polytechnic/vocational/ technical college		212 (23)		94 (22)		118 (25)	
University		333 (37)		166 (39)		167 (35)	
Ownership of home	907		433		474		<0.001
Rent		502 (55)		286 (66)		216 (46)	
Own		405 (45)		147 (34)		258 (54)	
Income range	771		353		418		0.14
< 20,000 Naira/month		262 (34)		128 (36)		134 (32)	
20,000-100,000 Naira/month		342 (44)		143 (41)		199 (48)	
> 100,000 Naira/month		167 (22)		82 (23)		85 (20)	
Employment	866		412		454		0.28
Self-employed		450 (52)		206 (50)		244 (54)	
Formal employment		416 (48)		206 (50)		210 (46)	

Table 4.2: ITN use by children in the sample

Variable	All N	All Frequency (%)	Urban N	Urban Frequency (%)	Rural N	Rural Frequency (%)
Use the night before the survey-Yes	911	542 (59)	437	251 (57)	474	291 (61)
Use the week before the survey	907		431		476	
Never		207 (23)		115 (27)		92 (19)
Less than every day		340 (37)		130 (30)		210 (44)
Every day		360 (40)		186 (43)		174 (37)

Table 4.3: Chi-square associations between selected socio-demographic variables and short-term ITN use

Variable	Did the child sleep under the ITN the night before the survey?					
	All		Urban		Rural	
	Valid N	Frequency (%)	Valid N	Frequency (%)	Valid N	Frequency (%)
Gender of Caregiver						
Male	336	207 (62)	152	94 (62)	184	113 (61)
Female	558	322 (58)	277	151 (55)	281	171 (61)
p-value		*0.26*		*0.15*		*0.92*
Gender of Child						
Male	413	237 (57)	200	117 (59)	213	120 (56)
Female	481	293 (61)	229	129 (56)	252	164 (65)
p-value		*0.31*		*0.7*		*0.06*
Age of child						
4-7 years	574	333 (58)	267	150 (56)	307	183 (60)
8-14 years	248	148 (60)	127	70 (55)	121	78 (65)
p-value		*0.7*		*0.91*		*0.38*
Age Range of Caregiver						
<=30 years	182	124 (68)	79	51 (65)	103	73 (71)
31-40 years	354	197 (56)	165	83 (50)	189	114 (60)
>40 years	310	167 (54)	154	84 (55)	156	83 (53)
p-value		*0.01*		*0.11*		*0.02*
Income Range						
< ₦20,000/month	257	167 (65)	127	83 (65)	130	84 (65)
₦20,000 - ₦100,000/month	335	177 (53)	142	69 (49)	193	108 (56)
>₦100,000/month	165	96 (58)	81	41 (51)	84	55 (66)
p-value		*0.01*		*0.01*		*0.18*

Table 4.3: Chi-square associations between selected socio-demographic variables and short-term ITN use (continued)

Variable	Did the child sleep under the ITN the night before the survey?					
	All		Urban		Rural	
	Valid N	Frequency (%)	Valid N	Frequency (%)	Valid N	Frequency (%)
Educational level						
Primary school or less	182	119 (65)	76	53 (70)	106	66 (62)
Secondary school	166	99 (60)	90	52 (58)	76	47 (62)
Polytechnic/ vocational/ technical college	209	125 (60)	93	55 (59)	116	70 (60)
University	332	184 (55)	166	84 (51)	166	100 (60)
p-value		*0.18*		*0.05*		*0.99*

Table 4.4: Chi-square associations between selected socio-demographic variables and adherence to ITN use

		Use of ITN the week before Frequency (%)			
Variable	**N**	**Never**	**Partial**	**Every day**	**p-value**
State					0.09
Lagos	460	94 (20)	169 (37)	197 (43)	
Oyo	447	113 (25)	171 (38)	163 (37)	
Gender of caregiver					0.09
Male	341	67 (20)	125 (37)	149 (44)	
Female	550	137 (25)	208 (38)	205 (37)	
Gender of child					0.50
Male	413	88 (21)	156 (38)	169 (41)	
Female	478	117 (25)	178 (37)	183 (38)	
Age of child					0.57
4-7 years	570	138 (24)	206 (36)	226 (40)	
8-14 years	251	55 (22)	100 (40)	96 (38)	
Age range of caregiver					<0.001
<=30 years	184	22 (12)	89 (48)	73 (40)	
31-40 years	355	91 (26)	127 (36)	137 (38)	
>40 years	305	87 (29)	103 (34)	115 (38)	
Income range					0.14
< 20,000 Naira/month	259	46 (18)	113 (44)	100 (39)	
20,000-100,000 Naira/month	334	86 (26)	119 (36)	129 (39)	
> 100,000 Naira/month	163	40 (25)	62 (38)	61 (37)	

Table 4.4: Chi-square associations between selected socio-demographic variables and adherence to ITN use (continued)

		Use of ITN the week before Frequency (%)			
Variable	**N**	**Never**	**Partial**	**Every day**	**p-value**
Educational level					0.04
Primary school or less	185	28 (15)	80 (43)	77 (42)	
Secondary school	168	41 (24)	57 (34)	70 (42)	
Polytechnic/vocational/ technical college	206	43 (21)	81 (39)	82 (40)	
University	328	92 (28)	117 (36)	119 (36)	

Table 4.5: Binary logistic regression of the adjusted associations between negative perception statements and short-term ITN use (adjusted for location, age range, gender, educational level, and income range of caregivers)

Negative perception statement		**Child slept under ITN the night before the survey**			
		N	**OR**	**(95% CI)**	**p-value**
Bed nets can be treated with insecticide	Agree	308	1.22	(0.85-1.75)	0.29
	Disagree	225			
Treated bed nets get dirty easily	Agree	294	1.03	(0.74-1.44)	0.85
	Disagree	322			
Treated bed nets are too short	Agree	108	0.82	(0.53-1.28)	0.38
	Disagree	492			
Treated bed nets smell bad when new	Agree	192	1.04	(0.72-1.49)	0.84
	Disagree	401			
Insecticide may make treated bed nets unfit for young children	Agree	282	0.74	(0.52-1.04)	0.08
	Disagree	290			
A child can suffocate under a treated bed net	Agree	156	1.24	(0.83-1.86)	0.3
	Disagree	430			
Insecticide may cause cold-like symptoms and skin rashes	Agree	316	1.04	(0.74-1.47)	0.82
	Disagree	249			

Table 4.6: Binary logistic regression of the adjusted associations between negative perception statements and adherence to ITN use (adjusted for number of times child had malaria, location, age range, gender, educational level, and income range of caregivers)

Negative perception statement		Child slept under ITN the week before the survey				
			Partial		Everyday	
		N	OR (95% CI)	p-value	OR (95% CI)	p-value
Bed nets can be treated with insecticide	Agree	307	1.10 (0.67-1.79)	0.71	1.03 (0.64-1.66)	0.91
	Disagree	222				
Treated bed nets get dirty easily	Agree	297	0.95 (0.61-1.49)	0.84	0.94 (0.61-1.47)	0.8
	Disagree	315				
Treated bed nets are too short	Agree	109	1.04 (0.57-1.89)	0.9	0.73 (0.40-1.33)	0.3
	Disagree	486				
Treated bed nets smell bad when new	Agree	195	1.25 (0.76-2.06)	0.37	1.05 (0.64-1.71)	0.86
	Disagree	392				
Insecticide may make treated bed nets unfit for young children	Agree	279	1.18 (0.73-1.89)	0.5	1.16 (0.73-1.85)	0.53
	Disagree	292				
A child can suffocate under a treated bed net	Agree	158	0.73 (0.41-1.26)	0.26	1.15 (0.67-1.98)	0.62
	Disagree	425				
Insecticide may cause cold-like symptoms and skin rashes	Agree	317	0.71 (0.44-1.15)	0.16	1.42 (0.89-2.29)	0.15
	Disagree	245				

Table 4.7: Binary logistic regression of the adjusted associations between positive perception statements and short-term ITN use (adjusted for location, age range, gender, educational level, and income range of caregivers)

Positive perception statement		Child slept under ITN the night before the survey			
		N	OR	(95% CI)	p-value
Treated bed nets prevent mosquito bites	Agree	624	0.53	(0.23-1.23)	0.14
	Disagree	31			
Treated bed nets reduce mosquito bites	Agree	523	2.25	(1.50-3.37)	<0.001
	Disagree	125			
Treated bed nets kill mosquitoes	Agree	463	0.97	(0.66-1.42)	0.88
	Disagree	156			
Treated bed nets reduce malaria	Agree	568	1.32	(0.78-2.23)	0.29
	Disagree	73			
Treated bed nets prevent malaria	Agree	546	1.34	(0.83-2.17)	0.23
	Disagree	88			
Treated bed nets prevent other diseases	Agree	223	1.06	(0.74-1.51)	0.77
	Disagree	348			
Treated bed nets reduce other insects	Agree	417	1.72	(1.19-2.50)	0.004
	Disagree	168			
Treated bed nets kill other insects	Agree	365	1.08	(0.75-1.55)	0.68
	Disagree	199			
Treated bed nets protect against animals	Agree	195	1.31	(0.91-1.90)	0.15
	Disagree	380			

Table 4.7: Binary logistic regression of the adjusted associations between positive perception statements and short-term ITN use (adjusted for location, age range, gender, educational level, and income range of caregivers-continued)

Positive perception statement		Child slept under ITN the night before the survey			
		N	OR	(95% CI)	p-value
Treated bed nets make your home beautiful	Agree	360	1.14	(0.82-1.61)	0.44
	Disagree	247			
Treated bed nets prevent dirt falling on your bed	Agree	392	0.82	(0.58-1.15)	0.25
	Disagree	227			
Treated bed nets help you sleep better	Agree	543	2.41	(1.49-3.91)	<0.001
	Disagree	83			
Treated bed nets provide privacy	Agree	342	1.37	(0.97-1.94)	0.08
	Disagree	259			
It is easy to hang your treated bed net	Agree	512	2.38	(1.58-3.58)	<0.001
	Disagree	124			
It is easy to use your treated bed net every day	Agree	552	3.24	(1.95-5.39)	<0.001
	Disagree	79			
Treated bed nets do not wear and tear easily	Agree	433	1.55	(1.08-2.23)	0.02
	Disagree	178			
My child likes to sleep under the treated bed net	Agree	532	9.51	(5.36-16.9)	<0.001
	Disagree	91			

Table 4.8: Binary logistic regression of the adjusted associations between positive perception statements and adherence to ITN use (adjusted for number of times child had malaria, location, age range, gender, educational level, and income range of caregivers)

Positive perception statement		Child slept under ITN the week before the survey				
			Partial		Everyday	
		N	OR (95% CI)	p-value	OR (95% CI)	p-value
Treated bed nets prevent mosquito bites	Agree	617	0.47 (0.15-1.46)	0.19	1.05 (0.30-3.65)	0.94
	Disagree	32				
Treated bed nets reduce mosquito bites	Agree	519	0.99 (0.59-1.67)	0.98	1.52 (0.88-2.60)	0.13
	Disagree	123				
Treated bed nets kill mosquitoes	Agree	461	0.67 (0.39-1.16)	0.16	0.77 (0.45-1.33)	0.35
	Disagree	153				
Treated bed nets reduce malaria	Agree	561	0.72 (0.34-1.53)	0.39	1.15 (0.51-2.58)	0.74
	Disagree	73				
Treated bed nets prevent malaria	Agree	538	1.04 (0.54-1.98)	0.91	1.42 (0.73-2.78)	0.3
	Disagree	91				
Treated bed nets prevent other diseases	Agree	223	2.19 (1.33-3.62)	0.002	1.16 (0.70-1.93)	0.57
	Disagree	344				
Treated bed nets reduce other insects	Agree	415	1.79 (1.10-2.94)	0.02	2.28 (1.38-3.75)	0.001
	Disagree	164				
Treated bed nets kill other insects	Agree	364	1.40 (0.86-2.29)	0.18	1.11 (0.69-1.79)	0.66
	Disagree	197				
Treated bed nets protect against animals	Agree	197	1.55 (0.91-2.63)	0.1	1.88 (1.11-3.16)	0.02
	Disagree	374				

Table 4.8: Binary logistic regression of the adjusted associations between negative perception statements and adherence to ITN use (adjusted for number of times child had malaria, location, age range, gender, educational level, and income range of caregivers-continued)

Positive perception statement		Child slept under ITN the week before the survey				
			Partial		Everyday	
		N	OR (95% CI)	p-value	OR (95% CI)	p-value
Treated bed nets make your home beautiful	Agree	355	0.66 (0.42-1.04)	0.07	1.04 (0.66-1.64)	0.86
	Disagree	248				
Treated bed nets prevent dirt falling on your bed	Agree	389	0.69 (0.44-1.10)	0.12	0.93 (0.59-1.46)	0.75
	Disagree	225				
Treated bed nets help you sleep better	Agree	538	1.11 (0.63-1.96)	0.72	3.95 (1.96-7.94)	<0.001
	Disagree	83				
Treated bed nets provide privacy	Agree	336	0.89 (0.56-1.40)	0.61	1.40 (0.88-2.21)	0.15
	Disagree	261				
It is easy to hang your treated bed net	Agree	506	2.40 (1.44-4.01)	0.001	3.04 (1.81-5.10)	<0.001
	Disagree	123				
It is easy to use your treated bed net every day	Agree	545	1.88 (1.06-3.35)	0.03	5.16 (2.57-10.34)	<0.001
	Disagree	82				
Treated bed nets do not wear and tear easily	Agree	426	1.78 (1.10-2.88)	0.02	1.71 (1.07-2.74)	0.03
	Disagree	178				
My child likes to sleep under the treated bed net	Agree	525	2.56 (1.50-4.38)	0.001	21.7 (8.80-53.6)	<0.001
	Disagree	92				

Table 4.9: Perception scores for respondent caregivers

	All		Urban		Rural	
Variable	**Valid N**	**Mean (SD)**	**Valid N**	**Mean (SD)**	**Valid N**	**Mean (SD)**
Negative perception score	507	17.1 (3.3)	239	17 (3.3)	268	17.2 (3.3)
Positive perception score	454	50.2 (7.04)	216	50.5 (6.5)	238	50 (7.5)

Table 4.10: Binary logistic regression of the association between perception scores and short-term ITN use

Score (N)	**OR**	**(95% CI)**	**p-value**
Negative perception (397)	1.01	(0.95-1.09)	0.73
Positive perception (348)	1.05	(1.01-1.08)	0.006

Adjusted for location, age, gender, educational level, and income of caregiver

Table 4.11: Multinomial logistic regression of the association between perception scores and adherence to ITN use

Score (N)	**Partial**		**Every day**	
	OR (95% CI)	**p-value**	**OR (95% CI)**	**p-value**
Negative perception (398)	1.05 (0.96-1.15)	0.32	1.07 (0.98-1.18)	0.13
Positive perception (351)	1.04 (0.99-1.08)	0.1	1.08 (1.03-1.13)	0.001

Adjusted for location, age, gender, educational level, income of caregiver, and child's 6-month malaria prevalence

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Chapter 5

Influence of Bed Net Characteristics and Children's Sleeping Areas on Adherence to ITN Use among Nigerian Children

Abstract

Background: Insecticide treated bed nets are a major tool in the control of malaria, but efforts to encourage consistent use are needed. Studies show a discrepancy between ownership and use of an ITN. Characteristics of the treated net and sleeping area may be factors that either encourage or discourage adherence to the use of a net by children. This study aims to elucidate characteristics of the net and sleeping area, which can moderate consistent use of a net (defined as adherence).

Methods: 927 caregivers of young children who were owners of a treated net were recruited through a random school-based survey in two states of Nigeria. Data on characteristics of the net and the child's sleeping area were collected using a self-administered questionnaire. Socio-demographic data for each child and caregiver were also collected. Binary logistic regression was used to identify predictors of the child's short-term ITN use. Multinomial logistic regression was also used to assess factors associated with the child's adherence to use. A multivariate model was used adjusting for age and gender of the child and caregiver, location, season that

data was collected, total number of people in home, educational level of caregiver, and income in order to identify characteristics that predict adherence to use of an ITN by Nigerian children.

Results: The multivariate model showed the following five factors were associated with adherence to ITN use by Nigerian children: the caregivers having received education on how to hang the ITN, children regularly sharing ITN, more than one person sharing an ITN in the home, children sleeping on a bed/mattress with a frame, and whether there was more than one ITN in the home. Physical net characteristics such as shape, color, and size were not significant predictors of adherence to use. Neither was buying the net or how it was deployed associated with its use.

Conclusions: Our results lead us to conclude that educational activities around the hanging and use of nets should be incorporated into ITN distribution activities. Malaria control programs should increase access to and ownership of ITNs. They should create messages to encourage consistent year-round use for children who share ITNs. Ways of modifying the net or making it easier to hang should be identified for children who sleep on mats or other temporary materials.

5.1 Introduction

Insecticide treated nets (ITNs) are an important tool in the strategy to control malaria. However, for them to be effective in malaria prevention, they have to be used correctly and consistently. Studies have shown that socio-demographic determinants such as wealth, access to healthcare, gender, education, and age, among other factors, are related to ownership and

use of ITNs (Afolabi et al., 2009; Alaii et al., 2003a; Biswas et al., 2010; Graves et al., 2011; Ye et al., 2012; Wiseman et al., 2007). Cost has been perceived to be a major determinant of owning and therefore using ITNs (Chuma et al., 2010; Matovu et al., 2009; Okrah et al., 2002; Wiseman et al., 2007). With free or highly subsidized distribution of ITNs, cost is no longer supposed to be a significant barrier to owning ITNs. However, a review of the literature shows that ownership of an ITN does not translate to use of that ITN (Ankomah et al., 2012; Pulford et al., 2011).

In Nigeria, access to ITNs by all who are at risk of malaria infection is a key component of the national malaria control strategy. In the past few years, there have been massive campaigns to increase ITN ownership rates by distribution through several development partners, since it was believed that not owning an ITN was a major barrier to non-use of ITNs. The current distribution of ITNs in Nigeria is based on a mixed model with several approaches: free public sector campaigns as "stand alone" or integrated with other health activities (e.g. Immunizations), free public sector routine distributions through antenatal care (ANC) and expanded programme on immunization (EPI) services, and subsidized and at cost sales through the commercial sector (National Malaria Control Strategic Plan, 2008). Although increase in access to ITNs has been documented in Nigeria (Idowu et al., 2011; National Malaria Control Strategic Plan, 2008; NMIS, 2010; Ye et al., 2012), relatively little has been reported on adherence to use of ITNs. There is increasing recognition that control of malaria using ITNs is multifaceted in nature. This has led to some studies being done to investigate factors beyond demographics, which are known to influence ITN use (Adongo et al., 2005; Adjei and Gyimah, 2012; Alaii et al., 2003a; Atkinson et al., 2009; Baume et al., 2009; Baume and Koh, 2011; Chuma et al., 2010; Dunn et al., 2011; Gobena et al., 2012; Grietens et al., 2013; Iwashita et al.,

2010; Moiroux et al., 2012; Nankinga et al., 2012; Pulford et al., 2012; Rhee et al., 2005; Winch et al., 1994). Unfortunately, there is still a dearth of data on the factors associated with consistent use of an ITN (defined in this paper as adherence). Understanding what predicts adherence to ITN use may provide a grounded basis for making public health policy decisions about ITN distribution, information, and educational activities. It is important that once people receive ITNs, they not only use them but that they use them consistently so as to enhance the effect of these nets on controlling malaria transmission.

The inconvenience of having to mount ITNs daily has been noted in several studies as a major reason for non-use of ITNs (Alaii et al., 2003a; Ng'ang'a et al., 2009; Ordinioha, 2007). When sleeping spaces are temporary, the additional inconvenience of having to re-arrange the space for sleeping at night and/or also deploy the ITN may affect its use. In addition, ITN use can be inhibited by limited space if more than one is available to be used in the same sleeping area (Loha et al., 2013). Also, changing the function of a room between day and night, and where sleeping patterns follows social rules (sometimes preventing the vulnerable from using ITNs) has been associated with non-use of ITNs (Toe et al., 2009). Having to deploy an ITN daily because of limited number of rooms or changes in the function of a room is tedious and may be difficult to sustain and this will definitely be a determinant as to whether a child uses an ITN consistently.

Using a bed or mat may also affect if an ITN will be used and used properly (Baume et al., 2009; Ordinioha, 2007). Brieger et al. (1996) lists three steps to correct bednet use which include tucking in the net partially at first, tucking in the net fully when one has entered the bed, and sleeping away from the edge of the bed. All these things are easier done when

sleeping on a bed; it might not be so easy when a mat is used for sleeping. Furthermore, sleeping arrangements might present logistical challenges to good ITN use (Alaii et al., 2003a). If sleeping spaces are shared by multiple individuals, social patterns of sharing spaces may affect who uses an ITN. In addition, those of a lower socio-economic status (SES) might be more likely to have fewer rooms and beds, and therefore be more likely to share beds. A study in Nigeria found that sleeping arrangement differs by age, with younger children sleeping with parents and older children sleeping on their own (Ordinioha, 2007). If a child shares a bed with an adult who uses an ITN, they will be protected as well (Iwashita et al., 2010; Mugisha and Arinaitwe, 2003).

Since sharing sleeping spaces can also influence sharing of ITNs, the size of an ITN may be a determinant of use as seen in Kenya (Alaii et al. 2003b) and Ethiopia (Baume et al. 2009). The shape of the ITN might also have an effect on if it will be used or not. A study in Ethiopia showed conical ITNs were more likely to be used than rectangular ITNs (Baume et al., 2009). Other characteristics such as how long an ITN has been owned for (i.e. ITN age) (Baume and Koh, 2011; Graves et al., 2011), its color, and how the net was obtained have also been seen to predict its use (Baume and Koh, 2011; Gobena et al., 2012).

Previous studies have shown that malaria control programs need to evaluate the knowledge, attitudes and practices of a place with respect to malaria control methods and use this information to refine their programs (Adongo et al., 2005; Binka and Adongo, 1997; Okrah et al., 2002; Rashed et al., 1999). It is unclear whether these factors reported in studies from other countries also apply to Nigerian children considering the differences in cultures and practices. As Nigeria works to increase access to ITNs, it becomes imperative for country

specific research to inform strategies that promote consistent ITN use. There are also few detailed studies that assess the factors associated with ITN usage patterns (not just the night before the survey) in sub-Saharan Africa (SSA), specifically in Nigeria. Most studies have mainly asked questions on ITN use the night before the survey (Adjei and Gyimah, 2012; Afolabi et al., 2009; Baume and Marin, 2007; Frey et al., 2006; Graves et al., 2011; Macintyre et al., 2006; Nankinga et al., 2012; Ye et al., 2012). In this study, we aim to measure adherence to use of ITNs by asking specifically about longer-term use -- the child's ITN use the week before the survey. Use the night before as an indicator excludes children who normally use a net but happened to not use one the night preceding the survey. It might also include respondents who do not regularly use a net but used one the night before the survey.

Previous research was used to inform the objectives of this study, which are to provide useful insight into how specific characteristics of the ITN and sleeping area affect adherence to the use of ITNs by Nigerian children. The goals of this study are as follows:

1) To evaluate the associations between net characteristics (such as color, age, shape, size, free or not, etc.) and adherence to net use; and
2) To determine what characteristics of the child's sleeping area are related to adherence to net use.

To our knowledge, this is the first study that evaluates the influence of characteristics of the ITN and children's sleeping area on adherence to ITN use in Nigeria. Data from this study can be used by local malaria control programs to fine-tune strategies for improving the use of ITNs consistently by children in Nigeria.

5.2 Methods

Study Area

The study was conducted in the southwestern part of Nigeria. Four local government areas (LGAs) were selected based on whether they had participated in ITN distribution campaigns (see figure A-1) – two LGAs were in Lagos State (Lagos Mainland and Ikorodu) and two in Oyo State (Ibadan North and Akinyele). This information was obtained from the malaria control programs in these states. The National Population Commission defines urban areas in Nigeria as settlements with a minimum population of 20,000 people. Lagos Mainland and Ikorodu represent the urban and rural LGAs visited in Lagos State, respectively. Ibadan North and Akinyele represent the urban and rural LGAs visited in Oyo State. Malaria transmission occurs throughout the year but becomes more frequent during the rainy season, which is generally between April and November. The majority of malaria cases are due to *Plasmodium falciparum* (WHO, 2008) with the predominant malaria mosquito vector being *Anopheles gambiae* (FMOH, 2008).

Survey Procedures and Sample Population

This was a cross-sectional school-based survey. Young children 4-14 years in primary school were the population of interest not only because they are more susceptible to malaria than adults but also for logistic (data collection) purposes. Primary schools were a convenient setting to recruit study subjects with low cost and high efficiency. A pre-piloted self-administered questionnaire was used for collection of data from caregivers.

The questionnaire was adapted from the 2010 Nigerian malaria indicator survey (MIS) and the 2008 demographic health survey (DHS) (NDHS 2008; NMIS 2010). Additional questions of interest were added and a pre-test of the survey instrument conducted for construct validity. Changes to the questionnaire were then made.

The survey was conducted in July and December 2011 in Lagos and Oyo States, respectively. 15 public and 21 private primary schools were randomly identified from the list of accredited schools in the LGA's identified. All of the approached schools agreed to participate with all children in grades one to three being eligible. Where a family had more than one child in the target grades, only one of the children was allowed to participate in the study. The first child who received the questionnaire was asked to take it home for the caregiver to complete. Each questionnaire had an informed consent form attached and instructions on how to complete the survey.

This study was part of a larger survey to assess factors associated with adherence to ITN use. To achieve a margin of error of 3% with 95% confidence interval and using an assumed percentage of 50% ITN owners in each state, final sample size was calculated to be 1,200 caregivers and children. To account for a minimum participation rate of 50%, 2,400 questionnaires were given out to children in the target grades. 1,939 questionnaires were returned (participation rate of 80%) and there were 927 ITN owners in the sample.

Predictor Variables

Socio-demographic variables such as age and gender of the child and caregiver were collected. Others include: season of data collection, location of residence, type of school the

child attends, educational level of caregiver, income range, ownership of home, employment status, and number of people in home.

Data was also collected on characteristics of the net such as: how the net was obtained (free or bought), if education on how to hang the net was received, source of the education, sharing of the net, number of people who share a net in home, length of time the net has been owned (age of net), shape of net, size of net, and how the net is hung.

The characteristics of the child's sleeping area of interest were: what the child sleeps on at night, where the child sleeps at night, who the child shares a bed with, if the sleeping area has to be rearranged to use the net every day, and if there is enough space to use the net.

Outcome Variables

There are two outcomes in this study. **Net use** was defined as the child using the net the night before the survey (Yes/No). This was defined as short-term use. **Adherence to net use** was measured based on the question "How often did your child sleep under a treated bed net in the past one week?" This was defined as consistent use. Children were categorized as poor adherers (if they did not use the net at any time during the week), partial adherers (if they used the net less than every day) and full adherers (if they used the net every day).

Statistical Analysis

The intent of this analysis was to identify factors associated with use of a treated net the night before the survey and identify factors that affect adherence to use by Nigerian children when a treated net is available in the home. All data were entered and cleaned using Microsoft Access and analyzed using SPSS version 20. Descriptive statistics were computed for all relevant data. Quantitative variables were summarized using mean (standard deviation), median, and

mode. Collinearity between the predictor variables was also determined. Binary logistic regression was used to determine the predictors associated with use of an ITN the night before the survey. Since adherence was a categorical variable with three category levels, multinomial logistic regression was used to determine which factors were associated with ITN adherence during the week before the survey. Where applicable, differences between urban and rural areas were assessed using appropriate interaction terms in logistic regression models. All variables that were significant in the bivariate analysis at $p<0.1$ were used to construct the final multivariate model. Odds ratios in the multivariate analysis were adjusted by entering a priori confounding factors such as age of child and caregiver, gender of child and caregiver, location (urban or rural), income, total number of people in home, educational level, and seasonal period that data was collected (rainy or dry) to the model. A Hosmer-Lemeshow test was used to test goodness of fit of the multivariate model.

Ethical Considerations

This project was determined to be exempt from institutional review board (IRB) review by the University of Michigan Health Sciences and Behavioral Sciences IRB. In both Lagos and Oyo states, permission to visit both public and private primary schools in the selected LGAs was gotten from the appropriate ministry and local government authorities. The principals of both the chosen public and private schools and owners (of the private schools) were given details about the study and permission was received before questionnaires were given out to the children.

5.3 Results

Socio-demographic characteristics of sample

Data was collected from 927 caregivers who owned an ITN recruited through 15 public and 21 private primary schools. The mean age of children in the sample was 7.2 years (SD±1.9). The average number of people and children in a household were 7 (SD±4.7) and 3.5 (SD±2.8) respectively. These did not differ in either urban or rural locations. Table 1 shows the frequencies of socio-demographic variable by location.

Over 50% of the children in the sample were from public primary schools and female in both urban and rural locations. Most of the children were 4-7 years (69%). Children in this sample ranged from 4-14 years with a mean age of 7.2 years (±1.9).

Caregivers in the sample were mostly female, self-employed, and younger than 40 years. About 60% had less than university education. There were more renters than owners overall but rural areas had more caregivers who owned their houses (54%) than rented. 66% of the caregivers who lived in urban areas rented their homes. Over 80% made less than ₦100,000 ($631) every month.

Net characteristics

Of the 927 caregivers who owned a net, 441 (48%) lived in urban locations and 486 (52%) were rural residents (Table 2). 56% of the nets in the sample had been purchased by caregivers. About 66% of the caregivers indicated that they were shown how to hang the net when they received it (either for free or paying for it).

32% of the children in the sample were said to share a net regularly with someone else in the home. Majority of the nets (approximately 80%) were shared by two or more people.

Most of the nets in the sample had been owned for a year or less (66%), were rectangular (86%), and white (59%). There were significantly more white nets owned by caregivers who lived in urban than in rural areas. Approximately 70% of the nets were larger than single size and hung on the wall. 79% of the nets were washed frequently and this washing behavior did not differ by location.

Sleeping area characteristics

Table 3 shows the characteristics of children's sleeping area by location. 21% of the children slept on the bare floor/mat/couch, 26% slept on a bed/mattress without a frame while 53% had access to a bed/mattress with a frame. There was no difference by location.

Approximately 90% of the children slept in a bedroom and shared a bed with someone else. Only 7% did not share a bed with any other person. The percentages of children sharing a bed at all were similar in urban and rural areas (93% vs. 94%), but children were more likely to share a bed with another child in urban areas, and more likely to share with an adult in rural areas.

Overall, 42% of the caregivers in the sample indicated that they had to rearrange their child's sleeping area with more of the caregivers having to do this in rural areas (46%). In addition, 88% of the sample indicated that there was enough space to mount the net.

Socio-demographic Variables and Net Use

Overall, use of a net by children in the sample was 59% the night before the survey (Table 4).

Table 5 shows the results of the bivariate analysis of socio-demographic variables and net use the night before the survey. There was no significant difference in use of nets by

children in both the rainy and dry seasons (p=0.42). None of the following variables were associated with a child sleeping under an ITN the night before the survey: caregiver's gender, child's age and gender, and educational level of caregiver.

There was a significant association between age range of the caregiver and net use by child (p=0.01). We found decreasing children's net use as age range of caregiver increased. However, no difference was found between urban and rural areas (interaction term p-value >0.05). In addition, income was inversely associated with use of nets by children (p=0.01).

The number of people in the home was not significantly associated with the child using a net overall (p=0.06). This finding was not different by location (interaction term p-value >0.05).

Net Characteristics and Net Use

Table 6 shows the results of the bivariate analysis between the characteristics of the net and its use by a child the night preceding the survey.

A positive association was seen between the number of nets owned and children's use of net (p<0.01). Overall, as the number of nets in a home increased, the percentage of children using a net the night before the survey increased also. In homes that had more than two nets, there was a significant difference found in children's use between urban and rural areas (interaction term <0.05).

There was no significant association seen between the source of the net and its use (p=0.07). However, there was a difference between urban and rural areas with respect to how net was obtained (interaction term p-value <0.05).

Receiving education on how to hang a net was associated with net use the night before the survey ($p<0.01$). Nonetheless, there was no difference between rural and urban areas (interaction term p-value >0.05).

Regular sharing of the net was significantly associated with its use by the child the night preceding the survey ($p<0.01$). This was similar between both rural and urban areas. Also, the number of people who shared the net was a significant predictor of net use by the child the night before the survey ($p<0.01$). The more people regularly sharing a net in the home, the greater the percentage of children sleeping under a net the night before the survey. Overall, 17% of children who lived in homes with no persons or one person using a net slept under a net the preceding night compared to 67% in homes with two people and 71% in homes with three or more people sharing a net, respectively. We found a difference in ITN sharing between urban and rural areas (interaction term p-value <0.05).

The age of the net was significantly associated with net use by children the night before the survey ($p=0.01$). 67% of the children used a net owned for 12 months or less compared to 57% using a net that had been owned for more than 12 months. No difference was found between urban and rural areas.

Shape, color, size of the net, and how the net was hung were not associated in the bivariate analysis with net use by child the night before the survey. These findings did not differ by location (interaction term p-value >0.05). Also, how often the net was washed was significantly associated with the use of the net ($p=0.00$).

Sleeping Area Characteristics and Net Use

Table 7 shows the results of the bivariate analysis of the associations between the characteristics of the child's sleeping area and use of the net by the child the night preceding the survey.

What the child slept on was significantly associated with net use by child the night before survey ($p<0.01$), with children sleeping on a bare floor or mat being least likely to use an ITN and children sleeping on a bed with a frame being most likely.

Where the child slept at night or whom they shared a bed with were not predictors of net use the night prior to the survey. However, we found a difference between net use by children who shared beds in urban and rural areas (interaction term p-value <0.05).

Having to rearrange the sleeping area of the child was a significant predictor of net use in the bivariate analysis ($p=0.01$). 65% of the children whose caregivers indicated that they had to rearrange their child's sleeping area were likely to use a net the night before the survey. In addition, having enough space for mounting an ITN was a significant predictor of use of a net the night before the survey ($p=0.02$). These findings were similar between both urban and rural areas (interaction term p-value >0.05).

Socio-demographic Variables and Adherence to Net Use

The results of the bivariate analysis of the socio-demographic variables and how often the child used a net the week before the survey (adherence to net use outcome) are shown in Table 8.

There was no significant difference between adherence to net use in the rainy season and that in the dry season ($p=0.09$). Again, there was no association between the gender of

both child and caregiver with adherence to net use. We also found no significant association between caregiver's income range and adherence to net use (p=0.14).

There was however, a significant difference in adherence to net use between urban and rural locations (p=0.00). 43% of the children in urban locations adhered to the use of a net every day while 37% in rural areas used a net every day.

The age of the caregiver was a significant predictor of adherence to the use of a net by a child in the week before the survey (p=0.00). Overall, as caregiver's age increased, there was a decrease in adherence to net use by children. Similarly, as educational level increased, there was a decrease in the percentage of children who adhered to use of a net (p=0.04). 42% of caregivers who had primary school or secondary school education had children that adhered to the use of a net every day while 40% of caregivers with polytechnic/vocational/technical college background had a child who used a net every day. 36% of caregivers with university education had children who used a net every day.

Having less than 5 people in the home was a significant predictor of adherence to use of a net (p=0.00). 47% of children in homes with ≤ 5 people adhered to the use of a net every day compared to only 34% of children in homes with > 5 people.

We found no difference in the aforementioned characteristics by location (interaction term p-value >0.05).

Net Characteristics and Adherence to Net Use

Table 9 shows the results of the bivariate analysis of the characteristics of the net and adherence to the use of that net the week before the survey.

The number of nets owned in the home was a significant predictor of adherence to net use by the child (p=0.00). Overall, as the number of nets increased, the percentage of children adhering to the use of a net increased. 30% of children in a home with one net adhered to the use of one every day while 46% of children in homes with two nets adhered to the use of a net every day. 69% and 52% of children in homes with three and four nets respectively also adhered to use of a net every day.

There was no significant association between how the net was obtained, net shape, net color, net size and adherence to its use.

Receiving education on how to hang the net was a significant predictor of adhering to the use of a net by a child in the sample (p<0.001). 42% of the children whose caregivers received education on hanging the net adhered to the use of a net every day compared to 36% of those whose caregivers did not receive education. There was a difference between urban and rural locations (interaction term p-value <0.05).

Another significant predictor of children's adherence to net use was regular sharing of the net (p<0.001). 56% of children who shared a net adhered to using a net every day while only 33% of the children who did not share a net used a net every day. In addition, the number of people who shared an ITN in the home was significantly associated with the child adhering to the use of a net (p=0.00). 71% of the children in homes that either nobody or only one person slept under a net did not use a net at any time the week before the survey. Whereas, only 14% of children in homes where two people and 10% of children in homes where three or more people shared a net respectively did not use a net at all.

The age of the net (i.e. how long the net has been owned) was significantly associated with adherence to its use (p=0.03). While the percentage of children using a net every day was similar between nets that had been owned for ≤ 12months and >12 months, 14% of the children who used a net that was owned for ≤ 12months and 22% who used a net that had been owned for > 12 months did not use the net at all during the week before the survey.

In addition, the frequency of washing the net was associated with adherence to the use of nets in the week before the survey (p=0.00). 42% of the children whose caregivers indicated that they did not wash the nets at all also did not use a net at any time during the week before the survey unlike only 12% of children whose caregivers washed the net at least once a month and 17% of the children whose caregivers washed the net 1-3 times/year. Also, 45% of the children whose caregivers washed the net at least once a month and 49% whose caregivers washed the net 1-3 times/year adhered to the use of a net every day during the week prior to the survey. This washing behavior differed by location (interaction term p-value <0.05).

Sleeping Area Characteristics and Adherence to Net Use

There was no difference seen between adherence to net use by children who slept in a bedroom and children who slept in another room (p=0.22). However, what the child slept on was a significant predictor of adherence to net use (p<0.001) (Table 10). 31% of the children who slept on a bare floor/mat/couch did not use a net at any time during the week preceding the survey while 23% who slept on a bed/mattress with no frame and 19% who slept on a bed/mattress with a frame did not use a net during the week before the survey, respectively. There was an increase in the percentage of children adhering to net use every day as a child

moved from sleeping on temporary materials such as a bare floor/mat/couch (29%) to sleeping on a bed/mattress with a frame (46%).

Whom the child shared a bed with was a significant predictor of adherence to net use ($p=0.03$). Overall, children who shared a bed with an adult were more likely to adhere to the use of a net than children who shared a bed with another child. There was a difference between children sharing with adults or other children in urban and rural areas (interaction term p-value <0.05).

Another predictor of adherence to net use was caregiver having to rearrange the child's sleeping area ($p<0.001$). We found that 42% of the children whose caregivers rearranged their sleeping area used a net every day during the week before the survey while 38% of the children whose caregivers did not rearrange their sleeping area used a net every day the week preceding the survey.

Having enough space for mounting the net was a significant predictor of adherence to use of a net by a child ($p=0.03$). 42% of the children whose caregivers said there was enough space to mount the net used a net every day compared to only 28% whose caregivers said there was not enough space to mount the net.

After adjusting for confounding factors (age and gender of both the child and caregiver, gender of child and caregiver, location (urban or rural), income, total number of people in home, educational level, and seasonal period that data was collected (rainy or dry) in the multivariate analysis, five variables remained significantly associated with adherence to use by Nigerian children (Table 11). Each additional net in the home increased the odds of every day ITN use versus no use by 91% (OR 1.91; 95% CI: 1.38-2.64; $p<0.01$). Children whose caregivers

were shown how to hang the ITN had twice the odds of using a net during the week before the survey. Sharing the ITN and the number of people who shared an ITN in the home were significantly associated with adherence to use by the child the week preceding the survey. Sleeping on the bare floor/mat/couch was negatively associated with use every day versus no days in the past week (OR: 0.19; 95% CI: 0.08-0.42; $p<0.01$).

5.4 Discussion

Some of the factors that significantly associate with sporadic ITN use may not necessarily be associated with longer-term consistent use (defined as adherence in this study) by children. Therefore, the intent of this study was to shed light on risk factors associated with adherence to ITN use the week before the survey. The final multivariate model showed that factors associated with whether the use of an ITN is being adhered to by a Nigerian child included whether the caregiver had received education on how to hang the ITN, whether the child regularly shared the ITN, whether more than one person shared an ITN in the home, whether the child slept on a bed/mattress with a frame, and whether there was more than one ITN in the home. We found no significant association between physical characteristics such as ITN size, color, shape and adherence to ITN use. Neither were there any associations between each of the following variables and adherence to ITN use: the method of deployment, how the ITN was obtained, and how long it had been owned.

Some of these findings have been previously reported in the literature. We found that children were more likely to adhere to using an ITN if there were multiple nets in the household. Other studies have reported that children are more likely to sleep under a net if there is more than one in the home (Graves et al., 2011; Korenromp et al., 2003; Macintyre et al., 2006). This is of particular interest because of large-scale distribution of ITNs that intend to place more than one ITN in households, allowing for use beyond vulnerable populations, as is currently being done in Nigeria. Furthermore, this has implications for malaria control because more nets in a household will end up repelling and killing more mosquitoes, thereby protecting those not sleeping under an ITN in that household.

The method of deployment of the ITN was not associated with adherence to the use of the ITN. However, when a caregiver received education on how to hang the ITN, their child was more likely to adhere to the use of the ITN. Similarly, Deribew and colleagues (2012) conducted a cluster-randomized trial on the effect of training household heads on the use of long lasting insecticide treated nets (LLINs) in Ethiopia. The authors observed a positive increase in LLIN use and this effect steadily increased over time. This finding was especially seen in children less than five years of age (Deribew et al., 2012). In our study, being shown how to hang the net was not significant in urban areas but it was significantly associated with adherence to ITN use in rural areas. This seems to imply that more educational activities are probably being carried out by the distribution programs in rural locations than in urban locations. We also found that the source of education was significantly associated with adherence to the use of an ITN. Children of caregivers who received education on hanging from health care workers were more likely to adhere to ITN use than children of caregivers who received education from family members, friends, or other people. This finding suggests that health care workers should be involved during ITN distribution. Actually explaining how the ITN should be deployed and used is likely to encourage those who receive the ITN to consistently use it.

Surprisingly, even though ITN distribution programs exist in these states, less than half the nets in this sample were free. Neither getting an ITN for free nor purchasing it was significantly associated with consistent use of the ITN. Similarly, a study from Zambia reported that purchasing an ITN was not associated with its deployment and hence use (Macintyre et al., 2011). Another study conducted in Kenya showed that there was no difference in use between free and purchased nets (Cohen and Dupas, 2008). On the other hand, studies from Ghana and

Ethiopia found that a net that was purchased had higher odds of being used than one that was free (Baume et al., 2009; Baume and Koh, 2011). This was attributed to the recognizing and valuing the benefits of the purchased item. In our study, the lack of difference seen in adherence rates between children of caregivers who received ITNs for free and caregivers who paid for ITNs suggests there is no difference in the perceived value of ITNs between both groups. Hence, this does not seem to be a driver of adherence to use by children in Nigeria.

Children who shared a bed regularly had increased odds of using an ITN and this could be for several reasons. Sharing a bed can be related to space availability, since if there is lack of space for multiple beds or other sleeping materials, there would have to be sharing. Mugisha and Arinaitwe (2003) reported that most children used mosquito nets as a result of sharing a bed with their parents in Uganda. A more recent study by Nankinga and colleagues (2012), also from Uganda, showed that sharing a bed with a parent was predictive of higher ITN utilization. In rural Burkina Faso, Okrah et al. (2002) observed that bed nets were mainly used for adults who were the heads of the household (household power structure). The study also reported that the number of people sharing a net was a significant predictor of adherence to use by the child. Another study of intra-household use across several African countries showed that nets were likely to be shared by two to three people (Baume and Marin, 2007). Our study corroborates these findings. Only about 20% of the people who had access to an ITN did not share one. In over 50% of the households, two people shared one ITN, which increases use for the child but 29% of caregivers indicated that three or more people shared an ITN in their households and this could negatively affect adherence to ITN use for children. Sharing sleeping areas and therefore ITNs seem to be common in this area of Nigeria, which could be attributed

to cultural and socioeconomic reasons. However, while sharing sleeping areas and hence nets may improve utilization of ITNs, it may also be detrimental for malaria protection. If too many people sleep under one ITN and it is limited in size, this could lead to improper protection from mosquitoes. This is because as individuals sleeping together move around during sleep, they may release the net from its holding points on the bed. Therefore, educational messages should be developed to discourage more than two people sharing one ITN.

The person the child shared a bed with was a significant predictor of adherence to use. Children who shared a bed with an adult had higher odds of using a net than children who shared a bed with another child. Other studies conducted in Nigeria also show that children who share a bed with a parent are more likely to use ITNs (Okafor and Odeyemi, 2012; Ordinioha, 2007). Studies from other SSA countries show that children share a sleeping area and bed with parents or other adults (Alaii et al., 2003b; Iwashita et al. 2010; Nankinga et al., 2012; Ndjinga and Minakawa, 2010). This has implications for malaria protection of children because if the adult does not want to use the net for some reason and the child has no choice but to share a bed with that adult, the child will not use an ITN. Frey et al. (2006) also show that parents who sleep with their young children are less likely to use an ITN throughout the year. A qualitative study from Kenya showed that net use was consistently higher among adults than for children, due to the belief that children are young and can endure the nuisance of mosquitoes while parents need their sleep to work the next day (Alaii et al., 2003b). Since sharing an ITN with adults seems to be a strong predictor of adherence to its use, it is imperative that qualitative studies are conducted in Nigeria to assess beliefs around sharing ITNs and ascertain if parents or other adults are considered as priority over children when

mosquito nuisance is high. In addition, educational messages should be incorporated into ITN distribution programs that encourage ITN use for children even if they share beds with adults.

The age of the ITN was associated with adherence to use but lost significance when put into the multivariate model. Nonetheless, the bivariate results show that children were more likely to adhere to use of a net that had been owned for a year or less. Baume and Koh (2011) found in Ghana that nets that had been owned for less than a year were more likely to be used. There are several reasons why there seems to be a preference for newer nets. For example, older ITNs might be worn or dirty, especially with the wear and tear that comes from use and care. Worn out ITNs might be deemed ineffective and this might inform the preference for using newer nets.

The present study shows that 79% of the caregivers washed their ITNs frequently. In addition, frequent washing of ITNs was significantly associated with adherence to its use. This is interesting because caregivers who wash and take care of their ITNs might recognize the benefits of its use and therefore be more likely to use it consistently. It also points out that nets used often are also more likely to be washed. The drawback of this is that washing the net often could lead to loss of insecticide and physical integrity of the net, which could lead to development of holes in the ITN. Other studies from malaria endemic regions corroborate our findings of frequent washing of nets (Alaii et al., 2003b; Kweka et al., 2011; Lover et al., 2011). These findings are important and it is recommended that education on net maintenance needs to be incorporated into the distribution and educational activities of malaria control programs.

ITN characteristics such as shape, color, and size were not associated with adhering to ITN use by children. Though color was not a predictor of adherence to ITN use by children, the

bivariate analysis does show that children were less likely to use a white net even though there was more ownership of white nets. This finding suggests that there might be a small preference for colors that might not show dirt as much as white. Similar findings have been reported from Ghana and Ethiopia (Baume and Koh, 2011; Gobena et al., 2012). The Baume and Koh (2011) study showed that shape and size of the ITN were not statistically associated with its use and this is confirmed in our study of adherence to the use of ITNs. In Zambia, shape and color were not significantly associated with ITN deployment and use (Macintyre et al., 2011). On the other hand, studies from other countries like Ethiopia and Sri Lanka reported that shape was a strong predictor of use, with conical nets more likely to be used than rectangular nets (Baume et al., 2009; Fernando et al., 2008). However, this was due to the type of houses in the area. Nigerian houses do not have this issue, which might explain the null finding.

Sleeping on anything other than a bed/mattress with a frame was seen to significantly decrease the odds of ITN adherence. Having to sleep on a mat or the floor will definitely hamper adherence to the use of an ITN. A recent study from upper west Ghana showed that women and children refused to use bed nets because they were not suited for their floor mats, which was a common method for sleeping in the area (Adjei and Gyimah, 2012). Similarly, other studies from Ethiopia and Kenya have shown that sleeping on mats is a barrier to net use (Baume et al., 2009; Chuma et al., 2010). A study from south-south Nigeria showed that people who slept on mats and other temporary materials were less likely to deploy nets and this affected whether the net was used or not (Ordinioha, 2007). Since ITNs are better suited for beds with frames, making them easier to hang for those who sleep on non-framed beds and mats will increase the self-efficacy of caregivers so they use the nets for protecting their

children from malaria. Furthermore, a study from Kenya showed that children who slept on anything other than a bed had higher prevalence of malaria (Iwashita et al., 2010). Moreover, for children who sleep on anything other than a bed, the ITN may be hung in a way that will not provide protection to the user, as evidenced in a study in Ethiopia (Baume et al., 2009). The researchers showed that often the ITN did not reach the sleeping place, especially if it was a mat, with the gap being as much as two or three feet (Baume et al., 2009). Hence, children were not properly protected when they did not sleep on a bed. It is therefore important that if an ITN is used, it is used with a bed as this has implications for protection from mosquitoes and malaria transmission.

Increased use of nets was also seen in Lake Victoria by residents who slept on beds in bedrooms (Iwashita et al., 2010). However, we found that where the child slept at night was not associated with adherence to use. Furthermore, in the bivariate analysis but not in the multivariate model, we were surprised to find that having to rearrange the sleeping area was a positive predictor for adherence to ITN use, as was having space for net deployment. Previous studies have shown the reverse: that having to rearrange the sleeping area is likely to decrease utilization of nets (Dunn et al., 2011; Iwashita et al., 2010). Our study shows that while having to rearrange the sleeping area was associated with higher odds of using an ITN consistently the week prior to the survey, caregivers who rearranged their sleeping areas to use the nets for their children were also likely to have received education on how to hang the net. Therefore, receiving education on hanging the ITN was a downstream predictor of adherence to its use.

Our study shows that the proportion of households with at least one ITN is a sign that lots of progress has been made. In the 2008 Nigerian DHS (NDHS), the proportion of households

owning one or more ITNs was only 8%. The 2010 MIS showed overall ownership of at least one ITN was 42% and more than two ITNs was 25%. 33% and 45% of households had at least one ITN in urban and rural households while 19% of urban and 28% of rural households owned more than one ITN, respectively. Comparing the results of the MIS with ownership of ITNs in this survey, we see that our study echoes the efforts of the malaria control program to increase access to ITNs. In our sample, 58% had one ITN while 42% had two or more ITNs. 56% and 60% had one ITN while 44% and 40% owned two or more ITNs in urban and rural homes respectively. While these findings are encouraging with respect to access to ITNs, this is still way below the goal of universal access, defined as two ITNs per household, which was the goal to have been achieved by the end of 2010 (Malaria Operational Plan, 2011).

Overall, even though the difference was not significant, there were slightly more ITN owners in rural areas than in urban areas. This is similar to findings from Ghana where the authors observed that households in rural areas were more likely to own a bed net (Agyepong and Manderson 1999; Adjei and Gyimah, 2012). Equity access to nets is important for poorer and rural areas since they are more likely to have a higher burden of malaria (Steketee and Eisele, 2009). It is good that equity in net ownership is achieved in rural areas since they are assumed to have a lower SES than urban areas; however, the lower number of ITNs in urban areas suggests targeted distribution and campaigns might be necessary to increase possession and use in these areas.

There are a few limitations of this study. First, the study was based on self-interview; we were not able to validate reported ownership and use of ITNs by observation. Second, the cross-sectional nature of this study is limited in its ability to establish a cause and effect

relationship between predictors and outcomes. Third, the information collected on adherence to use of nets was based on a recall period of the week preceding the survey (i.e. seven days) so the data could be subject to recall bias and social desirability bias where caregivers might have reported more ITN use by children than their actual use. However, there are several strengths of this study such as the reasonable sample size of the caregivers and children and collection of detailed information on socio-demographic variables that could confound the relationship between characteristics and adherence to ITN use. Most studies evaluate factors associated with ITN use the night before a survey. However, this study not only examines ITN use the night before but also the week before the survey therefore adding to the literature on country-specific factors associated with adherence to ITN use.

Tables

Table 5.1: Socio-demographic variables by location

Variable	All Valid N	All Frequency (%)	Urban Valid N	Urban Frequency (%)	Rural Valid N	Rural Frequency (%)	p-value
Season	927		441		486		0.02
Rainy		474 (51)		207 (47)		267 (55)	
Dry		453 (49)		234 (53)		219 (45)	
Type of School	927		441		486		0.15
Private		403 (44)		203 (46)		200 (41)	
Public		524 (56)		238 (54)		286 (59)	
Gender of caregiver	910		433		477		0.17
Male		345 (38)		154 (36)		191 (40)	
Female		565 (62)		279 (64)		286 (60)	
Gender of child	910		433		477		0.79
Male		420 (46)		202 (47)		218 (46)	
Female		490 (54)		231 (53)		259 (54)	
Age of child	837		397		440		0.33
4-7 years		579 (69)		268 (68)		311 (71)	
8-14 years		258 (31)		129 (32)		129 (29)	
Age range of caregiver	862		402		460		0.31
<=30 years		189 (22)		80 (20)		109 (24)	
31-40 years		361 (42)		168 (42)		193 (42)	
>40 years		312 (36)		154 (38)		158 (34)	

Table 5.1: Socio-demographic variables by location (continued)

	All		Urban		Rural		
Variable	**Valid N**	**Frequency (%)**	**Valid N**	**Frequency (%)**	**Valid N**	**Frequency (%)**	**p-value**
Educational level	905		429		476		0.03
Primary school or less		191 (21)		77 (18)		114 (24)	
Secondary school		169 (19)		92 (21)		77 (16)	
Polytechnic/vocational/ technical college		212 (23)		94 (22)		118 (25)	
University		333 (37)		166 (39)		167 (35)	
Ownership of home	907		433		474		<0.001
Rent		502 (55)		286 (66)		216 (46)	
Own		405 (45)		147 (34)		258 (54)	
Income range	771		353		418		0.14
< 20,000 Naira/month		262 (34)		128 (36)		134 (32)	
20,000-100,000 Naira/month		342 (44)		143 (41)		199 (48)	
> 100,000 Naira/month		167 (22)		82 (23)		85 (20)	
Employment	866		412		454		0.28
Self-employed		450 (52)		206 (50)		244 (54)	
Formal employment		416 (48)		206 (50)		210 (46)	

Table 5.2: Net characteristics by location

Variable	Valid N	All Frequency (%)	Valid N	Urban Frequency (%)	Valid N	Rural Frequency (%)	p-value
Number of ITNs owned	927		441		486		0.17
1		538 (58)		248 (56)		290 (60)	
2		233 (25)		125 (28)		108 (22)	
3		89 (10)		38 (9)		51 (10)	
4		67 (7)		30 (7)		37 (8)	
How ITN was obtained	887		421		466		1.00
Free		389 (44)		185 (44)		204 (44)	
Bought		498 (56)		236 (56)		262 (56)	
How to hang ITN shown	900		427		473		0.32
Yes		593 (66)		274 (64)		319 (67)	
No		307 (34)		153 (36)		154 (33)	
Regular sharing of ITN with others	919		438		481		0.44
Yes		291 (32)		133 (30)		158 (33)	
No		628 (68)		305 (70)		323 (67)	
Number of people who sleep under ITN in home	914		433		481		0.07
0-1 people		158 (17)		88 (20)		70 (15)	
2 people		495 (54)		224 (52)		271 (56)	
3 or more people		261 (29)		121 (28)		140 (29)	
Age of ITN	677		319		358		0.63
<=12 months		445 (66)		213 (67)		232 (65)	
> 12 months		232 (34)		106 (33)		126 (35)	

Table 5.2: Net characteristics by location (continued)

	All		Urban		Rural		
Variable	**Valid N**	**Frequency (%)**	**Valid N**	**Frequency (%)**	**Valid N**	**Frequency (%)**	**p-value**
Shape of ITN	713		329		384		0.07
Rectangular		610 (86)		290 (88)		320 (83)	
Conical		103 (14)		39 (12)		64 (17)	
Color of ITN	753		357		206		<0.001
White		446 (59)		240 (67)		206 (52)	
Any other color		307 (41)		117 (33)		190 (48)	
Size of ITN	631		301		330		0.05
Single		194 (31)		102 (34)		92 (28)	
Double		333 (53)		160 (53)		173 (52)	
Triple/king		104 (16)		39 (13)		65 (20)	
How ITN is deployed	802		372		430		0.08
Wall		586 (73)		283 (76)		303 (71)	
Ceiling		216 (27)		89 (24)		127 (29)	
How often ITN is washed	857		399		458		0.78
Never		177 (21)		83 (21)		96 (21)	
At least 1 time/month		493 (57)		225 (56)		268 (58)	
1-3 times/year		187 (22)		91 (23)		96 (21)	

Table 5.3: Sleeping area characteristics by location

	All		Urban		Rural		
Variable	**Valid N**	**Frequency (%)**	**Valid N**	**Frequency (%)**	**Valid N**	**Frequency (%)**	**p-value**
What child sleeps on	906		431		475		0.98
Bare floor/mat/couch		194 (21)		92 (21)		102 (21)	
Bed/mattress (no frame)		235 (26)		113 (26)		122 (26)	
Bed/mattress (frame)		477 (53)		226 (52)		251 (53)	
Where child sleeps at night	909		435		474		0.20
Bedroom		812 (89)		395 (91)		417 (88)	
Living room/any other room		97 (11)		40 (9)		57 (12)	
Who child shares a bed with	878		424		454		0.01
With adults		377 (43)		160 (38)		217 (48)	
With other children/siblings		443 (50)		233 (55)		210 (46)	
Nobody		58 (7)		31 (7)		27 (6)	
Have to rearrange sleeping area to use ITN	900		423		477		0.01
Yes		376 (42)		158 (37)		218 (46)	
No		524 (58)		265 (63)		259 (54)	
Enough space for mounting ITN	898		427		471		0.07
Yes		786 (88)		383 (90)		403 (86)	
No		112 (12)		44 (10)		68 (14)	

Table 5.4: Use of nets by children in the sample

Variable	All N	All Frequency (%)	Urban N	Urban Frequency (%)	Rural N	Rural Frequency (%)
Use the night before the survey-Yes	911	542 (59)	437	251 (57)	474	291 (61)
Use the week before the survey	907		431		476	
Never		207 (23)		115 (27)		92 (19)
Less than every day		340 (37)		130 (30)		210 (44)
Every day		360 (40)		186 (43)		174 (37)

Table 5.5: Chi-square associations between selected socio-demographic variables and use of a net by the child the night before the survey

Variable	Did the child sleep under the ITN the night before the survey?					
	All		Urban		Rural	
	Valid N	Frequency (%)	Valid N	Frequency (%)	Valid N	Frequency (%)
Season						
Rainy	462	281 (61)	203	122 (60)	259	159 (61)
Dry	449	261 (58)	234	129 (55)	215	132 (61)
p-value		*0.42*		*0.33*		*1.00*
Gender of Caregiver						
Male	336	207 (62)	152	94 (62)	184	113 (61)
Female	558	322 (58)	277	151 (55)	281	171 (61)
p-value		*0.26*		*0.15*		*0.92*
Gender of Child						
Male	413	237 (57)	200	117 (59)	213	120 (56)
Female	481	293 (61)	229	129 (56)	252	164 (65)
p-value		*0.31*		*0.70*		*0.06*
Age of child						
4-7 years	574	333 (58)	267	150 (56)	307	183 (60)
8-14 years	248	148 (60)	127	70 (55)	121	78 (65)
p-value		*0.7*		*0.91*		*0.38*
Age Range of Caregiver						
<=30 years	182	124 (68)	79	51 (65)	103	73 (71)
31-40 years	354	197 (56)	165	83 (50)	189	114 (60)
>40 years	310	167 (54)	154	84 (55)	156	83 (53)
p-value		*0.01*		*0.11*		*0.02*
Income Range						
< ₦20,000/month	257	167 (65)	127	83 (65)	130	84 (65)
₦20,000 - ₦100,000/month	335	177 (53)	142	69 (49)	193	108 (56)
>₦100,000/month	165	96 (58)	81	41 (51)	84	55 (66)
p-value		*0.01*		*0.01*		*0.18*

Table 5.5: Chi-square associations between socio-demographic variables and use of a net by the child the night before the survey (continued)

Variable	Did the child sleep under the ITN the night before the survey?					
	All		Urban		Rural	
	Valid N	Frequency (%)	Valid N	Frequency (%)	Valid N	Frequency (%)
Educational level						
Primary school or less	182	119 (65)	76	53 (70)	106	66 (62)
Secondary school	166	99 (60)	90	52 (58)	76	47 (62)
Polytechnic/ vocational/ technical college	209	125 (60)	93	55 (59)	116	70 (60)
University	332	184 (55)	166	84 (51)	166	100 (60)
p-value		*0.18*		*0.05*		*0.99*
Total number of people in home						
≤ 5 people	394	249 (63)	204	129 (63)	190	120 (63)
> 5 people	509	289 (57)	233	122 (52)	276	167 (61)
p-value		*0.06*		*0.03*		*0.63*

Table 5.6: Chi-square associations between net characteristics and its use by child the night before the survey

Variable	Did the child sleep under the ITN the night before the survey?					
	All		Urban		Rural	
	Valid N	Frequency (%)	Valid N	Frequency (%)	Valid N	Frequency (%)
Number of ITNs owned						
1	529	277 (52)	246	122 (50)	283	155 (55)
2	230	149 (65)	125	73 (58)	105	76 (72)
3	88	69 (78)	38	34 (90)	50	35 (70)
4	64	47 (74)	28	22 (79)	36	25 (69)
p-value		*<0.001*		*<0.001*		*<0.001*
How ITN was obtained						
Free	385	219 (57)	183	96 (53)	202	123 (61)
Bought	489	308 (63)	235	148 (63)	254	160 (63)
p-value		*0.07*		*0.04*		*0.70*
How to hang ITN shown						
Yes	581	376 (65)	272	167 (61)	309	209 (68)
No	303	156 (52)	151	81 (54)	152	75 (49)
p-value		*<0.001*		*0.12*		*<0.001*
Regular sharing of ITN with others						
Yes	285	220 (77)	132	107 (81)	153	113 (74)
No	619	318 (51)	303	144 (48)	316	174 (55)
p-value		*<0.001*		*<0.001*		*<0.001*
Number of people who sleep under ITN in home						
0-1 people	157	26 (17)	88	11 (13)	69	15 (22)
2 people	484	324 (67)	223	145 (65)	261	179 (69)
3 or more people	258	183 (71)	119	90 (76)	139	93 (67)
p-value		*<0.001*		*<0.001*		*<0.001*
Age of ITN						
<=12 months	434	292 (67)	209	139 (67)	225	153 (68)
> 12 months	228	130 (57)	106	58 (55)	122	72 (59)
p-value		*0.01*		*0.05*		*0.10*
Shape of ITN						
Rectangular	598	387 (65)	286	179 (63)	312	208 (67)
Conical	101	64 (63)	39	22 (56)	62	42 (68)
p-value		*0.82*		*0.49*		*1.00*

Table 5.6: Chi-square associations between net characteristics and its use by child the night before the survey (continued)

Variable	Did the child sleep under the ITN the night before the survey?					
	All		Urban		Rural	
	Valid N	Frequency (%)	Valid N	Frequency (%)	Valid N	Frequency (%)
Color of ITN						
White	442	278 (63)	239	149 (62)	203	129 (64)
Any other color	301	195 (65)	117	71 (61)	184	124 (67)
p-value		*0.64*		*0.82*		*0.46*
Size of ITN						
Single	189	119 (63)	100	65 (65)	89	54 (61)
Double	328	217 (66)	158	107 (68)	170	110 (65)
Triple/king	103	68 (66)	39	27 (69)	64	41 (64)
p-value		*0.75*		*0.86*		*0.81*
How ITN is deployed						
Wall	575	376 (65)	279	176 (63)	296	200 (68)
Ceiling	212	125 (59)	89	52 (58)	123	73 (59)
p-value		*0.11*		*0.45*		*0.12*
How often ITN is washed						
Never	174	63 (36)	83	31 (37)	91	60 (64)
At least 1 time/month	482	355 (74)	221	166 (75)	261	189 (72)
1-3 times/year	185	107 (58)	91	47 (52)	94	32 (35)
p-value		*<0.001*		*<0.001*		*<0.001*

Table 5.7: Chi-square associations between the child's sleeping area characteristics and ITN use

Variable	Did the child sleep under the ITN the night before the survey?					
	All		Urban		Rural	
	Valid N	Frequency (%)	Valid N	Frequency (%)	Valid N	Frequency (%)
What child sleeps on						
Bare floor/mat/couch	185	91 (49)	91	40 (44)	94	51 (54)
Bed/mattress (no frame)	235	135 (57)	113	64 (57)	122	71 (58)
Bed/mattress (frame)	470	307 (65)	223	144 (65)	247	163 (66)
p-value		*<0.001*		*0.00*		*0.09*
Where child sleeps at night						
Bedroom	799	484 (61)	392	226 (58)	407	258 (63)
Any other room	94	51 (54)	39	24 (62)	55	27 (49)
p-value		*0.27*		*0.74*		*0.05*
Who child shares a bed with						
With adults	368	233 (63)	158	110 (70)	210	123 (59)
With other children/siblings	437	253 (58)	231	117 (51)	206	136 (66)
p-value		*0.13*		*<0.001*		*0.13*
Have to rearrange sleeping area to use ITN						
Yes	369	239 (65)	158	102 (65)	211	137 (65)
No	515	290 (56)	261	142 (54)	254	148 (58)
p-value		*0.01*		*0.05*		*0.15*
Enough space for mounting ITN						
Yes	777	480 (62)	380	226 (60)	397	254 (64)
No	105	52 (49)	43	21 (49)	62	31 (50)
p-value		*0.02*		*0.19*		*0.05*

Table 5.8: Chi-square associations between socio-demographic variables with adherence to ITN use

How often did the child sleep under the ITN the week before the survey? Frequency (%)					
Variable	**N**	**Never**	**Partial**	**Every day**	**p-value**
Season					0.09
Rainy	460	94 (20)	169 (37)	197 (43)	
Dry	447	113 (25)	171 (38)	163 (37)	
Location					<0.001
Urban	431	115 (27)	130 (30)	186 (43)	
Rural	476	92 (19)	210 (44)	174 (37)	
Gender of caregiver					0.09
Male	341	67 (20)	125 (37)	149 (44)	
Female	550	137 (25)	208 (38)	205 (37)	
Gender of child					0.50
Male	413	88 (21)	156 (38)	169 (41)	
Female	478	117 (25)	178 (37)	183 (38)	
Age of child					0.57
4-7 years	570	138 (24)	206 (36)	226 (40)	
8-14 years	251	55 (22)	100 (40)	96 (38)	
Age range of caregiver					<0.001
<=30 years	184	22 (12)	89 (48)	73 (40)	
31-40 years	355	91 (26)	127 (36)	137 (38)	
>40 years	305	87 (29)	103 (34)	115 (38)	
Educational level					0.04
Primary school or less	185	28 (15)	80 (43)	77 (42)	
Secondary school	168	41 (24)	57 (34)	70 (42)	
Polytechnic/vocational/ technical college	206	43 (21)	81 (39)	82 (40)	
University	328	92 (28)	117 (36)	119 (36)	

Table 5.8: Chi-square associations between socio-demographic variables with adherence to net use (continued)

How often did the child sleep under the ITN the week before the survey?					
		Frequency (%)			
Variable	**N**	**Never**	**Partial**	**Every day**	**p-value**
Income range					0.14
< 20,000 Naira/month	259	46 (18)	113 (44)	100 (39)	
20,000-100,000 Naira/month	334	86 (26)	119 (36)	129 (39)	
> 100,000 Naira/month	163	40 (25)	62 (38)	61 (37)	
Total number of people in home					<0.001
≤ 5 people	389	76 (19)	132 (34)	181 (47)	
> 5 people	510	127 (25)	207 (41)	176 (34)	

Table 5.9: Chi-square associations between net characteristics and adherence to net use

How often did the child sleep under the ITN the week before the survey?			Frequency (%)		
Variable	**N**	**Never**	**Partial**	**Every day**	**p-value**
Number of ITNs owned					<0.001
1	527	150 (29)	217 (41)	160 (30)	
2	224	42 (19)	78 (35)	104 (46)	
3	89	8 (9)	20 (22)	61 (69)	
4	67	7 (10)	25 (37)	35 (52)	
How ITN was obtained					0.25
Free	380	95 (25)	139 (37)	146 (38)	
Bought	488	99 (20)	187 (38)	201 (41)	
How to hang ITN shown					<0.001
Yes	578	96 (17)	239 (41)	243 (42)	
No	302	101 (33)	92 (31)	109 (36)	
Regular sharing of ITN with others					<0.001
Yes	283	23 (8)	102 (36)	158 (56)	
No	617	181 (29)	234 (38)	202 (33)	
Number of people who sleep under ITN in home					<0.001
0-1 people	157	112 (71)	24 (15)	21 (13)	
2 people	488	67 (14)	209 (43)	212 (43)	
3 or more people	252	25 (10)	104 (41)	123 (49)	
Age of ITN					0.03
<=12 months	438	62 (14)	185 (42)	191 (44)	
> 12 months	223	49 (22)	79 (35)	95 (43)	
Shape of ITN					0.44
Rectangular	597	102 (17)	226 (38)	269 (45)	
Conical	101	16 (16)	45 (45)	40 (40)	
Color of ITN					0.72
White	439	77 (17)	171 (39)	191 (44)	
Any other color	300	53 (18)	125 (42)	122 (41)	
Size of ITN					0.88
Single	189	31 (16)	75 (40)	83 (44)	
Double	327	48 (15)	125 (38)	154 (47)	
Triple/king	100	14 (14)	43 (43)	43 (43)	

Table 5.9: Chi-square associations between net characteristics and adherence to net use (continued)

How often did the child sleep under the ITN the week before the survey?					
		Frequency (%)			
Variable	**Valid N**	**Never**	**Partial**	**Every day**	**p-value**
How ITN is deployed					0.59
Wall	577	100 (17)	223 (39)	254 (44)	
Ceiling	208	42 (20)	81 (39)	85 (41)	
How often ITN is washed					<0.001
Never	176	73 (42)	57 (32)	46 (26)	
At least 1 time/month	481	59 (12)	207 (43)	215 (45)	
1-3 times/year	182	31 (17)	62 (34)	89 (49)	

Table 5.10: Chi-square associations between sleeping area characteristics and adherence to ITN use

How often did the child sleep under the ITN the week before the survey?					
		Frequency (%)			
Variable	**Valid N**	**Never**	**Partial**	**Every day**	**p-value**
What child sleeps on					<0.001
Bare floor/mat/couch	188	58 (31)	75 (40)	55 (29)	
Bed/mattress (no frame)	230	53 (23)	91 (40)	86 (37)	
Bed/mattress (frame)	470	89 (19)	167 (35)	214 (46)	
Where child sleeps at night					0.22
Bedroom	798	186 (23)	292 (37)	320 (40)	
Living room/any other room	94	16 (17)	42 (45)	36 (38)	
Who child shares a bed with					0.03
With adults	370	66 (18)	152 (41)	152 (41)	
With other children/siblings	432	110 (25)	154 (36)	168 (39)	
Have to rearrange sleeping area to use ITN					<0.001
Yes	370	59 (16)	154 (42)	157 (42)	
No	510	137 (27)	179 (35)	194 (38)	
Enough space for mounting ITN					0.03
Yes	770	164 (21)	284 (37)	322 (42)	
No	109	28 (26)	50 (46)	31 (28)	

Table 5.11: Predictors of adherence to ITN use by Nigerian children-adjusted[a]

	Partial			Every day		
Variable (N)	**OR**	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**
Number of ITNs in home	1.31	0.94-1.82	0.11	1.91	1.38-2.64	<0.001
How to hang the ITN shown						
Yes (383)	2.14	1.24-3.70	0.01	2.07	1.18-3.63	0.01
No*(226)						
Regular sharing of the ITN by child						
Yes (187)	1.27	0.65-2.52	0.49	2.22	1.13-4.38	0.02
No*(422)						
Number of people who share ITN in home						
2 people (336)	10.85	5.50-21.41	<0.001	12.48	5.96-26.13	<0.001
3 or more people (167)	12.55	5.47-28.79	<0.001	13.97	5.85-33.38	<0.001
0-1 person*(106)						
What child sleeps on at night						
Bare floor/mat/couch (120)	0.77	0.37-1.62	0.49	0.19	0.08-0.42	<0.001
Bed/mattress-no frame (166)	0.92	0.49-1.72	0.80	0.61	0.32-1.16	0.13
Bed/mattress-with frame*(323)						

Reference category for outcome: No use at all

*Reference category

[a] Multinomial logistic regression model adjusted for age and gender of child and caregiver, educational level, income, location, total number of people in home, and season data was collected

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Chapter 6

Conclusion

The purpose of this dissertation was to evaluate risk factors associated with adherence to ITN use by Nigerian children. This is a timely subject not only because of the large contribution of Nigeria to the current malaria burden in Africa, but also because the country has devoted resources to the largest scale-up of ITNs in Africa. It is therefore necessary that as access to nets increases, we understand what factors are associated not only with non-use but also consistent use of ITNs (adherence), especially by children who bear the brunt of malaria. The present work thus adds to the literature on predictors of adherence to ITN use.

Chapter 1 provided an introduction to the literature on control of malaria using ITNs, especially in sub-Saharan Africa, as well as an overview of the rest of the study. Chapter 2 focused on assessing caregivers' malaria knowledge in different domains (cause, transmission, risk perception, symptoms, and treatment). Our results showed the domain with the highest knowledge was risk perception, while the domain with the lowest knowledge was malaria transmission. We also wanted to evaluate whether a high level of correct knowledge of malaria overall was a predictor of ITN ownership and use. We found no difference in malaria knowledge with respect to ownership and use of ITNs. We believe this lack of association to be due to the existence of many misperceptions about malaria in Nigeria. This is evidenced by the small

number of caregivers in the sample that had correct knowledge in the 95th percentile (approximately 9% with scores of 75% or more).

This is not a unique situation to Nigeria; all over Africa, studies have found poor malaria knowledge (Adongo et al., 2005; Aikins et al., 1994). Despite the documentation of many misperceptions people have about malaria, it is unfortunate that malaria control programs have not made it a priority to address this issue over the years. It is therefore imperative that targeted messages are created to correct and discredit incorrect information about malaria both in Nigeria and elsewhere. Malaria and its control are multi-dimensional, so the malaria knowledge of a population should not be measured using one or a few questions. The current study highlights that caregivers are still not sure of the correct treatment for malaria, years after implementation of ACTs as the first line drug for malaria treatment. For instance, a significant proportion of the caregivers still believe that chloroquine is effective against malaria. This misconception is partly due to poor prescription practices of health care workers, who should be aware that chloroquine is no longer considered effective. It is important that the drug sector is properly regulated so that malaria prescription is standardized.

In terms of malaria transmission domain, the majority of the responses showed that mosquito nuisance is a problem that is perceived throughout the day. Differentiating between the types of mosquitoes may not be necessary; however, educating people about biting times is. Such education will ensure that even if people use alternate methods of repelling mosquitoes during the day, they still use nets at night to prevent the malaria vector-human contact. The risk of contracting malaria is also persistent throughout the year in Nigeria so even when there is low mosquito density, malaria is still transmitted. Awareness that children need

to be protected with ITNs throughout the year should be increased through informational and educational campaigns.

Overall, this dissertation identifies a need for targeted messages complementary to ITN distribution programs, which educate people on the cause, transmission, prevention, symptoms, and treatment of malaria. These messages should be periodically reinforced to encourage use of the nets, especially by children. Our results emphasize the need for measuring important domains of malaria knowledge as a base for developing effective educational interventions to control and eradicate malaria. Health communication can provide scientific knowledge and also address incorrect information regarding alternative causes, and other aspects, of malaria. This information can be delivered in relevant dialects using health care workers at clinics and hospitals, as well as local and national media sources (radio, television, newspapers). Partnerships between malaria control programs, employers of caregivers, hospitals, and other community-based organizations may be another approach to synergize the dissemination of malaria knowledge. Additionally, the science curriculum in schools could be used to address these deficiencies in knowledge.

Chapter 3 evaluated the use of methods to protect against the nuisance of mosquitoes. This chapter focused on the association between a caregiver's use of alternate methods and ownership and use of an ITN by children. The most common method used in this sample was insecticide sprays while the use of screening was poor. Our results showed an inverse relationship between the reported use of insecticide sprays and ownership of an ITN. We also saw an inverse relationship between use of window and door screening and ITN ownership. Both methods had an inverse association with adherence to ITN use. These findings suggest

that ITNs are used for protection from mosquito nuisance. Hence, other methods used for protection from mosquitoes may be seen as alternatives to ITN ownership and use. These results suggest that mosquito avoidance methods might be seen as alternatives to ITNs in Nigeria. This means that the malaria control program might need to address the issue of replacing existing methods with ITNs. They need to identify what message they want to send i.e. should people be supplementing ITNs with these methods? Or should they stop using these methods altogether and use nets only? Replacing existing methods of mosquito avoidance with ITNs may be hard since it is not easy to get rid of old habits; however, the malaria control program needs to send consistent, correct messages to encourage use of ITNs, especially for children.

We recommend that health education be used to create awareness that these methods should be complementary to ITN use. Nuisance mosquitoes are a problem and people deal with them in different ways. However, ITNs do more than protect from mosquitoes; they also reduce malaria. Hence, people can use repellants or other mosquito avoidance methods during the day when they are up and ITNs are not useful and use the nets at night while sleeping. However, we were unable to assess how combinations of methods influence malaria prevalence since that was not a primary focus of this study. Further research should be conducted to investigate combination of these methods and their influence on confirmed malaria. If they do offer little protection against malaria, it is important that targeted health education messages are strategically developed to redirect expenditure towards more effective tools like ITNs. On the other hand, if they become standardized and their efficacy is proven, these measures can be

formally promoted in addition to the use of ITNs in an integrated vector management (IVM) strategy.

Most importantly, the benefits of using ITNs for malaria prevention should be promoted. It needs to be emphasized that malaria is caused by night biting mosquitoes and while people can use measures such as mosquito repellants and insecticide sprays to control other types of mosquitoes, they should use ITNs specifically for malaria prevention. Hence, it is crucial that information about the biting times of malaria-causing mosquitoes is communicated. A few studies from other SSA countries show that net use is higher for adults than children due to the perception that children could endure the nuisance of mosquitoes while parents who have to provide for these children need to sleep well (Alaii et al., 2003; Adongo et al., 2005; Esse et al., 2008). We suggest that qualitative studies should be conducted to assess beliefs around sharing nets and ascertain if parents and other adults are prioritized above children when mosquito nuisance is high.

Chapter 4 evaluated both negative and positive perceptions of the ITN. We found that the negative perception statements were not associated significantly with ITN use; however, the positive perception statements were significantly associated with ITN use. Another finding was that positive perception statements that had to do with the ITN preventing or reducing malaria were not significant predictors of ITN use or adherence to ITN use. Conversely, statements that had to do with reduction of mosquitoes, reduction of other insects, perceived ease of use, and sleeping better were predictors of ITN use the night preceding the survey as well as the week before the survey. One interesting result was that children who liked to sleep under the nets were significantly more likely to adhere to the use of an ITN, signifying the

importance of children being players in malaria control and instrumental to consistent use of nets.

Again, these results suggest that malaria control programs need to advocate for regular use and focus on the benefits of using ITNs against malaria prevention. This is because there is evidence that people who use the nets as a protection tool against mosquitoes are less likely to use them when mosquito density is low than those who use them for malaria prevention (Atkinson et al., 2009; Toe et al., 2009; Yohannes et al., 2000). It also takes a while to see the perceived benefits of the ITN so promotion of ITNs needs to be backed up through sustained education and other advertising channels. One finding of this study was that younger children (4 – 7 years) were less likely to use ITNs when their caregiver believed that the insecticide on nets might be harmful. This perception needs to be dispelled by health education messages since younger children are at higher risk for malaria than older children. Regarding ownership, it is important to investigate negative perceptions that might prevent people from owning ITNs. More qualitative studies should be conducted to flesh out the negative and positive perceptions held by Nigerian caregivers. Quantitative studies that build on the results of these qualitative studies should also be conducted to assess the prevalence of negative perceptions. They can also be used as a tool to evaluate positive perceptions that can be used to promote ITNs not just in Nigeria, but also in similar countries.

Finally, Chapter 5 evaluated the association between net characteristics and adherence to its use. Chapter 5 also sought to assess the association between characteristics of the sleeping area and adherence to ITN use. We found that net characteristic such as age, shape, color, and size were not predictors of adherence to use. There was no difference between use

of an ITN with respect to children of caregivers who purchased the net or received it for free. However, the following were associated with adherence to ITN use: if a caregiver received education on how to hang the ITN, if there was regular sharing of the net in the home, if the child shared the net, if there was more than one net in the home, and if the child slept on a bed or mattress with a frame. In this study, we found that sleeping arrangements helped facilitate the use of nets. However, sleeping arrangements can also act as a barrier. When multiple people use an ITN that is limited by size, it may not protect them properly especially when they move around while sleeping. Since people are not likely to change this sharing behavior any time soon, more avenues for distribution of nets should be opened so that households will have more than one ITN. It is therefore imperative that distribution campaigns and other avenues are utilized to increase ITN ownership in Nigeria and other malaria-endemic countries.

The fact that over half of the caregivers who owned nets purchased them suggests a failure of the free distribution activities in the two states surveyed. In other words, distribution of nets through the use of campaigns is apparently not contributing to the overall number of nets in circulation. Instead, for one reason or the other, people who should be receiving nets are buying them. In addition, targeted messages to discourage the behavior of more than two persons sharing ITNs should be created and disseminated. Sharing of sleeping areas and consequently ITNs is obviously not unique to the sample population (Baume and Marin, 2007); hence, this needs to be addressed not just in Nigeria but also in other similar countries. The goal of malaria control programs is for one ITN to be used by two people; this should not be exceeded. We recommend that messages be created to discourage more than two people sharing a net. To encourage people who sleep on mats and beds without frames to use nets,

malaria control programs should explore making the net easier to hang by modifying the ITN. As our study showed, caregivers who received education on hanging were more likely to have children who adhered to ITN use. While it is important that communities are educated on the need for ITN use, it is also crucial that education on hanging, use, and maintenance of these nets are part and parcel of distribution activities. In fact, from the WHO position statement on ITNs states that, "Distribution of LLINs should be systematically accompanied by provision of *information on how to hang, use and maintain them properly*" (WHO, 2007). Sufficient attention therefore should be paid to the design and implementation of locally appropriate communication to accompany ITN distribution, not just in Nigeria but also in other countries dealing with malaria.

Caregivers in this study frequently washed ITNs. However, excessive or aggressive washing and the use of harsh detergents rapidly reduces the useful life of ITNs. Again, this is not unique to Nigeria because frequent washing of nets has been reported from other countries (Alaii et al., 2003b; Kweka et al., 2011). These findings show that this is an issue that needs to be tackled. In order to achieve maximum protection against malaria, public health education focusing on net use and maintenance should be incorporated into distribution of ITNs in Nigeria and other countries and reinforced by local and national media campaigns. This will help improve durability, and retention of these nets. Further research into perceptions of ITNs and washing practices should be conducted to inform the choice of media, messages, and promotion.

One recurrent finding of the study was the finding that younger caregivers (less than 30 years old) were more likely to own ITNs. They were also more likely to have children use the

nets the night before and adhere to the use of the nets the week prior to the survey. This finding suggests that health messages are indeed reaching younger people; however, health messages targeting older caregivers might need to be developed and disseminated to encourage consistent net use for their children.

The present work concludes that local malaria control programs in Nigeria need to not only continuously monitor the populations access to ITNs, but should also evaluate the impact of the distribution activities so that things that are working and not working can be used and eliminated as the case may be. Lessons learned can be used to improve information, education, and communication/behavior change communication (IEC/BCC) activities. Educational activities should also reinforce the use of ITNs so that the impact of this intervention on the burden of malaria can be seen. The current form of single or intermittent health education campaigns need to be replaced with continuous learning processes that transmit knowledge about malaria control and ITNs on an ongoing basis until ITN use becomes the norm for everyone.

The Big Picture

The results presented herein must be interpreted in the context of broader social and environmental factors. Approaches to control malaria would not be effective without addressing the distal causes of malaria such as poverty. Poverty is a determinant of malaria; however, it is also a consequence of the disease. Malaria slows down economic growth while poverty limits the response of the health care sector. Socio-economic development of SSA countries such as Nigeria needs to take place as economists estimate that holo-endemic malaria is associated with at least 1% decline in annual economic growth (Sachs, 2003). Thus,

there is a link between health and development, which needs to be appreciated. To that end, efficient health infrastructure should be a priority of the Nigerian government. The current shortcomings of the malaria control efforts highlight the need for adequately funded and functioning health systems. In the long run, strategies aimed at improving socio-economic aspects are more likely to be effective against malaria considering the vast amount of poverty in malaria-endemic countries such as Nigeria.

In addition, this dissertation would not be complete without discussing integration of methods to combat and control malaria. Neither the use of ITNs nor indoor residual spraying (IRS) alone is enough to achieve and maintain interruption of malaria transmission in holo-endemic areas (Etang et al., 2013) like Nigeria. IVM is recommended as a strategic approach to a cost-effective and sustainable approach to control of vector-borne disease such as malaria (WHO, 2008). However, compared to ITNs, IRS is relatively more expensive (White et al., 2007), which makes it hard to use on a large scale. One method which gets little or no attention is environmental management (EM) which is the "*The planning, organization, carrying out, and monitoring of activities for the modification and/or manipulation of environmental factors or their interaction with man with a view to preventing or minimizing vector propagation and reducing man-vector-pathogen contact*" (WHO, 1982). Environmental management is not a one size fits all approach; it is dependent on the local environment. Before the advent of DDT, EM was used successfully to reduce malaria. A well-known example of environmental intervention was the construction of the Panama Canal, which not only reduced malaria incidence but also led to yellow fever eradication (Keiser et al., 2005). Hence, integration of this method into IVM is likely to also contribute to control of other diseases. Although large-scale deployment of ITNs

is good, several key questions arise. How sustainable are the ITNs, which can only last so long and therefore have to be replaced? For a country with a large population like Nigeria, if the MDG of halting and reversing malaria incidence is to be achieved by 2015, it is important that multiple vector control methods are utilized to interrupt malaria transmission.

Another question that arises is even if ITNs contribute to a malaria-free situation, how can this be sustained without a collateral reduction in the *anopheline* population? Indeed, an old study from Lagos showed that when only ITNs or quinine or screening were used, malaria rates did not change. However, once EM was added to the control methods, there was a sharp decrease in malaria incidence (Gilroy and Bruce-Chwatt, 1945). Considering that 42% of the global malaria burden is due to modifiable environmental factors (Pruss-Ustun and Corvalan, 2007), the addition of EM into the malaria control paradigm is likely to lead to substantial reduction in malaria incidence. EM strategies have little or no toxicity, are low cost, low tech, and make use of local resources and knowledge, thereby contributing to local self-reliance (Keiser et al., 2005). An exclusive focus on controlling exposure with ITNs might look like a more immediate solution; however, a more integrated approach to vector control in Nigeria and other SSA countries is needed. We need to learn our lessons from the past and not reinvent the wheel.

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Appendix:

Survey Questionnaire

Purpose of Survey and Instructions

- The purpose of this study is to identify barriers that affect the use of treated bed nets for malaria control among young children in Nigeria.

- You were selected to participate because you have a young child in the age range 5 to 7 years old.

- The questionnaire should take about 15 minutes to complete. Please fill out answers to every question.

- Understand that the child being asked about in the questions is the child that brought this questionnaire home to you so please think about this specific child when answering the questions.

- Please send back completed questionnaire with your child in the attached envelope sealed.

- Please tick/circle/write answers for each question.

- Write the initials of the child you are answering the questions about here: ___
- Write the date you are completing this questionnaire and the name of the local government area you live in now
Date: _____
Day/Month/Year

_____
Name of Local Government Area

Section A: Background Information

- **Tick only one answer for each question**

QUESTION	ANSWER
DS1: WHAT IS YOUR GENDER?	Male ( ) Female ( )
DS2: IS YOUR CHILD MALE OR FEMALE?	Male ( ) Female ( )
DS3: HOW OLD IS YOUR CHILD?	Years _____ Months _____
DS4: WHAT IS YOUR MARITAL STATUS?	____ Married ____Unmarried ____Widower/widow ____Separated/ Divorced
DS5: WHAT IS YOUR AGE RANGE?	____ < 21 years ____ 21 – 30 years ____ 31 – 40 years ____ > 40 years
DS6: WHAT IS YOUR RELIGIOUS DENOMINATION?	____ Christian ____ Muslim ____ Traditional ____ No Religion Other (please write): _____
DS7: WHAT IS THE HIGHEST LEVEL OF SCHOOL YOU COMPLETED?	____ No school ____ Primary school ____ Secondary school ____ Vocational/Technical college ____ Polytechnic ____ University Other (please write): _____

DS8: DO YOU OWN OR RENT YOUR HOME?	Own ( ) Rent ( ) Live with someone else ( ) Other (please write): _____
DS9: HOW MANY ADULTS LIVE IN YOUR HOME? HOW MANY CHILDREN (18 YEARS AND UNDER) LIVE IN YOUR HOME?	Adults _____ Children _____
DS10: WHAT IS YOUR INCOME RANGE?	____ less than ₦20,000 per month ____ ₦20,000 to ₦100,000/month ____ ₦100,000 to ₦200,000/month ____ greater than ₦200,000/month
DS11: DO YOU OWN ANY OF THE FOLLOWING ITEMS? ***Please choose 'Yes' or 'No';***	Camera Yes ( ) No ( ) Computer Yes ( ) No ( ) Carpet Yes ( ) No ( ) Generator Yes ( ) No ( ) Car/Truck Yes ( ) No ( ) Deep freezer/fridge Yes ( ) No ( ) Motorcycle/bicycle Yes ( ) No ( )
DS12: DO YOU OWN ANY BED NET?	Yes ( ) No ( )
DS13: DO YOU OWN A TREATED BED NET?	Yes ( ) No ( )
DS14: WHY DON'T YOU OWN A TREATED BED NET?	------- No interest ____ They do not work ____ Use other method for preventing malaria ____ Expensive Other (please write): _____

DS15: DO YOU WORK FOR AN EMPLOYER? DO YOU HAVE YOUR OWN BUSINESS?	Yes ( ) No ( ) Yes ( ) No ( )
DS16: WHAT IS YOUR OCCUPATION?	Please write: _____
DS17: DO YOU SMOKE? IS THERE ANYONE IN YOUR HOUSEHOLD WHO SMOKES?	Yes ( ) No ( ) Yes ( ) No ( )
DS18: HOW MANY CIGARETTES DO YOU (OR SOMEONE ELSE IN HOUSEHOLD) SMOKE ON AVERAGE?	____ None ____ 1 to 5 cigarettes/week ____ 6 to 10 cigarettes/week ____ 11 to 20 cigarettes/week ____ More than 1 pack of cigarettes/week

Section B: Use of treated bed net

- ***Please fill out this section only if you have a treated bed net***
- ***Tick only one answer for each question unless 'tick all that apply' is written***

QUESTION	ANSWER
IA1: HOW MANY TREATED BED NETS DO YOU OWN? ***If more than one treated bed net is owned, please answer the next questions with respect to the most recently obtained treated bed net.***	____ 1 ____ 2 ____ 3 ____ 4 or more
IA2: HOW DID YOU GET YOUR TREATED BED NET?	____ It was free ____ It was bought Other (please write): _____ _
IA3: WERE YOU SHOWN HOW TO HANG THE TREATED BED NET WHEN YOU RECEIVED IT?	Yes ( ) No ( )

IA4: WHO SHOWED YOU HOW TO HANG THE TREATED BED NET?	____ Official from government agency or organization ____ Doctor/nurse/health worker ____ Family member/Friend ____ Nobody Other (please write): _____
IA5: WHO SLEEPS UNDER TREATED BED NETS IN YOUR HOUSEHOLD? TICK ALL THAT APPLY	____ Father ____ Mother ____ Child ____ Other children Other (please write): _____ ____
IA6: DOES YOUR CHILD USUALLY SLEEP UNDER A TREATED BED NET?	Yes ( ) No ( )
IA7: DID YOUR CHILD SLEEP UNDER ANY TREATED BED NET LAST NIGHT?	Yes ( ) No ( )
IA8: HOW OFTEN DID YOUR CHILD SLEEP UNDER A TREATED BED NET AT NIGHT IN THE PAST ONE WEEK?	____ Never ____ 1 – 3 times ____ 4 – 6 times ____ 7 times
IA9: HOW OFTEN DID YOUR CHILD SLEEP UNDER A TREATED BED NET IN THE PAST FOUR WEEKS?	____ Never ____ Once ____ 2 – 7 times per week ____ every day
IA10: DOES YOUR CHILD SLEEP UNDER A TREATED BED NET WITH ANYONE?	Yes ( ) No ( ) If yes, please write who: _____ ___
IA11: DOES YOUR CHILD SLEEP UNDER TREATED BED NET WITH OTHER PEOPLE REGULARLY?	____ Yes ____ No
IA12: IN YOUR HOUSEHOLD, HOW MANY PEOPLE SLEEP UNDER ONE TREATED BED NET REGULARLY?	____ 2 people ____ 3 or more people

Section C: Characteristics of bed net and sleeping area

- Please fill out this section only if you have a treated bed net

- Please tick only one answer for each question

IC1: HOW OLD IS THE TREATED BED NET THAT YOUR CHILD SLEEPS UNDER?	____ Less than 6 months ____ 6 to 12 months ____ Greater than 12 months ____ Don't know
IC2: WHAT IS THE SHAPE OF THE TREATED BED NET THAT YOUR CHILD SLEEPS UNDER?	____ Rectangular ____ Conical ____ Don't know
IC3: WHAT IS THE COLOUR OF THE TREATED BED NET YOUR CHILD USES?	write colour: _____
IC4: WHAT IS THE SIZE OF THE TREATED BED NET YOUR CHILD USES?	____ Baby ____ Single ____ Double ____ Triple/king ____ Don't know Other (please write): _____
IC5: HOW DO YOU HANG THE TREATED BED NET?	____ tied to nails on wall with string or rope ____ tied to ceiling with string or rope Other (please write): _____
IC6: DID YOU WASH THE TREATED BED NET WHICH YOUR CHILD NORMALLY SLEEPS UNDER BEFORE IT WAS USED THE FIRST TIME?	Yes ( ) No ( )
IC7: HOW OFTEN DO YOU WASH THE TREATED BED NET?	____ Never ____ Every week ____ 1 – 2 times per month ____ 1 – 2 times per year Other (please write): _____
IC8: DO YOU KNOW ANYONE WHO HAS SOLD THEIR TREATED BED NET?	Yes ( ) No ( )

IC9: DO YOU KNOW ANYONE WHO USES THEIR TREATED BED NETS FOR ANY OF THE FOLLOWING PURPOSES?	____ Ceiling covers ____ Bed covers ____ Room dividers ____ Curtains ____ Table cloth ____ None of the above Other (please write): _____

Section C, part II

Sleeping arrangements **Please tick only one answer for each question**	
SA1: HOW MANY ROOMS ARE IN YOUR HOUSE? ***Please add up all the rooms in your house including living room, kitchen and bedrooms; do not add bathrooms.***	*Write number:*_____
SA2: HOW OFTEN DOES YOUR CHILD PLAY OUTSIDE IN THE EVENINGS?	____ Never ____ two to three times per week ____ Almost every day ____ Every day
SA3: WHAT DOES YOUR CHILD SLEEP ON AT NIGHT? ***Tick only one option; Please choose what your child sleeps on regularly***	____ Couch ____ Mat ____ Bare floor ____ Bed/Mattress (no frame) ____Bed/ Mattress (with frame) Other (please write): _____

SA4: WHERE DOES YOUR CHILD SLEEP AT NIGHT? TICK ONLY ONE OPTION; PLEASE CHOOSE WHERE YOUR CHILD SLEEPS REGULARLY	____ Bedroom ____ Living room ____ Any other room Other (please write): _____ _
SA5: IF YOUR CHILD SHARES A BED, WHO DO THEY USUALLY SHARE THE BED WITH?	____ Father ____ Mother ____ Other children/siblings Other (please write): _____ _
SA6: DO YOU HAVE TO REARRANGE OR CHANGE THE SLEEPING AREA WHERE YOUR CHILD SLEEPS SO YOU CAN USE THE TREATED BED NET EVERY DAY?	Yes ( ) No ( )
SA7: IS THERE ENOUGH SPACE TO MOUNT THE TREATED BED NET?	Yes ( ) No ( )

Section D: Malaria knowledge

KM1 - *Please indicate how strongly you agree or disagree with the following statements* **- Please tick only one box for each question**	**Strongly Agree**	**Agree**	**Disagree**	**Strongly disagree**	**Don't know**
1. MALARIA HAS MORE THAN ONE CAUSE					
2. MALARIA IS TRANSMITTED ONLY BY FEMALE MOSQUITOES					
3. MALARIA IS TRANSMITTED BY PHYSICAL CONTACT WITH A MALARIA PATIENT					
4. OVERWORKING YOURSELF CAUSES MALARIA					

5. Too much exposure to sun causes malaria					
6. Mosquitoes are most likely to bite during the day time					
7. Mosquitoes are most likely to bite at any time					
8. Malaria is transmitted during the dry season					
9. Malaria is more serious for children than adults					
10. Malaria Affects all age groups					
11. Malaria can be prevented					
12. Malaria needs to be treated immediately					
13. Fever has more than one cause					
14. Vomiting is a symptom of malaria					

15. Anaemia is a symptom of severe malaria					
16. Convulsions are a symptom of severe malaria					
17. Malaria can be treated effectively with chloroquine					
18. Traditional Medicine/Herbs are a good way to treat malaria					
19. Coartem® is effective against malaria in children					
20. Sweating is a sign of recovery from malaria					

KM2: IN WHAT WAYS DO YOU PREVENT MOSQUITOES FROM BITING YOU AND/OR YOUR CHILDREN? ***Tick all that apply***	____ By using treated bed nets ____ By using insecticide sprays ____ By using mosquito coils ____ Door and window screens ____ Wearing protective clothing ____ Draining standing water ____ Covering yourself during sleep ____ Don't know ____ Do/use nothing Other (please write): _____

Section E: Malaria Risk

Please indicate how strongly you agree or disagree with the following statements: **-Please tick only one box for each question**	**Strongly Agree**	**Agree**	**Disagree**	**Strongly disagree**	**Don't know**
MR1: MY CHILD'S HEALTH IS VERY GOOD					
MR2: MY CHILD EASILY CONTRACTS MALARIA					
MR3: I EASILY CONTRACT MALARIA					
MR4: MALARIA IS A MAJOR HEALTH PROBLEM					
MR5: PREVENTING MALARIA IS A SERIOUS PRIORITY FOR ME					

Section F: Malaria incidence

- **Please tick only one answer for each question**

QUESTION	ANSWER
MI1: HOW MANY TIMES HAVE YOU HAD MALARIA IN THE PAST 6 MONTHS?	____ 0 ____ 1 time ____ 2 times ____ 3 times ____ 4 or more times
MI2: HAS YOUR CHILD EVER HAD MALARIA?	Yes ( ) No ( )
If you answered 'yes' to question MI2 above, please answer the following question. If you answered 'no', don't answer this question. MI3: HOW DO YOU TREAT YOUR CHILD WHEN THEY HAVE MALARIA?	____ go to private hospital/clinic ____ go to public hospital/clinic ____ treat at home ____ traditional herbs/medicine ____ no treatment Other (please write): _____
MI4: MI3: HOW MANY TIMES HAS YOUR CHILD HAD MALARIA IN THE PAST 6 MONTHS?	____ 0 ____ 1 time ____ 2 times ____ 3 times ____ 4 or more times
MI5: HOW MANY TIMES HAS YOUR CHILD BEEN TO THE HOSPITAL OR CLINIC FOR MALARIA IN THE PAST 6 MONTHS?	____ 0 ____ 1 time ____ 2 times ____ 3 times ____ 4 or more times
MI6: HOW MANY TIMES HAS YOUR CHILD BEEN TREATED AT HOME FOR MALARIA IN THE PAST 6 MONTHS?	____ 0 ____ 1 time ____ 2 times ____ 3 times ____ 4 or more times

Section G: Health

How many times your child has had the following symptoms in the past 6 months: **Please tick only one box for each question**	**0**	**1 time**	**2 times**	**3 times**	**4 or more times**
1. FEVER					
2. SHIVERING/CHILLS					
3. HEADACHE					
4. NAUSEA					
5. DIZZINESS					
6. WEAKNESS/FATIGUE					
7. TWITCHING					
8. INCREASED SWEATING					
9. NUMBNESS					
10. TINGLING SENSATIONS					
11. ITCHING/SKIN IRRITATION					
12. UNCOORDINATED WALKING					
13. TREMORS					
14. CONVULSIONS					
15. UNCONSCIOUSNESS					
16. SNEEZING					
17. COUGHING					
18. RUNNY NOSE					
19. DIFFICULTY IN BREATHING					
20. TIGHTNESS IN CHEST					
21. DIARRHEA					
22. VOMITING					
23. ABDOMINAL PAINS/CRAMPS					
24. BLURRED VISION					
25. EYE PAIN/EYE IRRITATION					
26. SWOLLEN FACE					
27. MUSCLE CRAMPS					
28. A LOT OF SALIVA					
29. WEAKNESS IN THE LEGS					
30. LOSS OF APPETITE					
31. BACK PAIN					

Section H: Perceptions of treated bed nets

Part I

- Please indicate how strongly you agree or disagree with the following statements: **- Please tick only one box for each question**	**Strongly Agree**	**Agree**	**Disagree**	**Strongly disagree**	**Don't Know**
1. TREATED BED NETS PREVENT MOSQUITO BITES					
2. TREATED BED NETS REDUCE MOSQUITOES					
3. TREATED BED NETS KILL MOSQUITOES					
4. TREATED BED NETS REDUCE MALARIA					
5. TREATED BED NETS PREVENT MALARIA					
6. TREATED BED NETS PREVENT OTHER DISEASES					
7. TREATED BED NETS REDUCE OTHER INSECTS (SUCH AS BEDBUGS, COCKROACHES, HOUSEFLIES)					
8. TREATED BED NETS KILL OTHER INSECTS					
9. TREATED BED NETS PROTECT AGAINST ANIMALS (SUCH AS RATS, SNAKES)					
10. TREATED BED NETS MAKE YOUR HOME BEAUTIFUL					
11. TREATED BED NETS PREVENT DIRT FALLING ON YOUR BED					
12. TREATED BED NETS HELP YOU SLEEP BETTER					
13. TREATED BED NETS PROVIDE PRIVACY					

14. IT IS EASY TO HANG YOUR TREATED BED NET					
15. IT IS EASY TO USE YOUR TREATED BED NET EVERYDAY					
16. TREATED BED NETS DO NOT WEAR AND TEAR EASILY					
17. MY CHILD LIKES TO SLEEP UNDER THE TREATED BED NET					

Can treated bed nets be used for any other uses not mentioned above? Yes ( ) No ( )

If you answered yes, please write:

_____

Part II

- Please indicate how strongly you agree or disagree with the following statements - **Please tick only one box for each question**	**Strongly Agree**	**Agree**	**Disagree**	**Strongly disagree**	**Don't know**
1. BED NETS CAN BE TREATED WITH INSECTICIDE					
2. TREATED BED NETS GET DIRTY EASILY					
3. TREATED BED NETS ARE TOO SHORT					
4. TREATED BED NETS STAY TUCKED IN DURING THE NIGHT					
5. TREATED BED NETS SMELL BADLY WHEN NEW					
6. INSECTICIDE MAY MAKE TREATED BED NETS UNFIT FOR YOUNG CHILDREN					
7. A CHILD CAN SUFFOCATE UNDER A TREATED BED NET					

8. INSECTICIDE MAY CAUSE COLD-LIKE SYMPTOMS (E.G. RUNNY NOSE) AND SKIN RASHES					

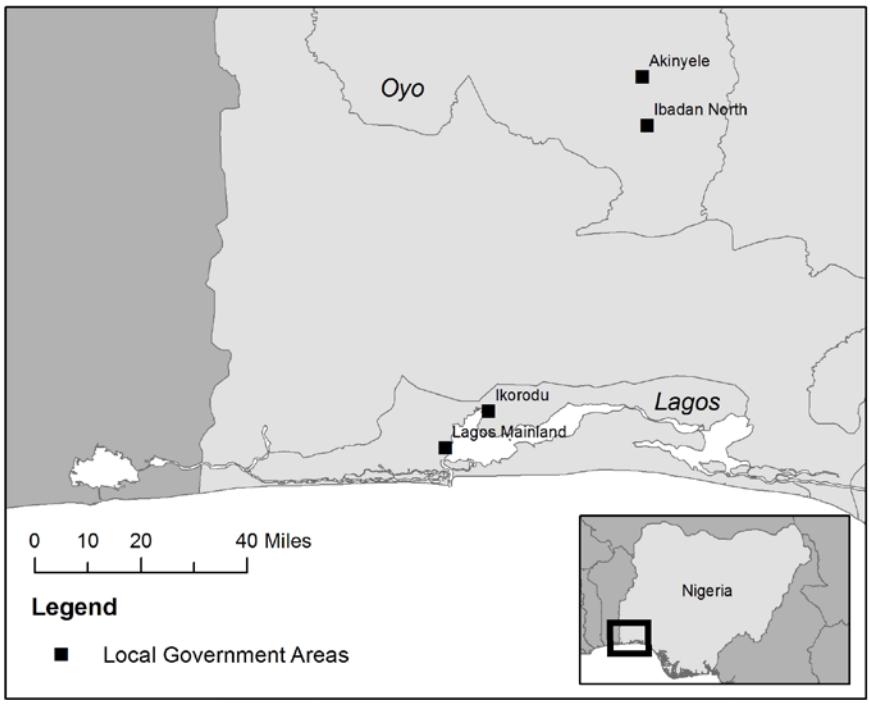

Figure A-1: Map of study areas