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Nadine Mushimbele April 17, 2017

Evaluation of the barriers to sustained coverage and use of long-lasting insecticide-treated nets, and of the effectiveness of door-to-door hang-up activities: The case of the Nord-Ubangi province, Democratic Republic of the Congo.

By

Nadine Mushimbele

Master of Public Health

Hubert Department of Global Health

Signature _____

Dr. Peter Brown, PhD

Committee Chair

Signature _____

Dr. Roger Rochat, M.D

Committee Member

Evaluation of the barriers to sustained coverage and use of long-lasting insecticide-treated nets, and of the effectiveness of door-to-door hang-up activities: The case of the Nord-Ubangi province, Democratic Republic of the Congo.

By: Nadine Mushimbele

B.S.N., Grand Valley State University, 2011

Thesis Committee Chair: Dr. Peter Brown

An abstract of a thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University in
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Master of Public Health in the Hubert Department of Global Health, 2017

Abstract

Evaluation of the barriers to sustained coverage and use of long-lasting insecticide-treated nets, and of the effectiveness of door-to-door hang-up activities: The case of the Nord-Ubangi province, Democratic Republic of the Congo.

By: Nadine Mushimbele

Background: Long-lasting insecticide treated nets (LLINs) have been proven to be effective in preventing malaria in at-risk populations. Between December 2015 and July 2016, 730,000 LLINs were distributed free-of-charge in the Nord-Ubangi province, Democratic Republic of the Congo (DRC) using the door-to-door hang-up strategy with the goal of achieving universal coverage. This study aims to evaluate the post-distribution rate of coverage of LLINs, the effectiveness of door-to-door hang-up activities on increasing household ownership and usage of LLINs, and the barriers to LLIN use.

Methods: This was a mixed-methods study conducted between June and July, 2016, in three of the eleven health districts in Nord-Ubangi. The study used a multiple stage sampling technique consisting of convenience sampling and simple random sampling. Data was collected from 305 randomly-selected households across the three health districts using structured household surveys and unstructured observations. The data were analyzed using Epi Info 7.2 and SAS 9.4.

Results: The proportion of households owning at least one campaign LLIN was 100% across all three health districts. However, only 48% of the campaign LLINs were found hung over sleeping spaces and 52% were not hung. 21% of observed household sleeping spaces were covered by non-campaign LLINs. This increased the percentage of LLIN coverage to 69%. The study determined that the major barriers to LLIN use include too few household LLINs to cover all sleeping spaces (33%), lack of materials for hanging LLINs (25%), lack of knowledge and assistance for hanging LLINs (13%), and sleeping spaces being used for other activities during the day (16%). LLINs surveyed were in very good condition. Of the 305 households surveyed, the proportion of LLINs hung by community health workers was 8%, while 92% were hung by members of the households.

Conclusion: The mass-distribution campaign was effective at rapidly increasing LLIN ownership, but the door-to-door hang-up strategy was not effective at increasing LLIN usage. The campaign did not achieve its universal coverage goal. Mass-distribution campaigns should incorporate behavior-change communication models and other determinants of behavior into future distribution campaigns. This could limit most of the barriers to sustained LLIN usage and help increase LLIN utilization among households.

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***

In memory of my dear father Theodore Mushimbele, who instilled in me a love of learning and a hunger for success which have made me the woman I am today. I am forever grateful.

This is for you father.

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LIST OF ACRONYMS

AMF: Against Malaria Foundation

CHWs: Community Health Workers

DHS: Demographic and Health Survey

DRC: Democratic Republic of the Congo

IMA: Interchurch Medical Assistance

ITNs: Insecticide treated Bed Nets

LLINs: Long-Lasting Insecticide nets

MERG: Roll Back Malaria Monitoring & Evaluation Reference Group (MERG)

MOH: Ministry of Health

NGOs: Non-Governmental Organizations

NMCP: National Malaria Control Program

PDCUs: Post-Distribution Net Use and Condition Check- Up

ProMPT: Promoting Malaria Prevention & Treatment Project Ghana,

PMI: President's Malaria Initiative

RBM: Roll Back Malaria

USAID: United States Agency for International Development

USD: United States Dollars

CHAPTER I: INTRODUCTION

1.0. Introduction

Vector control has been proven to prevent and reduce malaria transmission effectively when coverage is high (World Health Organization, 2015). The two primary methods of malaria vector control are long-lasting insecticide-treated nets (LLINs) and indoor residual spraying. The World Health Organization (WHO) recommends that all malaria-endemic countries protect those at risk of malaria with LLINs or with indoor residual spraying when possible. These vector management strategies seek to make malaria vector control more effective, more ecologically sound, more sustainable, and less costly (WHO, 2015).

LLINs play a major role in global campaigns to reduce and prevent malaria in Sub Saharan Africa. The efficacy and low cost of LLINs has been associated with improving malaria outcomes (WHO, 2015). LLINs are known to be very effective in reducing malaria mortality and morbidity, and they are designed to sustain biological efficacy against malaria vectors for at least three years. LLINs reduce contact between mosquitoes and humans by providing a complete physical barrier, and the insecticide in the nets kills mosquitoes on a large scale (WHO, 2015; Zhou et al., 2014). The three main components of effective use of the LLINs for malaria prevention and control include bed net ownership, net condition, and correct net use.

Previously, the model used for LLIN distribution focused only on vulnerable populations, including children under the age of five and pregnant women. However, recent studies have shown that by increasing the use of LLINs by all people in the targeted areas, increased and improved protection of vulnerable populations can be achieved while protecting all community members (Zhou et al., 2014). More recently, new WHO guidelines recommend “universal coverage” for populations living in high malaria-endemic areas in order to protect populations at

higher risk of contracting malaria (WHO, 2016). If achieved, universal coverage, in addition to providing personal protection to members of the community, will lead to a decrease in malaria transmission rates. The WHO currently recommends that malaria-endemic countries aim for universal coverage. To achieve this goal, all sleeping spaces within a household must be covered and community members need to have access to LLINs every night. The ideal goal of universal coverage is to have 100% of the population sleep under a LLIN every night. However, most malaria-endemic countries have set a more achievable target goal of 80 or 85% of the population sleeping under LLINs. If this more modest goal is achieved, it will be sufficient to achieve the universal coverage objective (WHO, 2016).

Malaria remains a major public health problem worldwide. The WHO estimates that in the year 2015 there were 214 million cases of malaria worldwide, and an estimated 438,000 malaria related deaths (WHO, 2015). In addition, the greatest malaria incidence was in Sub Saharan Africa, with an estimated 90% of all malaria deaths occurring there (WHO, 2015). Two thirds of these deaths occurred among children under age five (WHO, 2015). According to 2015 estimates by WHO, 3.2 billion people from 95 countries were at risk of malaria, 1.2 billion were at higher risk of malaria, and 42% of malaria-endemic countries were found in the African region. Of the 214 million cases reported globally, 88% of them were in Sub-Saharan African. **Of the estimated 438,000 malaria deaths in 2015, 90% occurred in Africa** (WHO, 2015).

The global burden of malaria remains concentrated in fifteen African countries (WHO, 2015). One of these malaria-endemic countries in Sub-Saharan African is the Democratic Republic of the Congo (DRC). The DRC is the second-largest country in Africa, contains the third-largest population, and has one of the highest malaria rates in Africa. Malaria remains one of the most important diseases in the DRC, causing significant mortality, morbidity and negative

socio-economic impact (PMI, 2016). It has been estimated that the DRC account for 11% of all cases of *plasmodium falciparum* in Sub-Saharan Africa. *Plasmodium falciparum,* the dominant species of malaria parasite is about 95% of all infection in the DRC. Malaria causes 40% of deaths among children under age five and 19% of deaths among pregnant women in the DRC (PMI, 2016). Forty percent of all outpatient visits in the DRC are attributed to malaria. The high proportion of malaria cases in the DRC is a consequence of the inability to prevent the spread of malaria through insecticide-treated bed nets (ITNs), lack of treatment for those already infected, and as well as uncontrolled flows of people due to civil war (PMI, 2016).

According to the DRC Ministry of Health (MOH), malaria is a threat to the health of the entire nation. Ninety-seven percent of the Congolese population lives in the tropical and equatorial forest areas, including the Nord-Ubangi province, where the rainy season lasts eight to ten months and transmission of malaria is the highest. People living in the rural areas have a higher incidence rate of malaria, but receive less treatment than urban areas (PMI, 2016). Malaria is a preventable and curable disease, yet its persistent and widespread presence in the DRC imposes a heavy national and regional health burden that calls for increasing efficiency and effectiveness of preventive, surveillance and treatment measures (PMI, 2016).

A review of the literature suggests that increased LLIN coverage, door-to-door hang-up assistance, and providing improved access to primary health care are essential to reducing malaria transmission in the DRC (Renggil et al., 2013). In addition, increased LLIN distribution, coverage and use instruction, as well as improved access and delivery are essential to the effort to control malaria transmission in the DRC, especially in the zones of highest transmission rates, like the Nord-Ubangi province. While the malaria problem is recognized globally and measures are being taken to encourage prevention through increased use of LLINs and improved access to treatment,

the overall effectiveness of the LLINs in the reduction of malaria transmission in the DRC remains unclear (Renggil et al., 2013).

Interchurch Medical Assistance (IMA) implemented a mass distribution of LLINs in partnership with Against Malaria Foundation (AMF) from December 2015 to July 2016 in the eleven health districts in the Nord-Ubangi province. IMA and AMF distributed 730,000 LLINs in order to achieve universal coverage (all sleeping spaces covered) with a goal to maintain sleeping spaces coverage at or above 80% across all eleven health districts (IMA, 2016). The campaign strategy included giving free, new LLINs to entire communities, with a goal universal LLIN ownership using a door-to-door hang-up assistance strategy. Approximately 1.3 million residents of Nord-Ubangi received LLINs during the distribution (IMA, 2016). Evidence suggests that when large numbers of people sleep under LLINs to protect themselves, transmission of malaria and mortality among community members can be reduced (WHO, 2015). This study aims to evaluate the barriers to the continued use of LLINs, the condition of the nets post-distribution, and the extent of LLIN coverage revealed during the post-distribution nets use and condition check-up (PDCU), and to assess the effectiveness of door-to-door hang-up activities in terms of increased household use of the bed nets and progress toward universal sleeping space coverage.

1.1. Problem Statement:

Despite the recent improvements in treatment and prevention measures, malaria remains a primary cause of morbidity and mortality in Sub-Saharan Africa. Appropriate and continuous use of LLINs could significantly reduce malaria cases and transmission in endemic areas. Studies have shown that effective use of LLINs depends, in part, on understanding of the causal factors associated with malaria (Ruyange et al., 2016). It is well-known that children under age five and pregnant women are the most vulnerable populations for malaria. Eighty-six percent of all deaths

in Sub-Saharan Africa attributed to malaria occur in children under age five (Song et al., 2016). Despite efforts in the DRC to distribute LLINs to pregnant women and children under five to achieve universal coverage, and despite multiple awareness campaigns on the importance of LLINs use, the number of those using LLINs in the DRC remains low (Song et al., 2016).

Approximately 180,000 deaths in the DRC are attributed to malaria each year. This amounts to about one-fifth of the **863,000 malaria deaths reported globally by the WHO in 2008.** The large number of malaria-deaths in the DRC is due to high malaria transmission rates, and the mortality rate is exacerbated by a long-lasting civil war that has destroyed the health care infrastructure and the government's ability to deliver social services (WHO, 2009). In the DRC, challenges remain to the ability of the health care system to deliver the level and quality of services needed to ensure universal coverage of LLINs in the population and reduce the burden of malaria. The lack of a reliable supply chain and distribution system for LLINs is an ongoing challenge for the entire health system in the DRC (PMI, 2016).

The DRC is classified into zones according to malaria transmission intensity and seasonality. The Nord-Ubangi province is in the high malaria transmission zone. Nord-Ubangi province is one of the most affected malaria provinces in the DRC. In 2013, of the 11 provinces of the DRC, Equatéur province which included Nord-Ubangi districts accounted for 61.5% of cases of malaria confirmed using the polymerase chain reaction method (DRC Demographic and Health Survey, 2014). About 500 people die per day from malaria, mostly children under age five. Large scale distribution of LLINs with a goal of universal coverage has the potential to improve the health of communities by reducing malaria transmission, which will help decrease malaria cases (AMF, 2015).

In 2013, in Sub-Saharan Africa, about 278 million (33%) of 840 million people at risk of malaria lived in households without access to LLINs (Roll Back Malaria (RBM), 2016). According to the Demographic and Health Survey (DHS) conducted in DRC in 2013 and 2014, 70% of households in the DRC own at least one ITN. The number of households which own ITNs varies by province, ranging from a low of 47 % in the Orientale and Équateur provinces, to 88 % in the Bandundu province. Nearly half of the population (47%) has access to ITNs; at least one LLIN for every two people per household. However, the percentage of those using the ITNs remains low (DRC DHS, 2014).

Despite previous efforts to evaluate the coverage, condition and usage of the nets in community households, and the door-to-door hang-up assistance, results still show that LLIN use remains low in DRC. The purpose of this study is to select households in the Nord-Ubangi province to evaluate the barriers to LLINs use and to achieving universal coverage, and to evaluate the effectiveness of door-to-door hang-up at the household level after mass distribution of LLINs in Nord-Ubangi province.

1.2. Purpose Statement

The purpose of this Master's thesis is to evaluate the LLIN coverage rates, the effectiveness of door-to-door hang-up activities, rates of LLINs ownership and usage, and the barriers to LLIN use among households found during the PDCU in the Nord Ubangi province, DRC.

1.3. Study Objectives

The objectives of this thesis are a) to evaluate the continued use and condition of LLINs and the coverage of LLINs found during the PDCUs; and b) to assess the effect of the door-to door hang-up process on increasing the household use of LLINs and on sleeping space coverage.

1.3.1. Specific Aims

1. To determine household ownership and utilization levels of LLINs in the Nord-Ubangi province, DRC;
2. To determine the number of sleeping spaces in each household;
3. To evaluation the effect of the door-to-door hang-up process on increasing the household use of mosquito nets;
4. To assess the use and condition of the LLINs post- mass distribution; and
5. To assess whether universal coverage was achieved;
6. To evaluate barriers to LLIN use.

1.4. Significance Statement

The study is expected to evaluate actual barriers to the utilization of the LLINs, problem of low LLIN coverage and the effect of the door-to-door hang-up process on increasing household use of the LLINs and sleeping space coverage in the Nord-Ubangi province. Through a process of evaluating this mass distribution campaign of the LLINs in the Nord-Ubangi province, DRC, non-governmental organizations (NGOs) and other malaria programs can understand how better to implement a comprehensive mass distribution campaign of the bed nets to increase coverage and utilization, and improve the door-to-door hang-up activities for community-based malaria prevention.

Malaria prevention programs can use the evaluation results to improve door-to-door hang-up process during the mass distribution campaign of LLINs if needed. In addition, the findings of this evaluation will provide a springboard for more comprehensive methods to increase use and coverage of the bed nets in DRC. With the knowledge gained from this study, non-governmental organizations can increase awareness of LLINs, educate communities on use of LLINs, train

more community health workers on the door-to-door hang-up process, and reach the objective of maintaining sleeping space coverage at or above 80 percent.

1.5. Definition of Terms

Bed net use: the percentage of the nets that were actually used to cover the bed over a total number of LLINs

Door-to-door hang-up process: the process of door-to-door installation of the bed nets in households by CHWs

Households: units headed by a male or female with his or her dependents and spouse who share a cooking pot or common eating place and sleep under the same roof

Insecticide-treated net (ITN): a mosquito net that repels, disables and kills mosquitoes coming into contact with insecticide applied to the netting material

Long-lasting insecticide-treated nets (LLINs): a factory-treated mosquito net made with netting material that has insecticide incorporated within the fibers

LLIN coverage: proportion of a household's sleeping spaces covered by at least one LLIN

LLIN ownership: the proportion of households owning at least one LLIN

Sleeping spaces: the areas in the household where people can sleep

Universal coverage: full coverage with effective vector control of all people at risk for malaria in a community

CHAPTER II: Comprehensive Literature Review

2.0. Introduction

Understanding global malaria transmission rates, transmission rates in Africa, and transmission rates in the DRC in particular, as well as understanding trends in the use of insecticide-treated bed nets as a tool to fight transmission, will assist in malaria transmission and prevention in the Nord-Ubangi province. This section reviews literature documenting the current status of malaria in the world, Africa and the DRC; implementation of the LLIN universal coverage strategy; LLIN ownership and usage statistics; the effectiveness of LLIN door-to-door hang-up assistance; and the perceived barriers to LLIN use at the individual, household and community levels in both the African population as a whole, and among DRC communities in particular.

2.1. Malaria Occurrence and Distribution

2.1.1. Malaria in the World

Malaria remains one of the greatest global public health challenges. Malaria is one of the most important public health issues in terms of mortality and morbidity worldwide. Almost half of the world's population is at risk of malaria infection. It is currently restricted mainly to subtropical regions of the world, including sub-Saharan Africa, Central America, South America, and Asia. Cibulskis et al. (2011), estimated that in 225 million malaria cases reported in 2009 in 99 malaria-endemic countries 78% were in WHO's Africa region, followed by 15% in the Southeast Asian and Eastern Mediterranean regions. Temperatures and rainfall in these regions are most conducive to the growth of the malaria-causing *Plasmodium* parasites in *Anopheles* vector mosquitoes (Hay et al., 2010).

Plasmodium falciparum, the most deadly type of *Plasmodium* parasite, causes approximately one million deaths each year (Hay et al. 2010). It is found primarily in sub Saharan Africa, where it causes high mortality rates, especially in children under five years of age. Hay et al. (2010) estimated the global number of clinical malaria cases associated with *P. falciparum* in 2007 at 451 million. Most of these estimated cases of *P. falciparum* occurred in India, Nigeria, the DRC, and Myanmar (Burma), where 1.405 billion people were at risk of malaria in 2007. Approximately 60% of 451 million *P. falciparum* cases occurred in sub-Saharan Africa. The two countries with the highest burden of infection were Nigeria and the DRC, both of which have extensive areas of high malaria endemism and large populations (Hay et al, 2010).

Murray et al. (2012) conducted a systematic study of global malaria deaths from 1980 to 2010. They estimated that global malaria deaths increased from 995,000 in 1980 to a peak of 1,817,000 in 2004, and then decreased to 1,238,000 in 2010 (Murray et al., 2012). In sub Saharan Africa, malaria deaths increased from 493,000 in 1980 to 1,616,000 in 2004, and declined by about 30 % to 1,133,000 in 2010. Outside of sub Saharan Africa, malaria deaths had steadily declined from 502,000 in 1980 to 104,000 in 2010 (Murray et al., 2012). The study estimated more deaths in children aged five years or older than had been estimated in previous studies: 435,000 deaths in Africa and 89,000 deaths outside of Africa in 2010 (Murray et al., 2012). Thirty-five countries accounted for approximately 98% of malaria deaths in 2010. Thirty of these countries are located in sub-Saharan Africa. Six countries--Nigeria, the DRC, Burkina Faso, Mozambique, Cote d'Ivoire, and Mali--accounted for 60% of malaria deaths in 2010 (WHO,2011). The World Malaria Report, 2014, estimated about 198 million global cases of malaria and 584,000 malaria-related deaths in 2013, with 90% of deaths occurring in Africa (WHO, 2014).

The World Malaria Report, 2016, estimated about 212 million new cases of malaria worldwide in 2015 in 91 countries and areas of ongoing malaria transmission (WHO, 2016). Sub- Saharan Africa accounted for 90% of new cases of malaria, followed by 7% of cases in Southeast Asia, and 2% in the eastern Mediterranean region. The estimated number of global malaria deaths was about 429,000 in 2015. Ninety-two percent of these deaths occurred in Africa, 6% in Southeast Asia, and 2% in the eastern Mediterranean region (WHO, 2016). However, between 2010 and 2015, malaria incidence rates decreased by 21% both globally and in the African region (WHO, 2016). During this period, malaria mortality rates declined by 29% globally and by 31% in the African region. Since 2010, malaria mortality rates decreased by 58% in the western Pacific region, 46% in Southeast Asia, 37 % in the region of the Americas, and 6% in the eastern Mediterranean region. No cases of malaria were reported in any of the European region countries in 2015 (WHO, 2016)

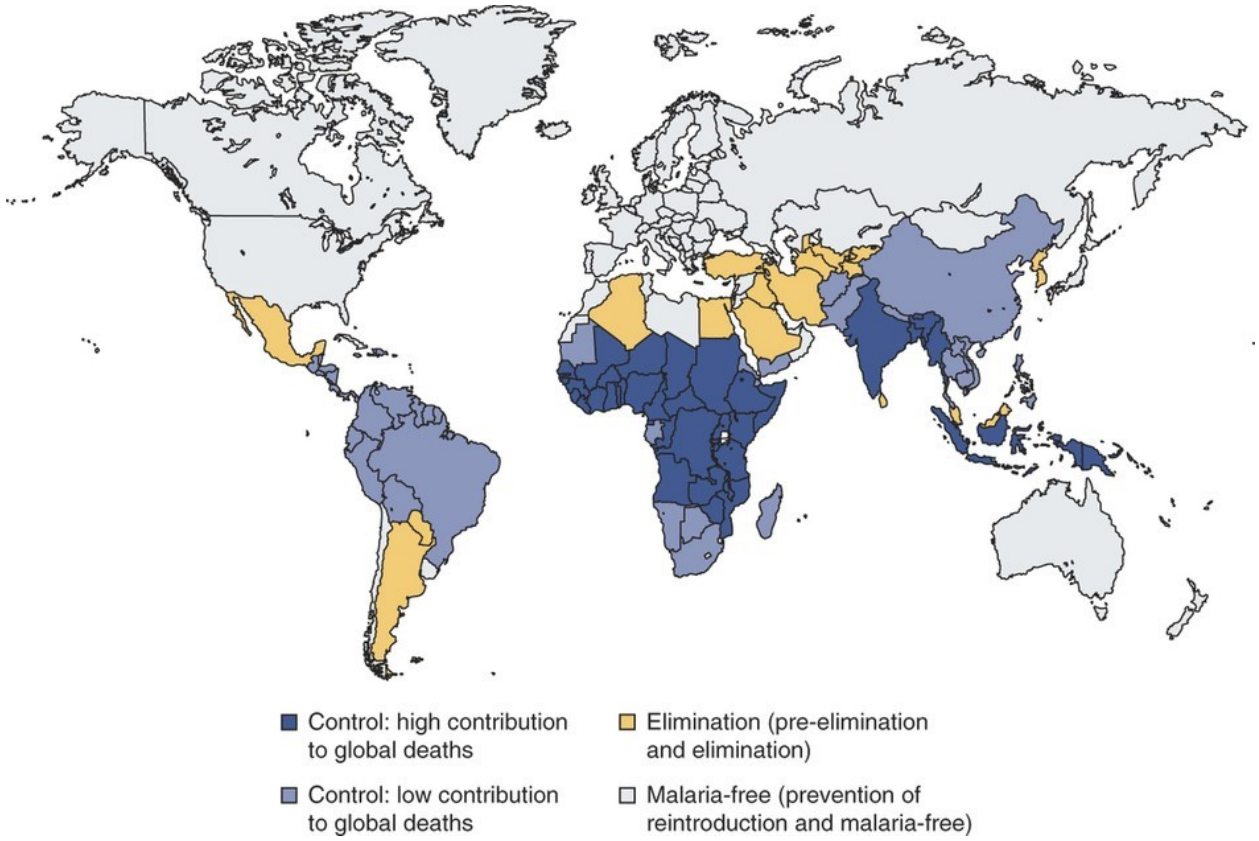

Figure 1: Worldwide malaria distribution and malaria burden stages.
http://www.nature.com/nm/journal/v19/n2/fig_tab/nm.3077_F2.html

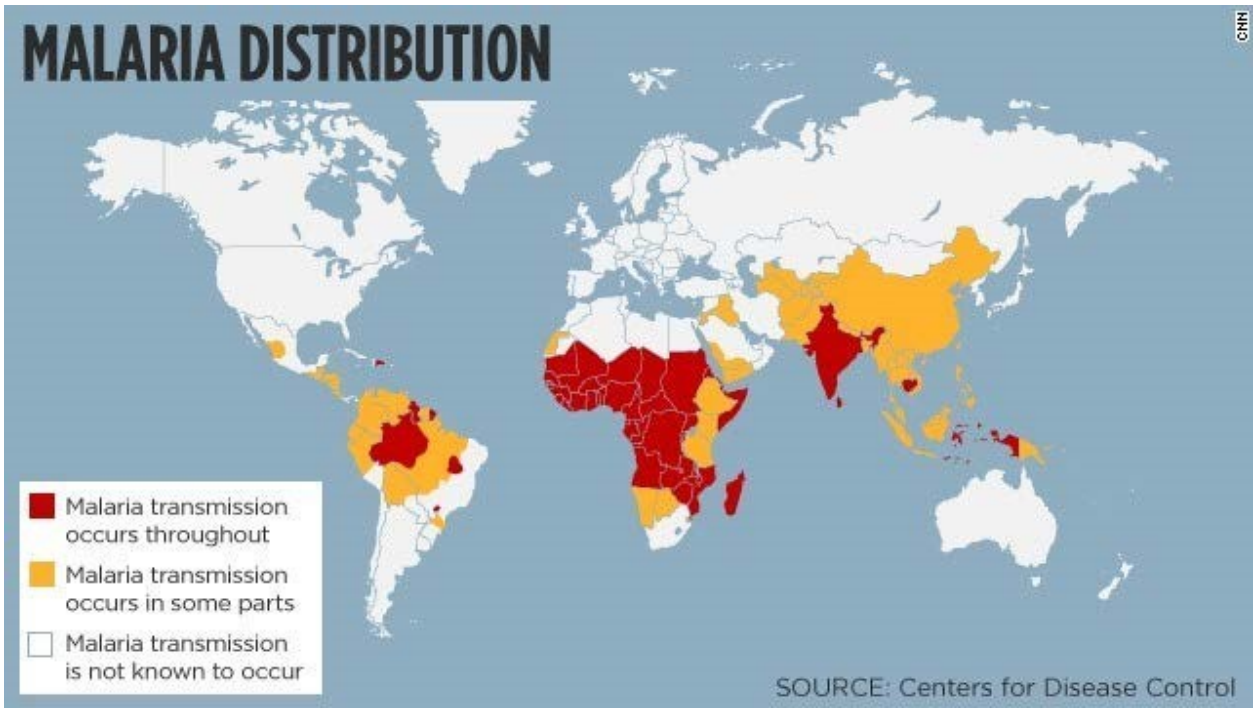

Figure 2: Global malaria distribution (Center for Disease Control, 2016). http://www.cnn.com/2014/11/13/world/africa/the-kit-that-could-end-malaria/

2.1.2. Malaria in Africa

Malaria is usually endemic in the tropics, with extension into the sub-tropics (Ghansah et al., 2014). In Africa, malaria is spread throughout the continent, but epidemics occur at the centers of the endemic regions. Epidemics are most predominant among the regions at the northernmost latitudes, across the arid regions of North Africa, among the highlands of the eastern, the central and Equatorial regions, and the Horn of Africa (Hay et al., 2010).

According to Roll Back Malaria (RBM), 2006, 90% of malaria deaths in 2006 occurred in Africa, mostly in young children in 2006, malaria caused an estimated 20% of deaths among children under five years of age. Deaths among children constituted 10% of the continent's overall malaria burden. Malaria in sub-Saharan Africa accounted for 40% of public health expenditure, 30-50% of inpatient admissions, and up to 50% of outpatient visits in areas with high malaria transmission between 2001 and 2010 (RBM, 2013). In 2009, Africa had 214 cases of

malaria per 1,000 people, compared with 23 per 1,000 in the eastern Mediterranean region, and nineteen per 1,000 in Southeast Asia. Of the six countries accounting for 80% of estimated malaria cases worldwide, four are in the Africa region (Cibulskis et al., 2011).

Griffin et al. (2013) reported that in 2010 an estimated 252 million cases of malaria occurred in sub-Saharan Africa. The estimate of clinical cases of malaria in children under five years of age varied from 60% of cases in high transmission zones to 20% in low transmission zones (Griffin & all, 2013). Contrary, WHO reported that between 2000 and 2013, increased malaria interventions helped to decrease the malaria incidence rate by 30% globally, and by 34% in Africa (WHO, 2014).

During the same period, malaria mortality rates declined by an estimated 47% globally and by 54% in sub-Sahara Africa (WHO, 2014). In children under five years of age, mortality rates declined by 53% worldwide and by 58% in Africa. The number of people infected with malaria in sub-Saharan Africa declined from 173 million in 2000 to 128 million in 2013 – a 26% reduction. This occurred despite a 43% increase in the African population living in high malaria transmission areas (WHO, 2014). Despite the incidence decrease in malaria-endemic countries in Africa, 57 % of the population in 2010 continued to live in regions with moderate-to-high transmission rates (Noor et al., 2014).

Gething et al. (2017) estimated a 57% decline in the rate of malaria deaths across sub Saharan Africa during the past 15 years (Gething et al, 2017). During that time, the mortality rate among children under five years of age decreased from 80% to less than 40% in Africa (Gething et al., 2017). The World Malaria Report, 2015, estimated that malaria mortality rates fell by 60% globally and by 66% in Africa. In children under five years of age, mortality rates decreased by 65% worldwide, and by 71% in Africa (WHO, 2015).

The WHO divides Africa into regions, including West Africa, Central Africa, and East Africa, and South Africa. In the Central Africa region, which includes the DRC, an estimated 174 million people were at risk of malaria and 161 million were at high risk. Fifty-seven percent of malaria cases in Central Africa were reported in the DRC, followed by 16% in Cameroon and about 9 % in Angola (WHO, 2016). The report estimated a 33% reduction in malaria cases and a 42% reduction in malaria mortality in the Central Africa region between 2010 and 2015. Recent reports do provide solid evidence that, where effective vector control measures are used in combination with anti-malaria therapies, significant reductions in malaria can be achieved in previously high-burden African countries (WHO, 2016).

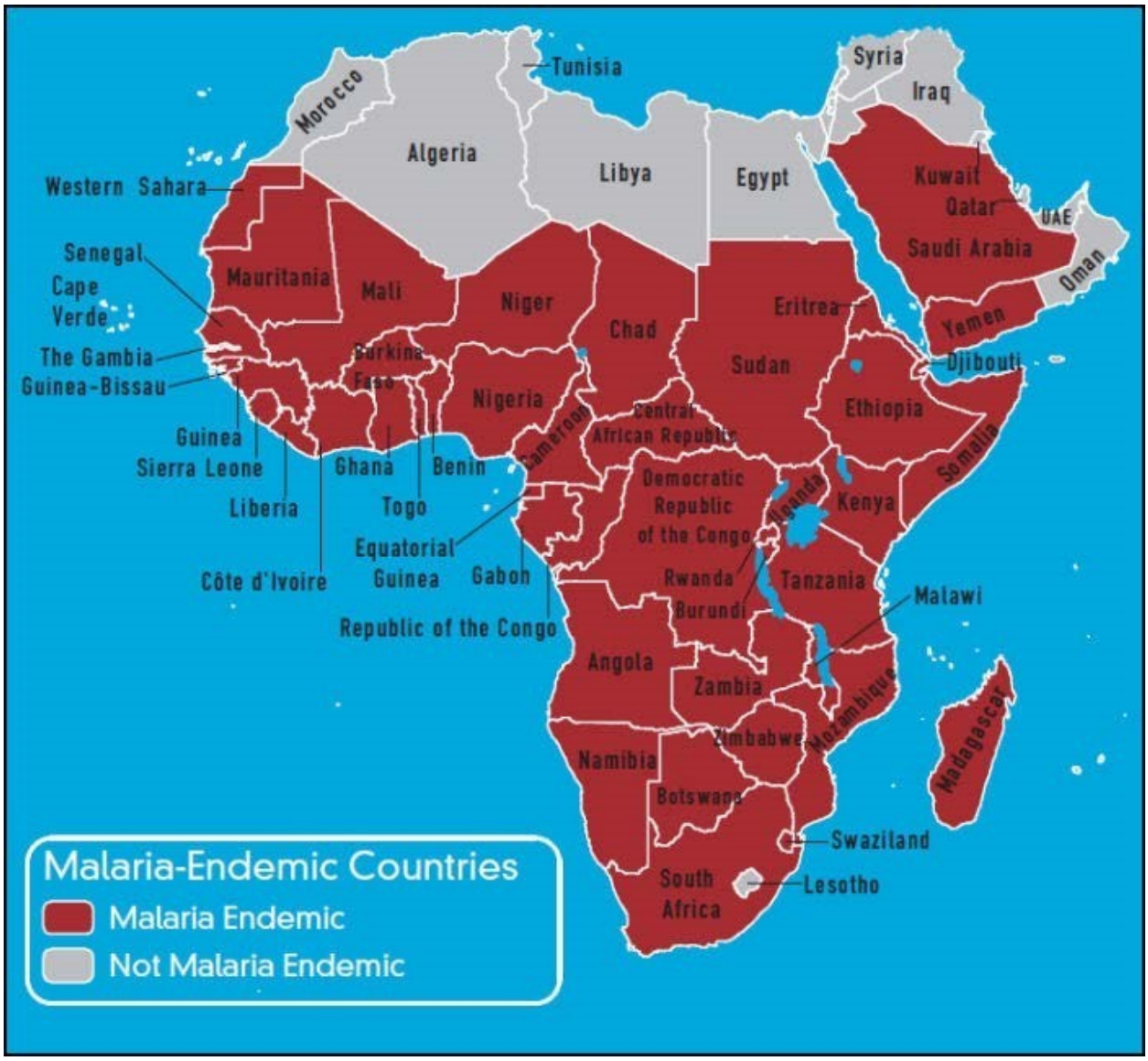

Figure 3: Malaria-endemic countries in Africa http://www.traveldoctor.co.uk/africa.htm

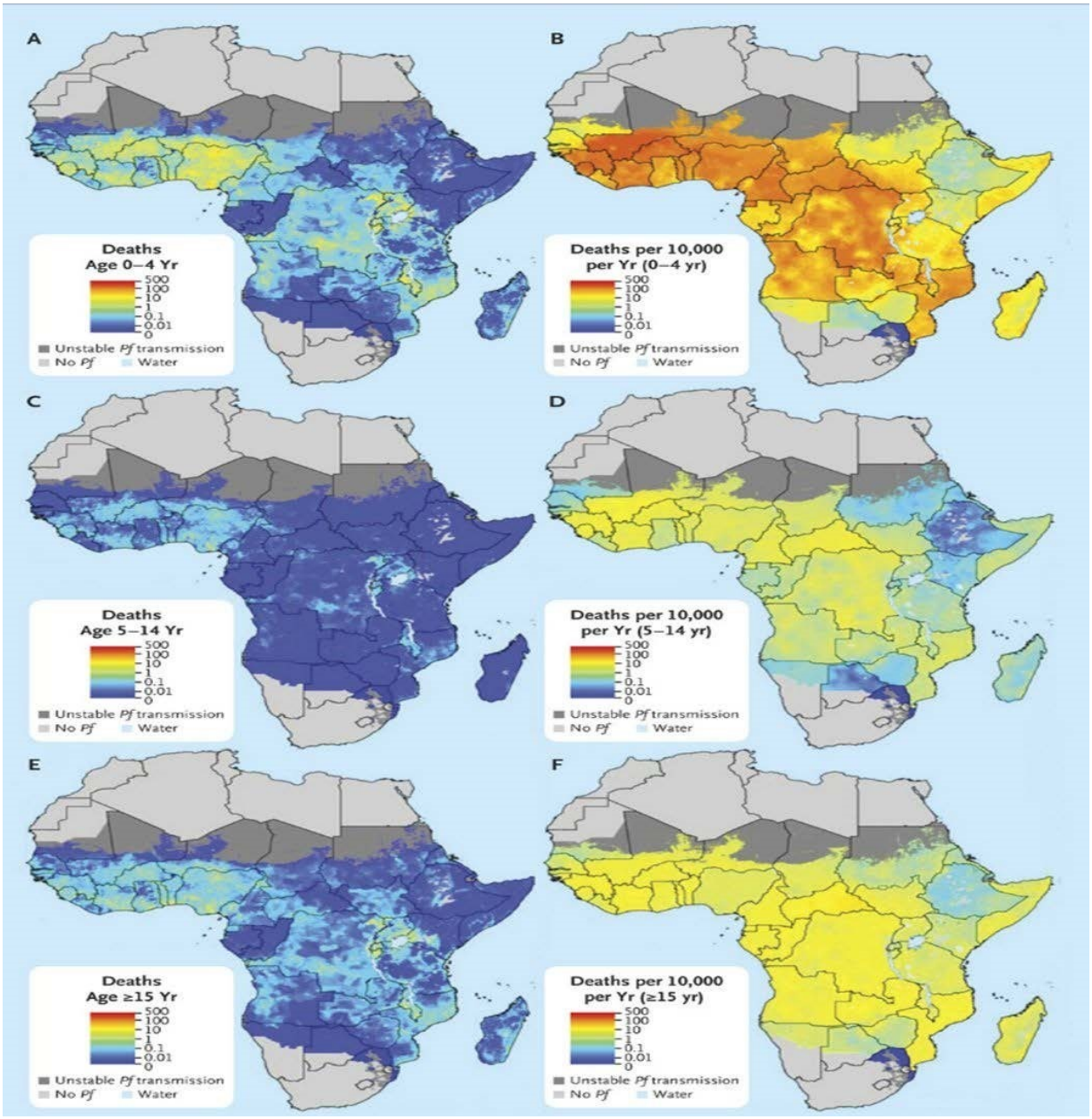

Figure 4: Mapping *P. falciparum* mortality in Africa. https://twitter.com/petergething

2.1.3. Malaria in the DRC

The DRC continues to have one of the highest malaria prevalence rates, with an estimated 11% of cases of *P. falciparum* malaria in sub-Saharan Africa occurring in the DRC (Taylor et al., 2011 & PMI, 2016). Messina et al. (2011), estimated 98% of the population in the DRC had been infected by *Plasmodium falciparum* (Messina et al., 2011). The central and east central

regions of the DRC were regions of low prevalence, as were the urban areas. By contrast, the northern region of the DRC had high malaria prevalence, as did the more rural regions (Messina et al., 2011). 97% of the DRC's 71 million people live in high malaria transmission areas. Malaria is a leading cause of mortality and morbidity in the DRC, accounting for more than 40% of all outpatient visits and for 19% of deaths in children under five years of age (PMI, 2016). Together with Nigeria, the DRC accounted for about 40% of the total estimated malaria cases in 2015, and for more than 35% of the total estimated malaria deaths (WHO, 2015).

In 2015, in the Central Africa region part of the WHO Africa region which include the DRC, an estimated 174 million people were at risk of malaria and 161 million were at high risk. Of these numbers, 57% of malaria cases were reported in the DRC. The prevalence rate was greater than one case of malaria per 1000 people in the DRC (WHO, 2016). However, there is limited data on Nord-Ubangi and other provinces of the DRC due to the weakness of the DRC surveillance system. The DRC is unable either to predict or even describe malaria outbreaks in its population, making it difficult for the DRC to identify the disproportional burden of malaria disease in the country (Nsibu et al., 2015). As correct estimates of malaria cases in the provinces are unavailable or unclear in countries like the DRC, obtaining more accurate estimates of malaria cases is important for allocating health resources (Nsibu et al., 2015). To combat the devastation caused by malaria in the DRC, increased funding for prevention measures has been implemented in many different provinces including Nord Ubangi (Nsibu et al., 2015).

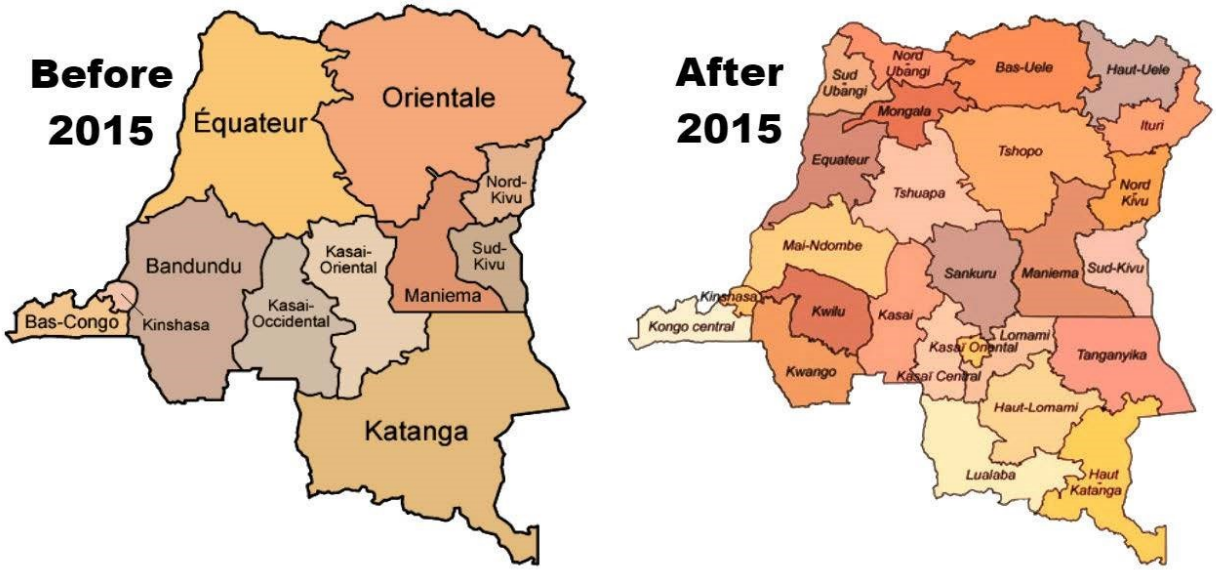

Figure 5: Pre- and post-2015 administrative map of the DRC
http://africacenter.org/spotlight/congo-drc-oversight-institutions-how-independent/

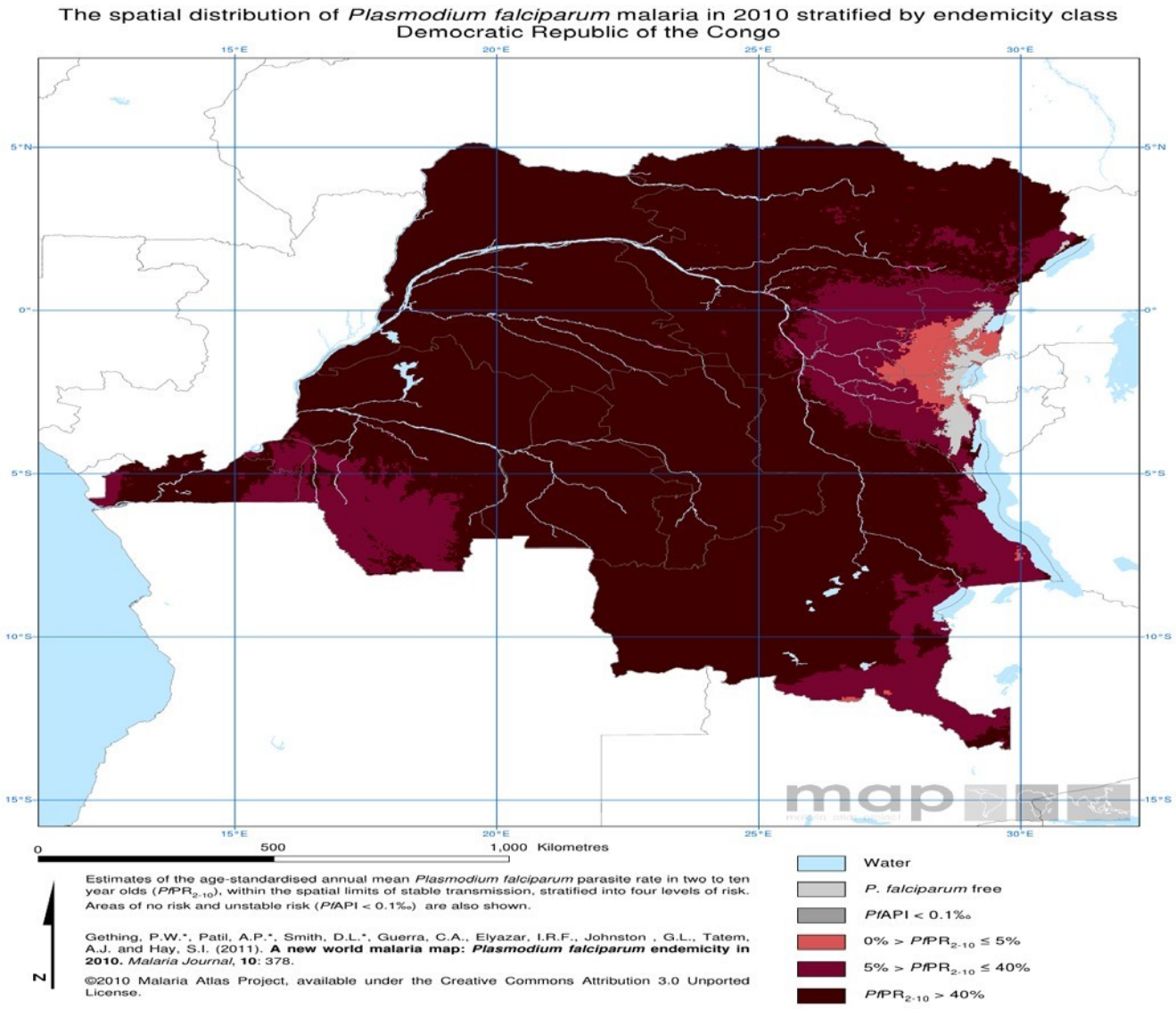

Figure 6. Spatial distribution of *P. falciparum* in 2010 DRC stratified by endemism class http://www.map.ox.ac.uk/browse-resources/endemicity/Pf_class/COD/

2.2. Universal Coverage of LLINs

In 1992, the World Health Organization held a conference to define a global strategy for malaria control and prevention measures (Lengeler et al., 1996). The WHO included the use of ITNs in the recommended preventative measures. ITNs had been emerging as a promising tool to reduce malaria transmission, and were proving suitable for promotion using the primary healthcare approach (PHC) (Lengeler et al., 1996). Large-scale randomized controlled trial studies

in Gambia, Ghana, and Kenya documented a 17 to 63 % decrease in overall child mortality as result of ITN use. Together, these studies revealed the potential of ITNs to contribute significantly to global malaria prevention strategies (Lengeler et al., 1996). Additionally, technical progress had enabled the development of reliable, long-lasting insecticide treatment for the production of LLINs (Lindlade et al., 2005), and for impregnation or re-impregnation of nets with an insecticide formulation (Yates et al., 2005).

One of the initial objectives was to increase the use of ITNs among children under five years of age and pregnant women to greater than 60 % of the global population. The goal was later increased to 80% coverage by the year 2015 (WHO, 2008). However, in 2007, the effort to promote the use of LLINs shifted emphasis from focusing only on pregnant women and children under five years of age to a broader objective of "universal coverage" (WHO, 2008). Universal coverage of LLINs was defined as "full coverage with effective vector control of all people at risk of malaria," regardless of age or gender (WHO, 2008).

The World Malaria Report, 2011, estimated that about 88.5 million LLINs were delivered to malaria-endemic countries in Africa in 2009. That number increased to 145 million in 2010. The WHO estimated that about 50% of households in sub-Saharan Africa had at least one bed net, and 96% of persons with access used a LLIN (WHO, 2011). Wanzira et al. (2016) found that, following a mass distribution campaign in Uganda in 2013, about 83.1% of children under five years of age and 80% of the general population slept under a LLIN (Wanzira et al., 2016). That study also reported that 75.2% of children aged from six to fifteen slept under a LLIN. Universal coverage was achieved in this study, with 80% of the population using a LLIN (Wanzira et al., 2016).

A similar study conducted in Sierra Leone six months after a mass LLIN distribution campaign reported that 87.6% of households owned at least one ITN and 67% of households possessed more than one ITN (Bennett et al., 2012). Among household members who owned an ITN, 76.5% had slept under an ITN the night before the survey. The study concluded that mass distribution was effective in achieving high LLIN ownership and use across the population (Bennett et al., 2012).

A study by Plucinski et al. (2014) reported increased LLIN ownership in Sofala, Mozambique. Ninety-eight percent of households owned at least one LLIN one month after a 2010 mass distribution of LLINs (Plucinski et al., 2014). Post-campaign LLIN ownership was high, with 98% of households owning at least one LLIN in the one-year follow-up survey, and 93% of households reporting having received at least one LLIN during the campaign (Plucinski et al., 2014). Eighty-five percent of households reported receiving a number of LLINs during the campaign equal to the number of sleeping spaces in the households in 2010 and 86% reported the same in 2011. One year after the mass distribution campaign, 65% of sleeping spaces in the wet season and 60% of sleeping spaces in the dry season were reported to be covered by a LLIN (Plucinski et al., 2014). It was estimated that 81% of sleeping spaces in Sofala were covered with a LLIN in 2010 and 2011, respectively, amounting to universal coverage (Plucinski et al., 2014).

2.2.1. Universal Coverage of LLINs in DRC

According to the DHS-DRC, 2007, only 9% of DRC households owned at least one ITN (DHS-DRC, 2007). ITN ownership was highest in the Bas-Congo province at 33 %, and lowest in the Orientale province at 3%. Equatéur province including Nord-Ubangi at 3.9% (DHS-DRC, 2007). The DRC, through its National Malaria Control Program (NMCP), is in the midst of unprecedented efforts to rapidly scale up malaria intervention (Ntuku et al., 2017). As recommended by the WHO to achieve universal coverage of LLINs, the NMCP has adopted a

combined strategy of free mass distribution campaigns every three years and routine distribution through antenatal care visits and immunization services (WHO, 2014). Even though mass distribution has been reported to be the best strategy to achieve rapid scale up, routine, smaller scale distribution is also important to maintain high coverage levels (WHO, 2013; MOH-DRC, 2013).

Since the DRC adopted a free LLIN policy in 2006, more than 75 million people have received a LLIN through mass distribution across the country, leading to a tremendous increased in ownership and use (MOH-DRC, 2013; USAID, 2013). The overall proportion of households with at least one LLIN increased from 9% in 2007 to 70% in 2014 (DHS-DRC 2007; DHS-DRC, 2014). However, this dramatic increase in coverage from these interventions has not been achieved across all areas of the DRC (Ntuku et al., 2017). For example, the 2013-2014 DHS-DRC showed a strong coverage difference between provinces, with the Orientale and Kasaï Occidental provinces having the lowest ownership rates at about 47% and 58%, respectively. Furthermore, the lowest reported LLIN usage numbers were among children under five years of age in Kasaï Occidental at 36% (DHS-DRC, 2014).

However, Ntuku and his colleagues conducted a study in the Kasaï Occidental province in 2014 and found that households owning at least one LLIN increased from 39.4% pre-campaign to 91.4% post-campaign, and the percentage of households with at least one LLIN for every two people increased from 4.1% to 41% (Ntuku et al., 2017). Households' access to LLINs increased from 22.2% to 80.7%, while overall LLIN use increased from 18% to 68.3%. The high LLIN ownership rate was achieved using the fixed delivery strategy rather than the door-to-door hang-up strategy. The study indicated that mass distribution campaigns result in increasing LLIN ownership and use. These achievements need to be sustained for a long-term decrease in the malaria burden in the DRC (Ntuku et al., 2017).

The adoption of universal coverage of the LLINs as a preventive measure to control malaria transmission has been a very effective strategy, yielding an unprecedented decrease in the global burden of malaria (WHO, 2016). Although mass distribution campaigns have been widely accepted as the best approach to rapidly increase ITN coverage, there is a gap between LLIN ownership and use, mainly attributed to a lack of ability or a lack of willingness to hang the LLINs (Rickard et al., 2011; Macintyre et al., 2012).

2.3. Effectiveness of Door-to-Door LLIN Hang-up Campaigns in Sub-Saharan Africa

The door-to-door hang-up distribution strategy was developed in order to increase and sustain use of LLINs. Using this method, LLINs are delivered to households at the individual and the community levels to achieve high retention and usage of LLINs (Wang et al., 2016). Most of the literature shows that door-to-door hang-up assistance during LLIN mass distribution campaigns has increased LLIN use in communities (Ntuku, et al., 2017). However, the addition of door-to-door hang-up activities require a large commitment of resources, both financial and human (Kilian et al., 2015). Thus, door-to-door hang-up campaigns have costs even when carried out by community volunteers. Programs regularly utilize hang-up activities despite varying accounts of the effectiveness of the approach (Kilian et al., 2015).

The effectiveness of door-to-door hang-up activities in terms of ownership and use of LLINs was assessed by a study conducted by Ghana Promoting Malaria Prevention and Treatment (ProMPT) in 2009 (USAID, 2012). The study reported that door-to-door hang-up activities showed a significant increase in LLIN ownership and use rates among the population in the northern regions of Ghana (USAID, 2012). The study estimated that households owning at least one LLIN increased from 32.6% in 2008 to 98.1% in 2012 The study also found that 73% of LLINs were found hanging in 2012 compared to only 45% in 2008 (USAID, 2012). ProMPT

found that door-to-door hang-up activities to be very effective in increasing LLIN ownership and use in Ghana (USAID, 2012).

By contrast, a study conducted by Wang, et al., in rural Zambia reported that community point distribution increased the ITN retention and use rates more effectively compared to the door-to-door hang-up strategy (Wang et al., 2016). Of the households surveyed, 96.4% reported attending the community point distribution of ITNs and completing the self-installation. About 90.2% of distributed ITNs were still in the households at seven to eleven weeks post-distribution, and 85.7% were still in the households five to six months post-distribution (Wang & all, 2016). Retention rates did not differ between households that received the nets from Community Health Workers (CHW) and those that did not. While a CHW hang-up visit was associated with increased usage at seven to eleven weeks post-distribution, this difference was no longer apparent at five to six months (Wang & all, 2016). At seven to eleven weeks post-distribution, households had an average of 73.8% of sleeping spaces covered by an ITN, compared to 80.3% at five to six months. On average, 65.6% of distributed ITNs were hanging seven to eleven weeks post distribution, compared to 63.1% at five to six months.

A cluster randomized controlled trial study conducted by Kilian et al. (2015) in Uganda found that both initial hanging and sustained use of the LLINs increased in all three study arms in a similar ways (Kilian et al., 2015). The percentage of households who used a LLIN the night before the survey was about 64%, for one additional hang-up visit, 68.2% for two hang-up visits, and 64% for the control arm who did not received hang-up visit. The households with campaign LLINs hanging increased from 55.7% to 72.5% at the end line with no difference between study arms. The study indicated that hang-up assistance was effective in inducing a high level of hanging

LLINs and continued use; however, the study concluded that hang-up assistance was not cost-effective (Kilian et al., 2015).

However, Desroches et al. (2014) in their cluster randomized control trial study in Togo from 2011 to 2012 found that households that received door-to-door visits post- distribution were estimated to use LLINs 5% to 10% more than the control households, while LLIN ownership rates did not differ among the control arms and households receiving hang-up intervention (Desroches et al., 2014). Eight months post-distribution, children under five years of age and women of reproductive age in the arm that received all three intervention visits used the LLINs 11.3% to 14.4% more than the control arms (Desroches et al., 2014). The study concluded that door-to-door hang-up intervention had little effect on LLIN use among households, but did increase the message of LLIN use in the community in general (Desroches et al., 2014).

2.3.1. Door-to-Door Hang-up Campaigns in the DRC

Ntuku et al. (2017) estimated an increase in household ownership of at least one LLIN from 39.4% pre-campaign to 91.4% post-campaign in the Kasaï-Occidental province, DRC. The percentage of households with at least one LLIN for every two people also increased from 4.1% pre-campaign to 41.1% post-campaign. The higher LLIN ownership and use rates were reached using the fixed delivery strategy, as opposed to the door-to-door hang-up strategy (Ntuku et al., 2017). The total financial cost per LLIN distributed was $6.58 USD for the fixed distribution strategy compared to $6.61 USD for the door-to-door hang-up strategy. The study suggested that mass distribution was effective for rapidly increasing LLIN ownership and use rates. However, the fixed delivery strategy achieved higher LLIN coverage and use with a lower delivery cost compared with the door-to-door hang-up strategy (Ntuku et al., 2014).

2.4. LLIN Ownership and Usage in Sub-Saharan Africa

Long-lasting insecticide treated nets are a highly effective method of controlling and reducing the morbidity and mortality associated with malaria in endemic areas (Ntuku et al., 2017). Sustained high coverage of LLINs is important to achieve and maintain the reduction of the global malaria burden (WHO, 2015). However, the effectiveness of LLINs is not only measured by LLIN coverage, but also includes ownership rates and proper usage of the LLINs (Rickard et al., 2011).

Mass distribution campaigns have been shown to result in a fast increase in LLIN ownership and use in many countries (Bennett et al., 2012; Larson et al., 2014). Across sub Saharan Africa, several distribution methods such as fixed delivery and door-to-door hang-up delivery have been used with varying effects on LLIN coverage, ownership and use. Several factors affect LLIN use, including demographic characteristics; individuals' knowledge and beliefs about malaria and LLINs; family size; sleeping arrangements; LLIN characteristics; environmental factors; community and cultural characteristics; distribution strategy; and household net density (Macintyre et al., 2012; Bennett et al., 2012; Larson et al., 2014).

Rickard et al. (2011) conducted a study in Ghana of ITN usage after the implementation of hands-on instruction and assistance in the ITN hang-up process. The number of individuals who used an ITN increased significantly from 29% at baseline to 88.7% at six months, to 96.6% at twelve months (Rickard et al., 2011). Among children under five years of age, the ITN usage rates increased from 46% at baseline to 95.7% after six months, to 94.4 % at twelve months (Rickard et al., 2011). Gobena et al. (2012) conducted a similar study in Kersa, Ethiopia and reported that about 65% of the households interviewed had at least one LLIN, but only 33.5% of households that owned an LLIN had used at least one LLIN the night before the interview

(Gobena et al., 2012). The study indicated that only about one-third of households that owned a LLIN were actually using at least one LLIN for defense against mosquitoes bites (Gobena et al., 2012). Another study conducted by Biadgilign et al. (2012) in rural eastern Ethiopia found similar results to the Gobena et al. study. Biadgilign et al (2012) reported 62.4% of households owned a LLIN, but only 21.5% of households that owned a LLIN used at least one LLIN every night. The findings indicate a low LLIN ownership-to-utilization ratio in rural eastern Ethiopia (Biadgilign et al., 2012).

A study conducted in eastern Sierra Leone showed that 83.4% of households owned at least one LLIN, and in 94.1% of those households, the nets were observed hanging correctly (Gerst et al., 2010). Of 4,997 household members, 67.2% reported having slept under a LLIN the night before the survey, including 76.8% of children under five years of age and 73% of pregnant women. The study demonstrated that Sierra Leone was one of the few countries in sub-Saharan Africa to almost reach the WHO target of at least 80% coverage in 2010 (Gerst et al., 2010). **By contrast, Ndjinga and Minakawa, 2010, conducted a study outside of the Kinshasa province, DRC and found that less than 50% of household members older than the five years of age used LLINs** (Ndjinga & Minakawa, 2010).

Ezeigbo et al. (2016) conducted a study in Abia State, Nigeria, and found that 77.0% of participants reported being aware of ITNs, and of this number, only 38.6% owned at least one ITN (Ezeigbo et al. (2016). Approximately 47% of those who owned an ITN reported using an ITN every night, and 44.7% reported that ITNs were too hot to sleep under. The study team observed that, of those who did not use an ITN every night, 11.6% used ITNs as a fence on their farms (Ezeigbo & all, 2016).

2.5. Barriers to LLIN Use in Sub-Saharan African

Owning a LLIN is not enough to protect against malaria. To provide the maximum benefit, the owner of a LLIN must use it correctly and consistently. People in the community need to have a full understanding of malaria's presence, how the disease is transmitted, and treatment methods before net distribution will be successful in malaria prevention and control (Song et al., 2016). In recent years, many studies have suggested that a gap exists between households that own LLINs and households that effectively use the nets that they own. If a gap exists between net ownership and use, closing this gap would require a better understanding of the underlying reasons for the households' or populations' lack of proper LLINs usage (Rickard et al., 2010; Song et al., 2016). It is essential to know not only who is least likely to sleep under a LLIN, but also why they are not doing so (Rickard et al., 2010). This knowledge can be applied to malaria control programs and strategies aimed at increasing a populations' ability and willingness to use LLINs (Rickard et al., 2010).

Lover et al. (2011) found in Timor-Leste that there was uncertainty in the household about which family members could or could not sleep under the nets. The people surveyed believed the nets were only for use by pregnant women and young children. Net use also depended on the availability of sleeping spaces under a limited number of nets within the households (Lover et al, 2011). The shape of the ITNs was also considered a barrier to the use of nets. The participants also complained that the ITNs were too hot and too small. One couple reported that the ITNs forced them to sleep in different rooms. These grievances had a detrimental effect on ITN usage patterns. (Lover et al, 2011).

Pulford et al. (2011) reviewed seventeen survey-based studies and reported that discomfort, primarily due to heat, was the most widely-reported factor affecting whether ITN

owners chose not to use a bed net on one or more nights. The next most widely-reported reason for not using an ITN in a household was a perceived low mosquito density. This perception was reported by12.3% of all respondents in the combined data set, compared to 47.5% of respondents citing discomfort due to heat. This suggests that a perception of low mosquito numbers was widely reported, but often at a relative low frequency (Pulford et al, 2011).

Lengeler et al. (1996) reported that a population's knowledge, attitudes and practices affect its behavior and, by extension, its use of ITNs. In their book *Net Gain*, Lengeler et al. reported that the chemicals used to treat nets, heat and stuffiness, and the cost of ITNs were factors associated with choosing not to use an ITN among bed net owners (Lengeler et al, 1996). A study conducted by Chukwuocha et al. (2010) in Nigeria bears this theory out. Chukwuocha et al. reported that factors affecting the use of ITNs were included the high cost of ITNs; the belief that the chemicals used to treat ITNs would have dangerous effects on pregnancy; and poor utilization of health services, particularly antenatal care and delivery care, leading to missed opportunities to own an ITN or to be educated on how to use one (Chukwuocha et al, 2010).

Misuse of LLINs hinders NGOs and governmental health organizations in their malaria prevention efforts (Minakawa et al, 2008). A study conducted by Minakawa et al. (2008) around Lake Victoria in Kenya found that the majority of the villagers were not fully convinced of the effectiveness of ITNs for malaria prevention. The study noted significant misuse of ITNs for drying fish and fishing in the study region (Minakawa et al, 2008). Diema et al. (2017) found that, in the upper east region of Ghana, ITNs were used as window curtains and for warmth during cold weather. The ITNs were also used for nursing seedlings, protecting chickens, fishing, and fencing of animal pens (Diema et al, 2017). The study also identified a lack of access to ITNs, the cost of ITNs, room shape and size, lack of knowledge on usage, feelings of

claustrophobia, inappropriate handling and retreatment of the ITN, and design of ITNs as some of other factors affecting the use of ITNs (Diema et al, 2017).

A study by Toe et al. (2009) in Burkina Faso reported that the reasons for decreased use of ITNs were household members' conception of malaria, the inconvenience of using bed nets in small houses, and organization of the houses, which changed between day and night. They described a functional and temporal organization of the household space, where its use differed between daytime and nighttime. The interior household space, including the sleeping areas, served multiple functions. The attachment of the ITNs in such a space was not easy for the household members because, once set up, the ITNs were fixed, limiting the sleeping space arrangement and any other use of that part of the household. Additionally, it was difficult for them to hang the ITNs and take them down on a daily basis (Toe et al., 2009).

Addressing whether the chemical used in the ITNs is a main contributor to the non-use of ITNs, Gyapong et al. (1996) reported that very few people complained about side effects from the chemical. Reported side effects included slight skin irritation, especially during the first week after treatment when the smell of the chemical was strong (Gyapong et al 1996). In contrast, a study in Nigeria reported that the participants associated the use of the ITNs with poor pregnancy outcomes due to the chemical on the nets (Chukwuocha et al., 2010).

However, Awason et al. (2013) found that, in Nigeria, the lack of ITN ownership was the major barrier to ITN utilization, and educational level was a major determinant to ownership and use of ITNs. This was due to a strong association between education level and occupation and purchasing power--most of the study households purchased their own ITNs. In Rwanda, non-use of ITNs was also associated with poverty and level of education (Awason et al., 2013).

A study in Malawi by Dembo (2012) showed that beliefs about traditional methods of treating and preventing malaria, and the beliefs about ITNs as a cause of infertility and other reproductive disorders among married couples were the primary factors affecting the use of ITNs (Dembo,2012). Furthermore, most participants reported that using ITNs at night reduced sexual activity which could lead to reduced level of conceptions in families. Local communities further associated chemicals used to treat the nets as contraceptive methods used by the government (Dembo, 2012).

2.5.1. Barriers to LLIN Use in the DRC

Pettifor et al., (2008) reported that the cost of LLIN and education level were the reason for not owning a net by 48% of the 236 women who did not own one in Kinshasa, DRC. Women who had secondary school or higher education were 3.4 times more likely to own a net and 2.8 times more likely to have used a net compared to women with less education. Also married women were more likely to own a LLIN and sleep under a LLIN the night before the interview compared to single women. The study concluded that education was the most factors associated with non-use of LLINs among women seeking antenatal care in Kinshasa (Pettifor et al., 2008).

The overall majority of the literature reports that education level, discomfort due to heat, beliefs and cultural perceptions, cost of ITNs, and adequate knowledge about malaria transmission are factors associated with the use of LLINs in the population. The literature provides plenty of evidence that lack of knowledge about how to hang an LLIN correctly, lack of materials needed to hang an LLINs (ropes and nails), age, gender, education attained, wealth, urban/rural location, seasonality and weather were also associated with the use of LLINs

(Ngondi et al., 2011; Deribew et al., 2010; Pettifor et al., 2008) Therefore, many countries in sub-Saharan Africa have difficulty achieving the universal coverage goal of 80% of sleeping space covered by a LLIN.

2.6. Summary

As outlined here, malaria is a global public health issue. It has received a lot of attention as it contributes tremendously to the public health burden and causes the deaths of over 3 billion people worldwide (WHO, 2016). Although much literature exists regarding the malaria burden, the most effective actions for elimination of the disease have not yet been identified. Currently, control and prevention of malaria is a multifaceted chain of methods that often complement each another. In addition, the increased use and ownership of LLINs had shown decline in malaria prevalence and incidence cases globally, mostly in sub-Saharan Africa, including the DRC where malaria has a high prevalence. Even though mass distribution campaigns have increased coverage and has resulted in universal coverage in some countries, a gap between LLINs ownership and use still exists. Several studies have outlined different barriers to LLIN use at the individual, household and community levels.

CHAPTER THREE: RESEARCH METHODOLOGY

3.0. Introduction

This chapter outlines the methodology used to obtain information for the study, and the research methods adopted to ensure the credibility of the data and information acquired. The specific sub-headings in this section are “Research Design,” “Target Population,” “Indicators and Data Sources,” “Sample Size Procedure and Techniques,” “Data Collection and Research Instrument,” “Quality Control Measures,” “Data Analysis,” “Research Ethics Adopted for the Study,” and “Study Limitations and Delimitations”.

3. 1. Research Design

A post-LLIN distribution survey was conducted to evaluate the effect of the LLIN mass distribution campaign on LLIN use and ownership. A mixed methods study design was used to evaluate barriers to LLIN use and coverage, and to assess the effectiveness of door-to-door hang-up activities on increasing household use and ownership of LLINs. This study also assessed use and the condition of the LLINs in the period following the mass distribution campaign. The data presented here were collected from in June and July 2016 using a combination of qualitative and quantitative methods. Quantitative data provided a measurement of LLIN coverage among all households within the target population, while qualitative data provided an understanding of each individual household’s LLIN use and coverage. This mixed methods approach allowed for a fuller understanding and better expression of the views of the study households, and yielded more accurate descriptive statistics to support study findings. The specific research design adopted was a cross-sectional household survey and observational study which facilitated an in-depth understanding of the factors that influence the use of LLINs, such as door-to-door hang-up

activities, number of sleeping spaces, and barriers to sustained usage of the LLINs in the Nord-Ubangi province.

3.2. Target Population

Nord-Ubangi is one of 26 provinces comprising the Democratic Republic of the Congo (DRC). It is located in the extreme northwest of the DRC on the Ubangi River. Nord-Ubangi shares borders with the Central Africa Republic in the north, South Sudan in the northeast, the Sud–Ubangi province in the west, the Mongala province in the south, and the Bas-Uele province in the east. Nord-Ubangi has four territories—Bosobolo, Businga, Mobayi-Mbongo, and Yakoma, and it has one major city, Gbadolite. After the DRC obtained independence from Belgium in 1966 to 2015, Nord-Ubangi was administered as one of the five districts of the Equateur province. Nord-Ubangi's total area is about 56,644 sq. km. (21,870 sq. mi.) and it has a population of approximately 1.4 million. The official language of the province is French, though Lingala is the most widely-spoken language in the province.

Figure 7. Nord-Ubangi province administrative map
https://www.caid.cd/index.php/donnees-par-province-administrative/province-de-nordubangi/?donnees=fich

Nord-Ubangi is divided into eleven health districts which are subdivided into 144 health zones (Figure 8). This province-level PDCU of LLINs drew a sample of three out of eleven health districts that received LLINs. The specific areas where the household survey took place were in twelve health zones in the Bosobolo, Gbadolite, and Karawa health districts. The target population included all people living in the areas where the LLIN mass distribution campaign took place from December 2015 to July 2016. See Table 1 for the respective populations of the selected health districts.

Health Districts	Health Zones	Population 2016
ABUZI	14	76,757
BILI	17	186,463
BOSOBOLO	20	166,212
BUSINGA	13	128,985
KARAWA	24	252,838
LOKO	15	127,109
GBADOLITE	13	146,075
MOBAYI MBONGO	17	113,210
WAPINDA	11	79,292
WASOLO	13	73,793
YAKOMA	12	98,544
TOTAL	144	1, 449,279

Table 3.1: List of Nord-Ubangi health districts and corresponding populations (IMA, 2016)

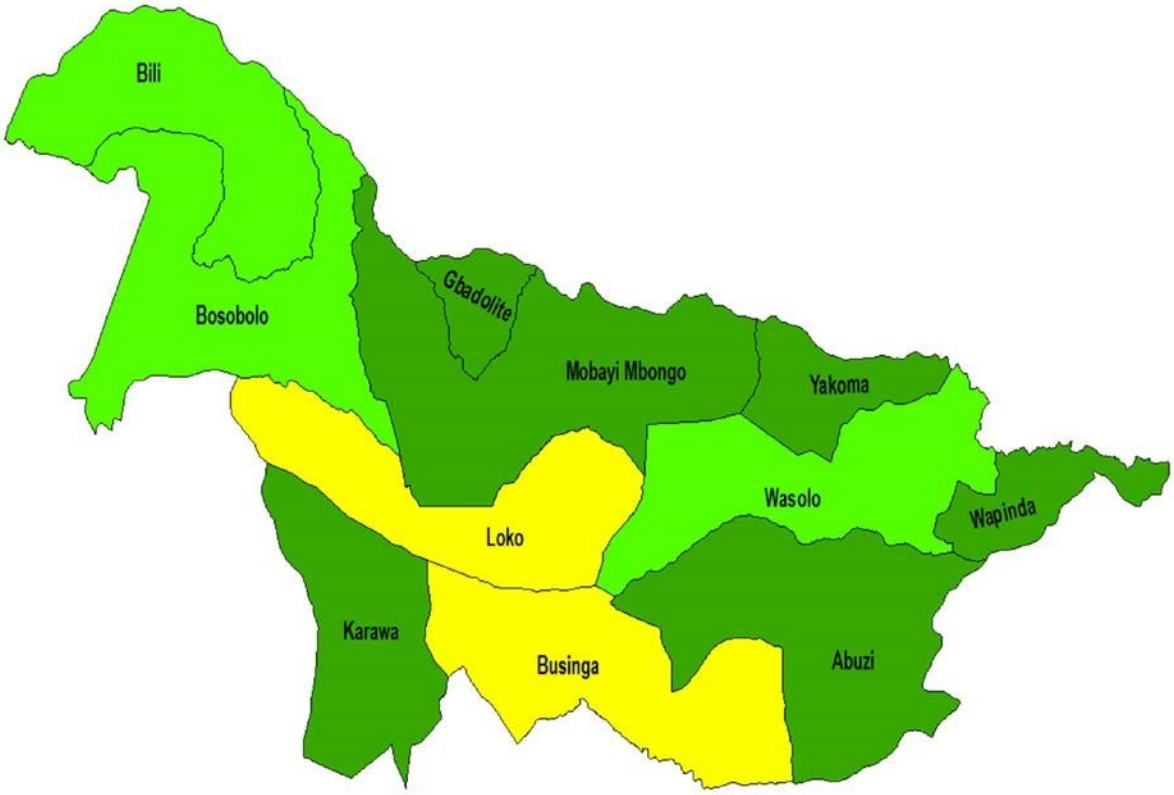

Figure 8: Nord-Ubangi health district map. (IMA)

3.3. Indicators and Data Sources

The data were collected at the household level and focused on key PDCU indicators adopted from standard Malaria Indicators Surveys. Five categories were evaluated: household LLIN ownership, household LLIN coverage, LLIN usage, LLIN hang-up methods and net condition, and household knowledge of the correct use of LLINs. Three of these indicators—household LLIN ownership, household LLIN coverage, and LLIN usage—are recommended by WHO for assessing universal coverage. The two other indicators—net hang-up methods and net condition, and knowledge of correct use of LLINs—were added because they are considered to provide a more accurate assessment of the effectiveness of door-to-door hang-up activities, and they provide a more thorough understanding of the barriers to sustained use of LLINs. These indicators were specific to the study (Tables 2 and 3).

Indicators	Unit of analysis	Definition
Household ownership of LLIN		
Proportion of households with at least one LLIN	Household	Proportion of households that received at least one LLIN during the campaign
LLIN label	Household /Observation	Number of LLIN with campaign label
LLIN in the package	Household/Observation	Number of campaign LLIN find in the package
Household LLIN coverage		
Number of sleep spaces	Sleeping spaces	Number of sleeping spaces counted by interviewer during the survey
Proportion of sleeping spaces covered by LLIN	Sleeping spaces	Proportion of sleeping spaces with a campaign LLIN designated for the sleeping spaces or proportion of LLIN observed to hung over a sleeping spaces
Proportion of sleeping spaces with a hung LLIN	Sleeping spaces	Proportion of sleeping spaces for which a campaign LLIN was found hanging from ceiling during household survey
Proportion of sleeping space covered by other LLINs		Proportion of sleeping spaces covered by other LLIN not from the campaign
Nets Usage		
Proportion of LLIN in the household not hung	Household/Observation	Proportion of campaign LLIN in the household but not hung over a sleeping space or proportion of LLIN observed to not be hung
Proportion of LLIN missing	Household	Proportion of campaign LLIN missing in the households at the time of the survey
LLIN usage video instruction	Household	Proportion of household member who watched the LLIN usage video instruction during the campaign
LLIN hang-up and Condition		
LLIN condition	Household/ Observation	Proportion of campaign LLIN with any hole, tear in the netting and split seams
Proportion of LLIN repaired	Household	Proportion of campaign LLIN repair in a household
Number of LLIN holes repaired	Household/ Observation	Number and size of holes repaired on campaign LLIN
Proportion of LLIN hung by Community Health Worker in household	Household	Proportion of campaign LLIN reported hung by a Community Health Worker
Proportion of LLIN hung by of household	Household	Proportion of campaign LLIN reported hung by head of household
Knowledge of correct use of LLINs		
Proportion of households sleeping under a LLIN every night	Household	Proportion of households reporting sleeping under a campaign LLIN every night correctly or proportion of HH that use LLIN

Proportion of households feeling comfortable sleeping inside a LLIN	Household	Proportion of households reporting feeling comfortable sleeping inside a campaign LLIN
Proportion of households who demonstrated sleeping under a LLIN	Household Observation	Proportion of households observed or demonstrate sleeping under a campaign LLIN

Table 3.2: Indicators Used to Evaluate Post-Mass Distribution LLIN Coverage in Nord-Ubangi province, DRC

Project Description	Performance Indicators	Means of Verification	Assumptions
Goal: To achieve universal coverage of malaria control interventions (sleeping space coverage at or above 80 % among the population of Nord-Ubangi	% of individuals with access to a LLIN in their household % of sleeping spaces covered by a LLIN	• Survey • Direct observation • Direct observation	• Availability of effective and affordable LLIN • The distribution of free LLINs will take place without interruption and will meet required volume
Purpose: 1. Access to and utilization of LLINs increased among the population of Nord-Ubangi	1a. % of households with at least one LLIN 1b. % of individuals who slept under a LLIN the previous night	• Household Survey • Household Survey	• Availability of LLINs • Availability of LLINs
		• Activity report	

Outputs 1.1: LLINs distributed to target population **1.2:** LLIN hang-up activities carried out by Community Health Workers (CHWs) in target population **1.3:** Target population demonstrate Increased knowledge toward the correct use of LLINs	1.1a. Number of LLINs distributed to target population 1.1b. Proportion of households with sufficient LLINs 1.2a. % of Community Health Workers who hang-up LLIN in target population 1.2b. % of sleeping spaces with a hung LLIN by CHWs 1.2c. Number of LLINs hung by CHWs 1.3a. % of the households who understand the use of LLIN correctly 1.3b. % of individuals feeling comfortable sleeping inside a LLIN	/program records • Household Survey • Household Survey • Household Survey • Household Survey • Direct Observation • Household Survey	• Funds available for distribution and communication camp • Availability of LLINs • Community Support • Enough Community Health Workers to hang-up LLIN • Availability of CHWs • High community awareness and acceptance of LLIN • LLIN accepted by household member
<u>Activities 1.1.1</u>: LLIN mass distribution Campaign **1.2.1<u>:</u>** Community Health Workers (CHWs) trained by master trainers on LLIN hang-up activities **1.3.1:** Educated the target population on LLIN use during the campaign	1.1.1a.Number of LLIN distribution campaigns 1.1.2a. Number of CHWs in participating in LLIN hang-up activities trained by master trainers 13.1. % of households who saw the LLIN usage video instruction	• Activity reports/programs records • Activity reports/programs records Household Survey •	• Funds available for distribution and communication campaign • Enough CHWs trained for hang-up activities The LLIN usage video instruction • able to function

Table 3.3: Logical Frameworks: LLIN Universal Coverage Post-Mass Distribution in Nord-Ubangi province, DRC

3.4. Sample Size Procedure and Techniques

The Nord-Ubangi province is divided into eleven health districts. The three health districts surveyed were selected as representative of the province. The sampling procedure was designed to obtain a representative sample of the province population and to include households in the four health districts that received LLINs during the mass distribution campaign conducted between December 2015 and July 2016.

The study used a multiple stage sampling technique consisting of convenience sampling and simple random sampling methods. Convenience sampling was used to select the surveyed health districts in the province due to the inaccessibility of some health districts. The simple random sampling method was used to select the health zones and households in each health district. Sixteen health zones, four from each health district, were selected. Next, researchers randomly selected 26 households from the each of the selected health zones to participate in the survey. A total of 416 households were selected to be surveyed.

The sample size calculation was obtained using OpenEpi software. The parameters included a total population of 751,588 for four health districts at 95% confidence coefficient, ± 5% confidence interval width, an estimated design effect (DEFF) of 1.0, and 100% percent response rate. A sample of 384 households was generated. This was rounded up to 390 households to be surveyed. The sample size was then adjusted to 416 households to have an equal number of households in each health district.

However, the household survey was ultimately conducted in only three health districts because the LLIN distribution campaign was delayed in Bili, one of the health districts originally included in the survey. Because of this, the sample size was readjusted to a total of 312 households in three health districts. In addition, at the time of the survey in one of the health

zones, Bosolindo II, seven households were not interviewed due to the absence of the head of the household. The final survey included 305 households that received LLINs during the mass distribution campaign in 24 clusters, with two clusters in each health zone. Three hundred and five heads of the household responded to the survey questionnaire. The researchers observed the use of LLINs among household members and counted the number of sleeping spaces in each household and the number of sleeping spaces covered by a LLIN. Through the questionnaire and observations, the researchers collected information from the 305 surveyed households on household ownership of LLINs, household LLIN coverage, LLIN usage, LLIN hang-up methods and net condition, and knowledge of correct use of LLINs.

3.4.1. Selection of Health Districts

A convenience sample of most accessible four out of eleven health districts in the NordUbangi province were selected to conduct the household survey due to the remoteness of the province's health districts. In each health district, health zones included in the LLIN mass distribution campaign were selected. **3.4.2. Characteristic of Health Districts**.

3.4.2.1. Gbadolite Health District

Gbadolite is located in the middle of the tropical forest, and it is the capital city of the Nord-Ubangi province. Gbadolite is best described as an urban area with people of all income and educational levels. The houses in the city are mostly detached house built with concrete, however, there are few mud and huts thatched houses. It is sometime called Gbado, for short, extends over 11.2 kilometers squares. Gbadolite was the home town of the former Zaire (DRC) president, Mobutu Sese Seko.

Mobutu made sure that the populations of Gbadolite enjoyed privileges that the rest of the province, including electricity, did not have. During Mobutu time, the city was transformed to luxurious city and the roads of the province were among the best maintained in the country.

He also built a dam and a hydroelectric power station on the Ubangi River, an international airport that could accommodate the Concorde, and three immense palaces. Now Gbadolite is home to several humanitarian organizations including United Nation High Commissioner for Refugees (UNHCR), Doctors Without Borders (MSF), World Vision, and many more due to the Central Africa Republic (CAR) conflicts. Most of the population migrated from Kinshasa, the capital city of the DRC for work.

Figure 9: LLIN hung over a sleeping space in a household in Gbadolite HD. Courtesy of Nadine Mushimbele

Figure 10: Gbadolite Airport. Courtesy of Nadine Mushimbele

3.4.2.2. Bosobolo Health District

Bosobolo is a small town in Nord-Ubangi Province. It is located in the north part of the Nord-Ubangi province, of which is bounded in the North by Central African Republic (CAR) whose Ubangi River separates the DRC and the CAR. Bosobolo is predominantly rural with most of the houses in the form of huts, mud and thatch. The population is mostly low income and low educational level. The main economic activities of the districts is farming and fishing.

Figure 11: LLIN hung over a sleeping spaces in a household in Bosobolo HD. Courtesy of Nadine Mushimbele

Figure 12: Type of house in Bosobolo health district. Google image.
http://keywordsuggest.org/gallery/660352.html

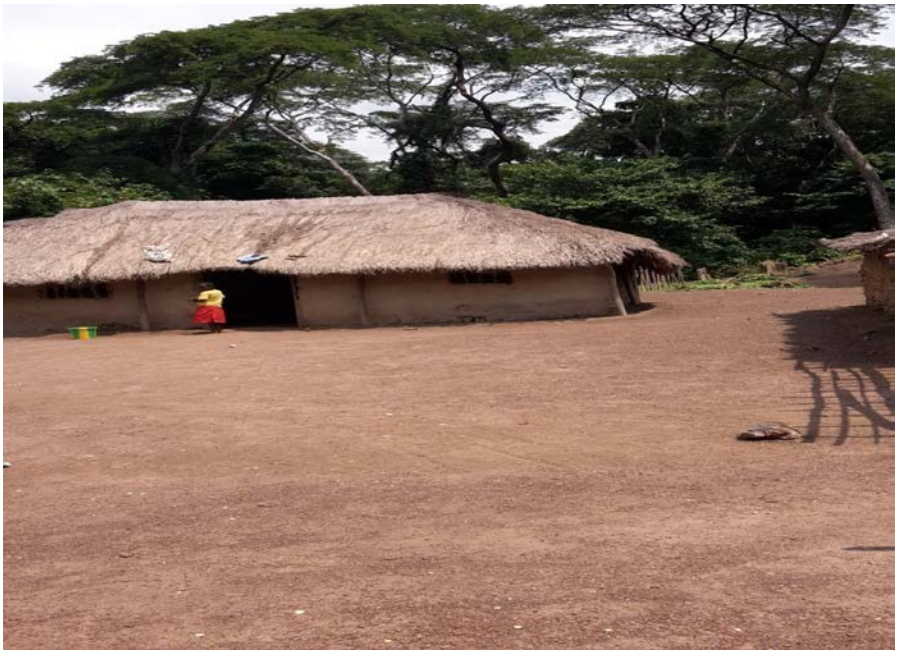

Figure 13: Health Center in Bosolindo II Health Zones, Bosobolo HD. Courtesy of Nadine Mushimbele

3.4.2.3. Karawa Health District

Karawa is also predominantly rural area with mixture of huts, mud and thatch and concrete houses. Karawa has a general Hospital serving the population of the district and surrounding villages. Karawa general hospital included physiotherapy, ophthalmology, dentistry, radiography and ultrasound services. The hospital was built in 1937 by the protestant missionary. The population of Karawa are predominantly low income and average educational level. The main economic activities is farming and exploitation of rubber and wood.

Figure 14: LLIN hung over a sleeping spaces in a household in Karawa HD. Courtesy of Nadine Mushimbele

Figure 15: LLIN hung over a sleeping spaces in a household in Karawa HD. Courtesy of Nadine Mushimbele

Surgery Department of Karawa Hospital

Figure 16: Surgery Department, of Karawa hospital in Karawa HD. Courtesy of Nadine Mushimbele

3.4.2. Selection of Health Zones

In each of the four health districts originally selected for inclusion in the study, the survey was to be conducted in a fixed number of health zones. These health zones were selected by simple random sampling method from the exhaustive list of all the health zones in the selected health districts. The names of all health zones in the four selected health districts were written on pieces of paper, which were folded and put into four different baskets representing each health district. The baskets were shaken thoroughly and four pieces of paper were picked by a person on the research team to determine the health zones for the study. Sixteen health zones, four from each health district, were selected. Ultimately the survey was conducted in only twelve health zones due to the exclusion of the Bili health district from the study. Each health zone had two clusters that included 26 households selected randomly for the survey.

3.4.3. Selection of Households

The study's sole household inclusion criterion was receipt of LLINs during the mass distribution campaign. Household who had not received LLINs during the mass distribution campaign were excluded. In each health zone, the households were divided into two clusters and then a simple random sampling was used to select the household to be surveyed. The focus point for clustering in rural areas was the village chief's house, and the focus point for clustering in urban areas was the health center. The focus points were used to randomly select the streets where the households would be interviewed. The streets formed the clusters. In the clusters, the first surveyed household was selected randomly from the left or right side of the street. Thirteen households were interviewed in each direction without skipping a house unless the house was empty or no one was available at the time of the survey. A total of 26 households were surveyed in each health zone. Household locations in each health zone were accessed and recorded using GPS.

3.5. Data collection and Research Instruments

The data was collected using structured household surveys and unstructured direct observations. The instruments which were employed in the data collection included survey questionnaires administered by the interviewer and an observational checklist (Appendix A). For the purpose of this study, three main indicators based on those used for standard Malaria Indicator Surveys were monitored and evaluated: household LLIN ownership, household LLIN coverage, and the condition and usage of the nets. LLIN "ownership" is defined as the proportion of households owning at least one LLINs; LLIN "coverage" is defined as the proportion of households with at least one LLIN per sleeping space; and "condition and usage"

is defined as the proportion of sleeping spaces for which an intact bed net without holes was found hanging from ceiling during the household visit (MERG, 2016).

The names of the health districts and health zones, including the location of the households, were recorded using a smartphone GPS device. Researchers recorded the number of sleeping spaces in each household, the condition and use of nets in the households, the type of LLIN used, and the label on the LLINs. If a net was present but not hung, the reason given to the interviewer was recorded. In addition, the number of repaired LLINs was recorded. The householders' knowledge of the correct use of LLINs was assessed and tested, including when and how to use LLINs. The reason for any missing LLINs was also recorded. The door-to-door hang-up activities were assessed by asking the head of the household who hung up the LLIN in his or her house. The LLINs and sleeping spaces were verified by the interviewer who checked for the presence of LLINs, the type of LLIN used, and if the LLIN was from the mass distribution campaign.

3.5.1. Survey Questionnaire

The questionnaire was adapted from the standard Malaria Indicator Survey. However, the survey differed from the standard Malaria Indicator Survey in that no blood tests were conducted and some of the indicators were specific to the research study. The questionnaire contained 20 questions classified into five categories: household ownership of LLINs, household LLIN coverage, net usage, net hang-up methods and net condition, and the head of the household's knowledge of correct use of the nets. The questionnaires were translated into French and administered in Lingala by the interviewer. The interviews were conducted by the principal investigator, who spoke Lingala. The interviewer explained the purpose of the survey to each

head of the household before administering the survey or conducting any observations. Signed consent was obtained from each head of the household.

3.5.2. Unstructured Observations

Unstructured observations were conducted in households during the interview. Direct observation took place after obtaining the written consent of the head of the household. Each household was visited unannounced. These observations focused on aspects of LLINs usage and coverage including the location of sleeping spaces, number of sleeping spaces in the households, the ways LLINs were hung over sleeping spaces, and the condition and type of the nets. The observation also focused on the aspect of the hang-up process and community health workers activities during the mass distribution campaign of LLINs. At the end of each day of data collection activities, the researchers described these observations in a notebook, including descriptive notes, comparisons with observations conducted at the other households, reflexive notes, and a list of key themes and topics relevant to the observations. At the end of each survey, the data were downloaded onto the interviewer's personal computer for data storage and analysis.

The data collected from the questionnaires and observations were programmed into a Microsoft Excel spreadsheet which was loaded into the Open Data Kit program. After the first stage of cleaning, the data set was transferred to Epi Info 7.2 and SAS 9.4 for a second stage of cleaning and analysis.

3.6. Quality Control Measures

This section outlines the different methods and systems that were adopted to ensure that study instruments were valid and reliable.

3.6.1. Validity of the Questionnaire

The validity of an instrument is the extent to which the instrument measures what it is intended to measure. To ensure the validity of the questionnaires, draft copies were given to some Emory University Healthcare Emergency Room employees, who read through them and made necessary corrections. The questionnaires were also subjected to critique by friends and classmates to check for mistakes and completeness. After this review, the questionnaires were sent to the researcher's supervisor in the field for further review for completeness and accuracy. The study questionnaires were then piloted using World Vision's employees at its Gbadolite office. Judging from the responses to the pilot study, participants clearly understood the questions and the questions were not confusing. The questionnaires were comprehensive enough to collect the information needed to address the purpose and goal of the study. All data collected were entered into EpiInfo 7.2 and SAS 9.2 software to compare missing and accuracy of the data to ensure validity and quality.

3.6.2. Reliability of the Questionnaire

To ensure reliability of the instruments used for the study, a pilot test was conducted using employees at World Vision's office in Gbadolite. The participants in the pilot study had the same characteristics as the study participants at the research sites in the region. The researchers chose this pilot location because Gbadolite was one of the health districts chosen for inclusion in the study. The researcher and pilot participants discussed any vagueness, doubt, and incoherencies that pilot participants encountered in the draft questionnaires. The pilot study helped to remove unclear questions, and all corrections and changes were made before data collection. The survey tool was also pretested for consistency and validity with participants who were not within the study health zones. Pretesting was conducted in Gbadolite because it has a

blend of both rural and urban characteristics. The Gbadolite health district also has social, cultural, and geographical characteristics similar to the other study districts.

3.7. Data Analysis Technique

In order to ensure the quality of the data, the interviewer carefully supervised all stages of data collection. The interviewer was responsible for the accuracy of data collected in the field. She ensured that the data was collected in accordance within standards and guidelines of the research purpose. At the end of each day, the data were checked for consistency or missing information. Controls were programmed directly on the smartphones used for data collection, thus limiting the need for data cleaning. All completed surveys were double-entered using Microsoft Excel to verify accuracy of the data entry whenever possible. Back-up files of the database were created after each survey. Both Excel spreadsheets were compared and any inconsistency in the data was verified using the original questionnaires. For quality control, the check of the household surveys was programmed directly into the Open Data Kit software used for data collection to reduce the need for data cleaning, to limit the entry of incorrect data, and to ensure entry of data into required fields.

After data entry and cleaning, the data was analyzed using EpiInfo 7.2 software and SAS 9.2 software. Descriptive statistics were produced— the categorical data were summarized as a proportion, and the numerical data were summarized as an average with standard deviation. Multiple linear regression was used to assess whether covariates were associated with the use of LLINs. Covariates considered included independent variables like door-to-door hang-up activities, number of sleeping spaces in the household, LLIN ownership, LLIN condition, and comfort when sleeping under a LLIN. Dependent variables included sleeping spaces coverage by LLINs. Data from unstructured observation were used to understand the barriers to sustained use

of LLINs among the households, and the data were used as a guideline to interpret findings and form preliminary theories for the evaluation.

3.8. Ethical Considerations

The study was reviewed and approved by Institutional Review Boards at the Emory University Rollins School of Public Health, the University Of Kinshasa School Of Medicine, and the DRC Ministry of Health. In addition, survey questionnaires were reviewed and approved by the chief medical officer of each health district before administration. Written informed consent was obtained from the heads of the household before each interview took place. The household heads were assured of maximum confidentiality and were provided the right to opt out at any time they deemed necessary during interview after being briefed on the objectives, study procedure, and rationale of the survey and the voluntary nature of participation.

3.9. Limitations and Delimitations

3.9.1. Limitations

The survey methodology had several limitations. The survey was conducted in three health districts selected for convenience due to road condition, remoteness of some health districts, and limited time to complete the surveys in all selected health zones. A small sample size was chosen as representative of eleven health districts for a post-distribution check-up on the LLINs. The survey was conducted during the peanut harvest seasons. The interviewer reported difficulty interviewing all heads of the household during the day in one of the health zones (Bosolindo II). Also, the survey was conducted one week after the mass distribution of the LLINs in two of the health districts (Bosobolo and Karawa) instead of four to six months post distribution.

The study was limited to a small but representative sample of the Nord-Ubangi study population because of time and resource constraints. Also, while the study assessed LLIN coverage, LLIN usage, effectiveness of door-to-door hang-up activities, and knowledge of correct use of the nets to assess barriers to sustained LLIN use, it did not visit all of the health districts who received the LLINs during the mass distribution campaign. However, as households were representative of the study health districts, generalization of this study was necessary as poor roads condition rendered some health districts and health zones inaccessible.

3.9.2. Delimitations

This study is limited to LLIN coverage, usage, ownership, and condition; effectiveness of door-to-door hang-up activities; and household heads' knowledge about correct use of LLINs. Special focus will be placed on LLIN use, LLIN coverage, the extent to which the door-to-door hang-up activities increase LLIN use, and the barriers to sustained use of LLINs among the population of the Nord-Ubangi province.

CHAPTER FOUR: RESULTS

4.0. Introduction

This chapter analyzes and systematically presents information and data gathered in the field from structured questionnaires and direct observation. The findings and results of the study are organized by study objectives, which were as follows: (1) to determine household ownership and utilization of LLINs; (2) to determine the number of sleeping spaces covered with an LLIN to evaluate whether universal coverage was achieved; (3) to assess the effect of door-to-door hang-up of LLINs on household use of LLINs; (3) to assess the use and condition of LLINs post mass distribution campaign; and (4) to assess the knowledge of correct use of LLINs in order to evaluate barriers to sustained use of LLINs in the Nord- Ubangi province. The results are based on a response rate of 98%.

4.1. Survey Questionnaire Response Rate

The survey questionnaire response rate for this research study was 98 % as shown in Table 4.1.

Category	Frequency	Percentage
Households surveyed	305	98
Households not surveyed	7	2
Total	**312**	**98**

Table 4.1: Survey Questionnaire Response Rate

Table 4.1 shows a total of 305 (98%) participant households participated in the survey while only seven (2%) did not participate. The high response rate was attributed to the interviewer personally going to the field to collect data every day. Since this was a household survey, the seven households that were not interviewed were those in which the head of the household was absent or the household was empty at the time of the survey.

4.2. Overview of the Results

A mass distribution of LLINs took place in Nord-Ubangi from December 2015 to July 2016. During the campaign, 668,162 LLINs were distributed in eleven health districts in order to achieve coverage of all sleeping spaces (universal coverage) in the province. Of the 668,162 LLINs distributed, 257,181 were distributed in the Bosobolo, Gbadolite, and Karawa health districts, which were the study districts. A total of 305 households that received an LLIN during the mass distribution campaign were surveyed in three out of eleven health districts to evaluate the effect of the LLIN mass distribution campaign.

Among the 305 (100%) households surveyed, all reported receiving a campaign LLIN (see Table 4.2). The survey showed that a total of 1,262 LLINs were received during the campaign, with an average of 4.1 LLINs received per surveyed household across all three health districts (mean (M) =4.1, standard deviation (SD) =2.0). In terms of LLIN ownership, the number of households with at least one LLIN resulted in a finding of 100% among surveyed households (see Table 4.2). The proportion of household ownership of at least one LLIN after was significantly higher in all three health districts.

The total number of sleeping spaces reported by households was 1275, and the number counted by the observer was 1,246 sleeping spaces (M=4.0, SD=1.7) as shown in Table 4.2. During the observation of 305 households, and 608 (M=2.0, SD=1.8) of the observed sleeping spaces were covered with one LLIN from the campaign. The proportion of sleeping spaces covered by a campaign LLIN among the 305 households surveyed was 48% (608). This percentage was lower than the 80% goal of the 2015-2016 distribution campaign. As a result, in terms of usage, the proportion of sleeping spaces actually covered by a designated campaign LLIN was very low and did not reach universal coverage (see Table 4.2).

In terms of LLIN utilization in the household, results showed that of the 1,262 LLINs received by study participants, 654 (52%) (M=2.3, SD=2.0) of LLINs were present in the households but not hung at the time of the survey. The main reasons given by the heads of the household for not using campaign LLINs were sleeping spaces used for different activities during the day, lack of materials to hang LLINs, not enough LLINs for sleeping spaces, and some households reported lacking of knowledge necessary to hang LLINs (especially older adults) (see Table 4.4). In terms of the condition of LLINs, of 305 households interviewed, 305 (100%) reported that none of the campaign LLINs had a hole at the time of the survey (Table 4.2).

Indicators	**Health Districts**	
	Total (%)	Mean (Standard Deviation) per household
Household ownership of LLINs		
Number of LLIN received in Household 1262 Proportion of household with at least one LLIN	**100%**	
Household LLINs coverage		
Number sleeping spaces	1246	4.1 (1.7)
Number of sleeping spaces covered by LLIN Proportion of sleeping spaces covered by LLIN	608 **48%**	2.0 (1.8)
Number of other nets covering sleeping spaces Proportion of other nets covering sleeping spaces	264 **21%**	0.86 (1.4)
Nets usage		
Number of LLIN in the household not hung Proportion of LLIN in the household not hung	654 **52%**	2.3 (2.0)
Nets condition		
Number of the holes repaired	0	0.0 (0.0)

Table 4.2: Descriptive Statistics Summary of Mean and Standard Deviation of Indicators for Health Districts

Of the 305 households surveyed, 302 (99%) had LLINs with a campaign label and three (1%) did not have LLINs with a campaign label. As shown in Table 4.3, 283 (93 %) of campaign

LLINs were unpacked and 22 (7%) were found still in the packaging. Of the 305 households interviewed, no household reported LLINs received during the campaign as missing (see Table 4.3).

Among those households surveyed, 305 (100%) reported not having seen the LLIN instruction video during the mass distribution campaign. Of the 305 households interviewed, 293 (96%) reported that the LLINs received during the campaign were in very good condition, while twelve (4%) reported the campaign LLINs were in good condition. When asked, 280 (92%) households reported hanging their own LLINs. Only 25 (8%) of surveyed households reported that at least one of their LLINs was hung by community health workers (CHWs) during the campaign. Of the 305 households interviewed, 305 (100%) reported that none of the LLINs received during the campaign had required repair at the time of the survey (see Table 4.3).

As shown in Table 4.3, of the 305 households who received a campaign LLIN, 244 (80%) reported sleeping under the LLIN every night, while 61 (20 %) reported not sleeping under a campaign LLIN every night. Of the 61 households who reported not sleeping under a LLIN, the reasons given were 5 (8%) households reported discomfort due to heat, 2 (3%)being claustrophobic, 1 (2%) allergies to chemical in the LLIN, 20 (33%) not enough LLINs for each sleeping space, and 8 (13%) lack of knowledge and assistance to hang the LLIN(Table 4.4). 15 (25%)reported that lack of materials and tools for hanging LLIN and 10 (16%) reported that sleeping spaces use for other daily activities were also barriers to LLIN use (Table 4.4). Out of the 305 households surveyed, 301 (99%) reported feeling comfortable sleeping inside a campaign LLIN, and only four households (1%) reported not feeling comfortable. The reasons given for not sleeping inside of a campaign LLIN were discomfort due to heat (3%), allergies to the chemical in the LLIN (2%), and claustrophobia (3%) (see Table 4.4). Of the 305 households

interviewed, 303 (99%) demonstrated correct use of an LLIN, while two (1%) households did not demonstrate correct use of an LLIN during the survey. The reasons given for incorrect use of an LLIN were lack of knowledge of how to use an LLIN (1%), LLIN not being hung because the sleeping space was used for other activities during the day(1%), and not able to hang the LLIN (1%), (see Table 4.3).

Indicators	Health Districts	
	Response Frequency (%)	
	YES	NO
Household ownership of the LLINs		
LLIN label	302 (99 %)	3 (1%)
LLIN in the package	22 (7%)	283(93%)
Nets Usage		
Proportion of LLIN missing	305 (100%)	0
LLIN usage video instruction	0	305 (100%)
Hang-up and nets condition		
LLIN condition VERY GOOD GOOD	293 (96 %) 0	0 12 (4 %)
Proportion of LLIN hung by: Community Health Workers Households	25 (8 %) 280 (92 %)	0 0
Proportion of LLIN repaired	0	305 (100%)
Knowledge of correct use of the nets		
Proportion of HH sleeping under a LLIN every night	244 (80 %)	61 (20 %)
Proportion of HH feeling comfortable sleeping inside a LLIN	301 (99 %)	4 (1 %)
Proportion of HH who demonstrated sleeping under a LLIN	303 (99 %)	2 (1 %)

Table 4.3: Descriptive Frequency and Percentage of Indicators Across Health Districts

Indicators	Health Districts
	Frequency (%)
Lack of knowledge and assistance to hang the LLIN	8 (13%)
Lack of materials and tolls for hanging LLIN	15 (25%)
Not enough LLIN for each sleeping space	20 (33%)
Sleeping spaces use for other daily activities	10 (16%)
Discomfort due to heat	5 (8%)
Feeling of claustrophobia	2 (3%)
Allergies to chemical in the LLIN	1 (2%)

Table 4.4: Distribution of Barriers to LLIN Use Across Health Districts

The table below indicates that out of the 305 households surveyed, 1262 campaign LLINs and 264 non-campaign were counted during the household survey. 30% of sleeping spaces covered was the percent goal achieved in Bosobolo, 65 % in Gbadolite and 52% in Karata Health Districts. The overall percent goal achieved by campaign and non-campaign LLIN covering sleeping spaces was 58% in Bosobolo, 88% in Gbadolite and 62% in Karawa Health Districts (see Table 4.5). However, this study was unable to access all 11 health districts to better evaluate the mass distribution campaign goal set.

Health Districts	Number of Households	Number of LLINs		Percent sleeping spaces covered		Campaign goal (80% coverage %)	Percent goal achieved campaign LLIN	Percent goal achieved by campaign and noncampaign LLINs
		Campaign LLINs	Non campaign LLINs	Campaign LLINs	Non campaign LLINs			
Bosobolo	97	403	111	120 (30%)	111 (28%)		30%	58%
Gbadolite	104	470	103	286 (65%)	103 (23%)		65%	88%
Karawa	104	389	50	202 (52%)	50 (12%)		52%	62%

Table 4.5. Distribution of Overall Campaign Goal Achieved Across Health Districts

4.3 Findings Per Indicator Across Health Districts

This section presents the summary of findings and results of the study by health district.

4.3.1 Household Ownership of LLINs by Health Districts

Household Ownership in the Bosobolo Health District

Of the 97 households surveyed in the Bosobolo health district, 97 (100%) reported owning at least one campaign LLIN. Surveyed households in Bosobolo received 403 (32 %) of the 1,262 campaign LLINs received by all 305 households surveyed across the three health districts. Among the LLINs received by households in the Bosobolo health district, 400 (99%) had a campaign label, and three (1%) did not have a campaign label. Of the 403 campaign LLINs received by the 97 households surveyed, 400 (99 %) were unpacked and three (1%) were still in the original packaging (see Table 4.6).

Indicators	Total Households	Frequency (%)	
		YES	NO
Proportion of campaign LLINs in Bosobolo households	97	403 (32%)	0%
LLIN with campaign label	97	400 (99%)	3 (1%)
LLIN in the packaging	97	3 (1%)	400 (99%)

Table 4.6: Household LLIN Ownership in Bosobolo Health District

Household Ownership in the Gbadolite Health District

Of the 104 households interviewed in the Gbadolite health district, 104 (100%) reported owning at least one campaign LLIN. The households surveyed in Gbadolite received 470 (37%) of the 1,262 LLINs counted during the survey. Of the 470 campaign LLINs received by Gbadolite households, 468 (99.6%) had a campaign label and two (0.4%) did not have a campaign label. Of the 470 campaign LLINs, 451 (96%) were unpacked and 19 (4%) were still in the original packaging at the time of the survey (see Table 4.7).

Indicators	Total Households	Frequency (%)	
		YES	NO
Proportion of campaign LLINs in Gbadolite households	104	470 (37%)	0%
LLIN with campaign label	104	468 (99.6%)	2(0.4%)
LLIN in the packaging	104	19 (4%)	451 (96%)

Table 4.7: Household LLIN Ownership in Gbadolite Health District

Household Ownership in the Karawa Health District

Of the 104 households surveyed in the Karawa health district, 104 (100%) reported receiving at least one campaign LLIN. As shown in Table 4.7, households in Karawa received 389 (31%) of 1,262 campaign LLINs distributed among surveyed households. All of the 389 LLINs received by Karawa households had a campaign label at the time of the interview. All of the 389 campaign LLINs received by households in Karawa were unpacked at the time of the survey (see Table 4.8).

Indicators	Total Households	Frequency (%)	
		YES	NO
Proportion of campaign LLINs in Karawa households	104	389 (31%)	0%
LLIN with campaign label	104	389 (100%)	0%
LLIN in the packaging	104	0 (0%)	389 (100%)

Table 4.8: Household LLIN Ownership in Karawa Health District

4.3.2 Household LLIN Coverage by Health District

LLIN Coverage in the Bosobolo Health District

A total of 411 sleeping space were reported by households interviewed in the Bosobolo health district. The total number counted by the interviewer was 400. The 400 counted sleeping spaces comprised 32% of the 1,246 sleeping spaces counted across the three surveyed health districts. Of the 400 sleeping spaces counted in Bosobolo, **120 (30%) were covered by a**

campaign LLIN, and **111 (28 %) were covered by a non-campaign LLIN** (see Table 4.9 and Table 4.12).

Indicators	Total Households	Frequency (%)	
		YES	NO
Number of sleeping spaces	97	400 (32%)	0%
Proportion of sleeping spaces with a hung campaign LLIN	97	120 (30.0%)	0%
Proportion of sleeping spaces covered by other LLIN	97	111 (28%)	0%

Table 4.9: Household LLIN Coverage in Bosobolo Health District

LLIN Coverage in the Gbadolite Health District

Of the 104 households interviewed in the Gbadolite health district, 446 sleeping spaces were reported by households, and 439 sleeping spaces were counted by the interviewer. The counted sleeping spaces comprised 35% of the total 1,246 sleeping spaces counted across the three surveyed health districts. Of these 439 sleeping spaces, **286 (65%) were covered by a campaign LLIN at the time of the survey**, and **103 (23 %) were covered by a non-campaign LLIN** (see Table 4.10 and Table 4.12).

Indicators	Total Households	Frequency (%)	
		YES	NO
Number of sleeping spaces	104	439 (35%)	0%
Proportion of sleeping spaces with a hung campaign LLIN	104	286 (65%)	0%
Proportion of sleeping spaces covered by other LLIN	104	103 (23%)	0%

Table 4.10: Household LLIN Coverage in Gbadolite Health District

LLIN Coverage in the Karawa Health District

The 104 households interviewed in the Karawa health district reported 418 sleeping spaces, whereas the total number counted by the interviewer was 407. The 407 sleeping spaces counted

in Karawa comprised 33% of the 1,246 total sleeping spaces counted across the three surveyed health districts. Of these 407 sleeping spaces, **202 (50%) were covered by a campaign LLIN,** and **50 (12%) were covered by a non-campaign LLIN** (see Table 4.11 and Table 4.12).

Indicators	**Total Households**	**Frequency (%)**	
		YES	**NO**
Number of sleeping spaces	104	407 (32.7%)	0%
Proportion of sleeping spaces with a hung campaign LLIN	104	202 (52%)	0%
Proportion of sleeping spaces covered by other LLIN	104	50 (12%)	0%

Table 4.11: Household LLIN Coverage in Karawa Health District

Indicators	**Bosobolo**	**Gbadolite**	**Karawa**
	Frequency (%)	**Frequency (%)**	**Frequency (%)**
Proportion of sleeping spaces covered by a campaign LLIN	120 (**30%**)	286 (**65%)**	202 (**50%**)
Proportion of Sleeping spaces covered by other LLIN	111 (**28%**)	103 (**23%)**	50 (**12%)**
Proportion of sleeping spaces covered by a campaign LLIN and other LLIN	231 (**58%)**	389 **(88%)**	252 **(62%)**

Table 4.12: Distribution of Campaign and Non-Campaign LLINs Covering Sleeping Spaces

4.3.3 LLIN Usage Per Health District

LLIN Usage in the Bosobolo Health District

Out of the 403 LLINs received in the Bosobolo health district during the campaign, 283 **(**70.0%) were reported not hung by households at the time of the survey. As shown in Table 4.12, all 97 surveyed households reported that none of the campaign LLINs were missing at the time of the interview. Ninety-seven households reported not having seen the LLIN instruction video during the campaign (see Table 4.13).

Indicators	Total Households	Frequency (%)	
		YES	NO
Proportion of LLIN not hung	97	**283 (70%)**	0%
Proportion of LLIN missing	97	0%	97 (100%)
LLIN usage video instruction	97	0%	97 (100%)

Table 4.13: LLIN Usage in Bosobolo Health District

LLIN Usage in the Gbadolite Health District

Of the 470 campaign LLINs received by households surveyed in the Gbadolite health district, 184 (39.2%) reported not hung by households at the time of the interview. Of the 104 households interviewed, 104 (100%) reported that none of the campaign LLIN were missing. All 104 (100%) households reported not having seen the LLIN instruction video during the campaign (Table 4.14).

Indicators	Total Households	Frequency (%)	
		YES	NO
Proportion of LLIN not hung	104	184 (39.2%)	0%
Proportion of LLIN missing	104	0%	104 (100%)
LLIN usage video instruction	104	0%	104 (100%)

Table 4.14: LLIN Usage in Gbadolite Health District

LLIN Usage in the Karawa Health District

A total of 187 (48 %) out of 389 campaign LLIN received by 104 households interviewed in the Karawa health district were not hanging over the bed at the time of the survey. A total of 104 (100%) households reported that none of the campaign LLINs were missing. All of the 104 (100%) surveyed households reported that they did not see the LLIN instruction video during the campaign (see Table 4.15)

Indicators	Total Households	Frequency (%)	
		YES	NO
Proportion of LLIN not hung	104	**187(48%)**	0%
Proportion of LLIN missing	104	0%	104 (100%)
LLIN usage video instruction	104	0%	104(100%)

Table 4.15: LLIN Usage in Karawa Health District

Indicators	Bosobolo	Gbadolite	Karawa
	Frequency (%)	Frequency (%)	Frequency (%)
Proportion of HH that own at least one LLIN	97 (100)	104 (100%)	104 (100%)
Proportion of HH that sleep under LLIN every night	64 (66%)	94 (90%)	86 (83%)
Proportion of HH that did not sleep under LLIN every night	33 (34%)	10 (10%)	18 (17%)
Proportion of LLIN observed to be hung over sleeping spaces	120 (30%)	286 (65%)	202 (50%)
Proportion of LLIN observed not to be hung over sleeping spaces	283 (70%)	184 (39%)	187 (48%)
Proportion of sleeping spaces covered by other LLIN	111 (28%)	103 (23%)	50 (12%)

Table 4.16: Summary of Household LLIN Ownership and Usage Rates

Table 4.16 shows the summary of ownership and usage of the LLIN across all three districts. The ownership in the surveyed health districts was high at 100%, every household received at least one campaign LLIN. However, the LLIN usage differed across health districts, 65 % of LLINs received in Gbadolite HD were observed to be hung over sleeping spaces, 50% in Karawa HD and 30% in Bosobolo HD during the survey (see Table 4.16). It was also observed that 70 % of LLIN were not hung in Bosobolo HD, 48 % in Kawara HD and 39% in Gbadolite HD. These results show a low usage of campaign LLIN especially in Bosobolo HD. On the other hand, 90% of HH in Gbadolite HD reported sleeping under the LLIN every night, 86 % in Karawa HD and 64% in Bosobolo HD. The proportion of HH sleeping under LLIN every night was high because HH reported using non-campaign LLIN during the night, 28% in

Bosobolo HD, 23% in Gbadolite HD and 12% in Karawa HD (see Table 4.16). Combining both the proportion of campaign LLIN and the proportion of non-campaign LLIN used by the HH show an increase in usage which help achieve universal coverage in Gbadolite HD with 88% of sleeping spaces covered with a LLIN but for other two health districts; 62% in Karawa HD and 58% in Bosobolo HD (see Table 4.12 and 4.16).

4.3.4 LLIN Hang-up and Condition by Health District

LLIN Hang-Up and Condition in the Bosobolo Health District

Out of the 97 households interviewed in the Bosobolo health district, 96 (98.97%) reported hanging their own campaign LLIN, and only one (1.03%) household reported that at least one of the campaign LLINs was hung by CHWs. Of the 97 households surveyed, 97 (100%) reported that the campaign LLINs were in very good condition, did not have any holes, and had not been repaired at the time of the survey (see Table 4.17)

Indicators	Total Households	Frequency (%)	
		YES	NO
LLIN condition: Very Good	97	97(100%)	0%
Good	97	0%	0%
Proportion of LLINs repaired	97	0%	97 (100%)
Number of LLINs holes repaired	97	0%	97 (100%)
Proportion of LLINs hung by CHWs	97	1 (1.03%)	0%
Proportion of LLINs hung by households	97	96 (98.97%)	

Table 4.17: LLIN Hang-Up and Condition in Bosobolo Health District

LLIN Hang-Up and Condition in the Gbadolite Health District

Of the 104 households surveyed in Gbadolite health district, 104 (100%) reported hanging their own campaign LLINs. Of those 104 households, 92 (88.46%) reported that the campaign LLINs were in very good condition, while twelve (11.54%) reported that the campaign

LLINs were in good condition. Out of the 104 households interviewed, 104 (100%) reported that the campaign LLINs did not have any holes and had not been repaired at the time of the interview (see Table 4.18).

Indicators	Total Households	Frequency (%)	
		YES	NO
LLIN condition Very Good Good	92 12	92 (88.5%) 12 (11.5%)	0% 0%
Proportion of LLIN repaired	104	0%	97 (100%)
Number of LLIN holes repaired	104	0%	97 (100%)
Proportion of LLIN hung by CHWs	104	0%	104 (100%)
Proportion of LLIN hung by households	104	104 (100%)	

Table 4.18: LLIN Hang-Up and Condition in Gbadolite Health District

LLIN Hang-Up and Condition in the Karawa Health District

Of the 104 households surveyed in Karawa, 80 (77%) reported hanging their own campaign LLINs, and 24 (23%) reported that at least one of the campaign LLINs was hung by CHWs during the campaign. Of the 104 households interviewed in Karawa, 104 (100%) reported that the campaign LLINs did not have any holes, were in very good condition, and had not been repaired at the time of the interview (see Table 4.19).

Indicators	Total Households	Frequency (%)	
		YES	NO
LLIN condition Very Good Good	104 104	104 (100%) 0%	0% 0%
Proportion of LLIN repaired	104	0%	100 (100%)
Number of LLIN holes repaired	104	0%	100 (100%)
Proportion of LLIN hung by CHWs	104	24(23%)	0%
Proportion of LLIN hung by households	104	80 (77%)	0%

Table 4.19: LLIN Hang-Up and Condition in Karawa Health District

4.3.5. Knowledge of Correct LLIN Use by Health District

Knowledge of Correct LLIN Use in the Bosobolo Health District

Of the 97 households surveyed in the Bosobolo health district, 64 (66%) reported sleeping under an LLIN every night, while 33 (34%) reported not sleeping under an LLIN every night. The reasons households provided for not sleeping under an LLIN every night included 3 (9%) sleeping spaces were used for different activities during the day, 6 (18%) not enough LLINs for sleeping spaces, 4 (12%) lack of knowledge and assistance for hanging an LLIN, 16 (49%), 2 (6%) discomfort due to heat, lack of materials and tools for hanging LLIN and feelings of claustrophobia 1 (3%) (see Table 4.21). Out of these 97 households, 95 (98%) reported feeling comfortable sleeping inside an LLIN, and two (2%) reported not feeling comfortable sleeping inside an LLIN. The primary source of discomfort reported by household was heat. Of the 97 households surveyed, 95 (98%) demonstrated sleeping under an LLIN correctly, and two (2%) did not demonstrate sleeping under an LLIN correctly (see Table 4.1). The main reasons reported by household for not sleeping under an LLIN were that not enough LLINs for sleeping spaces (18%) and a lack of materials to hang the LLIN (49%) (See Table 4.20 and 4.21).

Indicators	Total Households	Frequency (%)	
		YES	NO
Proportion of households sleeping under an LLIN every night	97	64 (66)%	33 (34%)
Proportion of households feeling comfortable sleeping inside an LLIN	97	95 (98%)	2 (2%)
Proportion of households who demonstrated sleeping under an LLIN	97	95 (98%)	2 (2%)

Table 4.20: Knowledge of Correct LLIN Use in Bosobolo Health District

Indicators	Frequency (%)
Lack of knowledge and assistance to hang the LLIN	4(12%)
Lack of materials and tolls for hanging LLIN	16 (49%)
Not enough LLIN for each sleeping space	6 (18%)
Sleeping spaces use for other daily activities	3(9%)
Discomfort due to heat	2 (6%)
Feeling of claustrophobia	1(3%)
Allergies to chemical in the LLIN	1 (3%)

Table 4.21: Distribution of Barriers to LLIN Use in Bosobolo Health District

Knowledge of Correct LLIN Use in the Gbadolite Health District

Of the 104 households interviewed in the Gbadolite health district, **94 (90%) reported sleeping under an LLIN every night** and ten (10%) reported not sleeping under an LLIN every night. Of the 104 households surveyed, 103 (99%) reported feeling comfortable sleeping inside an LLIN and one (1%) reported not feeling comfortable sleeping inside an LLIN. The reported sources of discomfort included heat 2 (20%), not enough LLIN for each sleeping spaces 4 (40%), sleeping spaces use for other daily activities 2 (20%), lack of materials and tools for hanging LLIN one (10%) and lack of knowledge and assistance to hang the LLIN one (1%), (see Table 4.23). Of the 104 households interviewed in Gbadolite, 104 (100%) demonstrated sleeping under an LLIN (see Table 4.22). Based on observation, the high household LLIN use in the Gbadolite

health district might be because is the capital city of Nord-Ubangi and the majority of the population have secondary or higher educational level, compared to Bosobolo and Karawa.

Indicators	Total Households	Frequency (%)	
		YES	NO
Proportion of households sleeping under an LLIN every night	104	94 (90%)	10 (10%)
Proportion of households feeling comfortable sleeping inside an LLIN	104	103 (99%)	1 (1%)
Proportion of households who demonstrated sleeping under an LLIN	104	104 (100%)	0

Table 4.22: Knowledge of Correct LLIN Use in Gbadolite Health District

Indicators	Frequency (%)
Lack of knowledge and assistance to hang the LLIN	1(10%)
Lack of materials and tolls for hanging LLIN	1 (10%)
Not enough LLIN for each sleeping space	4 (40%)
Sleeping spaces use for other daily activities	2 (20%)
Discomfort due to heat	2 (20%)
Feeling of claustrophobia	0%
Allergies to chemical in the LLIN	0%

Table 4.23: Distribution of Barriers to LLIN Use in Gabolite Health District

Knowledge of Correct LLIN Use in the Karawa Health District

Of the 104 households surveyed in the Karawa health district, 86 (83%) reported sleeping under an LLIN every night and 18(17%) reported not sleeping under an LLIN every night. The reasons given for not sleeping under an LLIN every night were not enough LLINs for sleeping spaces 9 (50%), sleeping spaces use for other daily activities 4(22%), and lack of knowledge and assistance to hang the LLIN 3 (17%) (see Table 4.25). Of the 104 households surveyed, 103 (99%) reported feeling comfortable sleeping inside an LLIN. One (1) household reported not feeling comfortable sleeping inside an LLIN because of discomfort due to heat, feeling of

claustrophobia 1 (5.5%) and 1(5.5%) allergic to chemical in the LLIN. Of the 104 households in Karawa, 104 (100%) demonstrated sleeping under an LLIN correctly (see Table 4.24 and Table 4.25).

Indicators	Total Households	Frequency (%)	
		YES	NO
Proportion of households sleeping under an LLIN every night	104	86 (83%)	18 (17%)
Proportion of households feeling comfortable sleeping inside an LLIN	104	103 (99%)	1 (1%)
Proportion of households who demonstrated sleeping under an LLIN	104	100 (100%)	0

Table 4.24: Knowledge of Correct LLIN Use in Karawa Health District

Indicators	Frequency (%)
Lack of knowledge and assistance to hang the LLIN	3 (17%)
Lack of materials and tolls for hanging LLIN	0%
Not enough LLIN for each sleeping space	9 (50%)
Sleeping spaces use for other daily activities	4 (22%)
Discomfort due to heat	0%
Feeling of claustrophobia	1 (5.5%)
Allergies to chemical in the LLIN	1 (5.5%)

Table 4.25: Distribution of Barriers to LLIN Use in Karawa Health District

4.4. Other Findings

A total of 268 bed nets were found in the households during the survey which the households did not receive from the campaign. Of these 268 nets, 264 (21%) were covering sleeping spaces and four (1.5%) were still in the original packaging. On average, about one-third of the sleeping spaces were covered with a bed net other than a campaign LLIN. At least 111 of the observed non-campaign nets covered sleeping spaces in the Bosobolo health district, 103 covered sleeping spaces in the Gbadolite health district, and 50 covered sleeping spaces in the Karawa health district (see Table 4.15).

The multiple linear regression analysis results showed that the proportion of households owning at least one LLIN (p value= <0.0001) and the proportion of campaign LLINs not hung over sleeping spaces (p value= <0.0001) were found to be significantly associated with predicting the proportion of sleeping spaces covered by a LLIN. Proportion of LLINs other than the campaign LLINs, LLIN hang-up activities, discomfort when sleeping inside an LLIN, and number of sleeping spaces in the households were not significantly associated with predicting sleeping spaces covered by a campaign LLIN.

4.5. Unstructured Observations Results

Unstructured observations were conducted in households during the survey and mass distribution campaign of LLIN. These observations focused on the aspect of LLIN use including number of sleeping spaces, number of campaign LLIN covering sleeping spaces and condition of the LLIN. Also the observation focused on the aspect of the hang-up process and community health workers activities during the mass distribution campaign of the LLINs. It was observed that households reported a total of 1275 sleeping spaces, while the observer counted 1246 sleeping spaces across all three districts. The observation showed that 48 % (608) sleeping spaces were covered by a campaign LLIN, while 52% (654) were not hung. The observer also reported that 264 (21%) of non-campaign LLIN were covering sleeping spaces during the households' observation.

The observer spent couple days with the community health workers at two health districts (Bosobolo and Karawa HD) to observe the logistics of the mass distribution campaign in order to evaluate the door-to-door hang-up campaign. It was observed that there were few CHWs (24) to carry out the campaign activities in one health districts which include many health zones as well as many villages. Also there was only one field supervisor during the mass-distribution

campaign to manage all the logistics of the campaign including LLIN and materials procurement, transportation from- to the field, safety of materials and the supervision of 24 CHWs. The observer reported that time limit set by the campaign was also a reasons the door-to-door hang- up activities was not effective, it was observed that the time limit was one week to carry out all the distribution in each health district that was difficulty to accomplish if the CHWs had to hang-up 2 or more LLINs in a households. For example, Karawa HD has 24 health zones, and these health zones have multiple villages and some of them in very remote area where only a motorcycle or bicycle can reach; hang-up activities could not have being carried out appropriately due to transportation issues. Finally, it was also observed that CHWs were not appropriately trained on the hang-up process because the CHWs were trained for a week and they had to train community volunteer to assist them during the distribution. The community volunteers were trained for three hours before started the distribution using the ODK to collect distribution data at the same time. Most of the community volunteers never used a phone and CHWs had to paid the community volunteer incentives from their own salary. All these factors were associated with the ineffectiveness of door-to-door hang-up campaign in Nord-Ubangi province.

4.6. Summary of Findings

This PDCU incorporates two types of data--a structured survey of heads of households and direct observation. Each section describes a different indicator to evaluate the household LLIN ownership and utilization levels LLINs; to assess the effect of door-to-door hang-up activities on household use of LLINs; to assess the use and condition of LLINs; and to assess the knowledge of correct use of LLINs in order to evaluate the barriers to sustained use of LLINs in Nord-Ubangi province, DRC. Overall, the proportion of households owning at least one

campaign LLIN was significantly high across the health districts. Only 48% of sleeping spaces were covered by a campaign LLIN at the time of the survey, with high coverage in the Gbadolite health district. Sleeping spaces coverage was lower than the 80% coverage goal set during the campaign. However, when the proportion of sleeping spaces covered by campaign LLINs is combined with the proportion of sleeping spaces covered by non-campaign bed nets in Gbadolite health districts, the 80% goal for universal coverage was reached.

The usage rate of LLINs was about 50% lower than the rate of ownership. The main reasons given by the head of the households for not using LLINs were sleeping spaces used for different activities during the day (16%), lack of materials (25%), lack of knowledge and assistance to hang a LLIN (13%), and not enough LLINs for sleeping spaces (33%). Overall, the LLINs surveyed were in very good condition and there were no holes. The door-to-door hang-up activities by CHWs did not influence the households' use of LLINs. Only 8% of households reported that the campaign LLINs were hung by CHWs. Overall, most of the households surveyed had sufficient knowledge to enable correct use of LLINs

CHAPTER FIVE: DISCUSSION AND CONCLUSION

5.0. Introduction

This section presents a summary of the research findings, discusses the results, and draws conclusions regarding universal coverage of LLINs, the effectiveness of door-to-door LLIN hanging campaigns, LLIN ownership and usage, and barriers to LLIN use for the prevention of malaria in Nord-Ubangi province.

5.1. Main Findings

By observing all sleeping spaces during the household survey and counting sleeping spaces, it was possible to determine the rate of coverage, usage, and ownership of campaign LLINs, the effectiveness of the door-to-door hang-up activities, and barriers to LLIN usage following a free mass-distribution in Nord-Ubangi province. The proportion of households that received at least one campaign LLIN was 100% across all three health districts. Within these households, 48% of sleeping spaces were covered by a campaign LLIN, and 80% of households surveyed reported sleeping under the LLINs every night. When combining the proportion of non-campaign LLINs and campaign LLINs covering sleeping spaces, 48% coverage increases to 69% coverage across all three health districts.

Even though the survey participants reported sleeping under the nets every night, 52% of campaign LLINs were not hung, and 20% of households reported not sleeping under a campaign LLIN every night because the LLINs were not hung. Together, these circumstances result in incomplete protection of the population, with only 48% of observed sleeping spaces covered by hanging LLINs. Therefore, the campaign did not achieve its objective of covering 80% of sleeping spaces (universal coverage).

The reasons for low sleeping space coverage were ineffective door-to-door hang-up activities; lack of space in the households, sleeping spaces used for other activities during the day, lack of materials to hang LLINs, not enough LLINs for sleeping spaces, and lack of knowledge necessary to hang the LLINs (especially among older adults). A few households also reported discomfort from heat, allergies to the chemical in the LLINs, and feelings of claustrophobia as barriers to using LLINs.

The study showed that door-to-door hang-up campaign activities were not carried out appropriately as planned by the campaign. Of the 305 households surveyed, 280 (92%) hung their own campaign LLINs, compared to only 25 (8%) of households in which at least one campaign LLIN was hung by CHWs. The door-to-door hang-up activities were carried out once during the mass distribution, the CHWs responsibility were to hang at least two LLIN per households while distributing the LLINs. The results indicate that door-to-door hang up assistance did not increase the households' use of LLINs to the point of achieved universal coverage as planned by the campaign.

5.1.1. Universal Coverage

The use of LLINs is a highly efficient method of controlling and reducing the mortality and morbidity associated with malaria in endemic areas. Sustained high coverage of LLINs is important to achieve and maintain the reduction of malaria burden (Ntuku et al., 2017; WHO, 2008). WHO has set universal coverage, defined as full coverage with effective vector control, as the goal for all people at risk of malaria (WHO, 2008). Free mass-distribution campaigns are a cost-effective way to quickly achieve high and equitable LLIN coverage in at-risk populations (Zou et al.2014). The mass-distribution campaign evaluated by this study defined 'universal

coverage' as 80% of all sleeping spaces covered by a designated campaign LLIN. The results of the study indicate that this goal was not achieved by the campaign.

The observation showed that LLINs were not equally distributed among households. During the observation, the interviewer noticed that some households received more LLINs in relation to the number of counted sleeping spaces, and some households received fewer LLINs in relation to the number of sleeping spaces in the household. This shows a failure on the part of the campaign to count accurately the number of sleeping spaces per household, especially in those households that use the sleeping spaces for other activities during the day. The proportion of sleeping spaces with a designated campaign LLIN and the proportion of sleeping spaces over which campaign LLINs were found hanging from the ceiling during the survey were very low in this study compared to the study conducted in Sofala province in Mozambique. In that study, it was reported that 81% of sleeping spaces were covered by campaign LLINs and 85% of the population slept in sleeping spaces covered by designated campaign LLINs (Plucinski et al., 2014).

Also, a study conducted in Sierra Leone six months after a mass-distribution campaign found that when limiting the maximum number of LLINs one household can receive, households with more than five sleeping spaces were less likely to have sufficient LLINs to cover all sleeping spaces (Bennett et al., 2012). In this study, the percentage of sleeping space coverage was highest in the Gbadolite health district at 65%, followed by Karawa at 52%, and then Bosobolo at 30%. The high coverage in Gbadolite, could be attributed to the fact that it is the capital of Nord-Ubangi province and majority of households have high education level compare to Bosobolo and Karawa HD.

5.1.2. Effectiveness of Door-to-Door Hang-Up Campaigns

The door-to-door hang-up campaign was developed in order to increase and sustain the use of LLINs among populations at risk of malaria. Using this method to deliver LLINs to households at the individual and community levels helps achieve high retention and usage of LLINs (Wang et al., 2016). Most of the literature shows that door-to-door hang-up activities have increased LLIN use in the communities (Ntuku et al., 2017). In this study, door-to door hang-up activities was defined as the proportion of campaign LLIN hung by CHWs.

In a study conducted in the northern regions of Ghana, ProMTP found door-to- door hang-up activities to be very effective in increasing LLIN ownership and use, finding 73% of households with hanging LLINs in 2012, compared to only 45% in 2008 before the initiation of the door-to-door hang-up activities in Ghana (USAID, 2012). In this study, the effectiveness of door-to-door hang-up process was evaluated using the proportion of LLIN hung by CHWs and the unstructured observation. This study's findings are contrary to the findings of ProMTP. This study found that door-to-door hang- up activities were ineffective at increasing household use of LLINs, with only 8% of households reporting that at least one of their campaign LLINs was hung by a CHW. Only one household in Bosobolo HD reported that CHWs hung their LLIN. In Karawa, 24 households reported that CHWs hung at least one LLIN, and in Gbadolite, no household reported that CHWs had hung LLINs.

These findings are consistent with studies conducted in in rural Zambia and in Kasaï Occidental province, DRC. In Zambia, Wang et al. (2016) reported that community point distribution was more effective in increasing LLIN use and retention compared to door-to-door hang-up activities (Wang et al., 2016). Nkutu et al. (2017) reported that higher LLIN ownership and use rates in Kasai Occidental province were achieved by using the fixed delivery strategy, as

opposed to the door-to-door hang-up strategy (Ntuku et al., 2017). Based on the unstructured observation, the reasons the door-to-door hang-up activities were not effective across the health districts were too few CHWs to carry out the campaign activities, lack of CHWs supervision during the mass-distribution campaign, time limits set by the campaign, and lack of appropriate CHW training on the hang-up process.

5.1.3. LLIN Ownership and Usage

Combined efforts to scale up universal coverage of LLINs through free mass-distribution campaigns in Nord-Ubangi province have quickly increased ownership of the LLINs, but have not increased usage of LLINs (Table 4.15). The universal coverage goals set by the WHO--in terms of the proportion of households owning at least one LLIN and the proportion of the population with access to a LLIN within the household--have been achieved (WHO, 2008). The results of this study are consistent with what is well-known about the ability of free mass distribution campaigns to rapidly scale-up LLIN coverage in low-coverage areas (Bennett et al., 2012; Larson et al., 2014). However, in at least one study conducted in Abia State, Nigeria, only 38.6% of households owned at least one LLIN after a mass-distribution campaign of LLINs (Ezeigbo et al, 2016).

Even though mass-distribution campaigns have been accepted as the best approach to rapidly increase LLIN coverage, there is still a gap between LLIN ownership and use, mostly attributed to the lack of ability or willingness to hang the LLINs by households (Rickard et al., 2011; Macintyre et al., 2012). Findings from this study showed that ownership of LLINs was very high across the three districts surveyed in Nord-Ubangi province. However, this high ownership rate did not translate to a high usage rate. Similar results were reported in a study conducted in Kersa, Ethiopia, where 65% of households owned at least one LLIN, but only 35%

of these households reported using the LLINs the night before the survey (Gobena et al., 2012). Another study conducted in rural eastern Ethiopia found also similar results. In that study, 62.4% households owned an LLIN, but only 21.5% of households that owned a LLIN used at least one LLIN every night (Biadgilign et al., 2012).

Compared to both studies conducted in Ethiopia, LLIN usage in households was higher in this study. The proportion of campaign LLINs observed in the households not hung was 52%; however, the proportion of households who reported sleeping under an LLIN every night was 80%, and only 20% of households reported not sleeping under an LLIN every night. This high proportion of households reporting using LLINs nightly is attributable to the use of LLINs from previous campaigns in some households. In terms of the mass-distribution campaign evaluated by this study, the usage was low across all three health districts, with 70% of the campaign LLINs not hung in the Bosobolo health district, followed by 48.08% in Karawa, and 39.15 % in Gbadolite.

Even though the 80% coverage target set by the campaign was not met in this study, there has been a noticeable improvement in terms of usage and ownership when compared to the proportion of usage reported in the DRC Demographic Health Survey in 2007 (DHS-DRC, 2007). This shows that with more effort and increased education more than 80% coverage could be achieved.

5.1.4. Barriers to LLIN Use

As showed by the literature and by the findings in this study, the barriers to sustained use of LLIN are more complex than can be addressed by a national malaria control program alone. It is essential to know not only who is least likely to sleep under a LLIN, but also why they are not doing so (Rickard et al., 2010; Song et al., 2016).

The findings of this study showed that households demonstrated understanding the correct use of an LLIN, and the households understood that the primary use of an LLIN within the household was to sleep under to protect one's self from mosquito bites and malaria. In this study, no households reported using the LLINs for reasons other than sleeping, unlike in the study conducted around Lake Victoria in Kenya by Minakawa et al. (2008). Minakawa et al. reported that LLINs were used for drying fish and fishing in the study region (Minakawa et al., 2008). A similar study conducted in the upper region of Ghana reported that LLINs were used for nursing seedlings, protecting chickens, fishing, and as animal pen fencing (Diema et al., 2017).

This study found that there are several common barriers to LLIN use. Households reported lack of knowledge and assistance to hang LLINs (especially older adults); lack of materials and tools for hanging LLINs; not enough LLINs per sleeping space; feelings of claustrophobia; and discomfort due to heat. Use of sleeping spaces for different activities during the day made hanging LLINs on a daily basis difficult. Other reported barriers include allergic reactions to the LLIN chemicals, and not enough rope and nails to hang every single. These barriers were similar in all three health districts surveyed, with the main barriers being not enough LLINs for every sleeping spaces, lack of materials and tools to hang the LLINs, and lack of knowledge and assistance to hang LLINs. Interestingly, many studies conducted in sub Saharan Africa reported similar barriers to the use of LLINs, including discomfort due to heat, lack of knowledge about how to hang a LLIN correctly, lack of materials and tools (ropes and nails), education level, and use of sleeping spaces for other activities during the day (Pettifor et al., 2008; Deribew et al., 2010; Ngondi et al., 2011).

Despite a dramatic increase in LLIN ownership, it was observed that even households with a sufficient number of LLINs, enough materials, and enough knowledge to hang the LLINs still had low LLIN usage rates. This suggests a behavioral pattern is driving the low LLIN usage rates. The low LLIN use rate obviously puts the households and community at higher risk of malaria (Rickard et al., 2010; Song et al., 2016). While remarkable efforts are being made to increase ownership of LLINs, it is also essential that national malaria programs focus on developing communications strategies focused on behavior changes, and plan to facilitate sustained LLIN usage both at the households and community levels.

5.2. Study Limitations

There were some limitations to the methodology used for this study. The study was cross-sectional and was conducted in three out of eleven health districts in Nord-Ubangi province. The surveyed health districts were selected for convenience due to road conditions and the remoteness of some health districts and health zones. Though the interviewer observed LLINs owned by households and counted sleeping spaces, most LLIN-related findings reported in this study were drawn from data reported by households, thus they may be subject to information bias. In the Bosobolo and Karawa health districts, the survey was conducted one week after distribution instead of four months after distribution. The survey was conducted during the peanut harvest season. This means that, despite the fact that the interviewer made a reasonable effort to administer the survey to all randomly selected households, in the Bosobolo health district, no one was present at some of the households selected. As a result, the interviewer conducted the survey at fewer households than expected.

5.3. Conclusion

This evaluation study was conducted in three health districts in Nord-Ubangi province after a free LLIN mass-distribution campaign to evaluate the LLIN coverage rates, the effectiveness of door-to-door hang-up activities, rates of LLINs ownership and usage, and the barriers to LLIN use among households. The study showed substantial improvement in LLIN ownership but not in LLIN coverage, LLIN usage, or in the effectiveness of door-to-door hang-up activities. Based on the findings of this study, ownership of LLINs was evenly distributed among all three health districts. This reflected the massive scale-up of LLIN mass distribution campaigns in the DRC.

Although most of the campaign targets were not met, much progress has been made. It was found that lack of sufficient LLINs for all sleeping spaces was the major determinants of LLIN use among the households in reaching universal coverage. Also, door-to-door hang-up activities were found to be ineffective on increasing households' LLIN usage rates because of the lack of sufficient CHWs in the field, and lack of supervision during the campaign. The study found several barriers to LLINs use among households across all three health districts, including lack of knowledge and assistance to hang LLINs, insufficient LLINs for all sleeping spaces in some households, lack of materials to hang LLINs, use of sleeping spaces for other activities during the day, feelings of claustrophobia, and discomfort due to heat. Therefore, to attain and sustain universal coverage, additional promotion measures and new distribution strategies need to be considered. These findings also suggest that a revision of door-to-door hang-up activities and the mass-distribution campaign LLIN guidelines would go a long way toward covering all sleeping spaces endemic areas. Efforts to improve the use of LLINs must extend further than sharing information about the benefits of LLIN use. Malaria programs must create

communications strategies that target behavior patterns currently preventing effective LLIN use among households.

CHAPTER SIX: RECOMMENDATIONS

6.0. Introduction

This was a cross-sectional study aimed to evaluate universal coverage of LLINs, the effectiveness of door-to-door LLIN hang-up activities, rates of LLIN ownership and usage, and barriers to LLIN use post-mass-distribution campaign in Nord-Ubangi province. The study has demonstrated the feasibility of LLIN use in households. The study also suggests there is need for improvement among NGOs and other malaria prevention programs.

6.1. Recommendations

Awareness of LLINs has become universal, and almost all households now own at least one LLIN. After assessing the barriers to LLIN use, the effectiveness of door-to-door hang-up activities, and LLIN usage among households, the following recommendations are suggested:

1. Coverage of LLINs in Nord-Ubangi province can be increased by incorporating behavior change communication models and other behaviors education measures during the mass distribution campaign and after.
2. Before free mass-distribution of LLINs, it is important to identify all sleeping spaces within the households and to define sleeping spaces in the context of the population of interest (living room and kitchen can be sleeping spaces at night, for example). This will help provide households with sufficient LLINs for each sleeping space.
3. The study revealed households' indifferent hang-up practices as one of the major barriers to regular LLIN use. Because of this, it is recommended that malaria prevention programs train CHWs to continue visiting households to reinforce LLIN use.
4. Malaria prevention programs need to consider household characteristics, including the type of the house, in order to design appropriate LLINs that will fit sleeping spaces.

5. In the context of the present study setting, fixed delivery strategies are recommended for LLIN distribution, combined with follow- up of door-to-door hang-up assistance to increase LLIN use and coverage. Additional distribution strategies need to be researched and new distribution methods need to be implemented.
6. To increase the LLIN usage rates, malaria prevention programs must incorporate culturally sensitive messaging, capitalize on positive use of LLINs, and reinforce behaviors that already exist in the households and communities. Community-based education on malaria and the importance of the use of LLINs should be done continuously by the health districts after a mass-distribution campaign.
7. It is important that any future mass-distribution campaign using door-to-door hang-up activities consider training a sufficient number of CHWs, and provide adequate supervision and assistance to CHWs during the distribution. Malaria prevention programs should review guidelines of door-to-door hang-up activities, increase the number of hours for CHW training, and provide enough supervision during the mass distribution campaign.

6.2. Recommendations for Further Research

There are other factors that influence sustained use of LLINs at the household and community levels that need further investigations. This study suggests the following research priorities:

1. Understand individual, household, and community level cultural barriers to LLIN use in the Nord-Ubangi province,

2. Improve NGO performance by identifying effective CHW training methods, and by identifying how much support and supervision CHWs require during door-to-door hangup activities.
3. Determine why households have difficulty using LLINs in Nord-Ubangi province, regardless of whether they are urban or rural, and irrespective of their education and income level.
4. Evaluate distribution strategies to determine optimal strategies to assure universal coverage of all sleeping spaces.
5. Using longitudinal research designs, monitor households in Nord-Ubangi province or other parts of the DRC to determine if households sleep under LLINs every night throughout the year and if that protects them from contracting malaria.

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APPENDICES

APPENDIX 1: SURVEY QUESTIONNAIRE (ENGLISH)

1. How many sleeping spaces are there in your household?
2. May I come in to count them? (If no, why?)
3. How many nets did you receive from AMF/IMA during their recent distribution?
4. How many sleeping spaces are covered by an AMF/IMA net in your household?
5. May I look at the labels to confirm that these nets were part of our distribution? (If no, why?) (If no, skip 4-8; for questions 4-8 we only want your confirmed answers.)
6. Record the number of true sleeping spaces
7. Record the number of AMF/IMA nets covering the sleeping spaces
8. Record the number of other nets covering the sleeping space
9. Record the number of AMF/IMA nets found in the household that are not installed? 10. Record the number of other nets not hung 11. Are these nets still in the package?
12. Who hung up the nets?
13. Can you show me how you sleep under the nets?
14. Do you sleep under the net every night?
    a. Yes
    b. No (If no, why not?)
15. Work for the organization that distributed the nets. Anything you share with me about the use of the nets will not be against you. I'm not here to judge you. I only want to know how you value the nets and what they are used for other than sleeping under them. How many nets you received are not present in your household? Why?
    a. Lost
    b. Burned
    c. Stolen
    d. Other (If other, explain_____)
16. When the distribution took place, did the people who gave you your nets show you a video on how to care, use and clean the nets?
    a. Yes
    b. No
17. What is the condition of the AMF/IMA nets you received?
    a. Very Good
    b. Good
    c. Not Good
    d. Other, explain (in case they are gone or they will not allow you to inspect) 18. Have you ever repaired your nets?
        a.Yes
        b. No
19. How many holes did you repair?
20. Do you feel comfortable sleeping inside the net?
    a. Yes
    b. No (If no, why?)

APPENDIX 2: SURVEY QUESTIONNAIRE (FRENCH)

1. Combien des places à dormir sont disponible dans votre ménage?
2. Est-ce que je peux venir les conter ? si la réponse est non, Pourquoi?
3. Combien des moustiquaires avez-vous reçus d'AMF/IMA pendant leur récente distribution?
4. Combien des places à dormir sont couverte par une moustiquaire d'AMF/IMA dans votre ménage?
5. Est-ce que je peux regarder l'étiquette pour confirmer que les moustiquaires fait partie de AMF/IMA distribution ? si la réponse est non, Pourquoi ? Si la réponse est non, passer 5-8 (pour les questions 5-8, juste l'observation de l'interviewer)
6. Enregistre le nombre de vraies places à dormir
7. Enregistre le nombre d'AMF/IMA moustiquaires qui couvrent les places à dormir
8. Enregistre le nombre d'autres moustiquaires qui couvrent les places à dormir
9. Enregistre le nombre d'AMF/IMA moustiquaires trouvé dans le ménage qui ne sont pas installé?
10. Est-ce que ces moustiquaires sont dans le sachet? (L'observation de l'interviewer) 11. Enregistre le nombre des autres moustiquaires qui ne sont pas installé?
12. Qui a installé cette moustiquaire dans votre ménage?
13. Est-ce que tu peux me montrer comment tu dors sous la moustiquaire?
14. Est-ce que tu dors sous la moustiquaire chaque nuit ? Si la réponse est non, Pourquoi?
15. Je travaille avec l'organisation qui a distribuée les moustiquaires, tous ce que vous allez me dire ne sera pas utiliser contre vous. Je veux juste savoir votre opinion sur l'importance des moustiquaires et leur utilisation de dormir avec ou d'autre utilisation. Combien de moustiquaires que vous avez reçues sont absents dans votre ménage?
    A. Perdue
    B. Brulées
    C. Volées
    D. Autre, justifié :
16. Quand la distribution a eu lieux, Est-ce que les gens qui vous avez donné les moustiquaires, vous avez montré le film de comment utiliser, garder and nettoyer les moustiquaires?
    A. OUI
    B. NON
17. Quel sont les conditions de moustiquaires que vous avez reçues d'AMF/IMA?
    A. Très bien
    B. Bien
    C. Pas bien
    D. Autre, justifié :
18. Avez-vous déjà réparé votre moustiquaire?
    A. OUI
    B. NON
19. Quel est le nombre de trous que vous avez réparé?

20. Est-ce que tu te sens confortable de dormir sous la moustiquaire? A. OUI B. NON, si la réponse est non, Pourquoi?

APPENDIX 3: UNSTRUCTURED OBSERVATION OF THE COMMUNITY HEALTH WORKERS

A. Observation of the CHWs during the mass distribution campaign of the LLIN
B. Number of CHWs per health zones
C. Number of the mass distribution campaign supervisor in the Field
D. Time spend in health districts to carry out the mass distribution campaign of LLIN
E. Time the CHWs trained community volunteers to assist them during the mass distribution campaign of LLIN
F. Number of community volunteers and incentive