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Research

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Long-lasting Insecticide-Treated Mosquito Nets in the Democratic Republic of the Congo: Knowledge, Attitudes and Practices among households in Bonzola Health Zone in Mbuji-Mayi.

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Malaria is the most widespread parasitic disease in the world. It is a major risk of morbidity and mortality for more than two billion human beings worldwide. In the Democratic Republic of the Congo (DRC), it is one of the three leading causes of death among the most vulnerable groups - children under five and pregnant women. The impregnated mosquito net is currently one of the best ways to prevent malaria.

The purpose of this study is *to assess the knowledge, attitudes and practices of households related to the use of long-lasting insecticide-treated net in Bonzola Health Zone in the City of Mbuji-Mayi.*

This is a cross-sectional descriptive study conducted with 360 households. Our statistical unit was the household. The interview technique was used to collect data that were encoded, processed and analyzed using Excel 2007 software. In our statistical analyses, we used the calculation of frequencies, mean, standard deviation and proportions. The Chi-square test was used for association research.

Overall, 93.83% of respondents have a good knowledge of the long-lasting insecticide-treated net (LLITN) and its benefits, 96.94% have a positive attitude towards its use and only 61.39% have good practices. The LLITN use rate the night before the survey is 90.28% and the availability rate of LLITNs in households is estimated at 94.44%.

Certain factors limit the effective use of LLINs by households. Although population knowledge and attitude are good enough, the utilization of LLITNs did not much progress comparing to the proportion of pregnant women sleeping under an ITN (60%) revealed in the 2013 MICS-DRC Report.

These results reflect what the last free distribution of LLITNs carried out in August 2015 by the Government (through the National Malaria Control Programme, in partnership with ASF/PSI) has largely produced as impact to the beneficiary population.

Key words: LLITN, knowledge, attitudes, practices, households, Bonzola Health Zone, Mbuji-Mayi.

Le paludisme est la maladie parasitaire la plus répandue dans le monde. Il constitue un risque majeur de morbidité et de mortalité pour plus de deux milliards d'êtres humains dans le monde. En République Démocratique du Congo (RDC), il compte parmi les trois premières causes de mortalité dans le groupe des plus vulnérables - enfants de moins de cinq ans et femmes enceintes. La moustiquaire imprégnée reste actuellement l'un des meilleurs moyens de prévention du paludisme.

Le but de cette étude était ***d'évaluer les connaissances, attitudes et pratiques des ménages de la Zone de Santé (ZS) de Bonzola à Mbuji-Mayi en rapport avec l'utilisation de la Moustiquaire Imprégnée d'Insecticides à Longue Durée d'action (MIILD).***

Ceci est une étude descriptive transversale menée auprès 360 ménages. Notre unité statistique a été constituée par le ménage. La technique d'interview nous a servi pour la collecte des données qui ont été encodées, traitées et analysées à l'aide du logiciel Excel 2007. Dans nos analyses statistiques, nous avons recouru au calcul des fréquences, de la moyenne, de l'écart-type et des proportions. Le test de Khi-carré a été utilisé pour la recherche d'association.

D'une manière générale, 93,83 % d'enquêtés ont de bonnes connaissances sur la MIILD et ses avantages, 96,94 % ont une attitude favorable face à l'usage de la MIILD et seulement 61,39 % ont de bonnes pratiques. Le taux d'utilisation de la MIILD la nuit précédant l'enquête est de 90,28 % et le taux de disponibilité des MIILD dans les ménages est évalué à 94,44 %.

Certains facteurs limitent l'utilisation efficace des MILD par les ménages. Bien que les connaissances et l'attitude de la population soient suffisamment bonnes, l'utilisation des MILD n'a pas beaucoup progressé par rapport à la proportion de femmes enceintes dormant sous une MILD (60%) révélée dans le rapport MICS-RDC 2013.

Ces résultats reflètent ce que la dernière distribution gratuite de MIILD effectuée en août 2015 par le gouvernement (par le biais du Programme National de Lutte contre le Paludisme, en partenariat avec ASF/PSI) a largement produit comme impact sur la population bénéficiaire.

Mots clés : MIILD, connaissances, attitudes, pratiques, ménages, Zone de Santé de Bonzola, Mbuji-Mayi.

1. Background

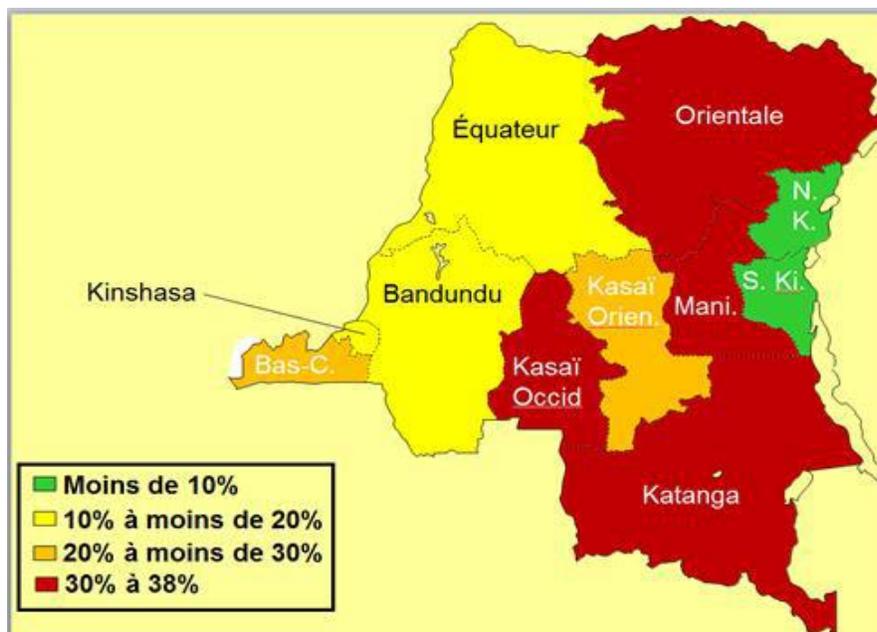
Malaria is the most widespread parasitic disease in the world. It is caused by a protozoan of the genus *Plasmodium* transmitted to humans through the bite of an infected female *Anopheles* mosquito. With 207 million episodes and 627 thousand deaths reported in 2012 according to the WHO report, Malaria is a major risk of morbidity and mortality for more than two billion people. Sub-Saharan Africa, which has only 8% of the world's population, accounts for 85 to 90% of Malaria cases (90% of which are due to *Plasmodium falciparum*). Children under five years of age and pregnant women are the first victims because of their vulnerability (18). Malaria kills 1.5 to 2.7 million people each year, including one million children under five years of age (22).

Malaria is rife in more than 100 tropical and subtropical countries, particularly in Sub-Saharan Africa, Asia, the Pacific and Latin America. It was estimated that there were 216 million malaria episodes in 2010, with a wide range of uncertainty from 194 to 274 million cases. Nearly 81%, or 174 million cases (between 113 and 239 million), occurred in the Africa region and 13% in South-East Asia (22).

In recognition of the value and effectiveness of LLITNs, the Abuja Summit on “Roll Back Malaria” in April 2000 endorsed a series of Malaria control measures, including making insecticide-treated nets (ITNs) readily available to the public. As a result, ITNs have become a central part of the malaria control strategy.

In DRC, according to the results of the thick smear, the prevalence of malaria (23% for all children aged 6-59 months) increases with age, rising from a minimum of 12% at 6-8 months to a maximum of 27% at 48-59 months. Estimated prevalence varies greatly according to province (see map below): the highest proportion of malaria positive children is found in the Kasai Provinces (29% in Kasai-Oriental and 32% in Kasai-Occidental), Katanga (32%), Maniema (34%) and especially in Province Orientale (38%). These proportions decrease considerably with the improvement in the educational level of mothers after primary school. In fact, while 26% of children of mothers with primary education level are positive, this proportion is only 8% when the mother has a higher level of education (18).

Map 1 : Malaria prevalence in DRC, 2014



Source: Main Report DHS-DRC II 2013-2014, September 2014.

According to the directory of Health Statistics published by the Directorate for Disease and Major Endemics Control of the DRC Ministry of Public Health, malaria remains the major endemic and the first cause of morbidity. It is also one of the three leading causes of mortality among the most vulnerable group, namely children under five years of age and pregnant women (24).

To date, the DRC has made progress as hoped. Figures providing reliable and comparable estimates on LLITN use testify to this; for example, the rate of ITNs use by children has increased significantly, from 6% in 2007, 38% in 2010 (MICS-DRC) and to 56% in 2013, and the proportion of pregnant women sleeping under an ITN has also increased significantly, from 7% in 2007, 43% in 2010 (MICS-DRC) and to 60% in 2013(18).

2. Justification

The impregnated mosquito net currently remains one of the means of malaria prevention. Its study provides information not only on its effectiveness on mosquitoes and its impact on malaria prevalence, but also on the problems that block its use and its popularization among populations.

The Consortium MSH, OSC and IRC had implemented in the DRC the project called "Projet de Santé Intégré" (PROSANI), targeting primarily children under the age of five and pregnant women and secondarily the entire population. This project ensured a free distribution of nearly 26,000 LLITNs

in the period from October 2013 to September 2014 in order to contribute to the reduction of at least 50% of morbidity and mortality attributable to malaria by the end of 2015 in DRC in 68 health zones - including the health zones of Kasai Oriental (20). During the month of August 2015, the DR Congolese Government, through the National Malaria Control Programme, in partnership with the ASF/PSI, conducted a campaign for free distribution of LLITNs in Mbuji-Mayi with the aim of increasing the fight against the pandemic. Several LLITNs were distributed to households in Mbuji-Mayi. (20)

While studies abound on malaria control, few report on household knowledge, attitudes and practices in this area; and overall, knowledge is estimated at only 58%, good attitudes at 71% and good practices in LLITN use at 28% according to the study conducted in June 2010 in Kisanga Health Zone in Lubumbashi by Davos D. Sangba, University of Lubumbashi (5). What about households in the city of Mbuji-Mayi?

In light of the above, the questions that this study has endeavoured to answer are as follows:

- ✓ What is the prevalence of LLITN availability and use?
- ✓ Are LLITNs accepted and used in households in Mbuji-Mayi in Bonzola Health Zone?
- ✓ What factors are associated with the use or non-use of LLITNs?

3. Objectives of the study

The overall objective of this study was to assess household knowledge, attitudes and practices related to the use of long-lasting insecticidal nets in Bonzola Health Zone, in Mbuji-Mayi (DRC), in order to contribute to the strengthening of the fight against malaria by improving knowledge on the use of the ITN as a means of malaria prevention and control and possibly to make recommendations to policy makers.

Specifically, this study was intended to:

- a. Describe the socio-demographic characteristics of households;*
- b. Determine the rate of LLITN use and availability in households;*
- c. Assess the level of household knowledge about the LLITN and its benefits;*
- d. Assess household attitudes towards the LLITN;*
- e. Describe household practices related to the use of LLITNs; and*
- f. Investigate factors associated with the use and non-use of LLITNs.*

I. INSECTICIDE-TREATED MOSQUITO NET

According to WHO, the Insecticide-Treated Mosquito Net is a net that repels, inactivates or kills mosquitoes that come into contact with the insecticide impregnated in the net (21).

The application of the long-lasting insecticide to fabrics to prevent vector-borne diseases such as malaria and leishmaniasis began during World War II, when warring forces used insecticide-treated nets and clothing (4). In the late 1970s, synthetic pyrethroids were shown to be effective for this purpose.

Early studies on insecticide-treated nets demonstrated the safety of pyrethroids and their impact on various entomological parameters, including the number of times the vector was able to feed, vectorial capacity and the number of bites inflicted on humans. These studies have also helped to better define the active mechanism (mosquito repellency and suppression) and the optimal dosages for various combinations of nets and insecticide (3).

Insecticides used for impregnation must meet WHO specifications. In addition, they must be registered and accepted by the country. The choice of insecticide type depends on vector sensitivity, efficacy, availability, cost and resources.

In terms of product types, the most suitable types for net treatment are synthetic pyrethroids and pseudo-pyrethroids and ofenprox, which have the advantage of being easily absorbed by the tissues and have a rapid action. Examples include permethrin, deltamethrin, lambdacyhalothrin, and ofenprox. (16)

ITNs are a product intended for household consumption and therefore, like any product, they must be renewed. This raises the question of the lifespan of an ITN. A long-lasting insecticidal net (LLITN) is a mosquito net pre-treated at the factory with an insecticide that has a duration of action of more than three years and does not require treatment (18); it has a lifespan of about 3 years or 20 washes (minimum), and does not need to be re-treated (washing is sufficient to reactivate it). The insecticide molecules give the net an exit-repellent effect (which keeps mosquitoes and other insects away) and a "KD: Knock Down" effect that stuns and kills the mosquito that comes into contact with the impregnated surface. LLITNs also have a known impact on other nuisance species: fleas, lice, cockroaches, bugs, bark beetles.

It appears that LLITNs are used to protect against nuisance and mosquito bites. It is now established that LLITNs provide effective protection against several vector-borne diseases such as leishmaniasis, human African trypanosomiasis, filariasis and malaria; in malaria-endemic areas, they can reduce overall child mortality by about 20% (25).

Some houses are not suitable for the installation of mosquito nets; they are very small and are used for cooking but also for sleeping. The use of LLITNs is applied on beds, but it is, however, conditioned by the type of housing the user lives in.

1. Use of LLITN

A survey of 420 households in Yaoundé, Cameroon, indicated that nets were used in only 14.5% of households, although pregnant women and children probably used them more than other people in the same household. This low percentage of net use was probably representative of large rural areas in Africa (26).

In DRC, data collected during the 2013-2014 Demographic and Health Survey estimated the proportion of households with LLITNs at 69.5%, with variations by province: Bandundu has the highest proportion of households with at least one LLITN (87%); Province Orientale has the lowest proportion of households with an LLITN (47%). In Kasai Oriental, 64% of households own an LLITN (18). (Table I).

Table I: Household ownership of LLITNs in DRC.

Residence	Percentage of households with an LLITN	Average number of LLITNs per household	Percentage of households with at least one LLITN for every two people who slept under it the last night	Number of households with at least one person who spent the last night in the household
Environment				
Urban	69,7	1,4	24,3	5 732
Rural	69,6	1,3	25,6	12 376
Provinces				
Kinshasa	57,4	1,1	17,1	1 517
Bas-Congo	75,1	1,3	30,9	909
Bandundu	87,1	1,7	35,1	2 955
Equateur	82,8	1,7	32,6	2 393
Orientale	46,6	0,8	18,8	1 994
Nord-Kivu	60,3	1,2	20,9	1 474
Sud-Kivu	70,0	1,3	21,1	1 343
Maniema	58,9	1,0	19,1	636
Katanga	79,0	1,6	32,5	1 835
Kasaï Oriental	64,0	1,1	18,6	1 868
Kasaï Occidental	58,0	0,9	14,0	1 184
Total				
	69,5	1,3	25,2	18 108

Source: Final Report DHS-DRC II 2013-2014, September 2014.

2. Impact of LLITN use in Africa

In recent years, insecticide-treated mosquito nets have emerged as an effective means of stemming the rising tide of malaria around the world (22). Several trials in Africa and elsewhere in the world confirm the efficacy of ITNs in highly endemic settings.

Indeed, four large-scale studies have been conducted to measure the effects of ITNs on overall child mortality rates in various malaria-endemic regions of Africa (Burkina Faso, The Gambia, Ghana and Kenya). The results of these four trials, now published, indicate that the child mortality rate decreased significantly (between 15% and 33%) in each of the sites (22).

3. Factors influencing the use of LLITN

Although the effectiveness of ITN use is particularly well established in modern medicine, there are certain factors that limit its use, namely (14):

- Sociological burdens (illiteracy and very low education level of the population); housing types; lifestyle and recreation;
- Anthropological factors (belief in particular rites, presence of traditional medicines...);
- Economic burdens (very low income level of most people) and finally
- Burdens related to the health care system (accessibility and equipment of Health Centres; insufficient supply of ITNs, which at times leads to long-term stock-outs or total unavailability of LLITNs).

i. People's knowledge of mosquito nets

In general, the majority of the population has an idea about ITNs; however, level of knowledge, lack of information, beliefs and education level show a significant influence on this knowledge. Some people who perceive no link between mosquitoes and malaria believe that the net is used to reduce the nuisance of mosquitoes rather than to protect against malaria. This has led to the perception of ITNs as a prestige item or as a way to get a good night's sleep for those who want to buy them.

In a study conducted in Brazzaville in two neighbourhoods after an awareness day, 56.7% of households surveyed in the sensitized neighbourhood said they were aware of the existence of ITNs and 30.6% in the control (non-sensitized) neighbourhood (2).

The lack of information and population's ignorance about the role of mosquitoes in malaria transmission raise concerns that have led some people to think that perhaps more emphasis should be placed on reducing the nuisance associated with bites to motivate the use of ITNs. This proposition is reinforced by the fact that net use is associated with high mosquito densities; when people are asked about the benefits of ITNs, they talk much more about reducing mosquito nuisance than they do about reducing malaria (15).

Education level is a variable that has been extensively studied to explain health behaviours. Education implies changes in behaviour, attitudes and thinking, resulting in better use of modern health services and better health practices in the household (10). An individual's education level reflects the acquisition of knowledge. An individual with a high level of education is more likely to know the real cause of malaria than an individual with no education. Thus, this variable accounts somewhat for knowledge because it remains highly correlated with knowledge. Indeed, education allows for progress in the standard of living.

It should also be noted that almost the majority of the population has no knowledge of the role or protection of ITNs against other vector-borne diseases such as leishmaniasis, human African trypanosomiasis and filariasis (25).

ii. Attitudes of populations towards mosquito nets.

Reduction of discomfort is, without doubt, the most immediate, frequent and best perceived result of using an ITN. However, this desire to avoid nuisance is not a sufficient reason to use a treated net all year round. It is quite common, in this context, not to use ITNs during the season when mosquitoes are less numerous.

Ecological factors are particularly important in determining whether or not to use the net:

- ✓ Mosquito proliferation causes a very considerable culicidal nuisance. As a result, these conditions can lead households to purchase nets. In Côte d'Ivoire, according to studies conducted in 2008 (7), almost half of households preferred insecticide-treated nets as a means of controlling mosquito nuisance.
- ✓ Cleanliness and drying of stagnant water near the houses are hygiene techniques that can prevent mosquitoes from multiplying. This can therefore limit the use of nets even in hyper-endemic areas, as the nuisance of mosquitoes will be less in places that are sanitized and maintained.

Although some people are indifferent to or reject the use of LLITNs because of suffocation, warmth during sleep, - assumed - allergies, or tightness of housing, a large proportion of the population communicates a positive attitude towards LLITNs not only as a means of reducing mosquito nuisance, but especially as a means of preventive malaria control.

iii. Population's practices with regard to mosquito nets

As mentioned above, there are a number of factors that justify the use or non-use of LLINs, including: ownership of an LLITN; accessibility and equipment of LLITN distribution points; types of housing...

To use an LLITN, you must first have one! The geographical accessibility of LLITN distribution points is an important factor determining LLITN ownership. It is measured by the proportion of the population living within a given radius of a distribution point (8). This is because access to these distribution points requires a travel and their remoteness makes this access much more difficult as it requires means of transport and time. However, door-to-door distribution makes it possible to circumvent this constraint.

In DRC, the Demographic and Health Survey II estimated that 72% of households had a treated net or an LLITN. However, the proportion of the population who spent the night before the interview under an ITN in a household with two ITNs was 25% and 21% in households with three ITNs (18). This is sufficient evidence that acceptance of LLITNs by the population is not complete, although the population is aware and/or willing to accept it.

Household size and sleeping habits (2, 26) are variables that influence net use/practice of the net to the extent that they influence the number of nets to be acquired. This is because large households require a relatively high number of nets. In Kasai Oriental, 64% of households own at least one LLITN; the average number of LLITNs per household is 1.1 and the percentage of households with at least one LLITN for every two people is 18.6% (18).

The adaptation of these nets to the organization of the domestic space greatly influences the daily use of nets. The small size of houses makes it impossible to leave these impregnated nets stretched over the sleeping berths during the day, so for one reason or another, LLITN use is no longer permanent (9).

Gender significantly influences the use of malaria preventive measures because women are more likely to encourage the use of malaria control measures than men.

Although the LLITN is designed to be a means of preventive control against malaria and other vector-borne diseases, this is not always the case in communities: some use it as curtains, some use it as a football net, and some use it as a fishing net.

II. METHODOLOGY

1. Study area

This study took place in the Democratic Republic of Congo in Bonzola Health Zone. This zone is located in the District of Kanshi, City of Mbuji-Mayi, Province of Kasai Oriental. It has an estimated population of 204,851 inhabitants living in 34,142 households. It has 15 Health Areas (Bimpe, Camp N'sele, Centre d'émission, Ciaciacia, Cikisha, Dubai, Kasamayi, Kashala Bonzola, Lubilanji, Mudiba, Nyongolo, Solola, Tubondo (1, 2 and 3), 2 Hospitals (Bonzola and Dipumba) and 2 Clinics (MIBA and La Rosée). Cfr Table II (*Source: BCZS Bonzola, Archives December 2015*).

2. Definition of concepts

In order to clearly outline the results of this study, the following definitions were used for each concept used:

- ✓ Factors influencing LLITN use: these are the factors that influence households to make the decision to use LLITNs.
- ✓ Household: is the set of individuals living under the same roof under the authority of one person and sharing common assets and resources.
- ✓ Mosquito net: is a synthetic fibre fabric (nylon or polyester) of varying shapes (rectangular, conical, etc.) and sizes (single or double) that surrounds the bed and under which people sleep to protect against mosquito bites.
- ✓ Long-acting insecticide-treated mosquito net (LLITN): this is a mosquito net with a "permanent" pyrethroid imprint that does not require any further treatment or a mosquito net that has been pre-treated at the factory with an insecticide that has a duration of action of more than three years and does not require treatment. It is a mosquito net that is soaked in a bath of insecticide from the factory and protects against mosquito bites and other insects.
- ✓ Knowledge of LLITN: is the fact that a household has been informed at least once about the use of LLINTs and their benefits.
- ✓ Attitude towards LLITNs: this is the behaviour displayed towards LLITNs, in terms of its use, despite being informed about its usefulness and benefits: acceptability.

- ✓ Practice with regard to LLITNs: the behaviour displayed with regard to LLITNs, in terms of use, although accepting it: effective use.

3. Type of study and sampling

We conducted a cross-sectional descriptive study in households in the Health Zone of Bonzola using a KAP (Knowledge, Attitudes, and Practices) survey related to LLITNs in Mbuji-Mayi. The statistical unit for the study was the household.

The sample size (n) was estimated by the formula: $n = \frac{pqz^2}{d^2}$, where:

- p is the proportion of households owning LLITNs in Kasai Oriental,
- q is the complement of p ($q = 1 - p$)
- z is the confidence level of the study,
- d is the degree of precision of the study.

In this study, the confidence interval is set at 95% equivalent to $Z=1.96$; the proportion of households with LLITNs in Kasai Oriental is estimated at 64% (DHS DRC II) and we have allowed for an error ($d=5\%$); this is a power of 95% for the study. Thus, the minimum calculated sample size for the study is: $n = \frac{0,64 \times 0,36 \times (1,96)^2}{(0,05)^2} = 354$ households.

In this study, the final sample size used is 360 households. The sample was drawn using the random sampling technique. On the basis of the enumeration that had been carried out in December 2015 in the HZ, we carried out a simple random selection to identify the households that joined our sample. The survey took place across all 15 HAs making up the Bonzola HA. The survey questions were addressed to the heads of households and/or their representatives found in the households and able to answer our questions.

Table II: Distribution of the total population of the BONZOLA Health Zone and of the sample in the 15 Health Areas

N°	HEALTH ZONE	HEALTH AREAS (HA)	TOTAL POPULATION	HOUSEHOLDS	CUMULATION OF HOUSEHOLDS	SAMPLE PER HA (%)
1	BONZOLA	Bimpe	15 106	2 518	2 518	27 (7.50)
2	BONZOLA	Camp N'Sele	9 259	1 543	4 061	16 (4.44)
3	BONZOLA	Centre d'émission	8 634	1 439	5 500	15 (4.17)
4	BONZOLA	Ciaciacia	11 982	1 997	7 497	21 (5.83)
5	BONZOLA	Cikisha	12 001	2 000	9 497	21 (5.83)
6	BONZOLA	Dubai	20 462	3 410	12 907	36 (10.0)
7	BONZOLA	Kasamayi	15 782	2 630	15 538	28 (7.78)
8	BONZOLA	Kashala Bonzola	13 334	2 222	17 760	23 (6.39)
9	BONZOLA	Lubilanji	13 383	2 231	19 991	23 (6.39)
10	BONZOLA	Mudiba	17 814	2 969	22 960	32 (8.89)
11	BONZOLA	Nyongolo	15 278	2 546	25 506	27 (7.50)
12	BONZOLA	Solola	19 154	3 192	28 698	33 (9.18)
13	BONZOLA	Tubondo 1	12 528	2 088	30 786	22 (6.11)
14	BONZOLA	Tubondo 2	9 752	1 625	32 412	17 (4.17)
15	BONZOLA	Tubondo 3	10 382	1 730	34 142	19 (5.27)
TOTAL			204 851	34 142		360 (100)

Source: Central Bureau of Bonzola Health Zone, Archives December 2015

Pour chaque AS, nous avons commencé avec un ménage pris au hasard et avons continué l'enquête avec le ménage le plus proche en utilisant un pas de sondage de 95.

For each Health Area, we started with a randomly selected household and continued the survey with the closest household using a sampling step of 95.

The sampling step (survey interval) was obtained according to the formula:

$$\text{Sample step} = \frac{\text{Number of HZ households}}{\text{sample size}} = \frac{34\,142}{360} = 94,838889 \approx 95.$$

4. List of variables and scale of measurement

In this study, we worked with the following variables:

The dependent variable is “the use of LLITNs by households”. It is a dichotomous event; either the household is using it or not. Household LLITN use was therefore measured by the probability of using LLITNs.

The independent or explanatory variables selected are:

- Age of the head of the household;
- Level of education of the head of household;
- Occupation of the head of household;
- Level of knowledge of the head of household about the disease;
- Size of the household;
- Knowledge of the LLITN;
- Acceptance of the LLITN;
- Possession of the LLITN;
- Means of protection used against malaria;
- Knowledge of the benefits of the LLIN.

Table III: List of variables and their scale of measurement

VARIABLES	OPERATIONAL DEFINITIONS	SCALE OF MEASUREMENT
1. Household use of LLITNs	The fact that one spent the night before the investigation under an LLITN	CATEGORIAL: Yes : uses No : don't use
2. Age of household head	Number of years	INTERVAL: years
3. Level of education of the head of household	Level of education of the head of household (high diploma acquired).	ORDINAL : Low: less than the equivalent of the State Diploma. Medium: State Diploma or equivalent. High: has exceeded the level of State Diploma.
4. Occupation of the head of household.	Occupation of the head of household.	NOMINAL
5. Level of knowledge of the head of the household about the disease (malaria).	Knowledge of the causes of Malaria (main mode of transmission).	ORDINAL: Good: cite the mosquito bite. Wrong: cite other mode or cannot identify the mosquito bite
6. Household size	Number of persons cared for by the head of household and all living under one roof.	INTERVAL: number of individuals
7. Knowledge of the LLITN.	The fact that a household has been informed or educated at least once about the use of LLITNs and its benefits.	ORDINAL: Good: heard at least once about the benefits of LLITNs. Poor/Bad : the opposite case
8. Acceptance of the LLITN	The fact that a household accept to sleep under an LLITN.	ORDINAL: Good: agrees to sleep under an LLITN Poor/Bad : the opposite case
9. Means of protection against malaria	Methods and materials used to protect against mosquitoes and malaria.	ORDINAL: Good: uses a good means of protection. Poor/Bad: does not use anything or uses inappropriate means
10. Awareness of the benefits of LLITNs.	The fact that a household has been informed or sensitized on the benefits of LLITNs at least once.	ORDINALE : Good: knows the benefits Poor/Bad : the opposite case

5. Data collection technique

Data collection was conducted using a questionnaire administered to participants. This anonymous questionnaire inspired by the DRC Demographic and Health Survey II (DRC DHS II Final Report) integrates elements related to socio-demographic data, knowledge, attitudes and practices in households.

The questionnaire consisted of four parts:

1. the first part focused on socio-demographic, cultural and economic characteristics
2. the second on knowledge, attitudes and practices related to LLITNs
3. The third addressed information on household LLITN use (practices).
4. The fourth dealt with the availability of LLITNs.

6. Data collection: authorization and period

- ❖ **Obtaining authorizations:** before starting the collection of data, an approval was obtained from the University of Mbuji-Mayi, followed by that of the Burgomaster of Kanshi local government area where the Bonzola Health Zone where the study was conducted is located. At the level of each household, the informed consent of the head of the household was obtained before proceeding with the interview.
- ❖ **Period of data collection:** field trip with the tool. Data collection in the households was spread over a period from 10 to 30 January 2016, i.e. a total of 21 survey days.

7. Statistical processing and analysis of data

- ✓ Organization of data: once completed, the forms were collected and kept under lock and key
- ✓ Breakdown into categories: for closes-ended questions, categories were already created. For the open-ended questions, categories were created after data collection based on the answers obtained.
- ✓ Coding and data entry: To facilitate the analysis, the collected data were converted into figures, taking into account the categories that were created. Data were entered using Excel software for processing.

- ✓ Before proceeding with the actual analysis, the data were organised in tables and graphs and described.

Data collected were encoded, processed and analyzed using Excel 2007 software. In our statistical analysis, we used the calculation of frequencies, mean, standard deviation and proportions. The Chi-square test (level of significance 0.05) was used to search for associations.

Univariate analysis:

A. Socio-demographic characteristics of households

- ❖ Age of household heads
- ❖ Sex of household heads
- ❖ Education Level of household heads
- ❖ Civil status of household heads
- ❖ Household size
- ❖ Occupation of household heads
- ❖ Means used for protection against malaria

B. Households' knowledge, attitudes and practices towards LLITNs

- ❖ Knowledge of malaria and routes of transmission
- ❖ Knowledge of the presence of mosquitoes in the plot/house
- ❖ Household information and sources of information on LLITNs
- ❖ Knowledge of the LLITN and its benefits
 - Knowledge ratings: according to the proportion of good knowledge in households, knowledge in the population is weighted as "low" for a proportion less than 50%, "medium" for a proportion varying between 50 and 79%, and "good" for a proportion greater than or equal to 80%.
- ❖ Possession of LLITNs
- ❖ Acceptance of the LLITN
- ❖ Reason for households' use of LLITNs
 - Attitude score: estimated from proportions of good attitudes towards LLITNs
- ❖ Use of LLITNs in BONZOLA HZ on the day before the survey
- ❖ Perception of household LLITN use all nights

- ❖ Availability and sources of LLITNs in households
- ❖ How and when the last LLITN was obtained
 - Household practices score: summarizes the proportions of good practices of different practices.

Bi-Variate Analysis :

- ✓ Rating of knowledge and information sources of the LLITN
- ✓ Knowledge and Attitude Score
- ✓ Rating of knowledge and education level, age, gender and occupation of heads of households
- ✓ Attitude and Practice Rating
- ✓ Knowledge and Practice Rating
- ✓ Rating of Practice and Possession of LLITNs
- ✓ Education and knowledge of the benefits of LLITNs
- ✓ Score of practices and level of education, age, sex and occupation of heads of households

8. Ethical considerations

Informed consent was obtained from the respondent prior to the administration of the questionnaire. Consent was free and verbal. In this study, data were collected anonymously and confidentially. We reserved the right to safeguard the privacy and personality of the respondent.

9. Limits

In this study, we did not assess respondents' knowledge of the roles of LLITNs against other vector-borne diseases, nor did we assess LLITN use in relation to housing type and suitability for different sleeping arrangements, let alone use by categorization: children under 5 years of age - pregnant women - other family members.

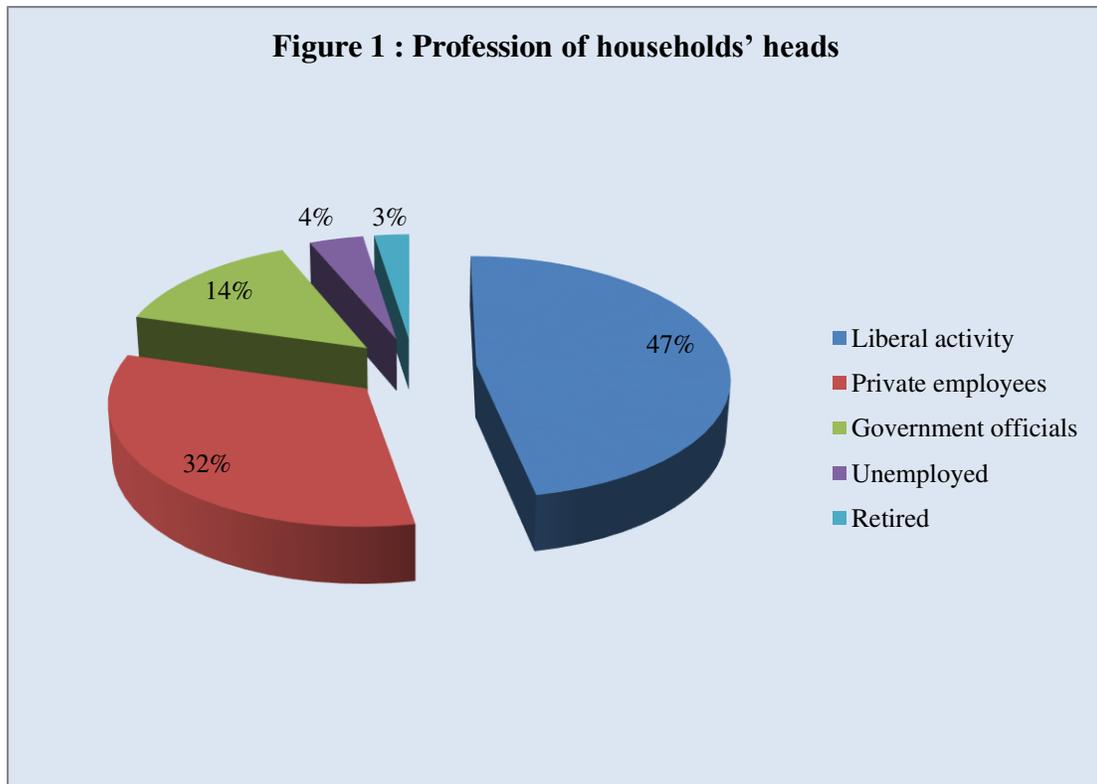
III. RESULTS

1. Overall results

Overall, **93.83% of respondents have good knowledge of the LLITN and its benefits, 96.94% have a favourable attitude towards its use and only 61.39% have good practices.** The rate of LLITN use the night before the survey is 90.28% and the rate of household availability of LLITNs is estimated at 94.44%.

2. Specific results

Specifically, 51.42% of households' heads surveyed are in the 46-65 age group; 12.22% of the households surveyed were headed by women; 78.33% of households' heads surveyed have at least finished their secondary school; 89.17% of households' heads surveyed are married and/or in common-law unions; 50% of the households surveyed are below average size. 93.61% of households' heads surveyed are employed; actual LLITN use is significantly associated with education level, age, gender and occupation.

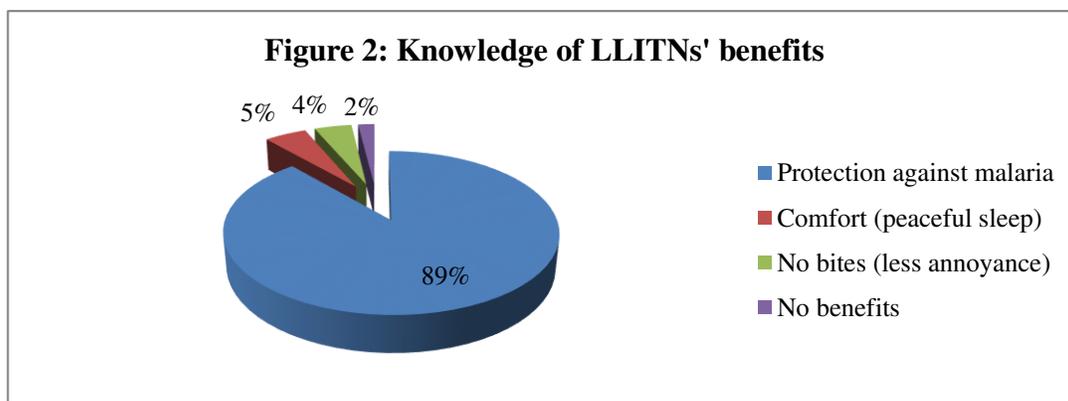


3. Knowledge on malaria and LLITNs in BONZOLA Health Zone.

Table IV: Distribution of heads of households in BONZOLA Health Zone according to their knowledge of the modes of transmission of malaria

Modes of transmission	Frequency	Percentage
Mosquito bites	295	81,94
Blood transfusion	11	3,06
Mother-to-child transmission	06	1,67
Drinking water	33	9,18
Don't know.	08	2,22
Others	07	1,93
TOTAL	360	100

All the heads of household surveyed in this health zone have already heard of malaria, 81.94% of them agree that mosquito bites are the main mode of malaria transmission.



All the households surveyed have heard about the LLITN, 68.89% of these households cited the media (TV, radio) as a channel for receiving the information. 88.61% of households' heads surveyed are knowledgeable about the benefits of using the LLITN.

Table V: Distribution of households' heads according to their knowledge of LLITNs' benefits in relation to their education levels, age, gender and occupation

Knowledge of LLITNs' benefits

		Good	Poor/Bad			Total	χ^2
		Protection against malaria (%)	Comfort (%)	No bites (%)	No benefits (%)		
<i>Education level</i>	Low	49 (62.82)	12 (15.38)	10 (12.82)	07 (08.97)	78	71,51 df=6
	Medium	173 (94.54)	04 (02.19)	06 (03.27)	00 (00.00)	183	
	High	97 (97.98)	02(02.02)	00 (00.00)	00 (00.00)	99	
<i>Age</i>	< 45 years	104 (84.55)	10 (08.12)	07 (05.69)	02(01.63)	123	51,10 df=6
	46-65 years	155 (95.09)	05 (03.07)	02 (01.23)	01 (00.61)	163	
	> 65 years	17 (54.84)	03 (09.68)	07 (22.58)	04 12.90)	31	
<i>Sex</i>	Male	294 (93.04)	15 (04.75)	02 (00.63)	05 (01.58)	316	89,74 df=3
	Female	25 (56.82)	03 (06.82)	14 (31.82)	02 (4.55)	44	
<i>Profession</i>	unemployed	05 (35.71)	03 (21.43)	03 (21.43)	03 (21.43)	14	95,54 df=6
	Retired	03 (33.33)	02 (22.22)	04 (44.44)	00 (00.00)	09	
	Various occupations	311 (92.28)	13 (03.86)	09 (02.67)	04 (01.87)	337	

Surveyed heads of households with medium and/or high levels of education, who are male under 65 years, have good knowledge of the benefits of LLITNs.

In terms of occupation, unemployed and retired people have poor/weak knowledge of the benefits of the LLITN (35.71% and 33.33% respectively).

Chi-square statistical analyses reveal that education, age, gender and occupation are significantly associated with knowledge about LLITNs.

In terms of LLITN use, respondents with medium and high levels of education, under 65 years of age and in an occupation had good practices in more than 60%. Statistical analyses reveal that education, age, gender and occupation are *also* significantly associated with household practices.

4. Attitudes towards LLITNs in households in BONZOLA Health Zone.

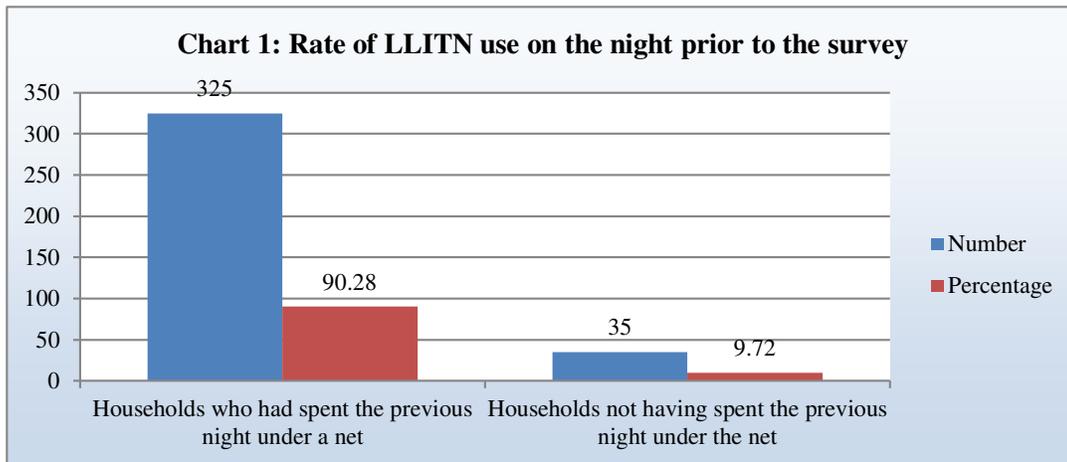
Table VI: Distribution of households heads according to attitudes towards the LLITN (reasons for acceptance and refusal)

Variables	Number	Percentage
Accept the LLITN	349	96,94
Protection against malaria	330	91,67
Protection against mosquitoes' bites	07	1,94
Comfort (peaceful sleep)	07	1,94
Accepting without reason	05	1,39
Don't accept it	11	3,06
Suffocation/ Choking/ heat/ discomfort	08	2,22
Not useful	03	0,83

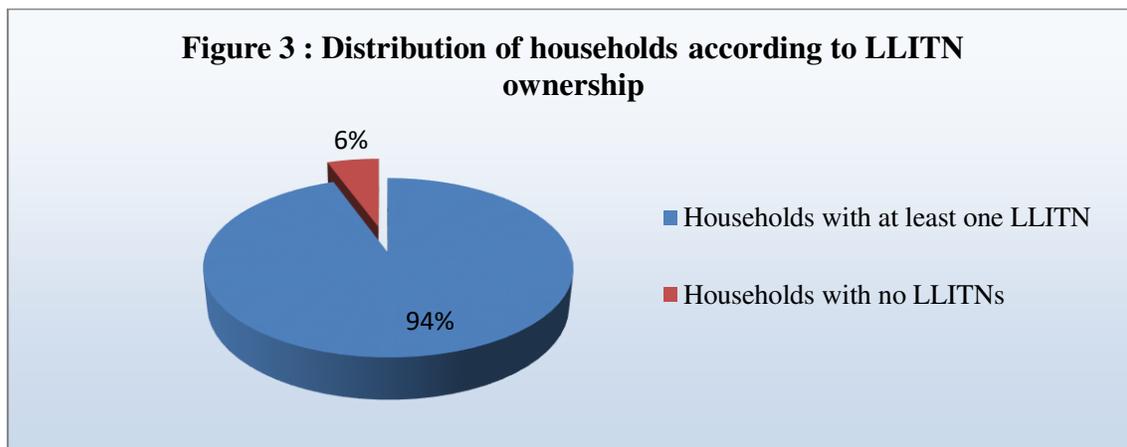
Attitudes towards LLITNs are good in more than 95% of cases. For the majority, protection against malaria is the major reason for their acceptance.

Among the household heads surveyed with good attitudes, only 63.32% have good practices. Statistical analyses reveal a significant association between attitudes towards LLITNs and household practices.

5. Practices related to LLITNs in households in BONZOLA Health Zone

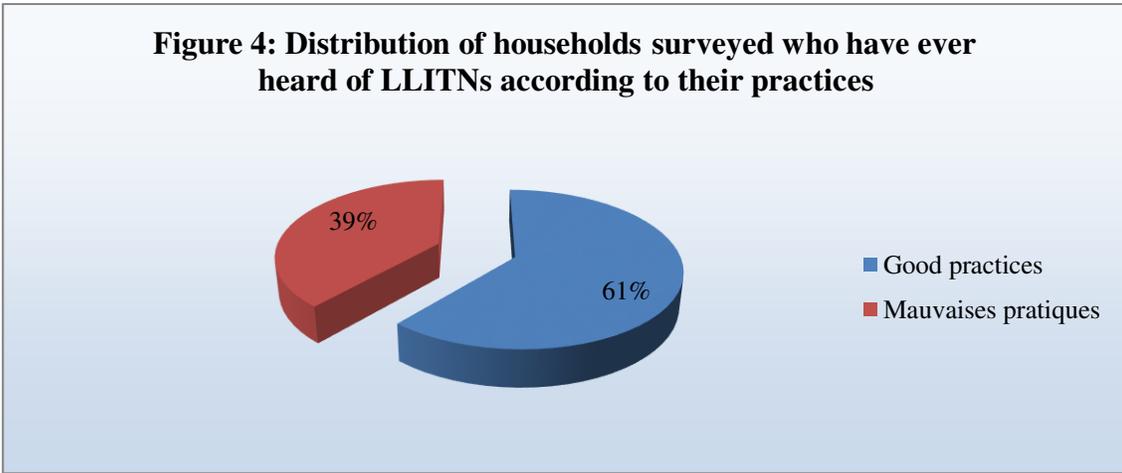


90.28% of households surveyed spent the night before the survey under a mosquito net. And only 61.39% make LLITNs a priority and report sleeping under them every night.

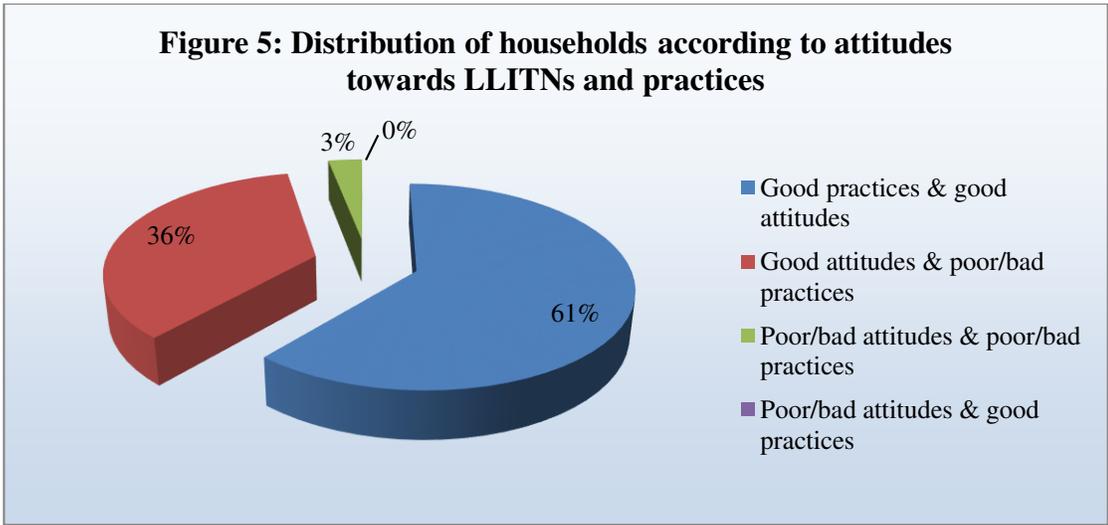


Out of 360 households surveyed, 340 (94.44%) reported owning at least one LLITN. The LLITNs owned by the households surveyed are substantial in relation to their respective sizes: 76.67% of households of less than 6 people own 2-3 LLITNs; 85.50% of households of 6 people own at least 2 LLITNs; 66.37% of households of 7-10 people own at least 4 LLITNs and 73.67% of households of more than 10 people own 4 or more LLITNs.

Of the surveyed households owning at least one LLITN, only 65% have good practices. Statistical tests reveal a significant association between LLITN ownership and household practices.



Among the heads of households surveyed who had heard of LLITNs, only 61.39% have good practices in using them. However, statistical analyses do not reveal a significant association between knowledge about LLITNs and household practices.



From the figure above, it can be seen that among the heads of households surveyed 61.39% have good attitudes and good practices regarding LLITNs. 36.68% are in favour of LLITNs, but they do not make good use of them. Statistical analyses reveal a significant association between attitudes towards LLITNs and household practices.

Figure 6 shows that 94% (318) of surveyed households report having obtained their LLITNs during the free distribution campaign and 6% had acquired them through a donation (family member, friends, etc.).

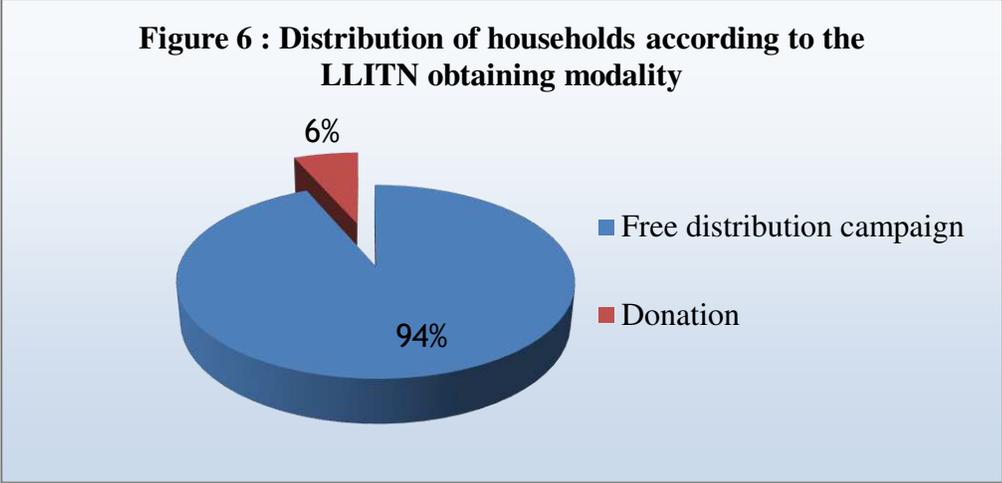
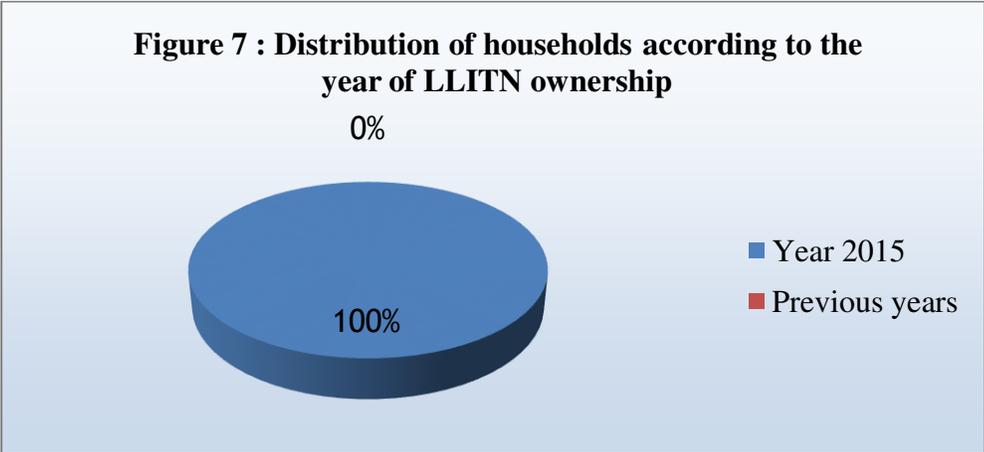


Figure 7 shows that all households surveyed acquired their LLITNs during 2015, from the last free distribution campaign conducted by the **Congolese government, through the National Malaria Control Programme, in partnership with ASF/PSI.**



1. Socio-demographic characteristics of households

Out of 360 heads of household surveyed, only 317 agreed to give their age, of whom 163 (51.42%) were between 46 and 65 years of age. Those under 46 accounted for 34.17%. Bintu B. (1) found that those under 45 accounted for 48.3%. The mean age in our study is 48.58 years with a standard deviation of 10.92 years.

- ✓ Only 12.22% of households surveyed were headed by women, in contrast to the results of the DHS-DRC II, where this proportion is 25% (Ministry of Plan DRC & al., September 2014) and those found by Danvene S. (5) and BINTU B. (1), where this proportion was 2.20% and 57.8% respectively. These huge differences could stem from the fact that our study targeted households without any other inclusion criteria, whereas for the other studies some other criteria were associated. The sex ratio is 7.18.
- ✓ More than 75% of heads of households surveyed have a significant level of education (50.83% who have completed their secondary school and 27.50% who have higher and university education). This observation is similar to that of BINTU B. where 44.50% of heads of household have completed the humanities. But it differs from the results of the DHS-DRC II, which estimates it at 38% among heads of households who have finished their secondary school in Kasai Oriental.
- ✓ Married heads of households account for nearly 90% of the cases in our study. Unmarried and divorced heads of households represent nearly 10% of the cases. The results presented by DHS-DRC II showed that 64% of the women surveyed and 55% of the men surveyed were living in a union, while 26% of women and 42% of men were single.
- ✓ The average household size in our study is 5.93 or 6 persons. This is in line with the results of DHS-DRC II, which estimated it at 5.7 persons in urban areas. 13.33% of the households surveyed have an average size of 6 persons while 50% of the households surveyed have a size below the average.

- ✓ 93.61% of households surveyed have heads with various occupations, 3.89% are unemployed and 2.50% are retired. Llupe N. (19) found in a study conducted in Bumbu in 2009, proportions of 80% of heads of households with gainful occupation. Danvene S. found that 10% of heads of households had no gainful occupation.
- ✓ 87.50% of households surveyed use LLITNs in combination with environmental sanitation as a means of malaria control, while 22 households (6.11%) use nothing. Insecticide bombs are used in 23 households surveyed (6.39%).

2. Households' knowledge of LLITNs.

All the heads of households surveyed have heard of malaria and only 81.94% believe that mosquito bites are the main mode of malaria transmission.

According to the study conducted by Danvene S., 83.5% of respondents attribute the occurrence of malaria to mosquito bites and for the DHS-DRC II, this proportion is 84% at the national level and 75% for Kasai Oriental.

All household heads surveyed had heard of the LLITN. Information reached some of them through the media (68.89%), and others through Health Centres and community relays (21.94%).

88.61% of heads of households surveyed have good knowledge of the advantages of using an LLITN: LLITNs help prevent malaria and protect against mosquito bites.

These results are similar to those found by Danvene S. (5), where 100% of the respondents had heard of the LLITN, 91.1% had good knowledge of the benefits of its use. However, they differ in terms of information channels: 42.5% by health facilities and only 38.3% by the media. On the other hand, these figures are different from those found in Côte d'Ivoire by the PNLN, where in a study, only 9% of respondents believe that the impregnated net is used to protect against malaria, but do not necessarily use it (27).

In general, 93.83% of respondents have good knowledge of the LLITN and its benefits, but this knowledge varies greatly from one variable to another: heads of respondent households with medium and high levels of education have good knowledge of the LLITN and its benefits, 94.54% and 97.98% respectively. In terms of age, respondents under 65 years of age have good knowledge of the benefits

of LLITNs. In terms of gender, females show average knowledge of the benefits of LLITNs (56.82%) compared to males who appear to be more knowledgeable (93.04%).

Regarding the occupation, unemployed and retired people have low awareness of the benefits of LLITNs (35.71% and 33.33% respectively) compared to those in gainful employment (92.28%).

Statistical analyses revealed that education, age, gender and occupation were significantly associated with knowledge about LLITNs.

Poor/low household knowledge reflects the inadequacy of the messages addressed to the population. This information mission is usually devolved to the community relays who do not visit households often (only 19.72% of households know the community relays), but also to the health centres, which must integrate it into all organized activities (only 2.22% of women received information on LLITNs at the health centre).

3. Households' attitudes towards LLITNs.

The research conducted revealed that 96.94% of respondents have a favourable attitude towards the use of LLITNs; 94.44% said they own at least one LLITN in their household. 3.06% have other reasons for being unfavorable to the use of LLITNs (e.g., it is suffocating, causes discomfort and heat, or is unnecessary). These results are not too different from those found by Mputu N. who noted that, in general, 71% have a favourable attitude towards the use of LLITNs and 90% have at least one LLITN; by Danvene S., who noted that 80% of respondents are in favour of LLITNs; and by DHS-DRC II, which showed that 70% of respondents own at least one LLITN.

Based on the observations on community-oriented information, we believe that people have largely adopted good attitudes towards the LLITN because they have been sufficiently informed; information shapes attitude, and attitude determines action.

In this study, we did not assess respondents' knowledge of the roles of LLITNs against other vector-borne diseases, nor did we assess LLITN use in relation to housing type and suitability for different sleeping arrangements, let alone use by categorization: children under 5 years of age - pregnant women - other family members.

4. Households' Practices

90.28% of households surveyed reported having spent the previous night under an LLITN. However, only 61.39% make LLITNs a priority and use them every night (overall proportion of good practices). 33.06% consider it an emergency but do not use it every night. In a study conducted by Kabena N. (13) all respondents had spent the previous night under the LLITN and only 48.8% use it every night.

The actual use of LLITNs depends on several parameters. Of the 94.44% of respondents who own at least one LLITN, only 65% use it. In terms of educational attainment, good practices are highly rated among respondents with medium and/or high levels of education; by age, they are highly rated among those under 65 years of age; by sex, they are highly rated among women; and by occupation, they are highly rated among respondents in gainful employment. Actual LLITN use is significantly associated with education, age, sex and occupation.

Our findings show that the LLITNs owned by households are significant in relation to their respective sizes: 76.67% of households of less than 6 people own 2-3 LLITNs; 85.50% of households of 6 people own at least 2 LLITNs; 66.37% of households of 7-10 people own at least 4 LLITNs and 73.67% of households of more than 10 people own 4 or more LLITNs. 94% of households reported having obtained their LLITNs during the free distribution campaign conducted in August 2015 and 6% acquired them through a donation (family member, friends, etc.).

The purpose of this a cross-sectional descriptive study was to assess the knowledge, attitudes and practices of households regarding long-lasting insecticide-treated net use in Bonzola Health Zone in Mbuji-Mayi City in the DR Congo, in order to contribute to the strengthening of the fight against malaria by improving knowledge on the use of the ITN as a means of malaria prevention and control and possibly to make recommendations to policy makers.

At the end of this assessment of the population of Bonzola Health Zone on LLINs, we found *that, overall, 93.83% of respondents had good knowledge about LLITNs and its benefits, 96.94% had a favorable attitude toward its use, and only 61.39% had good practices.*

Certain factors limit the effective use of LLINs by households. Although population knowledge and attitude are good enough, the utilization of LLITNs did not much progress comparing to the proportion of pregnant women sleeping under an ITN (60%) revealed in the 2013 MICS-DRC Report.

Regarding the ownership of LLITNs in households, 94.44% reported owning at least one LLITN. Thus, the use of LLITNs the day before our survey was important (90.28%). However, it is difficult to assess the sleeping habits of households taking into account the type of dwelling.

These results reflect what the last free distribution of LLITNs carried out in August 2015 by the Government (through the National Malaria Control Programme, in partnership with ASF/PSI) has largely produced as impact to the beneficiary population.

A two-year retrospective study (2017-2018) on the prevalence of Malaria in the study area can also give a perfect idea of the impact of utilization of LLITNs by the population. Furthermore, it will help to adapt awareness and sensitization messages to the population, strengthen health system at HZ level, provide appropriate measures and advocate for continual use of LLITNs.

We therefore recommend:

1. To the Ministry of Public Health:
 - ❖ To discuss with the Ministry of Education, the opportunity to insert in the different curricula, courses on health education. Indeed, given the weight of malaria on the health of the community, it would not be inconsistent to introduce this programme from primary school

onwards, in order to reach a critical mass capable of changing behaviours and educating other members of their community.

2. To the Health Zone of Bonzola:

- ❖ To increase household awareness of the benefits of LLITNs in order to increase their use (attitude towards) and to develop clear communication messages adapted to the local realities of the Health Areas to improve the level of use of the LLITNs received and prevent drop-outs over time.
- ❖ Develop a plan for monitoring the use of LLITNs and, at the same time, adopt revitalization measures.
- ❖ To strengthen the capacities of providers in hospitals and Health Centres in terms of malaria control strategies adopted by the NMCP.

3. To the population of DRC :

- ❖ To use this weapon, which is most relevant in public health, in order to contribute to the reduction of suffering in the community by changing negative behaviours into health-promoting behaviours. And by the same token, to significantly reduce the burden of disease/health costs in the community through the simple use of the LLITN.
- ❖ Obtain and continue to use the LLITN for the well-being of the family.

The long-lasting insecticide-treated net currently remains one of the most effective means of preventing malaria and several vector-borne diseases.

LIST OF ABBREVIATIONS

ASF/PSI	: Association Santé Familiale (Family Health Association) / Population Services International
DHS	: Demographic and Health Survey
DR	: Democratic Republic
DRC	: Democratic Republic of the Congo
HA	: Health Area
HZ	: Health Zone
ITN	: Insecticide-treated net
IRC	: International Rescue Committee
LLITN	: Long-acting insecticide-treated mosquito net
NMCP	: National Malaria Control Programme
MICS	: Multiple Indicator Cluster Survey
MSH	: Management Sciences for Health
OSC	: Overseas Strategic Consulting
PNLP	: Programme National de Lutte contre le Paludisme (National Malaria Control Programme)
PROSANI	: Projet de Santé Intégré (Integrated Health Project)
WHO	: World Health Organization

- **Ethics approval and consent to participate:**

Ethical approval was obtained from the University of Mbuji-Mayi, followed by that of the Burgomaster of Kanshi local government area where the Bonzola Health Zone where the study was conducted is located. At the level of each household, the informed consent was obtained from the respondent prior to the administration of the questionnaire. Consent was free and verbal.

- **Consent for publication:** This study does not contain any individual person's data that can identify participants.

- **Availability of data and materials:** The datasets generated, used and analysed during the current study are available from the corresponding author on reasonable request. In this study, data were collected anonymously and confidentially. We reserved the right to safeguard the privacy and personality of the respondent.

- **Competing interests:** There are no competing interests.

- **Funding:** This study is self-funded.

- **Author's contributions:** KC has completed the first draft of the study concept, design of the study, and analyses of literature, and KC extracted the data. KC analyzed and interpreted all the participant data and drafted the initial manuscript and revised the final manuscript. KC is the guarantor of the review.

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Figures

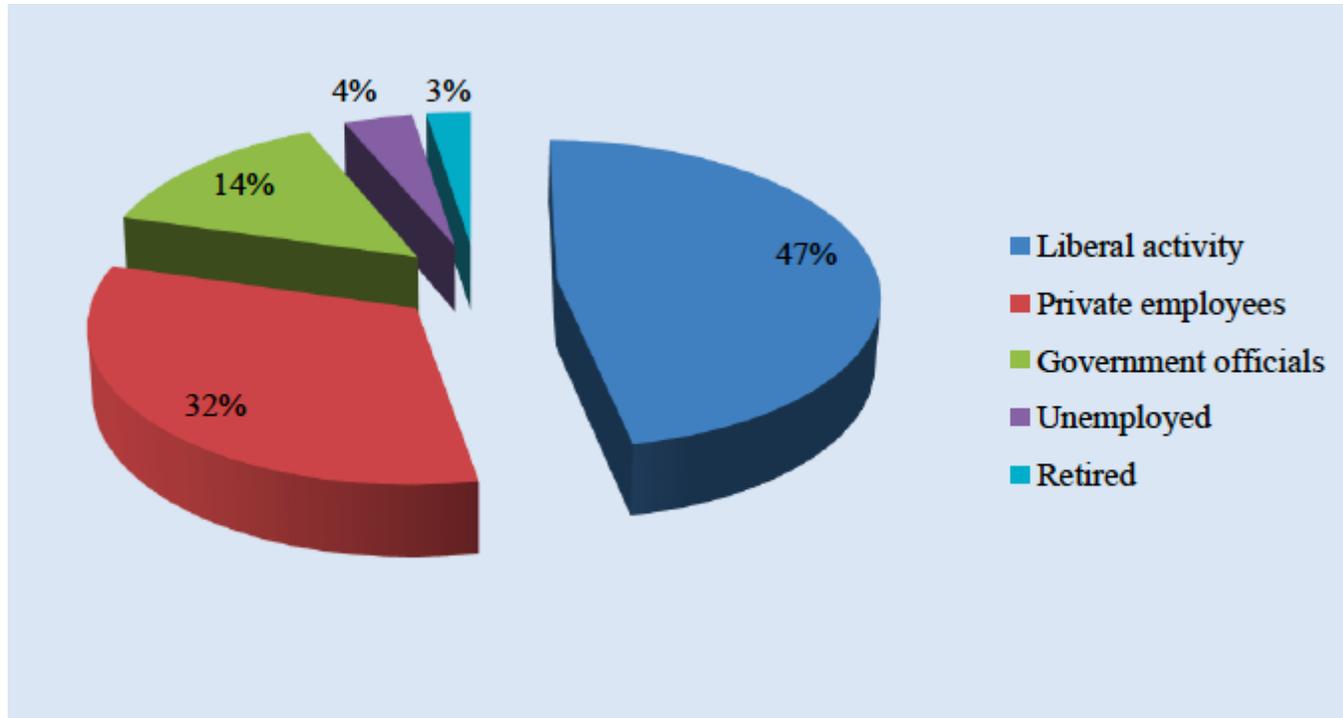


Figure 1

Profession of households' heads

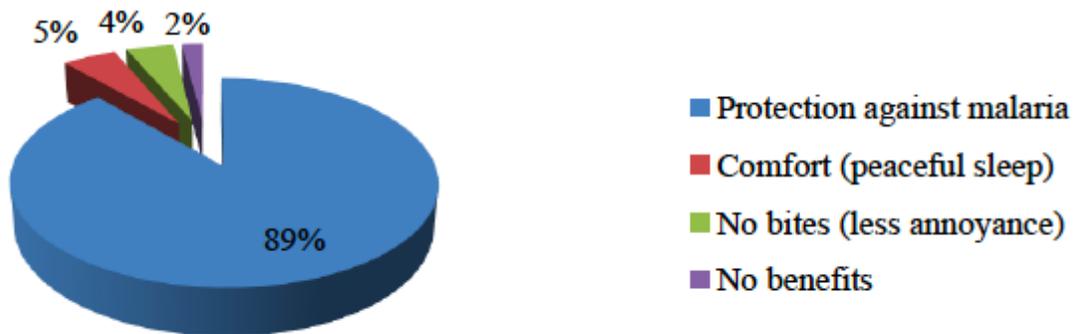


Figure 2

Knowledge of LLITNs' benefits

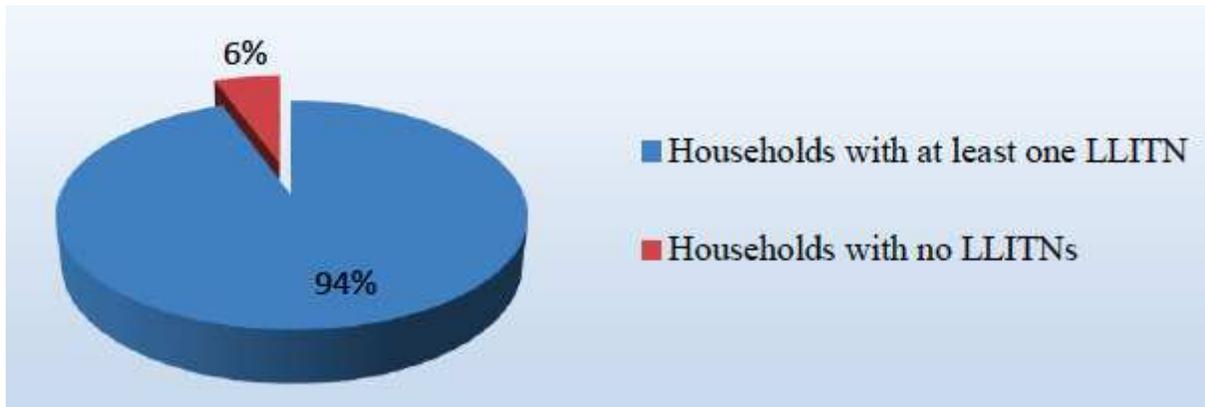


Figure 3

Distribution of households according to LLITN ownership

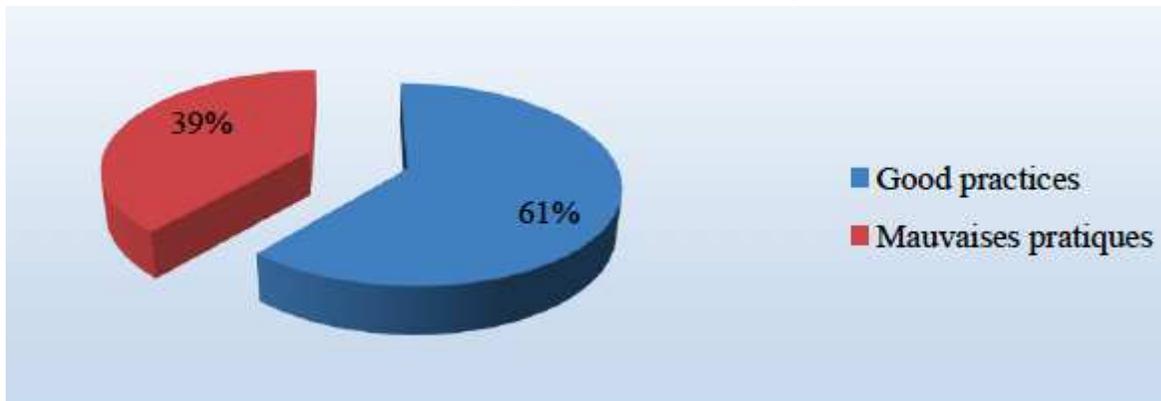


Figure 4

Distribution of households surveyed who have ever heard of LLITNs according to their practices

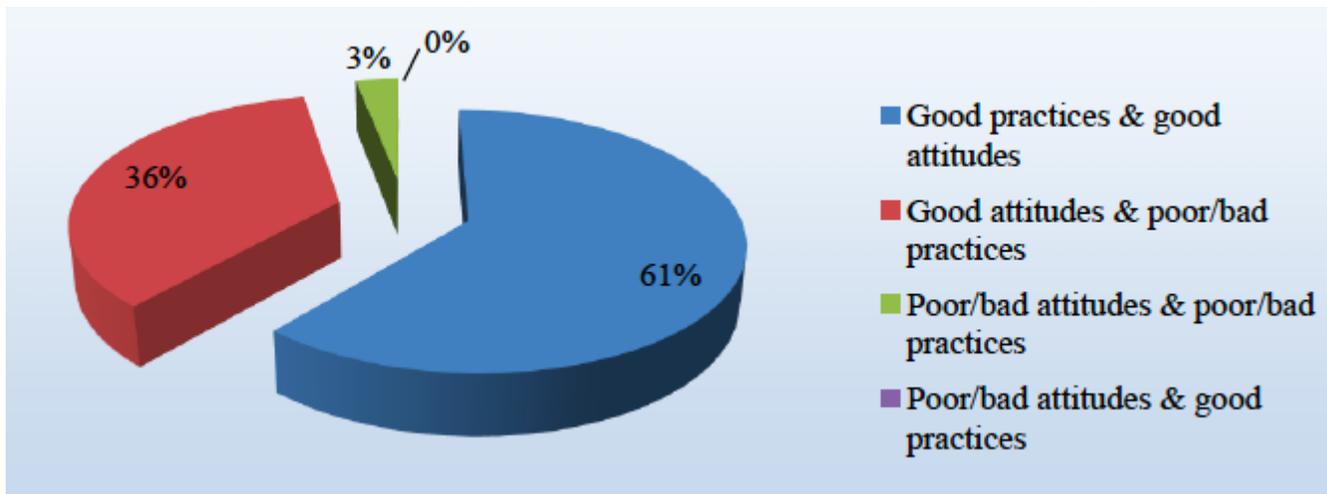


Figure 5

Distribution of households according to attitudes towards LLITNs and practices

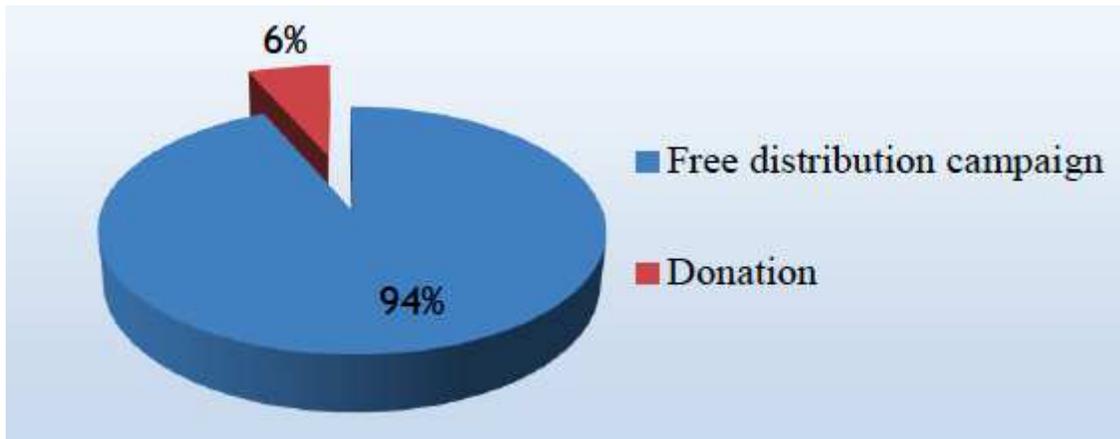


Figure 6

Distribution of households according to the LLITN obtaining modality

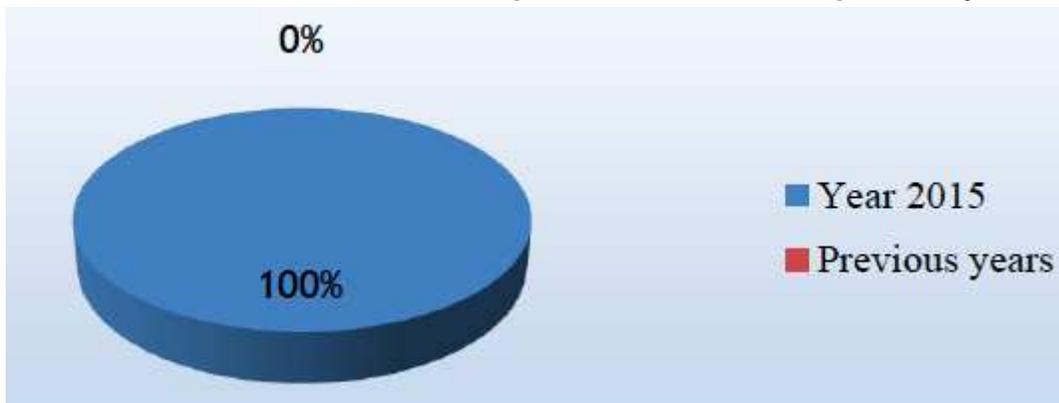


Figure 7

Distribution of households according to the year of LLITN ownership

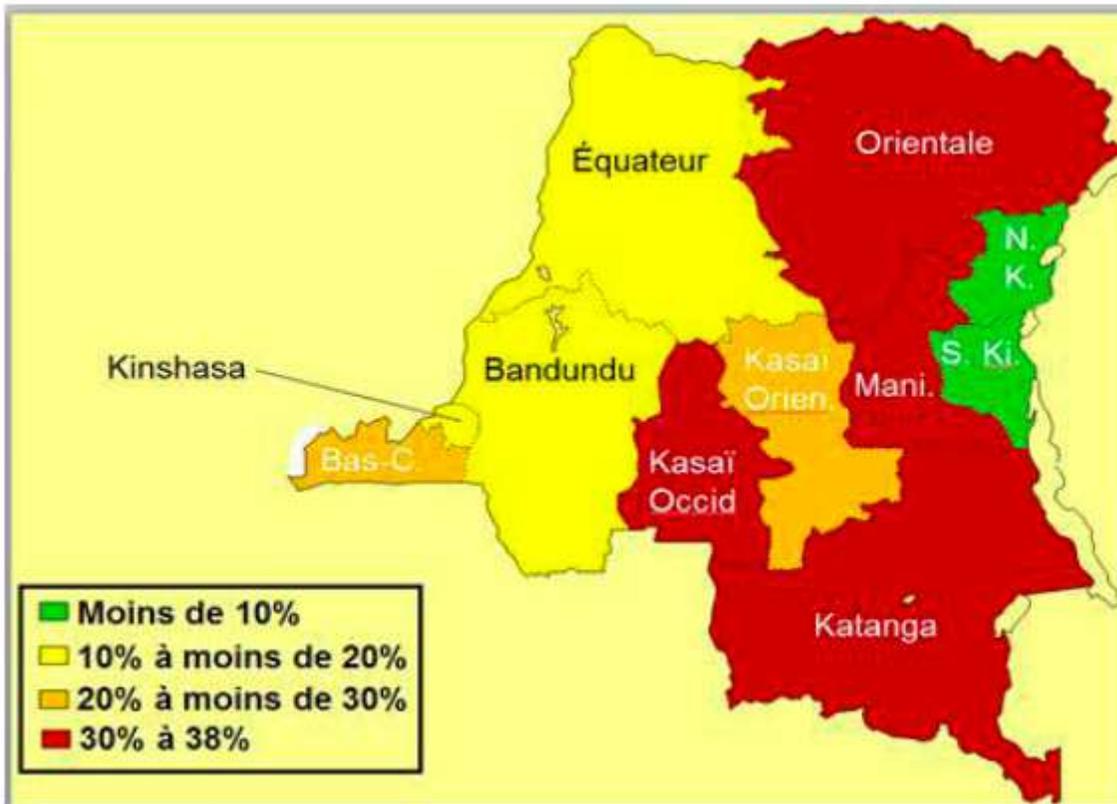


Figure 8

Map 1 : Malaria prevalence in DRC, 2014. Source: Main Report DHS-DRC II 2013-2014, September 2014.

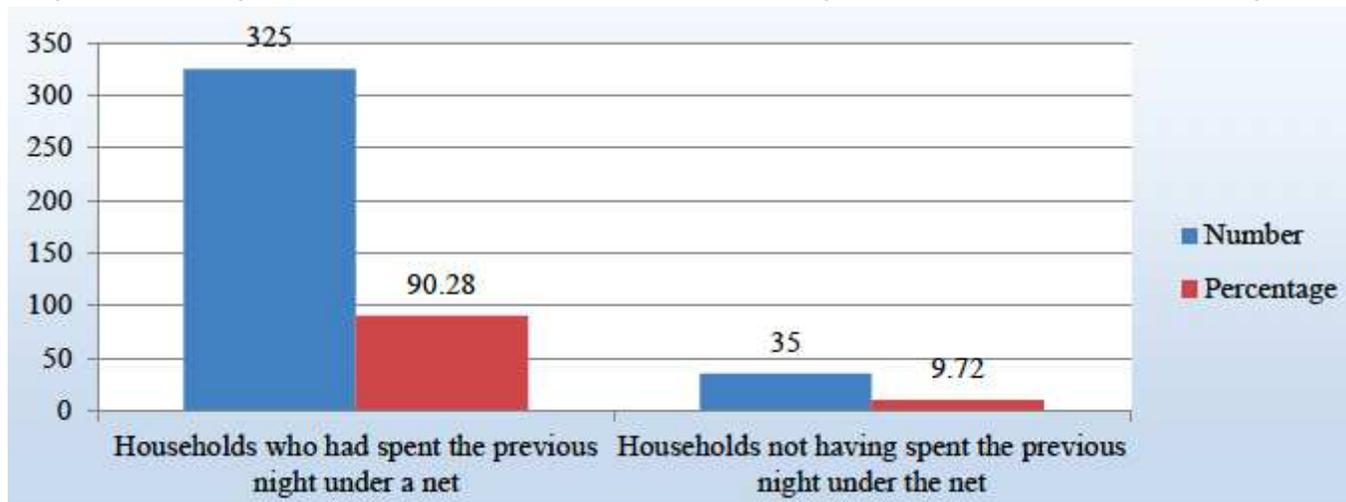


Figure 9

Chart 1: Rate of LLITN use on the night prior to the survey