**An Analysis of determinants of insecticide-treated mosquito nets**

**use among children less than 5 years in Côte d’Ivoire: Examination of 2011-2012 Demographic and Health Survey**

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**Abstract**

**Background**: Malaria remains a public health problem despite progress in its control since the launch of the Roll Back Malaria global partnership in 1998. Studies showed that insecticide-treated mosquito net has a positive impact on the reduction of morbidity and mortality of malaria. In Côte d’Ivoire, an estimated 16 million long-lasting insecticidal nets (LLINs) have been delivered from 2014 to 2016. We conducted a study to determined factors associated with LLINs utilization in Cote d’Ivoire. **Methods**: We conducted a cross-sectional study including children less than 5 years of age using 2011-2012 Côte d’Ivoire Demography and Health Surveys data. **Results**: Findings showed LLIN use among children less than 5 years was 32.28% in urban area and 40.18% in rural area. In urban area, Mothers’ education level, Region, and Number of defacto people in the household were associated with LLINs utilization. In rural area, Wealth index, and Number of defacto people in the household were associated with LLINs utilization. **Discussion**: Rural areas populations are more exposed to mosquito bites hence the higher LLIN use rate in the rural area. Education increases mothers' understanding of health, resulting in increased use of maternal and child care services by mothers. **Conclusion**: Health authorities and malaria programme manager in Côte d’Ivoire should take into account findings of this study to make policy and develop strategies for malaria control.

**Key words**: determinants, insecticide-treated mosquito nets, use, children, Côte d’Ivoire

**INTRODUCTION**

Malaria remains a public health problem despite progress in its control since the launch of the Roll Back Malaria global partnership in 1998 [1]. According to the World Health Organization (WHO), an estimated 212 million malaria cases and 429 000 deaths from this disease have been reported globally in 2015. It is a remarkable decrease of cases (22%) and deaths (50%) compared to 2000. In 2015, the vast majority of cases (90%) and deaths (92%) occurred in the WHO African Region and especially among children less than 5 years of age (303 000 deaths) [2]. In Côte d’Ivoire, an estimated 8 700 000 cases and 33 000 deaths occurred in 2000 while in 2015 cases and deaths were estimated to 7 900 000 and 14 000 respectively [2]. Malaria is caused by parasitic protozoa of the genus Plasmodium (falciparum, vivax, malariae, ovale, and knowlesi) [3, 4]. Mosquitoes of the *Anopheles* genus are the vectors of the *Plasmodium* species [5]. Two methods are commonly used to prevent mosquito bites: sleeping under an insecticide-treated mosquito net (ITN) and indoor residual spraying (IRS) [2]. Studies showed that ITN has a positive impact on the reduction of morbidity and mortality of malaria and other diseases such as Japanese encephalitis, Chagas disease, lymphatic filariasis, and leishmaniasis [2, 6, 7]. ITN provides two types of barrier: a physical barrier and a chemical one due to Pyrethroid insecticides witch repel, disable and/or kill mosquitoes coming into contact with the net. The chemical effect of ITN, especially long-lasting insecticidal nets (LLIN), last at least three years in the field under recommended conditions of use, precluding the need for regular insecticide treatment. Therefore, the WHO Global Malaria Programme (WHO/GMP) calls upon national malaria control programmes and their partners involved in insecticide-treated net interventions to purchase only long-lasting insecticidal nets [6, 7]. In Côte d’Ivoire, an estimated 17 million LLIN have been delivered from 2014 to 2016 [8, 9, 10, 11]. Findings of the Multiple Indicators Cluster Survey (MICS) conducted in the country in 2016 showed that LLIN ownership and use was estimated to 75% and 59% respectively [12] while in 2012 these indicators were assessed to 66% and 33% respectively [13]. Based on these findings, we conducted a study to determined factors associated with LLINs utilization in Cote d’Ivoire.

The objectives of the study were:

* To determine LLINs possession rate by residence place (urbane, rural) among children less than 5 years;
* To estimate the LLINs use rate by residence place among children less than 5 years;
* To identify factors associated with LLINs use among children less than 5 years in urbane, and rural areas.

**METHOD**

We conducted a cross-sectional study including children less than 5 years of age.

* **Data Source**

The 2011-2012 Côte d’Ivoire Demography and Health Surveys (DHS) data were used for this study. These data were obtained from DHS data at

http://www.dhsprogram.com/data/dataset\_admin/download-datasets.cfm, after a written request explaining the purpose of the study. This request was followed by a written agreement, from the Demographic and Health Survey Program and Inner City Fund (ICF) International, which authorized the data use.

Côte d’Ivoire DHS was based on a cluster survey with two level. The first level was clustered selection from urban areas and rural areas. Then a list of households was obtained from selected clusters from urban areas and rural areas. The second level was the selection of households to be interviewed. The number of households selected in each cluster was proportional to the total number of household by cluster [13].

* **Study sample**

The study sample was based on "personal record" data set from 2011-2012 DHS which contained 51 187 cases with 4 198 children less than 5 years.

* **Variables**

The outcome variable was LLIN utilization the day before the survey (Yes, No). Independent variables were mother education level (no education, primary, secondary and high), wealth index (poor, intermediate, rich), region (Abidjan, South without Abidjan, Centre, West, East, North), child’s age group in months (0-12, 13-24, 25-36, 37-48, 49-59), number of defacto people in the household (0-5, 6-10, 11+), and age of head of household in years (14-30, 31-40, 41-50, 51-60, 60+).

* **Statistical analysis**

The outcome variable has been stratified by the type of place of residence (urbane, rural). Descriptive analysis was performed to examine the rate of LLINs ownership and utilization in urban and rural areas, by region, and proportions of children less than 5 years who slept under a LLIN the day before the survey. The Chi-square test was computed to compare proportions among variables.

Univariate analysis was performed then multivariate analysis was performed to determine predictors of LLINs utilization using the logistic regression. Statistical analysis was performed using STATA 14.

**RESULTS**

## **Descriptive**

LLINs possession rate in the urban and rural area was 71.85% and 81.74% respectively.

LLINs utilization rate in the urban and rural area was 32.28% and 40.18% respectively.

Distribution of ITN ownership and utilization by region, in Cote d’Ivoire, is shown in figure 1. The proportion of ITN utilization was lower than ownership in all regions.

Distribution of absolute difference between ITN ownership and utilization by region is shown in table 1. The absolute difference between ITN ownership and utilization was highest in Abidjan.

Distribution of proportions of children less than 5 years who slept under ITN the day before the survey, in Cote d’Ivoire, is shown in table 2. In both urban and rural area, proportions differences were statistically significant for Wealth index, Region, and Number of defacto people in the household.

**Univariate analysis**

The result of the univariate analysis of ITN utilization with selected independent variables is presented in table 3. Wealth index and Number of defacto people in the householdwereassociated withITN utilization in both urban and rural area.

**Multivariate analysis**

The result of multivariate analysis of ITN utilization with selected independent variables is presented in table 4. In urban area, Mother education level, Region, and Number of defacto people in the household were associated with ITN utilization. In rural area, Wealth index, and Number of defacto people in the household were associated with ITN utilization.

**DISCUSSION**

Long-lasting insecticidal nets (LLIN) possession among children less than 5 years was higher in rural area (81%) compared to urban area (71%) in Côte d’Ivoire, in 2012. This situation could be explained by the fact that rural area has been privileged for the ITN distribution. In fact, the probability of malaria transmission is higher in rural area compared to urban area for climatic and environmental reasons [14]. A study conducted in Sierra Leon, in 2011, also showed that insecticide-treated mosquito net ownership was greater in rural area than in urban area [15]. Therefore, in a situation of LLIN distribution, it was logical to give priority to rural area where LLIN distribution target populations (pregnant women, and children less than five years) were higher compared to urbane populations [13].

LLIN use among children less than 5 years was 32.28% in urban area and 40.18% in rural area. This situation could be explained by many reasons. Firstly, the population in rural area could be more incline to comply with healthcare workers advice about malaria prevention. The majority of people living in rural area having a low education level (no education or primary) [12, 13], they may strongly believe in health care workers. Secondly, people in a rural setting could fear expenses related to medical treatment. Most of the people living in a rural area being poor [12, 13], they could be more incline to use LLIN to prevent malaria among children less than 5 years and, therefore, prevent malaria treatment-related expenses. Thirdly, the predominance of the malaria vector. Mosquitoes of the *Anopheles* genus are more prevalent in a rural area compared to the urban area [14]. Therefore, rural areas populations are more exposed to mosquito bites hence the higher LLIN use rate in the rural area.

Regarding the LLIN utilization, in our study, the number of defacto people in the household was associated with LLIN use in both urban and rural area. Indeed, children living in a household with at least 11 individuals were 2 times likely to use ITN compared to those living in a household with less than 6 persons. In fact, in Cote d’Ivoire, most of the families with at least 11 individuals are poor and live in a precarious neighborhood with poor hygiene and sanitation leading to the proliferation of malaria vector, the *Anopheles.* Therefore, children living in big size families are more exposed to mosquito bites hence children living in a household with at least 11 individuals were more likely to use ITN.

Especially in an urban area, factors associated with LLIN utilization were mother’s education level, and region. Children of women with secondary and high education level were more likely to use LLIN compare to children of women with no education. Education increases mothers' understanding of health, resulting in increased use of maternal and child care services by mothers [16]. In Cote d’Ivoire, in 2012, LLIN were distributed to pregnant women and children less than five years during the antenatal visit and routine immunization service visit [17].

As far as the region is concerned, children living in urban area of Northern, Western and Central regions were less likely to use LLIN compared to those living in Abidjan. This situation could be explained by many factors such as people education. Abidjan is the biggest town in the country with more than four millions inhabitants, and highly educated men and women. Education is associated with health service utilization [16] hence the more likelihood use of ITN among children of Abidjan compared to children in other cities. In addition, people access to media. In Abidjan, most of the people have access to information about LLIN utilization through different media (newspapers, television, and internet) and billboards. Studies showed that lack of access to media is associated with low utilization of health services [18, 19] which could explain the less likelihood of ITN use among children living in Northern, Western and Central regions compared to those living in Abidjan.

In rural area especially, wealth index was associated with LLIN utilization. In fact, children from intermediate families were more likely to use ITN compared to those living in poor families. Level of wealth index is most of the time related to the level of education. Parents of intermediate wealth index could have a better understanding of LLIN use advantage than poor parents hence the great likelihood of children from intermediate to use ITN compared to those of poor families.

Findings of this study should take into account its limitations. Firstly, the outcome variable (LLIN utilization) is based on the LLIN use the day before the survey. This situation may not reflect the real habit of the target population which should be observed on long periods (weeks, months). Secondly, the survey was conducted over the period 2011-2012. From the data collection period to present, many activities may have been done to increase LLIN possession and utilization rate. The impact of these activities on the population may change factors associated with LLIN utilization in Cote d’Ivoire.

In conclusion, long-lasting insecticidal nets possession rate and utilization rate were higher in rural area compared to urban area. However, in both rural and urban areas, long-lasting insecticidal nets utilization rate was about half of possession rate. Concerning factors associated with long-lasting insecticidal nets use, these factors were the number of defacto people in the household (in both urban and rural area), mother’s education level, and region (in an urban area), and wealth index (in a rural area). Health authorities and malaria programme manager in Cote d’Ivoire should take into account findings of this study to make policy and develop strategies for malaria control. Additional, studies should be conducted to understand the low rate of long-lasting insecticidal nets utilization, and trend of factors associated with long-lasting insecticidal nets use.

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**Authorship Contributions and Disclosure of Conflicts of Interest**

Alfred Douba, Christian Bangaman Akani, Isaac Hans Bahibo: conception and design, acquisition of data, and analysis and interpretation of data.

Petronille Acray-Zengbé, Nicaise Bernadin Lepri Aka: drafting the article, and revising it critically for important intellectual content.

Eric Ange Noba Assohou, Tanoh Roselin Akpegni Kouamé, Méa Antoine Tanoh, Serge-Brice Assi, Kouakou Martial Eric Ahoussou, Roland Konan Oussou, Guillaume Okoubo: final approval of the version to be published.

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**Tables**

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| Table 1: Distribution of absolute difference between ITN ownership and utilization by region, Cote d’Ivoire, 2011-2012 |
| Region  | Ownership (%) | Utilization (%) | Absolute Difference between ITN\* ownership et utilization (%) |
| Abidjan | 69,4 | 22,4 | 47,0 |
| West | 72,8 | 30,4 | 42,4 |
| Centre | 78,7 | 46,1 | 32,6 |
| East | 79,4 | 43,9 | 35,5 |
| North | 82,2 | 38,9 | 43,3 |
| South | 83,2 | 39,5 | 43,7 |
| **\*** insecticide-treated mosquito net |  |

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| Table 2: Distribution of proportions of children less than 5 years who slept under ITN the day before the survey, Cote d’Ivoire, 2011-2012 |
|  |  | Urban area |  |  | Rural area |  |
|  | Number | Proportions of children (%) | P value | Number | Proportions of children (%) | P value |
| **Independent variables** |  |  |  |  |  |  |
| **Mother education level** | **1 366** |  |  | **2 432** |  |  |
|  No education | 760 | 38.78 |  | 1 714 | 41.08 |  |
|  Primary | 336 | 30.91 | 0.013 | 630 | 38.93 | 0.383 |
|  Secondary and high | 270 | 24.80 |  | 88 | 49.21 |  |
| **Wealth index**  | **1 539** |  |  | **2 659** |  |  |
|  Poor | 25 | 58.29 |  | 1 912 | 42.64 |  |
|  Intermediate | 361 | 39.61 | 0.037 | 513 | 32.37 | 0.020 |
|  Rich | 1 153 | 29.41 |  | 234 | 37.23 |  |
| **Region** | **1 539** |  |  | **2 659** |  |  |
|  Abidjan | 619 | 21.81 |  | NA | NA |  |
|  South without Abidjan | 210 | 36.81 |  | 643 | 39.33 |  |
|  Centre  | 448 | 40.21 | 0.007 | 894 | 48.62 | 0.026 |
|  West | 113 | 42.68 |  | 496 | 27.21 |  |
|  East | 31 | 37.09 |  | 71 | 44.91 |  |
|  North | 118 | 37.83 |  | 555 | 38.58 |  |
| **Child age group (month)** | **1 539** |  |  | **2 659** |  |  |
|  0-12  | 357 | 36.46 |  | 648 | 41.84 |  |
|  13-24  | 327 | 35.72 |  | 532 | 43.21 |  |
|  25-36  | 294 | 28.49 | 0.183 | 558 | 41.21 | 0.316 |
|  37-48  | 307 | 30.22 |  | 517 | 36.18 |  |
|  49-59  | 254 | 28.85 |  | 404 | 37.25 |  |
| **Number of defacto people in the household** | **1 539** |  |  | **2 659** |  |  |
| 0-5 | 625 | 38.22 |  | 931 | 46.76 |  |
| 6-10 | 643 | 32.71 | 0.0003 | 1 150 | 40.87 | 0.0001 |
| 11+ | 271 | 17.56 |  | 578 | 28.23 |  |
| **Age of head of household (year)** | **1 539** |  |  | **2 659** |  |  |
| 14-30 | 213 | 39.35 |  | 455 | 46.45 |  |
| 31-40 | 469 | 37.71 | 0.072 | 749 | 41.49 | 0.024 |
| 41-50 | 388 | 29.25 |  | 566 | 41.98 |  |
| 51-60 | 258 | 24.93 |  | 453 | 39.56 |  |
| 61+ | 211 | 27.66 |  | 436 | 29.74 |  |

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| Table 3: Univariate analysis of ITN utilization with selected independent variables, Cote d’Ivoire,  2011-2012  |
|  |  | Urban area |  |  | Rural area |  |
|  | OR\* | 95%CI\*\* | P value | OR | 95%CI | P value |
| **Independent variables** |  |  |  |  |  |  |
| **Mother education level** |  |  |  |  |  |  |
|  No education | 1 |  |  | 1 |  |  |
|  Primary | 1.41 | 0.92-2.17 | 0.112 | 1.09 | 0.81-1.46 | 0.545 |
|  Secondary and high | 1.92 | 1.23-2.99 | 0.004 | 0.72 | 0.43-1.17 | 0.188 |
| **Wealth index**  |  |  |  |  |  |  |
|  Poor | 1 |  |  | 1 |  |  |
|  Intermediate | 2.13 | 0.54-8.36 | 0.277 | 1.55 | 1.11-2.15 | 0.009 |
|  Rich | 3.35 | 1.04-10.73 | 0.042 | 1.25 | 0.81-1.91 | 0.296 |
| **Region** |  |  |  |  |  |  |
|  Abidjan | 1 |  |  | NA |  |  |
|  South without Abidjan | 0.47 | 0.23-0.99 | 0.049 | 1 |  |  |
|  Centre  | 0.41 | 0.24-0.69 | 0.001 | 0.68 | 0.43-1.07 | 0.100 |
|  West | 0.37 | 0.15-0.91 | 0.031 | 1.73 | 0.80-3.72 | 0.157 |
|  East | 0.47 | 0.27-0.80 | 0.007 | 0.79 | 0.37-1.66 | 0.542 |
|  North | 0.45 | 0.26-0.80 | 0.007 | 1.03 | 0.65-1.61 | 0.890 |
| **Child age group (month)** |  |  |  |  |  |  |
|  0-12  | 1 |  |  | 1 |  |  |
|  13-24  | 1.03 | 0.72-1.46 | 0.859 | 0.94 | 0.71-1.24 | 0.690 |
|  25-36  | 1.44 | 0.96-2.15 | 0.076 | 1.02 | 0.82-1.27 | 0.813 |
|  37-48  | 1.32 | 0.94-1.84 | 0.097 | 1.26 | 0.86-1.85 | 0.221 |
|  49-59  | 1.41 | 0.95-2.09 | 0.082 | 1.21 | 0.88-1.66 | 0.232 |
| **Number of defacto people in the household** |  |  |  |  |  |  |
| 0-5 | 1 |  |  | 1 |  |  |
| 6-10 | 1.27 | 0.87-1.84 | 0.200 | 1.27 | 0.96-1.66 | 0.082 |
| 11+ | 2.90 | 1.79-4.70 | 0.0001 | 2.23 | 1.51-3.27 | 0.0001 |
| **Age of head of household (year)** |  |  |  |  |  |  |
| 14-30 | 1 |  |  | 1 |  |  |
| 31-40 | 1.07 | 0.66-1.72 | 0.77 | 1.22 | 0.86-1.72 | 0.245 |
| 41-50 | 1.57 | 0.90-2.73 | 0.11 | 1.19 | 0.81-1.77 | 0.362 |
| 51-60 | 1.95 | 0.99-3.84 | 0.05 | 1.32 | 0.90-1.93 | 0.145 |
| 61+ | 1.69 | 0.89-3.22 | 0.10 | 2.04 | 1.31-3.19 | 0.002 |
| \*Odds Ratio, \*\*Confidence Interval |  |  |  |  |  |

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| Table 4: Multivariate analysis of ITN utilization with selected independent variables, Cote d’Ivoire, 2011-2012  |
|  |  | Urban area |  |  | Rural area |  |
|  | Adj. OR\*  | 95%CI | P value | Adj. OR  | 95%CI | P value |
| **Independent variables** |  |  |  |  |  |  |
| **Mother education level** |  |  |  |  |  |  |
|  No education | 1 |  |  | 1 |  |  |
|  Primary | 1.23 | 0.80-1.91 | 0.334 | 0.99 | 0.75-1.30 | 0.966 |
|  Secondary and high | 1.68 | 1.04-2.72 | 0.034 | 0.73 | 0.42-1.26 | 0.264 |
| **Wealth index**  |  |  |  |  |  |  |
|  Poor | 1 |  |  | 1 |  |  |
|  Intermediate | 1.53 | 0.42-5.55 | 0.508 | 1.53 | 1.01-2.14 | 0.012 |
|  Rich | 1.75 | 0.56-5.45 | 0.329 | 1.21 | 0.82-1.79 | 0.325 |
| **Region** |  |  |  |  |  |  |
|  Abidjan | 1 |  |  | NA |  |  |
|  South without Abidjan | 0.53 | 0.25-1.12 | 0.097 | 1 |  |  |
|  Centre  | 0.41 | 0.23-0.72 | 0.002 | 0.64 | 0.41-1.02 | 0.063 |
|  West | 0.37 | 0.16-0.83 | 0.017 | 1.62 | 0.76-3.42 | 0.205 |
|  East | 0.58 | 0.31-1.11 | 0.102 | 0.66 | 0.30-1.46 | 0.309 |
|  North | 0.42 | 0.23-0.76 | 0.005 | 0.87 | 0.54-1.39 | 0.574 |
| **Child age group (month)** |  |  |  |  |  |  |
|  0-12  | 1 |  |  | 1 |  |  |
|  13-24  | 0.98 | 0.67-1.41 | 0.915 | 0.84 | 0.63-1.13 | 0.258 |
|  25-36  | 1.26 | 0.81-1.94 | 0.288 | 0.97 | 0.76-1.24 | 0.851 |
|  37-48  | 1.27 | 0.87-1.86 | 0.206 | 1.29 | 0.92-1.79 | 0.127 |
|  49-59  | 1.06 | 0.65-1.72 | 0.794 | 1.22 | 0.89-1.67 | 0.205 |
| **Number of defacto people in the household** |  |  |  |  |  |  |
| 0-5 | 1 |  |  | 1 |  |  |
| 6-10 | 1.11 | 0.75-1.66 | 0.581 | 1.14 | 0.83-1.55 | 0.409 |
| 11+ | 2.69 | 1.51-4.78 | 0.001 | 1.90 | 1.26-2.85 | 0.002 |
| **Age of head of household (year)** |  |  |  |  |  |  |
| 14-30 | 1 |  |  | 1 |  |  |
| 31-40 | 0.92 | 0.56-1.50 | 0.743 | 1.06 | 0.75-1.50 | 0.734 |
| 41-50 | 1.34 | 0.77-2.32 | 0.290 | 0.87 | 0.56-1.36 | 0.565 |
| 51-60 | 1.39 | 0.65-2.94 | 0.388 | 0.94 | 0.61-1.43 | 0.789 |
| 61+ | 1.22 | 0.60-2.46 | 0.573 | 1.66 | 0.96-2.87 | 0.067 |
| **\***Adjusted Odds Ratio |  |  |  |  |  |  |

**Figure**

**Figure 1**: Distribution of ITN possession and utilization by region, Cote d’Ivoire, 2011-2012