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Determinants of Insecticide-Treated Mosquito Nets Use Among Children Less Than 5 Years in Côte d'Ivoire: An analysis of Data from the 2011-2012 Demographic and Health Survey

Déterminants de l'utilisation des moustiquaires imprégnés d'insecticide à longue durée d'action chez les enfants de moins de 5 ans en Côte d'Ivoire: Leçons de l'enquête Démographique et Santé de 2011-2012.

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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 determine factors associated with LLINs utilization in Côte 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 with high education level. **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.

RÉSUMÉ

Introduction. Le paludisme reste un problème de santé publique malgré les progrès réalisés dans la lutte contre ce fléau depuis le lancement du partenariat mondial Roll Back Malaria en 1998. Des études ont montré que la moustiquaire imprégnée d'insecticide a un impact positif sur la réduction de la morbidité et de la mortalité dues au paludisme. En Côte d'Ivoire, 16 millions de moustiquaires imprégnées d'insecticide à longue durée d'action (MILDA) ont été distribuées de 2014 à 2016. Nous avons réalisé la présente étude pour déterminer les facteurs associés à l'utilisation des MILDA en Côte d'Ivoire. **Méthodes.** Nous avons réalisé une étude transversale incluant des enfants de moins de 5 ans à partir des données de l'enquête démographique et de santé de la Côte d'Ivoire de 2011-2012. **Résultats.** L'utilisation de MILDA chez les enfants de moins de 5 ans était de 32,28% en zone urbaine et de 40,18% en zone rurale. En zone urbaine, le niveau d'éducation des mères, la région et le nombre de personnes de facto dans le ménage étaient associés à l'utilisation des MILDA. En zone rurale, l'indice de richesse et le nombre de personnes de facto dans le ménage étaient associés à l'utilisation des MILDA. **Discussion.** Les populations des zones rurales sont plus exposées aux piqûres de moustiques, d'où un taux d'utilisation de MILDA plus élevé en zone rurale. L'éducation permet aux mères de mieux comprendre la santé, ce qui se traduit par un recours accru aux services de protection de la mère et de l'enfant par les mères ayant un niveau d'éducation élevé. **Conclusion.** Les autorités sanitaires et le responsable du programme lutte contre le paludisme en Côte d'Ivoire devraient tenir compte des résultats de cette étude dans l'élaboration des politiques et stratégies de lutte contre le paludisme.

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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 which 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 determine factors associated with LLINs utilization in Côte 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.

METHODS

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 levels. 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 Côte d'Ivoire, is shown in figure 1. The proportion of ITN utilization was lower than ownership in all regions.

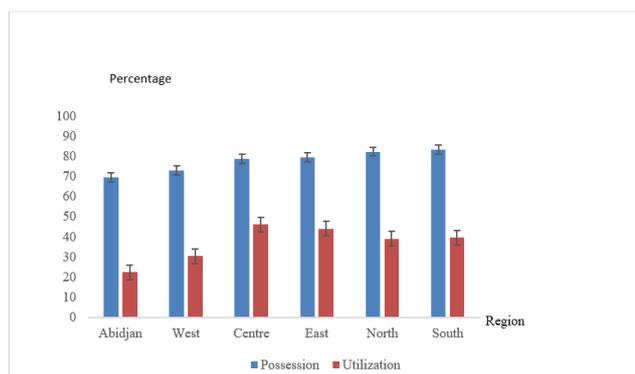


Figure 1: Distribution of ITN possession and utilization by region, Cote d'Ivoire, 2011-2012

Table 1: Distribution of absolute difference between ITN ownership and utilization by region, Cote d'Ivoire, 2011-2012

Region	Ownership (%)	Utilization (%)	Difference (%)
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

Absolute Difference between ITN* ownership et utilization (%)

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.

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		P value	Rural area		P value
	Number	Proportions of children (%)		Number	Proportions of children (%)	
Independent variables						
Mother education level	1 366			2 432		
No education	760	38.78	0.013	1 714	41.08	0.383
Primary	336	30.91		630	38.93	
Secondary and high	270	24.80		88	49.21	
Wealth index	1 539			2 659		
Poor	25	58.29	0.037	1 912	42.64	0.020
Intermediate	361	39.61		513	32.37	
Rich	1 153	29.41		234	37.23	
Region	1 539			2 659		
Abidjan	619	21.81	0.007	NA	NA	0.026
South without Abidjan	210	36.81		643	39.33	
Centre	448	40.21		894	48.62	
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	0.183	648	41.84	0.316
13-24	327	35.72		532	43.21	
25-36	294	28.49		558	41.21	
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	0.0003	931	46.76	0.0001
6-10	643	32.71		1 150	40.87	
11+	271	17.56		578	28.23	
Age of head of household (year)	1 539			2 659		
14-30	213	39.35	0.072	455	46.45	0.024
31-40	469	37.71		749	41.49	
41-50	388	29.25		566	41.98	
51-60	258	24.93		453	39.56	
61+	211	27.66		436	29.74	

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 household were associated with ITN utilization in both urban and rural area.

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						

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.

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

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 urban 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 Assouhou, 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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