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Provision and assessment of long-lasting insecticidal net, effectiveness of the distribution campaign in Plateau

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Abstract

Long-lasting insecticidal nets (LLINs) have proved to be an important tool for the malaria control and other vector-borne diseases. Benin, by its National Malaria Control Program, conducted in July, 2011 a universal distribution campaign where approximately 5 million of nets were distributed. But after this mass-distribution, questions arise: Do people effectively use or not use the mosquito nets freely distributed? To clarify these questions, this study was conducted on LLINs coverage, use and physical condition in Benin one year after their distribution. The households were randomly selected from 32 clusters. Data on bed net ownership and usage, physical condition of the nets, other characters and issues related to sourcing were asked of all targets to assess the origins of LLIN found at the household level. Of the total surveyed, 88.96% had at least one LLIN. 87.19% of these nets come from the last campaign, 9.1% were from pregnant women voucher clinic delivery systems and 3.20% were purchased full price. 84% of the nets were reportedly used the night preceding the survey. Around 89% of the total of LLINs observed was in good condition. The universal distribution campaign in Benin has significantly increased LLIN coverage and ownership policy in the community.

Keywords: Long-lasting insecticidal nets (LLINs), coverage, use, physical integrity, Benin.

INTRODUCTION

Long-lasting insecticidal nets (LLINs) have proved to be an important tool for the control of malaria and other

vector-borne diseases (World Health Organisation (WHO), 2005). Several studies in malaria endemic countries have shown the usefulness of LLINs in reducing man-vector contact from malaria (Greenwood et al., 2005; Lengeler, 2004; Eisele et al., 2006; Thwing et al., 2008). It is a technology based on the slow release of pyrethroid insecticides, rendering it wash-resistant and extending insecticide residual effectiveness to at least three years without the need of re-treatment. This is why the recent objective of roll back malaria (RBM) focuses duplication of efforts including maintaining universal coverage of nets to achieve a 75% reduction compared to 2000, the number of reported malaria cases in endemic countries in the African region, 2015 (OMS, 2011; AFR/RC50/12 – WHO, 2012) .

Benin, by its National Malaria Control Program, supported since 2000 the initiative RBM and conducted in July, 2011 a universal distribution campaign where approximately 5 million of nets were distributed. This distribution is intended to significantly increase the national coverage of insecticide-treated nets. Before the distribution, the proportion of households owning at least one net at national level was estimated at 52% (PNLP-AFRICARE BENIN-CRS BENIN, 2010). After the distribution of July, 2011, this proportion was around 86.4% (PNLP, 2011). In the net level analysis, factors independently associated in both surveys with reduced likelihood that a net would be used were: increasing net age, increasing damage of nets, increasing household net density (nets/person). Some studies have shown that several factors are associated with LLIN ownership and effective use (Graves et al., 2011). Factors associated with ownership were assumed to be: cultural beliefs and practices mechanisms of LLIN distribution and distance to LLIN suppliers, rumours about LLINs and social support and pressure (Wiseman et al., 2007; Baume and Marin, 2007). But factors associated with net used were reported to be: perceived benefits and disadvantages of nets, trust in health workers providing health education and LLINs, knowledge of appropriate net use/care practices, and net-hanging skills, household size and composition, the number of children under five years of age and use of other vector control measures (Toé et al., 2009; Edelu et al., 2010). Other studies conducted in Benin showed that several mosquito nets after 12 month of use had already holes (Gnanguenon, personnal communication). From these observations, questions arise: Do people effectively use the mosquito nets freely distributed? Or do people not use LLINs to their insufficient number or their poor physical condition? To clarify these questions, we conducted a study on insecticide-treated nets coverage, use and physical condition in plateau department in southern Benin one year after the distribution. This study aimed to provide useful data on the effectiveness of the distribution campaign.

METHODOLOGY

Study area

Plateau is a county of Benin in West Africa. The selection of this county was based on its geographic accessibility, the high use of mosquito nets by children under 5. Entomological surveys conducted in the plateau have shown that there are both high and low pyrethroids resistance areas (Yadouleton et al., 2010). According to the general report of the distribution campaign, 85.5% of the households received a LLIN with an average of 2.7 LLINs/Household. Ketou, Pobe, Adja-Ouere, Ifangni and Sakete are the top 5 cities that compose it. But our study was focused on only four districts (Ketou, Pobe, Ifangni and Sakete). Ifangni district is located at 2° 43' 14"E and 6° 38' 56"N; its area is 242 km² representing 7.28% of Plateau territory. Sakete district is located at 2° 39' 7"E and 6° 46' 3"N; covering an area of 432 km², it represents 13.29% of plateau territory. Ketou is located is at 2° 36' 4"E and 7° 27' 21"N; it has an area of 1775 km², representing 54.38% of Plateau county's area. Pobè district is located at 2° 41' 51"E and 7° 5' 12"N; it has an area of 400 km², representing 11% of the county's area. 32 rural villages were selected through all four districts (Figure 1).

Study design

Larvae prospection's for insecticides susceptibility tests on *Anopheles gambiae,* main malaria vector in Benin have been conducted in many villages of the targeted districts. This baseline study on the resistance of malaria vectors to deltamethrin in the department of Plateau helped to make the choice of sentinel villages where various activities were held in our work. A total of 32 clusters were selected including 17 clusters at Ifangni, 6 at Sakété, 2 at Pobè and 8 at Kétou. Each cluster (village) was composed of several hamlets and comprised a minimum of 100 Children under five years old. Household cross-sectional surveys were undertaken in each cluster in May and August, 2012, conducting during high malaria transmission period. The survey covered the targeted groups in different villages. The choice of the targeted population has followed the standards set in the collection of basic data on morbidity and mortality due to malaria in the monitoring/evaluation RBM/RBM in Benin in 2004 (Kinde-Gazard et al., 2004). The targeted persons by cluster were: 30 mothers of children or care for children less than 5 years to evaluate fever or malaria during the last two weeks, 25 Pregnant women in the third trimester of pregnancy and women who gave birth in the last 6 months to assess malaria prevention, 30 householders for the availability and use of LLINs.

The households were randomly selected from each cluster. Data on bed net ownership and usage, physical condition of the nets, demographics of household members, other characters and issues related to sourcing were asked of all targets to assess the origins of LLIN found at the household level. Data were gathered using an adapted version of the standard Malaria Indicator Survey (RBM, 2013). Specific questions relating to the Universal Campaign Coverage process were asked to the householder and to the mothers of children or care for children less than 5 years. The physical condition of the nets was estimated using one of the two indicators recommended by WHO: the proportion of LLINs with any hole(s) (WHO, 2011). The main hole category in the LLINs was recorded as follows:

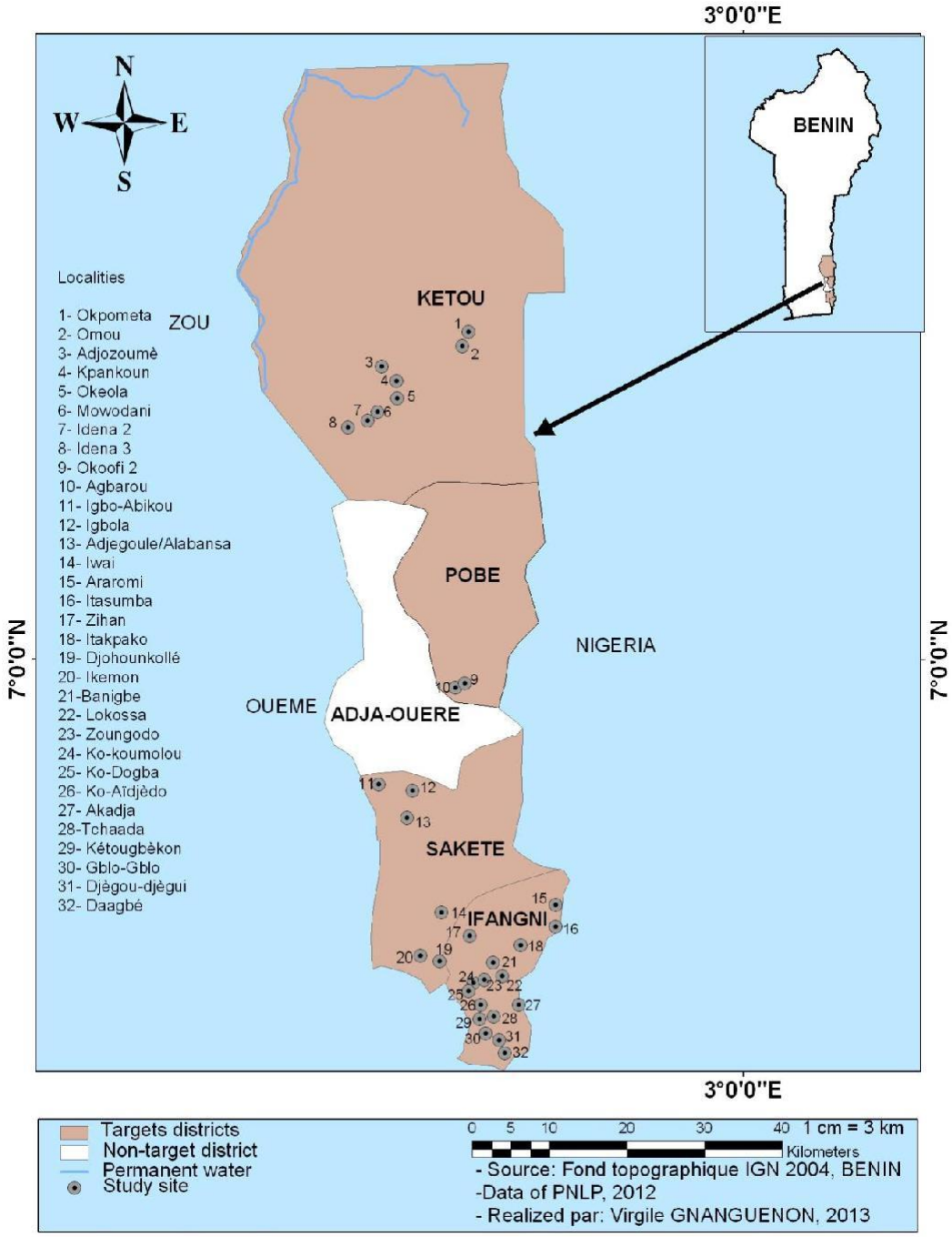

Figure 1. Map showing the study villages in Plateau department (Benin).

T1: holes size < thumb (0.5 to 2 cm);
T2: holes size > thumb < fist (2 to 10 cm);
T3: holes size > fist < head (10 to 25 cm);
T4: holes size > head (> 25 cm).

Statistical analysis

Interviews were conducted using questions. At the end of the survey, data were recorded with Epi-Info and data were transferred

Table 1. Background characteristics of the households surveyed.

Characteristic	Frequency (%)
Sex of the heads of households (n = 960)	
Male	386 (40.20)
Female	574 (59.80)
Educational level of the heads of households	
Illiterate	655 (68.23)
Elementary	188 (19.58)
Post elementary	117 (12.19)
Household size (n = 4688)	
Children under 5 years	1339 (28.56)
Pregnants women	800 (17.06)
Person over 5 years	2549 (54.37)

into SPSS 16.0 software. The investigators had cleaned and analysed the data using the same software program. Household ownership of LLIN was calculated as a proportion of households having at least one LLIN among the total surveyed households. LLIN use was estimated as the proportion of households using at least one LLIN in the LLIN owning households. Once the LLIN ownership and use were determined; the data were filtered into a separate file of LLIN owned households. Then, households using LLINs were compared to those who did not use any to identify the factors associated with LLINs non-use. Barriers of LLIN use were determined by using enter method multivariate logistic regression model. Data on the physical integrity of LLINs and those relating to the origins of LLINs were extracted. The various holes observed were divided into four and frequencies were estimated to assess the general condition of operation of LLINs (WHO, 2011; Kilian, 2012).

Ethics approval

This study was planned and approved by the Ministry of Health. The protocol was also reviewed and approved by National Ethics Committee for Health Research at the Ministry of Health. A briefing note indicating the objectives of the study, the advantages and disadvantages was given to the respondents in order to obtain consent. Confidentiality was respected and questionnaires were anonymous.

RESULTS

Study households characteristics

960 households and 4688 people were included in the survey and the response rate was 100% (Table 1). 59.80% of the heads of households interviewed were females versus 40.20% of males. 68.23% of the heads of households were illiterate, 19.58% have elementary school degree and 12.19% have an educational level over elementary school degree. Of the 4688 people included (Table 1), 1339 (28.56%) were under five years old; 800 (17.06%) were reported to be pregnant women and 2549 (54.37%) were people over five years old (without pregnant women).

LLINs ownership

Of the total surveyed households, 88.96% had at least one LLIN while 11.04% did not have any type of mosquito nets. The majority of households that owned LLIN had either one or two LLINs irrespective of their household size. 28.22% (25.47 to 31.16) had one LLIN, 31.85% (29.00 to 34.89) had two LLINs, 16.76% (14.54 to 19.27) had three LLINs and 12.18% (10.27 to 14.41) had four LLINs. The number of ITNs did not vary significantly between cluster (Table 2) and the average LLIN ownership among LLIN owned household was 1.82 (Table 2). 87.19% (84.76 to 89.27) of these nets come from the National distribution campaign of 2011, 9.1% (7.79 to 11.78) were from pregnant women voucher clinic delivery systems and 3.20% (2.21 to 4.61) were purchased full price (Figure 2).

Factors associated with ITN ownership

The sex of the heads of households (male and female) as well as their education level were not associated with ITN ownership ($p > 0.05$). Also, the composition of the household size in children under five, pregnant women and persons over five years old was not associated with ITN ownership ($p > 0.05$) (Table 3).

ITNs utilization

Of the total of 1746 reported LLINs, 42.96% (n = 750) LLINs were observed by the surveyors. 84% of the nets were reportedly used the night preceding the survey. The

Table 2. LLINs ownership by cluster.

Parameter	Cluster	LLINs	No. of households	Mean	CI 95%
Ketou	Okpometa	52	30	1.73	[1.40-2.05]
	Omou	69	30	2.3	[2.03-2.56]
	Adjozounme	82	30	2.73	[2.54-2.92]
	Kpankoun	59	30	1.97	[1.69-2.25]
	Oke Ola	38	30	1.27	[1.02-1.52]
	Mowodani	74	30	2.47	[2.24-2.70]
	Idena2	45	30	1.5	[1.11-1.88]
	Idena3	49	30	1.63	[1.24-2.01]
Pobe	Okoffi 2	73	30	2.43	[2.20-2.75]
	Agbarou	44	30	1.47	[1.11-1.82]
Sakete	Igboabikou	39	30	1.3	[1.04-1.55]
	Igbola	54	30	1.8	[1.44-2.15]
	Adjegounle/Alabansa	48	30	1.6	[1.22-1.97]
	Iwai	61	30	2.03	[1.68-2.37]
	Ikemon	52	30	1.73	[1.51-1.94]
	Djohounkolle	53	30	1.77	[1.51-2.02]
Ifangni	Akadja	69	30	2.3	[2.08-2.51]
	Araromi	40	30	1.33	[0.92-1.73]
	Banigbe	48	30	1.6	[1.28-1.91]
	Daagbe	49	30	1.63	[1.23-2.02]
	Djegou Djedji	65	30	2.17	[1.93-2.40]
	Gblo Gblo	23	30	0.77	[0.43-1.10]
	Ita Kpako	59	30	1.97	[1.62-2.32]
	Itassumba	56	30	1.87	[1.54-2.19]
	Ketougbekon	47	30	1.57	[1.24-1.90]
	Ko Dogba	56	30	1.87	[1.54-2.19]
	Ko-Aîdjedo	70	30	2.33	[2.12-2.54]
	Kokoumolou	51	30	1.7	[1.42-1.97]
	Lokossa	42	30	1.4	[1.00-1.79]
	Tchaada	64	30	2.13	[1.85-2.40]
	Zian	70	30	2.33	[1.98-2.67]
	Zougoudo	45	30	1.5	[1.09-1.90]
	Total	1746	960	1.82	[1.76-1.87]

CI = confidence interval.

proportion of nets in use varies from 47 to 100%, but not significantly different from one cluster to another (Table 4). It was only at Araromi that the level of net use was significantly low compared to other clusters. Among the target groups, 76.4% (73.46 to 79.34) of pregnant women really used LLINs, 82.88% (80.87 to 84.91) children under 5 years used nets while 69.78% (68.22 to 71.34) people over 5 years were reported as using LLINs (Figure 3). On the 807 LLINs observed, around 16% was found with hole(s) (Table 5). No significant difference was observed between categories of holes (T1 to T4) and while comparing the physical condition of the nets by the level of instruction of their owners ($p < 0.05$).

DISCUSSION

ITNs coverage was increased by the universal distribution

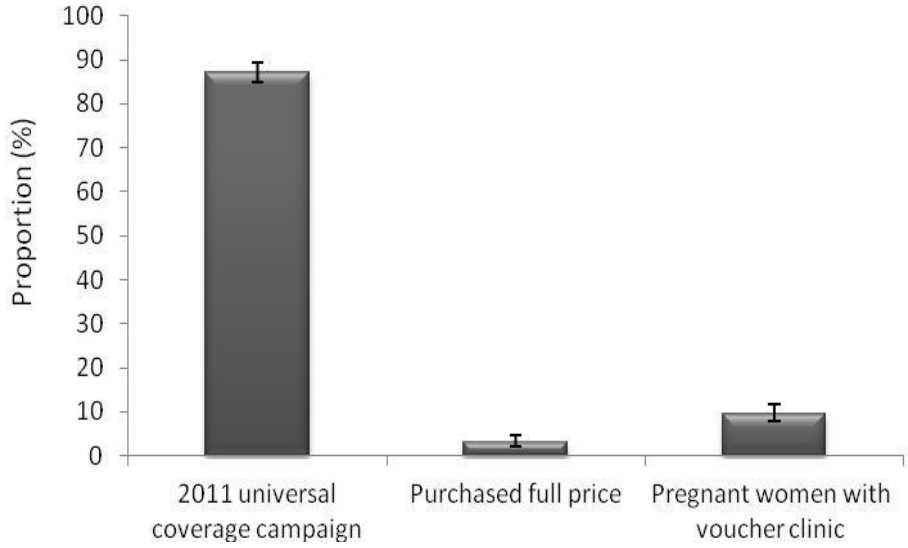

Figure 2. Source of ITN ownership.

Table 3. Multivariate regression on ITN ownership.

Factors	% ITN ownership (n)	CI = 95%	p-value
Heads of households	88.96 (854)		
Sex of the heads of households			
Male	43.85 (421)	[40.72-46.99]	0.680
Female	45.10 (433)	[41.96-48.25]	
Educational level of the heads of households			
Illiterate	60.31 (579)	[57.22-63.41]	
Elementary	17.5 (168)	[15.10-19.90]	0.332
Post elementary	11.15 (107)	[9.16-13.14]	

n = number CI = Confidence Interval.

distribution campaign with a proportion of 88.96% of households that owned at least one ITN. This proportion is higher when compared to the preceding distribution campaign evaluation (Tokponnon et al., 2013), and the average number of ITNs per household was around 2. Mosquito nets (LLINs) that were from the distribution campaign were significantly higher (87%) comparatively to those that were purchased full price (3%) or received from pregnant women antenatal consultation (9%). In our study, the average number of LLINs per household visited was 1.82 considering the 960 households. The average household size was 4.88 people visited. Thus we can say that about two nets are available for 5 people at the household level. However, the objective of this campaign is to increase the distribution level of 56% coverage (PNLP, 2012) at least 80% and have a LLIN for two people in the general population.

In the protocol of the LLIN distribution campaign of July, 2011, households of two people were covered with two LLINs and this rule has been well respected in rural areas in which the distribution has been fewer problems (Tokponnon et al., 2013). Our observations were consistent with the same requirements a year after the campaign. A disadvantage of the distribution was that 11% of households did not receive LLINs (PNLP, 2012). There were no significant differences between the availability of LLINs in different villages when considering the proportion of households with at least two LLINs. This

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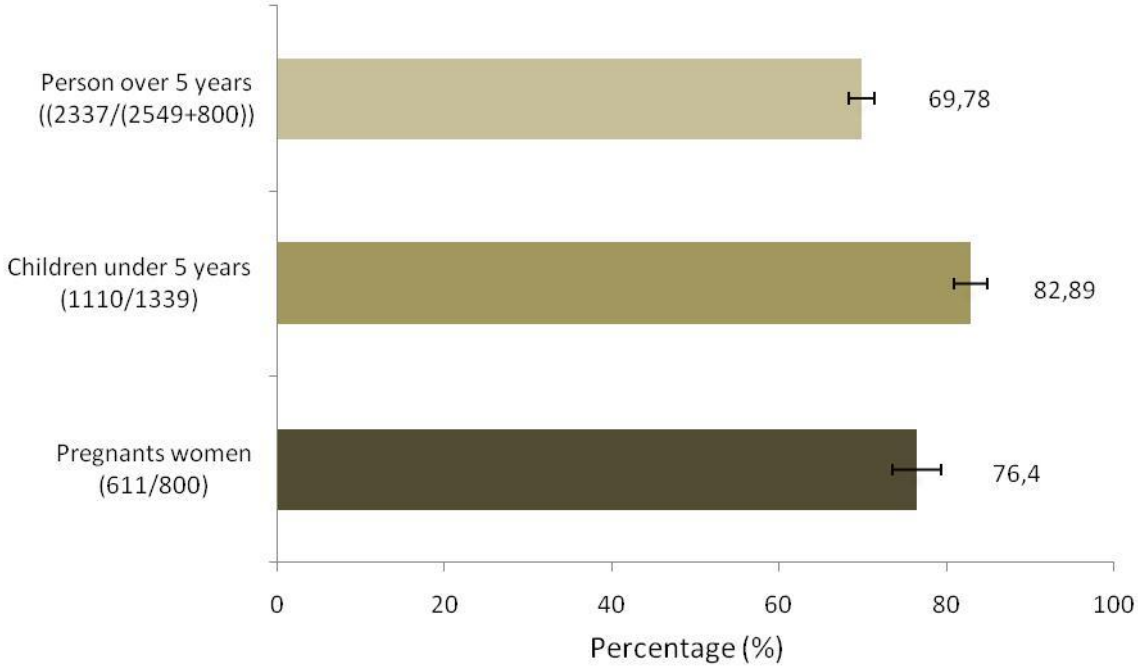

Figure 3. Net usages in target and non target group.

Table 4. Multivariate regression on ITN use.

Districts	Clusters	LLIN utilization			Proportion M+ (%)	OR	p
		M-	M+	Total			
Ketou	Okpometa	7	23	30	77	3.75	0.0194
	Omou	1	29	30	97	33.14	0.0012
	Adjozounme	0	30	30	100	69.41	0.0039
	Kpankoun	3	27	30	90	10.26	0.001
	Oke Ola	7	23	30	77	3.75	0.0194
	Mowodani	9	21	30	70	2.66	0.0698
	Idena 2	10	20	30	67	2.28	0.1208
	Idena 3	8	22	30	73	3.14	0.0379
Pobe	Okoffi 2	4	26	30	87	7.42	0.002
	Agbarou	13	17	30	57	1.49	0.4391
Sakete	Igboabikou	3	27	30	90	10.26	0.001
	Igbola	4	26	30	87	7.42	0.002
	Adjegounle/Alabansa	11	19	30	63	1.97	0.1967
	Iwai	4	26	30	87	7.42	0.002
	Ikemon	1	29	30	97	33.14	0.0012
	Djohounkolle	5	25	30	83	5.71	0.0044
Ifangni	Akadja	6	24	30	80	4.5714	0.0094
	Araromi	16	14	30	47	1	-
	Banigbe	6	24	30	80	4.5714	0.0094
	Daagbe	9	21	30	70	2.66	0.0698

Table 4. Contd.

Djegou - Djegi	6	24	30	80	4.5714	0.0094
Gblo-Gblo	14	16	30	53	1.3	0.6058
Ita - Kpako	0	30	30	100	69.41	0.0039
Itassumba	2	28	30	93	16	0.0007
Ketougbekon	11	19	30	63	1.97	0.1967
Ko Dogba	9	21	30	70	2.66	0.0698
Ko Aïdjedo	0	30	30	100	69.41	0.0039
Kokoumolou	9	21	30	70	2.66	0.0698
Lokossa	10	20	30	67	2.28	0.1208
Tchaada	9	21	30	70	2.66	0.0698
Zian	2	28	30	93	16	0.0007
Zougoudo	9	21	30	70	2.66	0.0698
Total	208	752	960	78.3		

M+: household who's everybody use LLIN the days before survey. M-: household who's not everybody use LLIN the days before survey. OR: odd ratio; Significant at $p < 0.05$ level.

Table 5. Physical condition of LLINs.

Level of instruction	LLINs without hole	LLINs with holes				Total LLINs with hole(s)	% LLINs with holes
		T1	T2	T3	T4		
Illiteracy	542	28	52	15	11	106	16,36
Primary school	163	10	12	3	3	28	14,66
Post primary school	102	7	3	4	1	15	12,82
Total	807	45	67	22	15	149	15,58

proportion was higher compared to those with three or four due to the fact that LLIN distribution campaign has limited the number of nets distributed for two people and a maximum of 8 LLINs for large households at the same size.

This observation is a good performance and the coverage attained was similar to what has been achieved in other countries (Tanzania, Nigeria and Togo) (West et al., 2012; Stevens et al., 2013). Continuous distribution of LLINs to pregnant women and children under five is an important way to increase nets coverage and replace torn nets (RBM, 2011). An additional continuous distribution system, via NGOs for example, can also be planned for other households. 78% of the net observed were reported to be used the previous night, and the proportion of nets use did not vary significantly between clusters, suggesting that awareness for net use was a success. But full net used by target group was not achieved.

76.4% of pregnants women were using ITNs while only 82.88% of children under five were using ITNs. This observation suggests that net usage could be improved in target group.

The high ITNs usage could be a consequence of the increased availability of ITNs at the household level due to the universal distribution campaign. This observation has already been noticed in Tanzania by West and colleagues (West et al., 2012). The level of ITN use could also be influenced by high temperature and mosquito density (Graves et al., 2011). But comparatively to other studies, ITN usage observed in target group in this study was higher than those observed in Tanzania and Nigeria (Ye et al., 2012; West et al., 2012). ITN ownership and use seems to reflect the general coverage and ITNs ownership in the whole population. The proportion of LLINs from the distribution campaign found in good condition was significantly higher than those observed in serviceable condition or torn out.

Conclusion

The universal distribution campaign in Benin has significantly increased ITN coverage and ownership policy in the community. Non target persons and target

persons (pregnant women and children under five) had similar level in ITN ownership and usage. The level of ITN ownership and usage were also similar between villages. This is an important indicator of universal coverage goal. But additional effort must be done to fully achieve universal coverage goal, and routine distribution must be used to maintain ITN coverage.

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