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Ownership and Use of Long-lasting Insecticidal Nets and Factors Associated, Immediately after a Mass Distribution Campaign in Uganda: A Cross-sectional Survey of Fourteen districts

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Summary

Background: *Uganda conducted its third mass Long-Lasting Insecticide-treated Nets (LLIN) distribution campaign in 2021. The target of the campaign was to ensure that 100% households own at least 1 LLIN per 2 persons, and to achieve 85% use of distributed LLINs. We assessed LLIN ownership, use, and associated factors 3 months after the campaign.*

Methods: *We conducted a cross-sectional household survey in 14 districts during 13-30 April 2021. Households were selected using multistage sampling. Outcomes were household LLIN ownership (at least one LLIN), adequate LLIN coverage (at least one LLIN per 2 residents), and LLIN use (residents slept under LLIN the previous night). Modified Poisson regression was used to assess associations between exposures and outcomes.*

Results: *In total, 5,529 households with 27,585 residents and 15,426 LLINs were included in the analysis. Overall, 95% of households owned ≥ 1 LLIN, 64% of households owned ≥1 LLIN per 2 persons in household, and 69% of residents slept under an LLIN the previous night. Factors associated with LLIN ownership included believing that LLINs are protective against malaria (aPR=1.13; 95% CI=1.04-1.24). Reported use of mosquito repellents was negatively associated with ownership of LLINs (aPR=0.96; 95% CI=0.95-0.98). The prevalence of LLIN use was 9% higher among persons who had LLINs 3-12 months old (aPR=1.09; 95% CI=1.06-1.11) and 10% higher among LLINs 13-24 months old (aPR=1.10; 95% CI=1.06-1.14), than those who had LLINs <3 months old. Of 3,859 LLINs not used for sleeping the previous night, 3,250 (84%) were <3 months old. Among these 3,250, 41% were not used because owners were using old LLINs, 16% were not used because of lack of space for hanging them, 11% were not used because of fear for chemicals in the net, 5% were not used because of dislike of smell of the nets, and 27% were not used because of other reasons.*

Conclusion: *Three months after the mass campaign, LLIN ownership and use both remained well below targets. The government should distribute more LLINs to supplement on recent mass distribution campaign and behavior change communication should be conducted before distribution of LLINs to counter misconceptions about new LLINs.*

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Introduction

Over the past 20 years, the scale-up of malaria control efforts has led to marked reductions in morbidity and mortality (1, 2). An estimated 663 million malaria cases were averted by malaria control interventions ; nearly 70% of these were attributed to use of long-lasting insecticide treated nets (LLINs) between 2000 and 2015(1). However, global progress has slowed in recent years, particularly in sub-Saharan Africa, which accounted for 94% of the world's 219 million cases in 2019 (2). In Uganda, malaria accounts for 30-50% of outpatient visits at health facilities, 15-20% of all hospital admissions, and up to 20% of all hospital deaths and 27.2% of inpatient deaths among children under five years of age.

Long-lasting insecticide treated nets are one of the core interventions recommended by the World Health Organization to reduce malaria transmission and prevent malaria in high-risk communities (3). Long-lasting insecticide treated nets have been shown to reduce malaria incidence among children under five years and pregnant women by up to 50 percent and all-cause mortality in children by about 20 percent(4). Since 2013, the government of Uganda has conducted 3 mass LLIN distribution campaigns to achieve universal LLIN coverage and to reduce inequality in ownership of LLINs between poor and wealth households. The most recent LLIN mass campaign was conducted in 2020/2021 and 27 million LLINs were distributed nationwide (5).

Despite LLINs mass campaigns, malaria burden remains high in Uganda. The Malaria Indicator Survey conducted in Uganda in 2018/19 (2018 MIS) showed that 54% households own at least one LLIN for 2 people and 59% of the population use the LLINs for sleeping. At individual level, factors influencing LLIN use have been reported to include age of the LLIN and beliefs and risk perceptions(6). Studies have also documented barriers to LLIN use, including lack of sufficient space to hang the net, lack of enough nets for a household, discomfort with the net material, and others; however, different settings have unique and dynamic barriers to LLIN use and may require unique strategies (7). We conducted a survey 3 months after the 2020/2021 mass distribution campaign to estimate LLIN ownership, use, and identify barriers to LLIN use in 14 districts in Uganda to inform programming of future mass distribution campaigns.

Methods

Study design and setting

We conducted a cross-sectional household survey in 14 districts (Buikwe, Buyende, Dokolo, Iganga, Jinja, Kagadi, Kaliro, Kayunga, Kibaale, Kyegegwa, Lamwo, Luuka, Mayuge, Mukono) in Uganda between 13-30 April 2021 (Figure 1). These districts were chosen because they received LLINs in the last phase of mass distribution campaign preceding the survey.

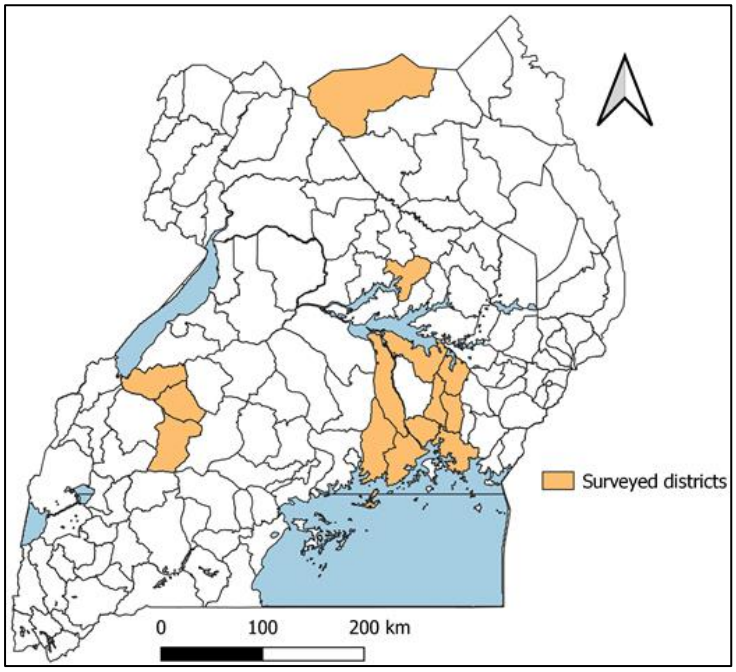

Figure 1: Map of Uganda showing the location of the 14 districts surveyed in the study

Sample size and sampling

Sample size for each district was 412 households. We calculated sample size for precision based on an estimated 84% of households having at least one LLIN in every district (8), 95% confidence, an error of +/- 5%, and a design effect of 2. We selected households for survey using multistage sampling.

Study outcomes

The primary outcomes were the percentage of households with at least one LLIN, percentage of households that achieved universal coverage of LLINs (defined as one LLIN for every two persons who stay in the household), and percentage of the household population that slept under an LLIN previous night before the survey.

Data collection

Study team members visited households and interviewed the head of household or one of his or her adult dependants. If no appropriate respondent was found at the house, the team scheduled another visit later that day. At least three attempts were made to reach a respondent before dropping the household without replacing it. The household questionnaire included a household member roster, questions about the mosquito net(s) owned by households and usable, whether the net(s) had been used the previous night by each member of the household, and participant's beliefs about LLINs. We also examined the LLINs for texture.

Data analysis

Household and household member characteristics, estimation of LLIN ownership and use are presented as percentages. We conducted multivariate analysis using modified Poisson regression and the measure of association was prevalence ratios (PRs) and 95% confidence intervals. PRs were used instead of odds ratios (ORs) because the prevalence of both LLIN ownership and LLIN use was more than 10%. P-values of <0.05 showed statistically significant associations between the outcomes and the independent variables. We considered independent variables with p-values ≤ 0.1 at bivariate analysis for the multivariable model.

Ethical consideration

Permission to conduct the survey was sought from Ministry of Health and administrative clearance was sought from District Health Officers. The survey protocol was reviewed and approved by Centers for Disease Control and Prevention, Atlanta, Georgia, USA (CDC) Associate Director for Science as non-research. The data collected did not have personal identifiers. During data collection and analysis, unique identifiers were used, and data were only accessible to the analysis team. During reporting, no identifiers were used.

Results

Household and household member characteristics

A total of 5,529 households and 27,584 household members were included in the survey. Mean household size was 5 persons (range, 1-25), 4220 (15.3%) of household members were <5 years of age, 13,241(48%) were males and 14,344(52%) were females. We found a total of 15,426 nets in these households. Of these, 12,260 (79.5%) nets were distributed in 2020/21 through the government mass distribution mechanism (Table 1).

Table 1: Characteristics of long-lasting insecticide treated nets immediately after a mass distribution campaign in Uganda

Characteristics (n=15,426 LLINs)

Variable	Frequency (n)	Percentage (%)
LLIN texture		
Polyester	6,189	40.1
Polyethylene	2,542	15.4
Polyester and polyethylene	4,866	31.5
Not sure	1,829	13.0
LLIN source		
Mass distribution 2020/21	12,260	79.5
Mass distribution 2017	2,201	14.3
Bought the LLIN	505	3.3
ANC	271	1.8
Others	90	0.6
Unknown	99	0.6
LLIN age		
New (<3 months)	11,101	71.9
3-12 months	1,583	10.3
>12-24 months	398	2.6
>24 months	2,195	14.2
Unknown	149	1.0

Long-lasting insecticide treated nets ownership in fourteen districts immediately after a mass distribution campaign in Uganda

Overall, 5,293 (95.7%) households owned at least 1 LLIN. A total of 3,557 (64.4%) households had at least one LLIN for every 2 persons in the household (achieved universal coverage of LLINs). The median number of LLINs in the household was 3.

Long-lasting insecticide treated nets use in fourteen districts immediately after a mass distribution campaign in Uganda

Among 27,434 household members, 18,954 (68.7%) slept under an LLIN the previous night before the survey.

Overall, 11,466 (74.3%) of 15,426 existing LLINs in the households were used the night before the survey. Of 3,859 LLINs not used for sleeping the previous night, 3,250 (84%) were <3 months old.

Among these 3,250,1333 (41%) were not used because owners were using old LLINs, 520 (16%) were not used because of lack of space for hanging them, 358 (11%) were not used because of fear for chemicals in the net, 163(5%) were not used because of dislike of smell of the nets and 878(27%) were not used because of other reasons.

Factors associated with household ownership of long-lasting insecticide treated nets in fourteen districts immediately after a mass distribution campaign in Uganda

The prevalence of household LLIN ownership was 2% higher among households with high wealth index compared to households with a low wealth index (aPR=1.02; 95% CI=1.01-1.04).

The prevalence of household LLIN ownership was 4% lower among households where respondents reported using mosquito repellants compared to households where respondents reported not using repellants (aPR=0.96; 95% CI=0.95-0.98).

The prevalence of household LLIN ownership was 13% higher among households where respondents believed LLIN would protect them from malaria compared to households where respondents did not believe LLINs would protect them from malaria (aPR=1.13; 95% CI=1.04-1.24) (Table 2).

Table 2: Factors associated with household ownership of long-lasting insecticide treated nets immediately after a mass distribution campaign in Uganda

Variable	LLIN ownership		Unadjusted PR (95% C.I)	p-value	Adjusted PR* (95% C.I)	p-value
	Yes	No				
Wealth index						
Low	1,805	98	1.00		1.00	
Medium	1,704	71	1.01 (0.99- 1.02)	0.095	1.01 (0.99- 1.03)	0.064
High	1,769	65	1.01 (1.00- 1.03)	0.016	1.02 (1.01- 1.04)	0.001
Repellant use						
No	4,345	161	1.00		1.00	
Yes	947	75	0.96 (0.94-0.98)	0.000	0.96 (0.95- 0.98)	0.000
Nets protect from malaria						
No	76	13	1.00		1.00	
Yes	5,125	174	1.13 (1.03- 1.23)	0.005	1.13 (1.04- 1.24)	0.004
Not sure	92	49	0.76 (0.66- 0.89)	0.000	0.77 (0.66- 0.89)	0.000
Malaria serious condition						
No	119	18	1.00			
Yes	5,174	218	1.10 (1.03- 1.18)	0.003		

Factors associated with use of long-lasting insecticide treated nets in fourteen districts, immediately after a mass distribution campaign in Uganda

The prevalence of LLIN use was 9% higher among LLINs 3-12 months old compared to LLINs <3 months old (aPR=1.09; 95% CI=1.06–1.11). The prevalence of LLIN use was 10% higher among LLINs 13-24 months old compared to LLINs less than 3 months old (aPR=1.10; 95% CI=1.06-1.14).

The prevalence of using LLINs with polyester material was 4% lower compared to the prevalence of use of LLINs with polyethylene material (aPR=0.96; 95% CI=0.94-0.97). Participants who reported that LLINs were hanged on their bed or sleeping space were 6.3 times more likely to use the net compared to those who reported that nets were not hanged (aPR=6.29; 95% CI=5.83-6.78) (Table 3).

Table 3: Factors associated with long-lasting insecticide treated nets immediately after a mass distribution campaign in Uganda

Variable	LLIN Utilisation		Unadjusted PR (95% C.I)	p-value	Adjusted PR* (95% C.I)	p-value
	Yes	No				
Age of net (Months)						
3-12	7,814	3,250	1.00		1.00	
>12- 24	1,428	153	1.27 (1.25- 1.30)	0.000	1.09 (1.06- 1.11)	0.000
> 24	364	34	1.29 (1.25- 1.34)	0.000	1.10 (1.06- 1.14)	0.000
Unknown	1,797	387	1.17 (1.14- 1.19)	0.000	1.02 (0.99- 1.05)	0.169
	63	35	0.91 (0.78- 1.06)	0.213	1.06 (0.98- 1.15)	0.147
Net texture						
Polyethylene	2,150	387	1.00		1.00	
Polyester	4,658	1,521	0.89 (0.87- 0.91)	0.000	0.96 (0.94- 0.97)	0.000
Both polyester and polyethylene	3, 283	1,564	0.79 (0.78- 0.82)	0.000	0.97 (0.95- 0.98)	0.000
Not sure	1,375	387	0.92 (0.89- 0.95)	0.000	0.92 (0.89- 0.95)	0.000
Source of net						
Mass distribution 2017	1,827	365	1.00		1.00	
Mass distribution 2021	8,843	3,360	0.87 (0.85- 0.89)	0.000	0.98 (0.95- 1.01)	0.138
ANC	233	38	1.03 (0.98- 1.09)	0.238	0.97 (0.94- 1.01)	0.173
Bought	450	55	1.07 (1.03- 1.11)	0.000	0.98 (0.96- 1.01)	0.249

Other	113	41	0.88 (0.79- 0.97)	0.010	0.92 (0.86- 0.99)	0.025
Net hanging over bed						
No	614	3,468	1.00		1.00	
Yes	10,852	391	6.42 (5.97- 6.90)	0.000	6.29 (5.83- 6.78)	0.000
Net condition						
No holes	9,563	3,476	1.00			
One or few holes	1,328	119	1.25 (1.23- 1.27)	0.000		
Many holes	553	224	0.97 (0.93- 1.02)	0.200		
Unknown	22	40	0.48 (0.35- 0.68)	0.000		

Discussion

Overall, 95% of households owned ≥ 1 LLIN, 64% of households owned ≥1 LLIN per 2 persons in household, and 69% of residents slept under an LLIN the previous night. The percentage of households that achieved universal coverage (at least one net for every two persons who stayed in the household last night) increased from 54% reported in UMIS 2018/19 to 64% in 2021, after a mass distribution of LLINs.This estimate still falls short of the NMCP target of 100% (5). Nonetheless, this is an indication of an improvement towards the right direction to fulfillment of this target.

A successful mass campaign is measured by the household population that uses the LLINs for sleeping to prevent malaria(5). There was an increase in the proportion of the population that slept under an LLIN the previous night from 59% reported in UMIS 2018/19 to 69% in 2021, after a mass distribution campaign. This achievement also falls short of the NMCP target of having 85% of the population using an LLIN (5).

Malaria disproportionately affects the poor and addressing inequalities has been the cornerstone of malaria control efforts. The distribution of LLINs also shifted from targeted distribution to mass distribution to increase equity of ownership of LLINs. Our findings show that Inequality in LLIN ownership between households with low and high wealth index was minimal. The minimal inequality observed in this study could be due to improved coverage on LLINs. A study evaluated the change in equity in ownership of LLINs in 19 sub-Saharan

African countries and concluded that equity of net ownership had improved in 13 countries including Uganda after mass distribution of LLINs(11). An evaluation conducted in Tanzania demonstrated that increasing the price of LLINs significantly reduces both demand and ownership (12).

The prevalence of LLIN ownership was lower among households where respondents reported using mosquito repellants. Respondents who had repellants possibly believed that repellants were protective enough and that could explain why they were not owning LLINs. The prevalence of LLIN ownership was higher among households where respondents believed LLIN would protect them from malaria. The health belief model illustrates that if individuals believe that net use and treatment would be beneficial in either reducing their susceptibility to malaria or alleviating it severity, they are likely to act to reduce their risks (13).

Participants preferred to use old LLINs compared to new ones. This study discovered phobia for chemicals as one of the factors responsible for non-use of new LLINs. The fear of harm from chemicals used in LLINs was also reported in Western Kenya(14). Some respondents feared perceived danger and harm associated with coming in contact with chemicals or insecticide used in LLINs, and therefore, chose not to use the nets but hang them out for several days for medicines to wear off. This could be an indication of behavioral change gaps in this setting. Community sensitizations should be prioritised in future campaigns to demystify these LLINs myths.

Participants preferred to use polyethylene material compared to the polyester material. Our findings observe a different trend compared to findings from India that showered polyester LLINs were preferred to polyethylene(15). However, this was a qualitative study that did not assess actual use. Acceptability reported may not necessarily translate to actual use. The source of LLIN was not associated with LLIN use. The results of this study contradict the data from a previous study conducted in Budondo subcounty in Uganda, that showed that bed nets that were bought were more likely to be used and used adequately than those obtained free from mass distribution campaign (16). This study was conducted on a small setting compared to our study, and different settings may have unique and dynamic enablers to use of LLINs.

Limitations

This study has several limitations. First, self-report was used to assess LLIN use, which could have underestimated or overestimated the actual use of LLINs. More so, reported use of LLINs the previous night before the survey only captures a cross-section of use at one night in time and thus provides a somewhat unclear indication of regular use. Although this is the recommended approach to measuring LLIN use(9), meta-analysis showed that self-reported measures overestimate LLIN adherence by 13% relative to objective measures(17), suggesting that the true proportion of the population who slept under LLIN the previous night could be lower than our estimates. Second, the ability to understand why individuals choose to use nets or not is limited by the quantitative nature of the questionnaire. Further exploration using qualitative research methods would be required to better understand local perceptions and why they are hesitant to take up new LLINs.

Public Health Action

We conducted community sensitization to demystify LLINs myths. We also conducted community sensitization on maintenance of LLINs and we volunteered to hang up nets in households were LLINs were available.

Conclusion

Long-lasting insecticide treated nets universal coverage (at least 1 LLIN for 2 people) was 36% short of 100% national target. Population that slept under LLIN night proceeding the survey was 16% short of 85% national target. Inequality in LLIN ownership between households with low and high wealth index was minimal. Ownership of LLINs was low when respondents used mosquito repellants. Participants reported misconceptions about new LLINs.

The government should distribute LLINs to achieve a target of ≥1 LLIN for 2 people in the household. We recommend that NMCP/stakeholders should design and conduct targeted behaviour change communication immediate after mass campaign to counter misconceptions about new LLINs. We further recommend that behavior change communication messages should advise communities to use mosquito repellants as adjuvants to malaria protection. We also recommend a more in-depth analysis of LLIN campaign messages to determine whether the methods of dissemination and messages being disseminated are accepted, consider norms and, are consistent with common local practices.

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Reference

1. Bhatt S, Weiss D, Cameron E, Bisanzio D, Mappin B, Dalrymple U, et al. The effect of malaria control on Plasmodium falciparum in Africa between 2000 and 2015. Nature. 2015;526(7572):207-11.
2. Organization WH. World malaria report 2020: 20 years of global progress and challenges. World malaria report 2020: 20 years of global progress and challenges2020.
3. World HO. World Malaria Report. 2018.
4. Phillips-Howard PA, Nahlen BL, Alaii JA, Ter Kuile FO, Gimnig JE, Terlouw DJ, et al. The efficacy of permethrin-treated bed nets on child mortality and morbidity in western Kenya I. Development of infrastructure and description of study site. The American journal of tropical medicine and hygiene. 2003;68(4_suppl):3-9.
5. Health Mo. The Uganda Malaria Reduction Strategic Plan 2014-2020. 2014. 2014.
6. Baume CA, Reithinger R, Woldehanna S. Factors associated with use and non-use of mosquito nets owned in Oromia and Amhara regional states, Ethiopia. Malaria Journal. 2009;8(1):1-11.
7. Health Mo. Malaria Indicator Survey. 2018-2019.
8. Health Mo. Uganda Malaria indicator Survey. 2018-2019.
9. Rowe A, Steketee R, Arnold F, Wardlaw T, Basu S, Bakyaita N, et al. Roll Back Malaria Monitoring and Evaluation Reference Group: Viewpoint: evaluating the impact of malaria control efforts on mortality in sub-Saharan Africa. Trop Med Int Health. 2007;12(12):1524-39.
10. Vyas S, Kumaranayake L. Constructing socio-economic status indices: how to use principal components analysis. Health policy and planning. 2006;21(6):459-68.
11. Taylor C, Florey L, Ye Y. Equity trends in ownership of insecticide-treated nets in 19 sub-Saharan African countries. Bulletin of the World Health Organization. 2017;95(5):322.
12. Comfort AB, Krezanoski PJ. The effect of price on demand for and use of bednets: evidence from a randomized experiment in Madagascar. Health policy and planning. 2017;32(2):178-93.

13. Champion VL, Skinner CS. The health belief model. Health behavior and health education: Theory, research, and practice. 2008;4:45-65.

14. Lee J, Tan CS, Chia KS. A practical guide for multivariate analysis of dichotomous outcomes. Ann Acad Med Singapore. 2009;38(8):714-9.

15. Das ML, Singh SP, Vanlerberghe V, Rijal S, Rai M, Karki P, et al. Population preference of net texture prior to bed net trial in Kala-Azar–Endemic areas. PLoS neglected tropical diseases. 2007;1(3):e100.

16. Moscibrodzki P, Dobelle M, Stone J, Kalumuna C, Chiu Y-HM, Hennig N. Free versus purchased mosquito net ownership and use in Budondo sub-county, Uganda. Malaria journal. 2018;17(1):1-12.

17. Krezanoski PJ, Bangsberg DR, Tsai AC. Quantifying bias in measuring insecticide-treated bednet use: meta-analysis of self-reported vs objectively measured adherence. Journal of global health. 2018;8(1).