Ownership and Use of Long-lasting Insecticidal Nets Three Months after a Mass Distribution Campaign in Uganda, 2021

Andrew Kwiringira (akwiringira@musph.ac.ug)
Uganda Public Health Fellowship Program

Carol Nanziri
Uganda National Institute of Public Health

Edirisa Juniour Nsubuga
Uganda Public Health Fellowship Program

Stella Martha Migamba
Uganda Public Health Fellowship Program

Vivian Ntono
Uganda National Institute of Public Health

Immaculate Atuhaire
Uganda Public Health Fellowship Program

Sherry Rita Ahirirwe
Uganda Public Health Fellowship Program

Alice Asio
Uganda Public Health Fellowship Program

Shaban Senyange
Uganda Public Health Fellowship Program

Petranilla Nakamya
Uganda Public Health Fellowship Program

Veronicah Masanja
Uganda Public Health Fellowship Program

Sarah Elayeete
Uganda Public Health Fellowship Program

Allan Komakech
Uganda Public Health Fellowship Program

Hilda T. Nansikombi
Uganda Public Health Fellowship Program

Patience Mwine
Uganda Public Health Fellowship Program

Rose Nampeera

Uganda Public Health Fellowship Program
Alex Ndyabakira
Uganda Public Health Fellowship Program
Paul Okello
Uganda National Institute of Public Health
Richard Migisha
Uganda Public Health Fellowship Program
Lilian Bulage
Uganda Public Health Fellowship Program
Benon Kwesiga
Uganda Public Health Fellowship Program
Daniel Kadobera
Uganda Public Health Fellowship Program
Damian Rutazana
Uganda National Malaria Control Program, Ministry of Health
Julie R. Harris
US Centers for Disease Control and Prevention, Kampala, Uganda
Alex R. Ario
Uganda Public Health Fellowship Program

Research Article

Keywords: Malaria, Long-lasting insecticide-treated nets, Ownership and use, Mass campaigns, Uganda

Posted Date: April 19th, 2022

DOI: https://doi.org/10.21203/rs.3.rs-1551290/v1

Abstract

Background: Uganda conducted its third mass Long-Lasting Insecticide-treated Net (LLIN) distribution campaign in 2021. The target of the campaign was to ensure that 100% of 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 April 13-30, 2021. We selected households using multistage sampling. We asked about LLIN ownership, use, duration since received until the time of interview, and visually verified the presence of LLINs. Outcomes were having at least one LLIN per 2 household members, and individual LLIN use. We used modified Poisson regression 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, 92% of the households owned ≥1 LLIN <3 months old, 81% of households owned ≥1 LLIN per 2 persons in the 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 those who had 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 identified in the households but 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 of chemicals in the net, 5% were not used because of dislike of the smell of the nets, and 27% were not used because of other reasons.

Conclusion: Three months after a LLIN distribution campaign, both LLIN ownership and use remained well below targets. The government should consider distributing additional LLINs to achieve and sustain a target of ≥1 LLIN for 2 household members and behavior change communication before the distribution of LLINs to counter misconceptions about new LLINs.

Introduction

Over the past 20 years, the scale-up of malaria control efforts has led to marked reductions in morbidity and mortality globally(1, 2). An estimated 663 million malaria cases were averted by malaria control interventions between 2000 and 2015; nearly 70% of cases averted were attributed to the use of long-lasting insecticide-treated nets (LLINs) (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). Uganda has the 3rd highest global burden of malaria cases (5%) and the 8th highest level of malaria deaths (3%).

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(2). Long-lasting insecticide-treated nets have been shown to reduce malaria incidence among children under five years and pregnant women by up to 50% and all-cause mortality in children by 20% (3). Since 2013, the government of Uganda has conducted 3 mass LLIN distribution campaigns to achieve universal LLIN coverage (have at least one LLIN for 2 people in the household for 100% of households) and reduce inequality in the ownership of LLINs between poor and wealthy households. The most recent mass distribution campaign occurred in 2020/21, when 27 million LLINs were distributed nationwide(4).

Despite the LLIN distribution campaigns, the malaria burden remains high in Uganda. Malaria accounts for 30–50% of outpatient visits at health facilities and 15–20% of all hospital admissions in the country(5). The Malaria Indicator Survey conducted in Uganda in 2018/19 (2018 MIS) showed that 54% of households own at least one LLIN for 2 people and 59% of the population used the LLINs while sleeping(6). Studies that have documented barriers to LLIN use have shown lack of sufficient space to hang the net, lack of enough nets for a household, discomfort with the net material, age of the LLIN, and belief that there harmful chemicals in new LLINs(7) can reduce LLIN use; however, different settings have unique and dynamic barriers to LLIN use and may require unique strategies(8). We conducted a survey 3 months after the 2020/2021 mass LLIN distribution campaign to estimate ownership and use and identify barriers to LLIN use in 14 districts in Uganda.

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 (Fig. 1). These districts were chosen because they received LLINs in the last wave of the mass distribution campaign in January 2021, 3 months before the survey.

Sample size and sampling

We calculated sample size for precision based on an estimated 84% of households having at least one LLIN (6), 95% confidence, an error of +/- 5%, and a design effect of 2, for a total of 412 households per district. From each district, we randomly selected one sub-county, one parish from each of the selected sub-counties, and 2 villages from the selected parish using a random number generator. We used probability proportional to size sampling to determine the number of households to sample from the selected villages and we used a systematic sampling process from a list of households in each village to select households for the survey.

Study outcomes, dependent variables, and data collection

We used the Roll Back Malaria Monitoring & Evaluation Reference Group (RBM MERG) indicators to report LLIN ownership and use (9). The primary outcomes were the percentage of households with at

least one LLIN, percentage of households that had at least one LLIN for every two persons who stayed in the household, and percentage of the household population that slept under an LLIN the night before the survey. We further identified LLINs in households not being slept under, and assessed why they were not being used.

The 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 participants beliefs about LLINs. We asked the duration since LLINs were received until the time of interview and categorised duration as < 3months, 3-12months, > 12–24 months, > 12 months and unknown. We corroborated self-reported duration with records of village health teams during the interview. We also examined the LLINs for material type (polyester vs. polyethylene).

Data analysis

Household and household member characteristics, estimation of LLIN ownership, and use are presented as percentages. We calculated the socio-economic status (SES) of each participating household by creating a wealth index based on materials used to construct the house, household amenities, and assets owned. A weighted score for each household was calculated using principal component analysis (PCA) and divided households into SES indices (10). Sampling weights were calculated to account for clustering by district, sub-county and parish. We conducted bivariate analysis between each of the two outcomes (households ownership of at least one LLIN and use of any LLIN) and the independent variables. We conducted a multivariate analysis using modified Poisson regression and the measure of association was prevalence ratios (PRs) and 95% confidence intervals. Prevalence ratios (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 in bivariate analysis for inclusion in the multivariable model.

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); 4,220 (15%) household members were < 5 years of age. We found a total of 15,426 nets in these households. Of these, 12,260 (80%) nets were distributed in 2020/21 through the government mass distribution mechanism (Table 1).

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

Overall, 96% (95% CI 94–99%) households owned at least 1 LLIN and 81% (95% CI 75–88) households had at least one LLIN for every 2 persons in the household (targeted coverage per household). Most (4,976; 92%) households had at least one LLIN that was < 3 months old.

Long-lasting insecticide-treated net use in fourteen districts three months after a mass distribution campaign in Uganda

Among 27,434 household members, 18,954 (69%) slept under an LLIN the night before the survey (Table 3). Overall, 11,466 (74%) of 15,426 existing LLINs in the households were used the night before the survey. Of 3,859 LLINs not used during sleeping the previous night, 3,250 (84%) were < 3 months old. Among these, 1,333 (41%) were not used because owners were using old LLINs; 358 (11%) were not used because of fear of chemicals in the net.

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

Household LLIN ownership (having any LLIN in a household) was slightly higher among households with a high wealth index compared to households with a low wealth index (aPR = 1.02; 95% CI = 1.01–1.04), and slightly lower among households in which respondents reported using mosquito repellents compared to those in which they reported not using repellents (aPR = 0.96; 95% CI = 0.95–0.98) (Table 2). 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).

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

Compared to LLINs < 3 months old (i.e., newly-distributed LLINs), the prevalence of LLIN use was higher both for LLINs 3–12 months old (aPR = 1.09; 95% CI = 1.06–1.11) and LLINs 13–24 months old (aPR = 1.10; 95% CI = 1.06–1.14) (Table 3). The use of LLINs with polyester material was 4% lower than use of LLINs with polyethylene material (aPR = 0.96; 95% CI = 0.94–0.97) (Table 3). Participants who reported that LLINs were hanged on their bed or sleeping space were 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).

Discussion

Three months after a mass LLIN distribution campaign in Uganda, we found that nearly all households owned at least one 1 LLIN, and four in every five households owned the targeted number of LLINs (at least one LLIN per 2 persons in the household). Two-thirds of residents slept under an LLIN the previous

night. LLIN ownership was associated with belief in their protectiveness against malaria, and LLIN use was associated with net age.

LLIN campaigns are meant to achieve universal coverage, with all households having at least one net per two persons in the home. Although the 81% of households we found with at least one net per 2 persons in the household falls short of this target, it does represent an increase from the 54% reported in the Uganda Malaria Indicator Survey (UMIS) conducted in 2018/19 (6) and the 70% after the 2016/17 campaign (11). Mass LLIN distribution campaigns begin with a registration exercise, in which a household member reports to the Village Health Team the number of people in the household. Previous studies have demonstrated that household registration rates were the most important determinant of receiving LLINs during mass distribution campaigns; allocation strategies also mattered, with universal coverage allocation achieving better results than fixed-number allocation (12). It is unknown if this might have been the cause of the failure to achieve universal coverage in Uganda; however, future distribution campaigns should include a post-distribution evaluation component to understand reasons for failure to receive adequate LLINs on the household level, to facilitate reaching universal coverage in Uganda.

Beyond achieving universal coverage, a related metric of success after a mass distribution campaign is the proportion of household members sleeping under the LLINs (4). We found 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% after the 2021 mass distribution campaign. However, this achievement also falls short of the NMCP target of having 85% of the population sleeping under an LLIN (13). It is not clear if our findings were related to insufficient numbers of nets, or lack of use of existing nets. Some reasons that people may not use nets, even when they are provided, include lack of sufficient space to hang the net, discomfort with the net material, belief that there harmful chemicals in new LLINs, and a desire to save LLINs for use when a household member is pregnant (3, 7). In our survey, we found that older nets were more likely to be used than the newest nets, with fear of chemicals cited as one of the factors responsible for the non-use of new LLINs. We also identified apparent preferences associated with LLIN material: the preference for polyester LLINs was slightly lower than that for polyethylene LLINs, and an increased use of LLINs among people who believed that they were protective against malaria. There is evidence that behavioral change communication (BCC), either through mass media (14), intensive and repeated inter-personal communication, or material incentives (15) can promote changes in behaviors, beliefs and attitudes towards LLINs (16). While BCC through mass media is the main approach used in Uganda (4), more data are needed to identify the optimal mix of approaches to maximize LLIN use after mass distribution campaigns.

We also noted that ownership of at least 1 LLIN was lower among households where respondents reported using mosquito repellents, compared with those that did not use repellents. Respondents who had repellents may have believed that repellents were protective enough and they did not need LLINs; however, it is also possible that people who did not receive or have enough LLINs may have used repellents as an alternative. While mosquito repellents do provide protection against malaria infection (17, 18), the combined use of mosquito repellent during the evening outdoor activities followed by the use

of LLINs during bedtime at community level significantly reduces malaria infection compared with repellant use alone (19). Both education and BCC may be required during LLIN distribution to ensure that repellents are used as adjuvants, and not substitutes, for LLINs.

This study has some limitations. First, LLIN use was self-reported, which could have underestimated or overestimated the actual use of LLINs. Second, reported use of LLINs the night before the survey only captures use at one point in time and might not represent regular use. Although this is the recommended approach to measuring LLIN use (9), a meta-analysis showed that self-reported measures overestimate LLIN adherence by 13% relative to objective measures (20), suggesting that the true proportion of the population who slept under LLIN the previous night could be lower than our estimates. Third, our ability to understand why individuals chose 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.

Conclusion

Long-lasting insecticide-treated nets universal coverage (at least 1 LLIN for 2 people for all households) and LLIN use fell well short of national targets immediately after distribution of LLINs in Uganda. This represented challenges of achieving universal coverage and LLIN use.

The government of Uganda might consider distributing additional LLINs, followed by spot-monitoring and evaluation, to achieve and sustain a target of ≥ 1 LLIN for 2 people in the household. NMCP and/or other stakeholders could consider designing and conducting targeted behaviour change communication immediately after the mass distribution campaign to counter misconceptions about new LLINs. We further recommend that behavior change communication messages be considered that inform communities about the need to use both mosquito repellents and LLINs to optimally protect themselves against malaria.

Declarations

Authors' contributions

AK developed the study protocol. AK, EJN, SMM, VN, IA, SRA, AA, SS, PN, VM, SE, AK, HTN, PM, RN, AD, and RM collected the data. AK, SMM, and EJN analyzed the data and contributed to interpretation. AK drafted the manuscript. PO, BK, DK, DR, JRH, ARA supervised the study and contributed to interpretation of findings. All authors contributed to the write up, and all read and approved the final manuscript.

Acknowledgments

We acknowledge the Public Health Fellowship Program and the Ministry of Health, Uganda for implementation support, Makerere University School of Public Health for support and oversight, the US Centers for Disease Control and Prevention, Uganda for financial support. Uganda Public Health

Fellowship Program is funded by the US Centers for Disease Control and Prevention, Uganda. No other funding was obtained for data analysis and the development of this manuscript.

Availability of data and materials

The datasets used and/or analyzed for the current study are available from the corresponding author on reasonable request.

The authors declare that they have no competing interests.

Funding

This project was supported by the President's Emergency Plan for AIDS Relief (PEPFAR) through the US Centers for Disease Control and Prevention through Makerere University School of Public Health to the Uganda Public Health Fellowship Program. The funder had no role in the design of the study, collection of data or decision to publish the work.

Ethics approval and consent to participate

We obtained permission from the Ministry of Health (MOH) and sought administrative clearance from District Health Officers to conduct this evaluation. The Office of Science, U.S. Centers for Disease Control and Prevention, determined that the primary intent of this evaluation was public health practice. It was determined therefore to not be human subject research.

We sought verbal consent from all respondents before data collection. We did not obtain written informed consent, to minimize the risk of spreading COVID-19 infection, since MoH Standard Operating Procedures (SOPs) discouraged exchange of materials by hand. Participants were told that their participation was voluntary and that there would be no negative consequences if they refused to participate. During data collection, respondents were assigned unique identifiers instead of names to protect their confidentiality. Information was stored in password-protected computers and was not shared with anyone outside the investigation team.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

References

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. WHO. World Malaria Report 2020.
3. Alaii JA, Van Den Borne H, Kachur SP, Shelley K, Mwenesi H, Vulule JM, et al. Community reactions to the introduction of permethrin-treated bed nets for malaria control during a randomized controlled trial in western Kenya. The American journal of tropical medicine and hygiene. 2003;68(4_suppl):128–36.
4. MOH. Uganda Malaria Reduction Strategic Plan. Ministry of Health; 2014–2020.
5. MOH. Annual Health Sector Performance Report. Ministry of Health; 2018.
6. MOH. Uganda Malaria indicator Survey. Ministry of Health; 2018–2019.
7. 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.
8. Ntuku HM, Ruckstuhl L, Julo-Réminiac J-E, Umesumbu SE, Bokota A, Tshefu AK, et al. Long-lasting insecticidal net (LLIN) ownership, use and cost of implementation after a mass distribution campaign in Kasaï Occidental Province, Democratic Republic of Congo. Malaria Journal. 2017;16(1):22.
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. Wanzira H, Eganyu T, Mulebeke R, Bukenya F, Echodu D, Adoke Y. Long lasting insecticidal bed nets ownership, access and use in a high malaria transmission setting before and after a mass distribution campaign in Uganda. PLoS One. 2018;13(1):e0191191.
12. Zegers de Beyl C, Koenker H, Acosta A, Onyefunafoa EO, Adegbe E, McCartney-Melstad A, et al. Multi-country comparison of delivery strategies for mass campaigns to achieve universal coverage with insecticide-treated nets: what works best? Malaria Journal. 2016;15(1):58.
13. Health Mo. The Uganda Malaria Reduction Strategic Plan 2014–2020. 2014. 2014.
14. Rickard DG, Dudovitz RN, Wong MD, Jen HC, Osborn RD, Fernandez HE, et al. Closing the gap between insecticide treated net ownership and use for the prevention of malaria. Progress in community health partnerships: research, education, and action. 2011;5(2):123–31.
15. Deribew A, Birhanu Z, Sena L, Dejene T, Reda AA, Sudhakar M, et al. The effect of household heads training about the use of treated bed nets on the burden of malaria and anaemia in under-five children: a cluster randomized trial in Ethiopia. Malaria Journal. 2012;11(1):1–8.
16. Greenwood B, David P, Otoo-Forbes L, Allen S, Alonso P, Schellenberg JA, et al. Mortality and morbidity from malaria after stopping malaria chemoprophylaxis. Transactions of the Royal Society of Tropical Medicine and Hygiene. 1995;89(6):629–33.
17. Durrheim D, Govere J. Malaria outbreak control in an African village by community application of ‘deet’mosquito repellent to ankles and feet. Medical and Veterinary Entomology. 2002;16(1):112–5.

18. Rowland M, Freeman T, Downey G, Hadi A, Saeed M. DEET mosquito repellent sold through social marketing provides personal protection against malaria in an area of all-night mosquito biting and partial coverage of insecticide-treated nets: a case–control study of effectiveness. Tropical medicine & international health. 2004;9(3):343–50.
19. Deressa W, Yihdego YY, Kebede Z, Batisso E, Tekalegne A, Dagne GA. Effect of combining mosquito repellent and insecticide treated net on malaria prevalence in Southern Ethiopia: a cluster-randomised trial. Parasites & Vectors. 2014;7(1):132.
20. 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).

Tables

Table 1

Characteristics of long-lasting insecticide treated nets, three months after a mass distribution campaign, Uganda, 2021 (n = 15,426 LLINs)

Characteristic 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

Table 2
Factors associated with household long-lasting insecticide treated nets ownership, three months after a mass distribution campaign, Uganda, 2021

Variable	LLIN ownership		PR	95% CI	p	aPR	95% CI	P
	Yes	No						
Wealth index								
Low	1,805	98	1.00			1.00		
Medium	1,704	71	1.01	0.99–1.02	0.10	1.01	0.99–1.03	0.06
High	1,769	65	1.01	1.00-1.03	0.02	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	< 0.001	0.96	0.95–0.98	< 0.001
Nets protect from malaria								
No	76	13	1.00			1.00		
Yes	5,125	174	1.13	1.03–1.23	0.01	1.13	1.04–1.24	0.004
Not sure	92	49	0.76	0.66–0.89	< 0.001	0.77	0.66–0.89	< 0.001
Malaria is a serious condition								
No	119	18	1.00					
Yes	5,174	218	1.10	1.03–1.18	0.003			
PR: prevalence ratio								
aPR: adjusted prevalence ratio								
CI: confidence interval								

Table 3
Factors associated with long-lasting insecticide treated nets use, three months after a mass distribution campaign, Uganda, 2021

Variable	LLIN used the night before the survey		PR	95% CI	p	aPR	95% CI	P
	Yes	No						
Age of net (months)								
< 3	7,814	3,250	1.00			1.00		
3–12	1,428	153	1.27	1.25–1.30	< 0.001	1.09	1.06–1.11	< 0.001
13–24	364	34	1.29	1.25–1.34	< 0.001	1.10	1.06–1.14	< 0.001
> 24	1,797	387	1.17	1.14–1.19	< 0.001	1.02	0.99–1.05	0.17
Unknown	63	35	0.91	0.78–1.06	0.21	1.06	0.98–1.15	0.15
Net texture								
Polyethylene	2,150	387	1.00			1.00		
Polyester	4,658	1,521	0.89	0.87–0.91	< 0.001	0.96	0.94–0.97	< 0.001
Polyester & polyethylene	3, 283	1,564	0.79	0.78–0.82	< 0.001	0.97	0.95–0.98	< 0.001
Not sure	1,375	387	0.92	0.89–0.95	< 0.001	0.92	0.89–0.95	< 0.001
Source of net								
2017 mass distribution	1,827	365	1.00			1.00		
2021 mass distribution	8,843	3,360	0.87	0.85–0.89	< 0.001	0.98	0.95–1.01	0.14
Antenatal clinic	233	38	1.03	0.98–1.09	0.24	0.97	0.94–1.01	0.17
Self-purchased	450	55	1.07	1.03–1.11	< 0.001	0.98	0.96–1.01	0.25

PR: prevalence ratio

aPR: adjusted prevalence ratio

CI: confidence interval

Variable	LLIN used the night before the survey		PR	95% CI	p	aPR	95% CI	P
Other	113	41	0.88	0.79–0.97	0.01	0.92	0.86–0.99	0.02
Net hanging over bed								
No	614	3,468	1.00			1.00		
Yes	10,852	391	6.42	5.97–6.90	< 0.001	6.29	5.83–6.78	< 0.001
Net condition								
No holes	9,563	3,476	1.00					
One or few holes	1,328	119	1.25	1.23–1.27	< 0.001			
Many holes	553	224	0.97	0.93–1.02	0.20			
Unknown	22	40	0.48	0.35–0.68	< 0.001			
PR: prevalence ratio								
aPR: adjusted prevalence ratio								
CI: confidence interval								

Figures

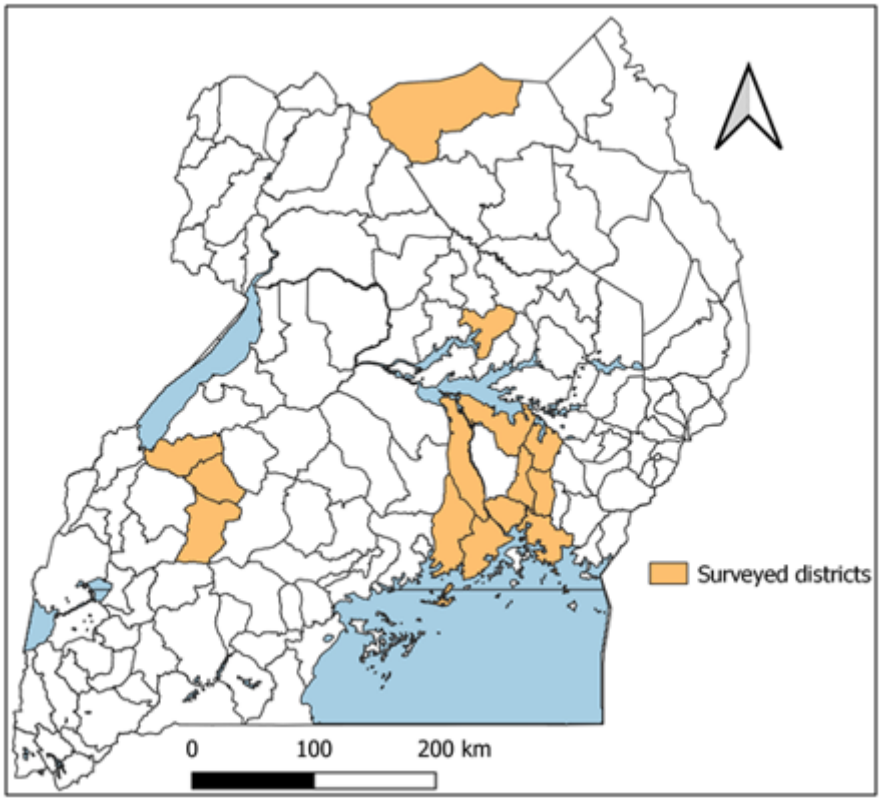

Figure 1

Location of the fourteen districts surveyed three months after a mass distribution campaign, Uganda, 2021