New Nets Project Interim ITN indicator supplement

PATH

Output 3: Evidence of effectiveness and cost-effectiveness of dual-AI ITNs created and disseminated

PATH

Contents

Partners

Funding partners

Supporting partners

Implementation partners

Industry partners

Evaluation partners

Burkina Faso

The **Centre National de Recherche et de Formation sur le Paludisme** (CNRFP) is the lead technical partner in Burkina Faso responsible for all in-country data collection management and reporting. CNRFP collaborates with the study partners on development of protocols, analyses, reporting, and dissemination.

Mozambique

In Mozambique, the New Nets Project pilot evaluation is led by the **Programa Nacional de Controlo da Malária** and **Instituto Nacional de Saúde**, with coordination and technical support from **Tropical Health LLP**.

Rwanda

The **Rwanda Biomedical Center** is the lead in-country technical partner and is responsible for data collection, management, and reporting activities. The **University of Rwanda** is the coordinating partner and is providing administrative support for contract implementation and technical support on the entomological and human behavior study components.

Nigeria

The evaluation in Nigeria is led by the **National Malaria Elimination Programme**, with support from **Ibolda Health International** for the epidemiological and human behavior components, the **Nigerian Institute of Medical Research** for the entomological and durability monitoring components, and **Tropical Health LLP** for the durability monitoring component. PATH is providing technical support on standard operating procedures and analysis.

Global

Imperial College London is the lead technical partner responsible for developing mathematical models for all pilot countries. **Liverpool School of Tropical Medicine** led the development of the methodology for the human behavior component and is providing analytic support in Burkina Faso and Rwanda. **Tulane University** is leading the cost and cost-effectiveness work across all pilot countries.

Abbreviations

AI	active ingredient
ANC	antenatal care
CSS	cross-sectional survey
EPI	Expanded Program on Immunization
IDI	in-depth interview
IG2	Interceptor G2
IRS	indoor residual spraying
ITN	insecticide-treated net
LGA	local government area
NMCP	National Malaria Control Program
NNP	New Nets Project
PBO	piperonyl butoxide
RG	Royal Guard
SMC	seasonal malaria chemoprevention

Project overview

The widespread emergence of pyrethroid resistance in malaria vectors has prompted the need to develop new technologies to ensure the continued effectiveness of insecticide-treated nets (ITNs) in the fight against malaria. Dual active ingredient (AI) ITNs present the best hope but there are a limited number of products currently available, they cost significantly more than pyrethroid-only nets, and the evidence base demonstrating their efficacy and cost-effectiveness is limited.

The New Nets Project partnership was established with the goal of making the latest dual-AI ITN technology more widely available to malaria programs throughout sub-Saharan Africa. As well as managing the rapid deployment of new nets to partner countries and negotiating a volume guarantee to reduce prices, New Nets Project partners oversee randomized control trials and pilot studies evaluating their efficacy and effectiveness. The evidence gathered from these studies will be used to ascertain the impact and cost-effectiveness of dual AI nets and support an appropriate ITN policy recommendation from the World Health Organization (WHO). The team is also gathering operational learnings in order to optimize future deployment of new nets.

The New Nets Project is co-funded by Unitaid and The Global Fund, with complementary funding provided by the Bill & Melinda Gates Foundation and USAID. The project is led by IVCC, who is responsible for the overall management of the project. Other project partners include The Alliance for Malaria Prevention, Imperial College London, Liverpool School of Tropical Medicine, London School of Hygiene and Tropical Medicine, PATH, Population Services International and Tulane University. The New Nets Project will not only result in accelerated access to new nets and updated policy recommendations, it will also establish critical guidance to countries looking for the best value for money in controlling malaria across a range of transmission settings

Methods

Overview

This report includes results from the observational studies accompanying ITN distributions in Burkina Faso, Northern Mozambique, Western Mozambique, Nigeria, and Rwanda of Interceptor® G2 (IG2) ITNs (a dual-AI ITN that uses alphacypermethrin and chlorfenapyr and is a registered trademark of BASF SE), and Royal Guard® (RG) ITNs (a dual-AI ITN that uses alphacypermethrin and pyriproxyfen and is a registered trademark of Disease Control Technologies LLC). The National Malaria Control Programs (NMCPs) in Burkina Faso and Rwanda incorporated IG2 ITNs into the mass distribution campaigns in 2019 and 2020, respectively, and the NMCPs in Nigeria and Mozambique incorporated both IG2 and RG ITNs into their 2020 mass campaigns. In addition, Burkina Faso, Nigeria, and Mozambique incorporated ITNs containing piperonyl butoxide (PBO), an insecticide synergist, in addition to a pyrethroid into their mass campaigns. A subset of districts that received either IG2, RG, PBO, or standard ITNs were selected as study districts. In Rwanda, PBO nets were distributed in the mass campaign, but there were no areas comparable to those receiving IG2 ITNs, and therefore the PBO ITN districts were not incorporated into the analysis.

This interim report on bed net indicators collected from annual cross-sectional surveys (CSSs) and anthropological activities is organized by evaluation site, with two distinct evaluations occurring in Mozambique. Within each evaluation, five in total, available indicators on bed net ownership, bed net characteristics, and bed net use are presented. Due to country-specific factors, the timing of data collection, management, and analysis varies. Data collection and analysis are ongoing, and definitive conclusions will not be drawn from these results at this time. The study evaluation period, the ITN type, and timing of ITN campaigns in each geography are presented below (Table 1).

Table 1. Overview of observational studies.

Geography	Study time period	ITNs evaluated	ITN distribution completed
Burkina Faso	2019–2022	IG2, PBO	June 2019 (PBO) August 2019 (standard) October 2019 (IG2)
Northern Mozambique	2020–2022	IG2, RG	November 2020
Western Mozambique	2020–2022	IG2, PBO	December 2020
Rwanda	2020–2022	IG2	February 2020 (standard) June 2020 (IG2)
Nigeria	2020–2022	IG2, RG, PBO	November 2020

Abbreviations: IG2, Interceptor G2; ITN, insecticide-treated net; PBO, piperonyl butoxide; RG, Royal Guard.

There are two primary reasons to carefully consider the data presented and trends described in this ITN indicator supplement. First, within each evaluation context it will be important to consider whether differences in ITN access or use might influence how differences in epidemiological impact (and, ultimately, cost-effectiveness) are interpreted. For example, if a new ITN type is shown to kill pyrethroid-resistant mosquitoes more effectively than standard ITNs, but it is not associated with an incremental improvement in malaria reduction compared to a standard ITN, could it be because suboptimal coverage

or use was obtained? Secondly, the data presented here (in conjunction with the qualitative and quantitative anthropological data to be presented elsewhere) may help inform our understanding of the limits of ITN interventions, regardless of ITN type. The specific objectives of this report are to:

- Summarize **key quantitative indicators of bed net ownership, access, and use, as well as other characteristics**, across study districts.

- Present **key qualitative findings that provide additional context to the quantitative indicators**, including barriers to and facilitators of ITN use and other behaviors relating to ITNs.

Methodology

Data sources

Cross-sectional surveys

Annual CSSs were conducted and included malaria-infection testing, a household questionnaire collecting data on socioeconomic status and ITN ownership and use, and questions about each bed net in the household. Table 2 shows the total number of households sampled in each survey represented in this ITN indicator supplement.

Table 2. Overview of annual cross-sectional surveys through November 2021.

Geography	Baseline	Year 1	Year 2
Burkina Faso	190 households per district; 570 total households	190 households per district; 570 total households	190 households per district: 570 households
Rwanda	150 households per district; 450 total households	150 households per district; 450 total households	
Nigeria	420 households per LGA; 1,680 total households		
Northern Mozambique	420 households per district; 1,260 total households	420 households per district; 1,260 total households	
Western Mozambique	420 households per district; 1,260 total households	420 households per district; 1,260 total households	

Abbreviation: LGA, local government area.

Durability monitoring

Durability monitoring is a key activity in determining the physical durability and insecticidal effectiveness of ITNs, ITN survivorship, and ways care and repair behaviors impact the physical durability of ITNs. It is funded and implemented by different organizations in each NNP country and, though not discussed in any detail in the present report, will be reported on in final project reports.

Anthropology

In-depth interviews (IDI) and focus group discussions (FGD) are conducted to collect data on the context and drivers of ITN use and nonuse across ITN types. The IDIs and FGDs use semi-structured guides based on themes emerging from analysis of other study components and previous rounds of anthropological data collection. Table 3 describes the number of IDIs and FGDs conducted in each country as of September 2021. Data collection in Mozambique began in October 2021.

Table 3. Number of in-depth interviews (IDIs) and focus group discussions (FGDs) through September 2021.

Geography	Number of IDIs	Number of FGDs
Burkina Faso	296	82
Rwanda	95	36
Nigeria	257	32

Bed net indicators

Bed net ownership

The following outcomes related to bed net ownership were calculated from CSSs for each district / local government area (LGA):

- Total number of ITNs found in surveyed households.
- Proportion of bed nets, by type.
- Proportion of households that own one ITN for every two people.
- Average household size and average number of persons per ITN.
- Proportion of 2019 or 2020 mass campaign ITNs reported to be lost for any reason.

Anthropological findings related to bed net ownership include whether there was access to ITNs, whether participants were able to obtain adequate ITNs, and what the barriers to access were.

Bed net access and use

The following outcomes on bed net use from the CSSs will be presented for each district/LGA:

- Proportion of total household members who slept under an ITN the previous night, by net type.
- Population ITN access and bed net use given access.
- Proportion of bed nets hung, stored, and not hung or stored.
- Proportion and frequency of bed nets used the previous week for 2020 and 2021 surveys, by district.
- Proportion of bed nets ever washed, by type.

Anthropological findings related to bed net use include information on drivers of ITN use and washing behaviors.

Bed net characteristics

The following outcomes on bed net characteristics from CSSs will be presented for each evaluation area:

- Proportion of bed nets attained through each of the four source types, by survey year and district.

- Proportion of ITNs received during the 2019 or 2020 mass campaign with reported holes, by type/district.

Anthropological findings related to bed net characteristics include information on common sources for obtaining ITNs.

Limitations

The timing of each mass ITN distribution campaign varied across study districts. This resulted in differences in the number of months since ITNs were deployed at the time of each CSS. These differences are noted in the first table of each country section, though any differences are likely to have been minimized with each subsequent annual survey. Future multivariate model analyses will adjust for timing in mass campaigns and different covariates.

Since these evaluations employ one survey annually and ITN use can vary with seasonality, these results are limited in the assessment of short-term temporal trends of key indicators in both the wet and dry seasons. Especially in districts where ITN use remains low following ITN distribution (e.g., Gaoua district in Burkina Faso and Cuamba district in Mozambique), more frequent surveys could provide insight into what is driving differences in use. The anthropological data collected during the dry and rainy seasons, however, will supplement survey results and provide insights on broader community practices and beliefs.

Due to the complexity of national malaria programming and each unique net distribution campaign, the study protocols are not identical; however, key indicators have been harmonized across studies. A single data analysis framework has been codeveloped by study partners. This framework accounts for local variations for each individual analysis, including differences measured at baseline in total duration of net ownership, delays in hanging campaign nets, and data gaps. The study protocol aims to ensure that the breadth of information and replication of similar analyses will strengthen conclusions on the cost-effectiveness of these interventions across a variety of settings in a way that a single evaluation or single measure could not.

Burkina Faso

Background

Study districts

Evaluations are taking place in Banfora (IG2), Orodara (PBO), and Gaoua (standard). The NMCP in Burkina Faso, in consultation with partners, used malaria incidence and insecticide-resistance data to document regions and districts with high pyrethroid resistance for receipt of either PBO or dual-AI (IG2) ITNs. Hence, this distribution concentrated mainly on the western districts of the country (Figure BF1).

Figure BF1. Map of the study districts in Burkina Faso.
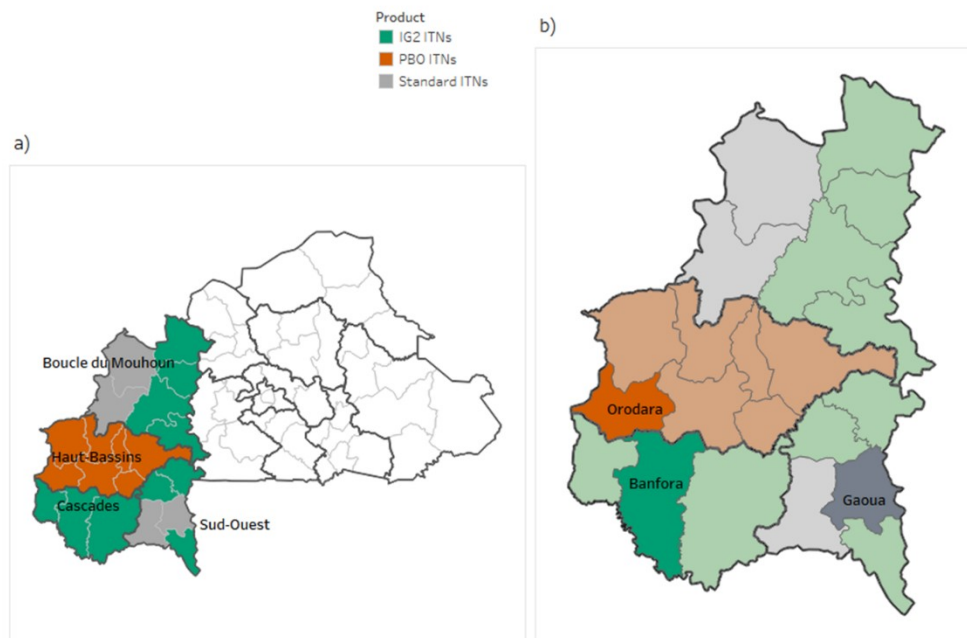
Note: (a) ITN distribution across four regions of Burkina Faso; (b) the three study districts. *Abbreviations*: IG2, Interceptor G2; ITN, insecticide-treated net; PBO, piperonyl butoxide.

ITN distribution and data collection

Malaria high transmission season occurs from June through October, and ITNs were distributed during the 2019 high transmission season: PBO ITNs in June, standard pyrethroid-only ITNs in August, and IG2 ITNs in October (Figure BF2).

The 2019 campaign's coordinating body included a coordination cell, a secretariat, and seven commissions. The initial timeline included the two campaign phases—the distribution of standard ITNs and PBOs in Phase 1, planned for May 2019, and the distribution of IG2s in Phase 2, planned for July 2019. Delivery of IG2 ITNs was delayed, however, pushing Phase 2 of the distribution to October 2019. A total of 12,174,202 ITNs were deployed: 9.3 million standard pyrethroid-only ITNs (119,898 of these

distributed in Gaoua), 1.3 million PBO ITNs (108,331 in Orodara), and 1.5 million IG2 ITNs (242,254 in Banfora).

The NCMP reported from post-campaign estimates that 96.5 percent of households in Banfora received ITNs. Reported coverage was highest in Orodara, at 98.7 percent, and lowest in Gaoua, at 93.0 percent.

The baseline survey was conducted in July 2019. At that time, Orodara had received PBO ITNs, the standard ITN campaign in Gaoua had been launched, and IG2 ITNs had not yet been delivered to the country (Table BF1 and Figure BF2).

Table BF1. ITN campaign and survey dates.

	Distribution date	Baseline Survey (July 2019)	Year 1 Survey (July 2020)	Year 2 Survey (June-July 2021)
Gaoua (standard)	August 2019	1 month pre-distribution	11 months post-distribution	23 months post-distribution
Banfora (IG2)	October 2019	3 months post-distribution	9 months post-distribution	21 months post-distribution
Orodara (PBO)	June 2019	2 weeks post-distribution	12 months post-distribution	24 months post-distribution

Abbreviations: IG2, Interceptor G2; ITN, insecticide-treated net; PBO, piperonyl butoxide.

Figure BF2. ITN distribution and transmission timeline.
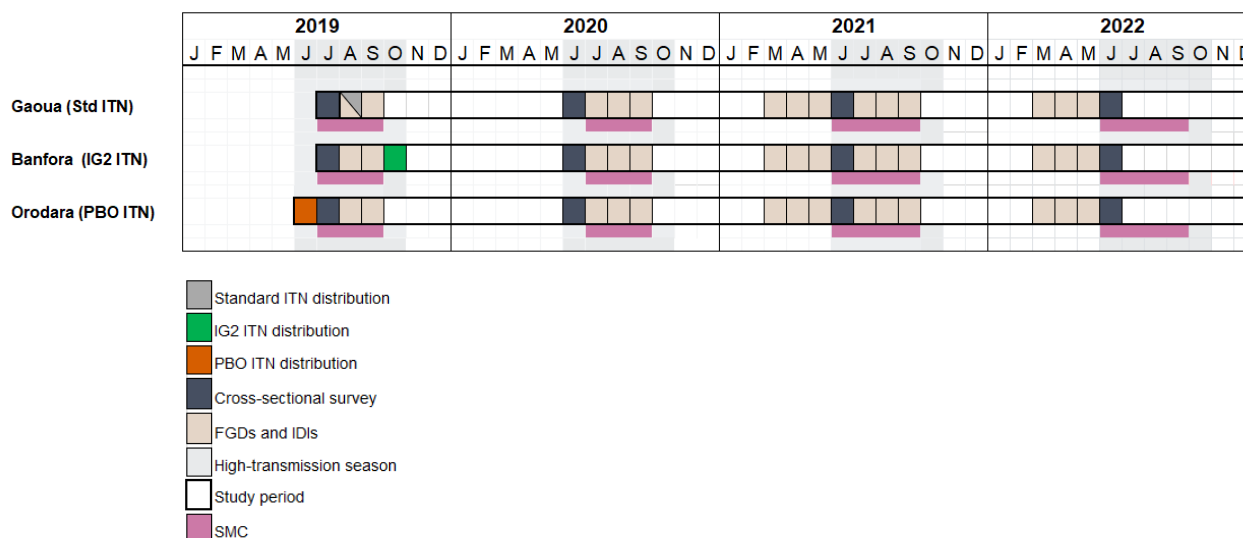
Abbreviations: FGD, focus group discussion; IDI, in-depth interview; IG2, Interceptor G2; ITN, insecticide-treated net; PBO, piperonyl butoxide; SMC, seasonal malaria chemoprevention.

Bed net ownership

At the time of the 2019 survey, Banfora had not yet received the IG2 ITNs; hence, households reported owning 367 ITNs in the 2019 survey, increasing to 479 and 493 in 2020 and 2021, respectively. Gaoua reported a consistent number of ITNs, except for an expected decrease in 2021, 2 years post campaign.

Similarly, Orodara had benefitted from their mass campaign at the time of the baseline survey and reported a decline in the number of ITNs owned from 2019 to 2021.

Gaoua had the lowest average number of ITNs per household in the three surveys, with fewer than 2.0 ITNs per household. Orodara had the highest average number per household, with about 3.6 in the 2019 survey (one to three weeks post-campaign) and decreasing to 2.4 in 2021. These numbers are in line with the post-campaign coverage estimates showing Gaoua with the lowest count.

During FGDs and IDIs, many participants reported receiving an insufficient number of nets for their households, especially in Gaoua. In many cases this was due to not being counted during the campaign or losing the census receipt and being turned away. Others reported being counted but given fewer ITNs than needed due to an insufficient number of available nets.

> *"The distribution went well, except for those who lost their census receipts. Those who lost their census receipts did not receive mosquito nets because distribution agents set conditions... 'no census receipt, no mosquito net.' There is also the other condition, which is to weed the [Center for Health and Social Promotion] yard in exchange for the mosquito nets. This way of doing things discourages the population."*
>
> *– FGD participant, Gaoua*
>
> *Participants also noted that ITNs are available for purchase but not everyone could afford them. "Yes, everyone sleeps under a mosquito net which was distributed during the campaign, but they were not enough, so I bought some."*
>
> *– FGD participant, Banfora*

Table BF2 presents the total number of nets found in sampled households, the total number of households sampled, and the average number of nets of any type per household, by year and district.

Table BF2. Total number of ITNs found in surveyed households.

		2019	2020	2021
Gaoua (standard)	Total # ITNs	271	269	185
	Total # households	195	190	190
	Average # ITNs per household	1.4	1.4	1.0
Banfora (IG2)	Total # ITNs	367	493	526
	Total # households	197	190	190
	Average # ITNs per household	1.9	2.6	2.8
Orodara (PBO)	Total # ITNs	677	489	456
	Total # households	190	190	191
	Average # ITNs per household	3.6	2.6	2.4

Abbreviations: IG2, Interceptor G2; ITN, insecticide-treated net; PBO, piperonyl butoxide.

The proportion of bed nets, by type (Figure BF3), found in each district aligns with the type of ITN each district received and the time of the campaigns. Here again the timing of the baseline survey in relation to the campaigns is important: Banfora households received their ITNs after the baseline survey, which explains why the majority of the ITNs (66 percent) were standard ITNs in 2019. Banfora also had a relatively high number of unknown types of ITNs in 2019 (34 percent). These unknowns are assumed to be standard ITNs which may have lost their tags since no other types had been distributed prior to 2019. IG2 ITNs were the predominant type in the survey in 2020 and 2021, at 82 percent and 77 percent,

respectively. Gaoua households had standard ITNs as the majority type for all three years. In Orodara, PBO ITNs were the expected type. Although they started off comprising only a little over half of the ITNs present in households during the 2019 baseline survey (a few weeks after the campaign), that proportion increased to 71 percent and 82 percent in 2020 and 2021, respectively. The fact that no survey had found 100 percent of the expected ITN type in households is not very surprising, as households are not expected to discard ITNs they currently own when they receive new ones.

Figure BF3. Proportion of bed nets, by type.
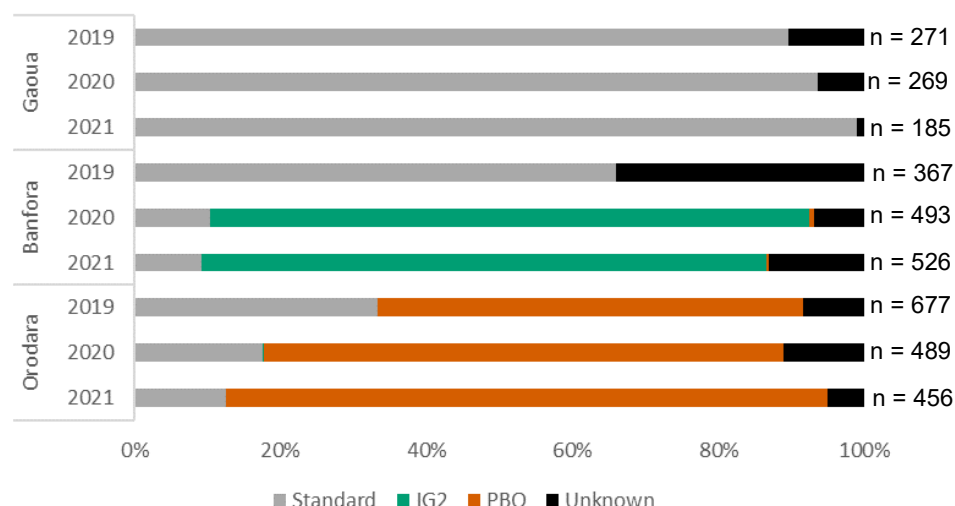
Abbreviations: IG2, Interceptor G2; PBO, piperonyl butoxide.

The proportion of households that own one ITN for every two people (Table BF3) was the highest (85 percent) in Orodara in 2019, the only district that had benefitted already from the campaign. By the 2020 survey, all three districts had benefitted from their ITN campaigns in the previous 9 to 12 months, with Gaoua having the lowest percentage for the indicator at 28 percent. At about 24 months post-campaign, the indicator was lower for all districts compared to that of the previous year: in Orodara, over half the households surveyed had one ITN for every two people; the percentage was lower in Banfora at approximately 38 percent and the lowest in Gaoua at only a little over 16 percent.

Table BF3. Proportion of households that own one ITN for every two people.

	2019	2020	2021
Gaoua (standard)	17.95%	27.89%	16.32%
Banfora (IG2)	24.37%	47.37%	38.42%
Orodara (PBO)	84.74%	62.63%	51.31%

Abbreviations: IG2, Interceptor G2; ITN, insecticide-treated net; PBO, piperonyl butoxide.

The average household size varied between around four and seven people across all years and districts (Figure BF4). The average person per net indicator was the highest in Gaoua in 2019 at almost 5.0 persons per net, going down in 2021 after the completion of the net campaign to 3.4 persons per net. This indicator was the lowest in Orodara in 2019 at 1.5 persons per net soon after the distribution campaign. The indicator gradually increased to 1.9 in 2020 and 2.1 in 2021.

Figure BF4. Average household size and average number of persons per ITN.
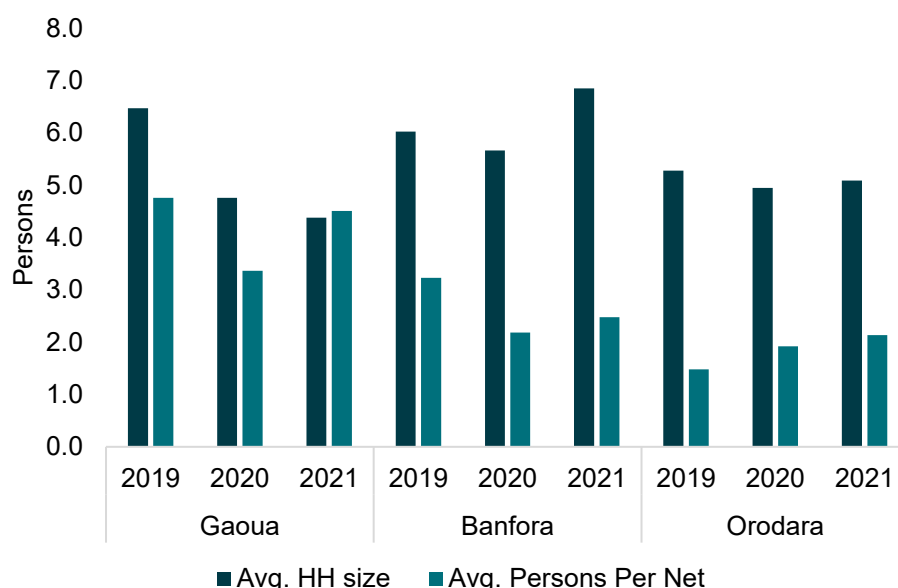
Abbreviations: HH, household; ITN, insecticide-treated net.

Households surveyed about a year post-campaign reported few ITNs lost. This indicator increased, however, the following year for all districts (Table BF4). Banfora had the lowest number of lost ITNs in 2020, most likely because the ITNs were distributed the most recently (about 8 months prior to the survey, as opposed to over 12 months prior for the other two districts).

Table BF4. Proportion of 2019 mass campaign ITNs reported to be lost for any reason.

	2020	2021
Gaoua (standard)	2.57%	7.14%
Banfora (IG2)	1.00%	6.64%
Orodara (PBO)	3.43%	4.44%

Abbreviations: IG2, Interceptor G2; PBO, piperonyl butoxide.

Bed net access and use

Overall, population use of ITNs, defined as the proportion of household residents sleeping under an ITN the night before the survey (Table BF5), was the highest in Banfora and Orodara, post-campaign. By ITN type, standard ITNs were the most predominantly used in the three districts in 2019, shifting to the campaign ITNs in 2020 and 2021. By 2021, PBO ITN use in Orodara increased from 57 percent to 69 percent. Reported IG2 use decreased in Banfora from 75 percent to 65 percent.

Looking at ITN use more specifically by type, the surveys found that although ITNs different from the 2019 distribution type were present and used in the households, the most used ITNs (post-campaign) in each district were the type distributed in the campaign.

Table BF5. Proportion of total household members who slept under an ITN the previous night, by net type.

	2019	2020	2021
Gaoua (standard)	n = 1,262	n = 905	n = 834
IG2	-	-	-
Standard	17.99% (227)	41.55% (376)	36.57% (305)
PBO	-	-	-
Unknown	2.77% (35)	2.65% (24)	0.36% (3)
Total	**20.76% (262)**	**44.20% (400)**	**36.93% (308)**
Banfora (IG2)	n = 1,185	n = 1,076	n = 1,302
IG2	-	75.00% (807)	64.75% (843)
Standard	47.00% (557)	10.41% (112)	8.45% (110)
PBO	-	0.19% (2)	0.31% (4)
Unknown	20.84% (247)	4.83% (52)	9.29% (121)
Total	**67.84% (804)**	**90.43% (973)**	**82.80% (1,078)**
Orodara (PBO)	n = 1,003	n = 940	n = 972
IG2	-	0.31% (3)	-
Standard	42.27% (424)	18.72% (176)	10.60% (103)
PBO	28.41% (285)	56.91% (535)	69.14% (672)
Unknown	8.08% (81)	8.94% (84)	3.81% (37)
Total	**78.76% (790)**	**84.89% (798)**	**83.54% (812)**

Note: "n" signifies total number of household members in the district for that survey year. *Abbreviations*: IG2, Interceptor G2; ITN, insecticide-treated net; PBO, piperonyl butoxide.

The use given access indicator increased from a year post-distribution (2020) to 2021 in all three districts (Table BF6).

Table BF6. Population ITN access and bed net use given access.

	Gaoua (standard)			Banfora (IG2)			Orodara (PBO)		
	2019	2020	2021	2019	2020	2021	2019	2020	2021
Population ITN access, % (95% CI)	44.4 (42.4–46.2)	53.8 (51.4–56.2)	40.5 (37.9–43.1)	58.9 (57.1–60.7)	84.2 (83.1–85.3)	74.9 (73.5–76.2)	94.0 (93.1–94.9)	87.4 (86.3–88.5)	82.0 (80.7–83.3)
Use given access*	0.47	0.82	0.91	1.15	1.07	1.11	0.84	0.97	1.02

*Use given access is calculated by dividing use (proportion of respondents that slept under a net the previous night) by population ITN access. Ratios over 1 are possible given that the population ITN access calculation assumes each net can be used by a maximum of two people. *Abbreviations*: CI, confidence interval; IG2, Interceptor G2; ITN, insecticide-treated net; PBO, piperonyl butoxide.

The proportion of hung ITNs increased in all districts from 2019 to 2021 except in Banfora, which at the time of the 2019 survey had not yet benefitted from the distribution of nets (Figure BF5).

Additional analysis to look more specifically at the types of ITNs that were hung were conducted (Appendix Table BF1).The most prevalent in each district post-campaign corresponded to the type distributed in that campaign. For example, from 2019 to 2021 in Gaoua, mostly standard ITNs were found hanging. In 2019 in Banfora, prior to the campaign, mostly standard ITNs were found hanging

(60 percent), but in 2020 and 2021 they were replaced by IG2 ITNs (with 63 percent and 62 percent of hung ITNs being IG2s, respectively).

In Orodara, in 2019 most ITNs found in households were indeed PBOs; however, the majority were still in storage, as the distribution had only been completed weeks prior. In 2020 and 2021, the proportion of hung ITNs (any type) went up to 75 percent and 83 percent, respectively (Figure BF5).

Figure BF5. Proportion of bed nets hung, stored, and not hung or stored.
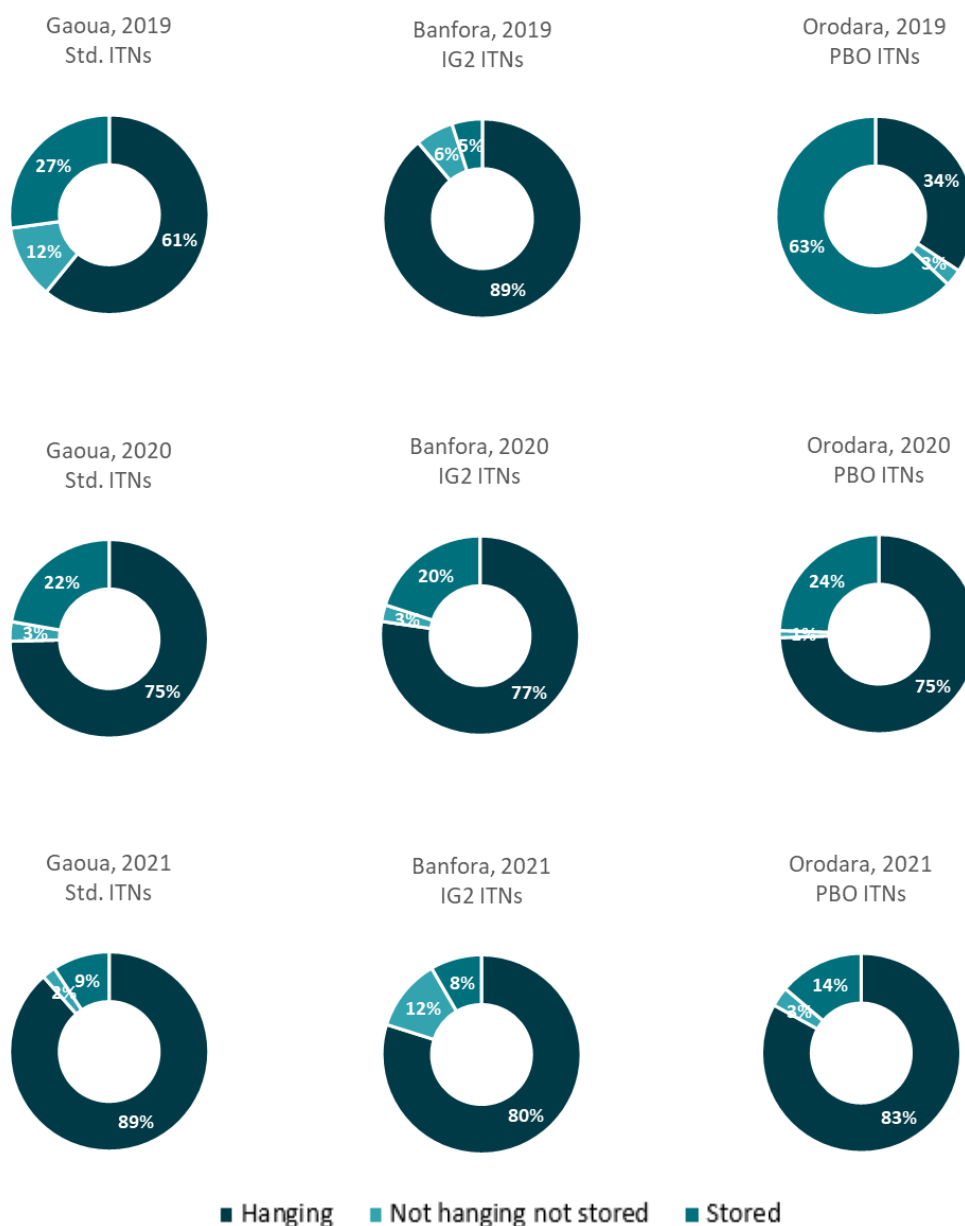
Abbreviations: IG2, Interceptor G2; ITN, insecticide-treated net; PBO, piperonyl butoxide.

In line with the population ITN use indicator, the frequency of ITN use shows that in Banfora and Orodara, close to 80 percent of ITNs were used every night in the previous week. In Gaoua, that proportion is closer to 50 percent in the 2020 and 2021 surveys.

Figure BF6 shows the frequency and percentage of ITN use for the previous week (7 nights, 5 to 6 nights, 1 to 4 nights, not used in the previous week, and not used at all), aggregated by survey year and study district.

Figure BF6. Proportion and frequency of bed nets used the previous week for 2020 and 2021 surveys, by district.
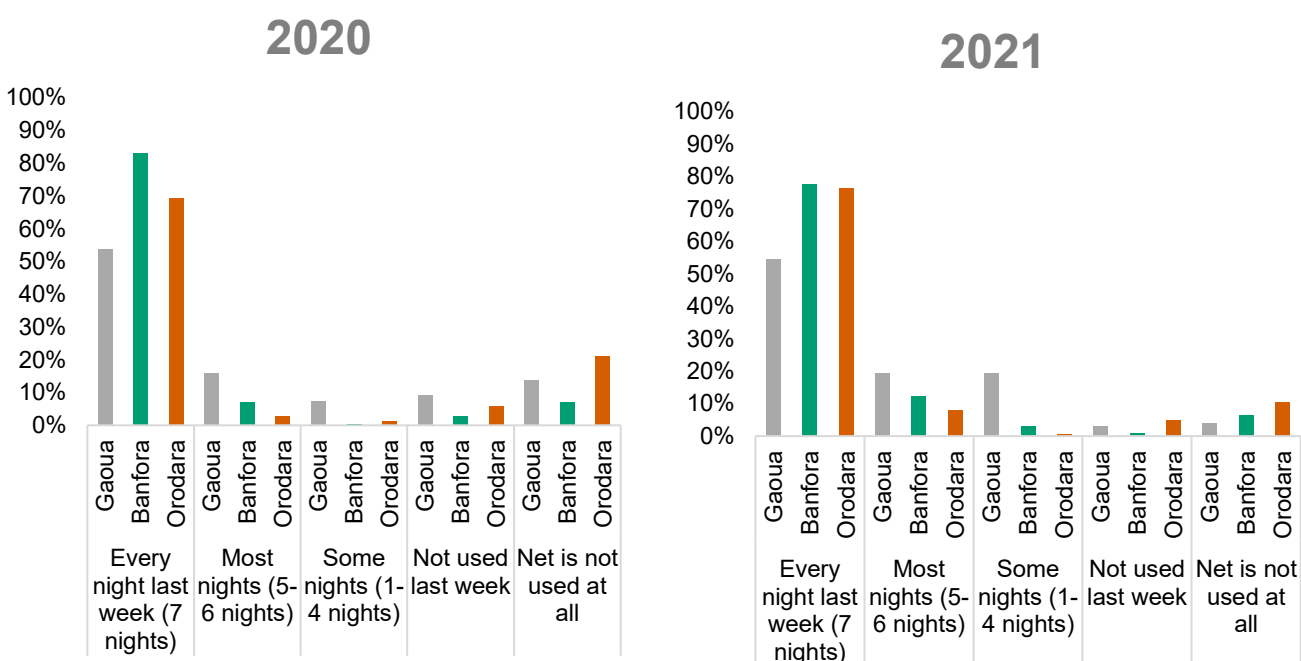
In the 2020 CSS, households reported washing more of their campaign ITNs than in the previous year, as would be expected as the campaign ITNs age. Table BF7 shows the percentage and number of ITNs washed, by survey year and district.

Table BF7. Proportion of bed nets ever washed, by type.

		2019	2020	2021
Gaoua (Standard)	Standard	52.54% (124/236)	54.17% (130/240)	82.02% (146/178)
Banfora (IG2)	IG2	--	80.99% (328/405)	92.87% (378/407)
	Standard	94.63% (229/242)	90.20% (46/51)	100.00% (47/47)
Orodara (PBO)	Standard	80.44% (181/225)	82.56% (71/86)	85.96% (49/57)
	PBO	2.55% (10/392)	52.87% (184/348)	82.71% (311/376)

Abbreviations: IG2, Interceptor G2; PBO, piperonyl butoxide.

Bed net characteristics

The majority of ITNs in the surveyed households were from mass campaign distributions, with the lowest proportion in Banfora in 2019 (53 percent), the only district that had not yet received any 2019 campaign ITNs at the time of the survey. Post-campaign, very few households (less than 10 percent) reported receiving ITNs from sources other than the mass campaign or a routine health visit (antenatal care [ANC] or Expanded Program on Immunization [EPI]), the most frequent being store purchases or gifts (from family/friend or workplace). Figure BF7 summarizes the proportion of ITNs received via four source categories, aggregated by survey year and district.

Figure BF7. Proportion of bed nets attained through each of the four source types, by survey year and district.
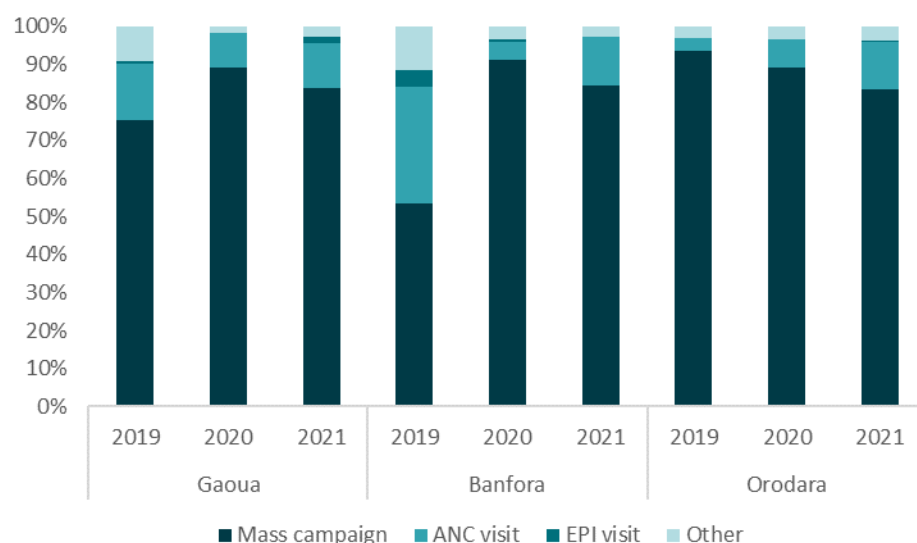
Abbreviations: ANC, antenatal care; EPI, Expanded Program on Immunization.

Households also reported on the number of ITNs received through the 2019 mass campaign that had any holes at the time of the survey (Table BF8). In 2020, approximately 12 months after the campaign, the majority of ITNs were still intact, with the highest proportion (8 percent) of ITNs with holes reported in Orodara, which had the oldest ITNs at the time. In 2021, however, Banfora reported a high proportion of ITNs with holes (42 percent).

Table BF8. Proportion of ITNs received during the 2019 mass campaign with reported holes, by type/district.

	2020	2021
Gaoua (standard)	6.55% (15)	11.04% (17)
Banfora (IG2)	3.83% (15)	42.22% (152)
Orodara (PBO)	7.65% (26)	17.78% (61)

Abbreviations: IG2, Interceptor G2; ITN, insecticide-treated net; PBO, piperonyl butoxide.

In all districts, only ITNs received through mass distribution campaigns were included. IG2 and PBO nets were distributed for the first time in 2019 in Banfora and Orodara, respectively, likely indicating that only nets distributed in 2019 were included. In Gaoua, however, standard nets were distributed in previous mass campaigns, and therefore nets older than those distributed in 2019 could have been included.

Summary

In the two years post-distribution, 2019 to 2021, ITN ownership had remained high in Banfora (86 percent to 94 percent), Orodara (93 percent to 99 percent) and Gaoua (93 percent to 100 percent). While all districts had several net types present and used in households, in general the most prominent type present and used for each district was the type distributed in the mass campaigns: in 2020, 82 percent of ITNs in Banfora were IG2 ITNs, over 94 percent in Gaoua were standard ITNs, and 71 percent in Orodara were PBO ITNs. This supports the likelihood that differences in malaria transmission trends observed after the 2019 campaign correlate with differences in the efficacy of the various net types, if other confounding factors (overall ITN access, use, climate, vector bionomics, etc.) are controlled for in the analysis.

In all districts ITNs were mostly used every night (7 days), although use of ITNs the previous night varied, with Gaoua's standard net use being suboptimal (42 percent) in 2021. In Banfora, IG2 ITN use the previous night decreased from 75 percent (2020) to 65 percent (2021), while in Orodara PBO ITN use increased from 57 percent (2020) to 69 percent (2021). It is important to understand what socioeconomic and behavioral factors or misinformation contributed to low use of nets and how such might influence the impact of the net distribution campaign on malaria transmission.

The majority of the ITNs received through mass campaigns were still intact approximately 12 months post-campaign. In 2021, however, Banfora reported a high proportion of ITNs with holes (42 percent). Durability monitoring, which investigates the integrity of ITNs in greater detail, may provide more context for this observation. If consistent, this observation may also provide insight into the decreased ITN use and any lower-than-expected impact of IG2 nets in Banfora.

Northern Mozambique

Background

Study districts and ITN distribution

The Northern Mozambique evaluation includes Gurue District (standard ITNs) in Zambezia Province and Cuamba (IG2 ITNs) and Mandimba (RG ITNs) Districts in Niassa Province (Figure MN1). The high transmission season occurs from January through June. The Northern Mozambique evaluation began in August 2020, and ITN distribution in pilot study districts was completed in October 2020 (Table MN1 and Figure MN2). Final reports on the distribution campaign results are expected from project partners in 2022.

2020 mass distribution campaign

Niassa Province was prioritized by the NMCP for receipt of dual-AI ITNs based on a high prevalence of malaria in children under 5 years old, estimated during the 2018 Malaria Indicator Survey, and high pyrethroid resistance, while standard ITNs were distributed in Zambezia Province. Though Niassa Province was targeted initially to receive only one brand of dual-AI ITNs (IG2), the opportunity to also distribute a limited number of RG ITNs was identified, and so Cuamba District received IG2 ITNs while Mandimba District was chosen to receive the RG ITNs based on its population size, which corresponded to the number of RG ITNs available. The 2020 campaign was completed by October, approximately one month after the baseline CSS. Further details describing the campaign and key outcome metrics from the final operations report will follow in a future report.

Figure MN1. Map of the study districts in Northern Mozambique.
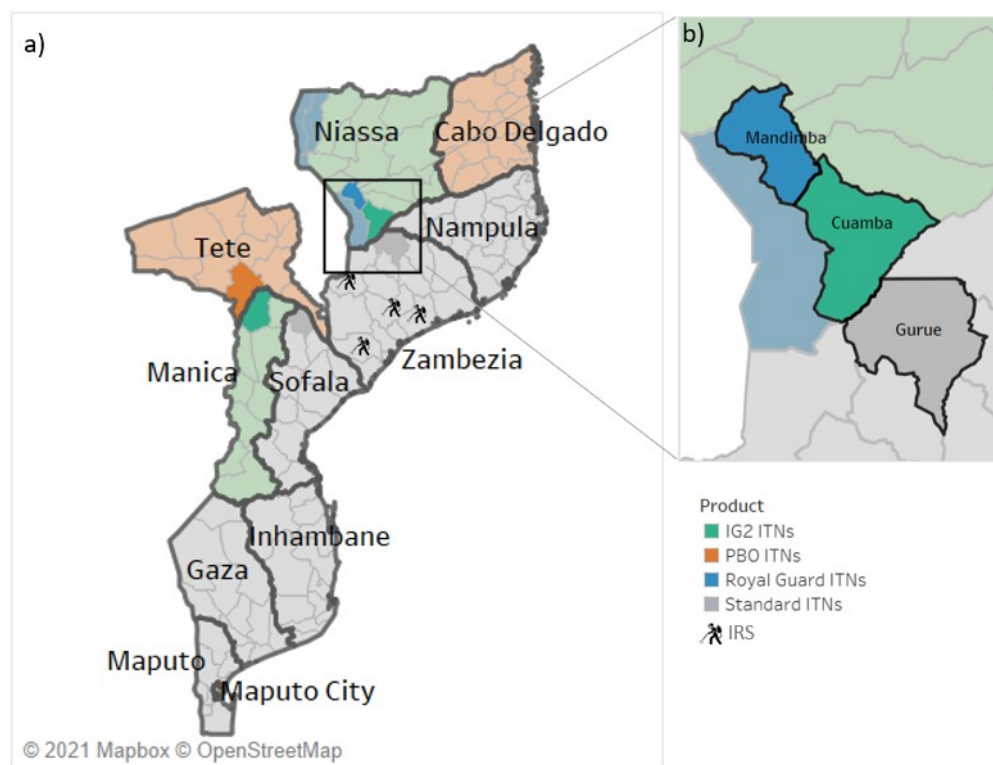
Note: (a) ITN distribution across Mozambique; (b) the three study districts. *Abbreviations*: IG2, Interceptor G2; IRS, indoor residual spraying; ITN, insecticide-treated net; PBO, piperonyl butoxide.

Table MN1. ITN campaign and survey dates.

	Distribution date	Baseline survey (September 2020)	Year 1 survey (August 2021)
Gurue (standard)	October 2020	1 month pre-distribution	10 months post-distribution
Cuamba (IG2)	October 2020	1 month pre-distribution	10 months post-distribution
Mandimba (RG)	October 2020	1 month pre-distribution	10 months post-distribution

Abbreviations: IG2, Interceptor G2; ITN, insecticide-treated net; RG, Royal Guard.

Figure MN2. ITN distribution and transmission timeline.
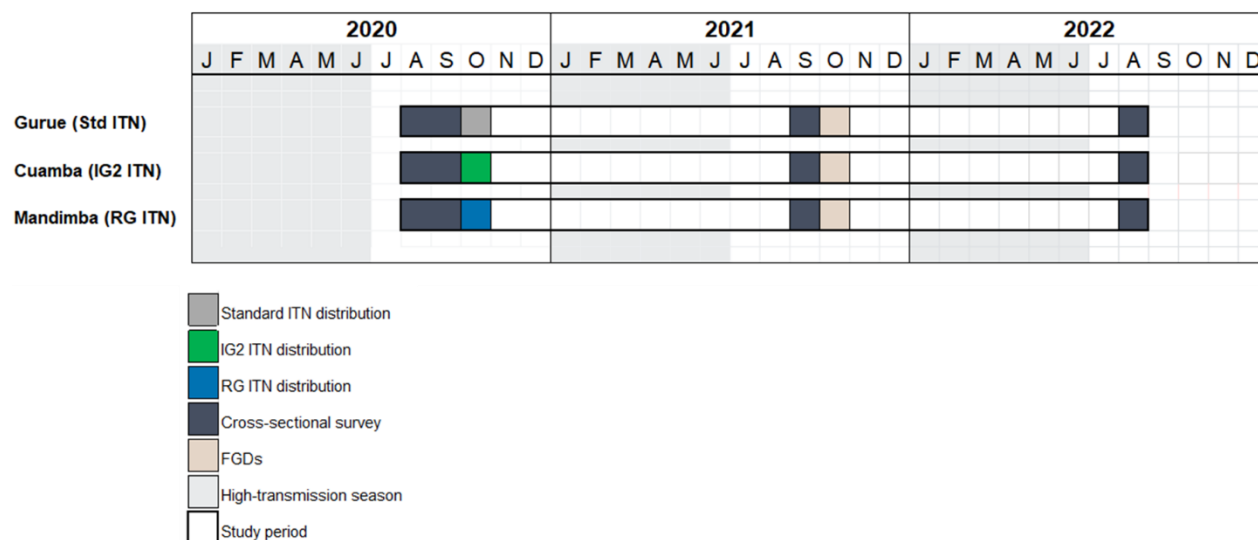
Abbreviations: FGD, focus group discussion; IG2, Interceptor G2; ITN, insecticide-treated net; RG, Royal Guard.

Bed net ownership

During the baseline survey in September 2020, prior to the distribution campaign, the overall number of ITNs was relatively low at significantly less than 1.00 per household (Table MN2). Not surprisingly, the number of ITNs encountered after the campaign, during the 2021 survey, had increased substantially (more than threefold) in each district (Table MN2). While the increase in the number of ITNs per household was dramatic across all districts, results were somewhat variable, with Gurue District (standard) having the highest number of ITNs per household at 2.43, followed by Mandimba (RG) at 2.06 and Cuamba (IG2) at 1.79.

Table MN2. Total number of ITNs found in surveyed households.

		2020	2021
Gurue (standard)	Total # ITNs	277	1,019
	Total # households	425	419
	Average # ITNs per household	0.65	2.43
Cuamba (IG2)	Total # ITNs	255	783
	Total # households	411	437
	Average # ITNs per household	0.62	1.79
Mandimba (RG)	Total # ITNs	181	864
	Total # households	426	420
	Average # ITNs per household	0.42	2.06

Abbreviations: IG2, Interceptor G2; ITN, insecticide-treated net; RG, Royal Guard.

Figure MN3 presents the proportion of ITNs by net type and illustrates the success of the multiproduct campaign in distributing different ITN types to the different districts with high fidelity. Any ITN whose brand

was "unknown" at baseline in 2020 was assumed to be a standard ITN since no other net type had been distributed in these districts. One year post-distribution, 99.8 percent of the ITNs in Gurue were standard, 97.8 percent of the ITNs in Cuamba were IG2, and 98.2 percent of the ITNs in Mandimba were RG.

Figure MN3. Proportion of bed nets, by type.
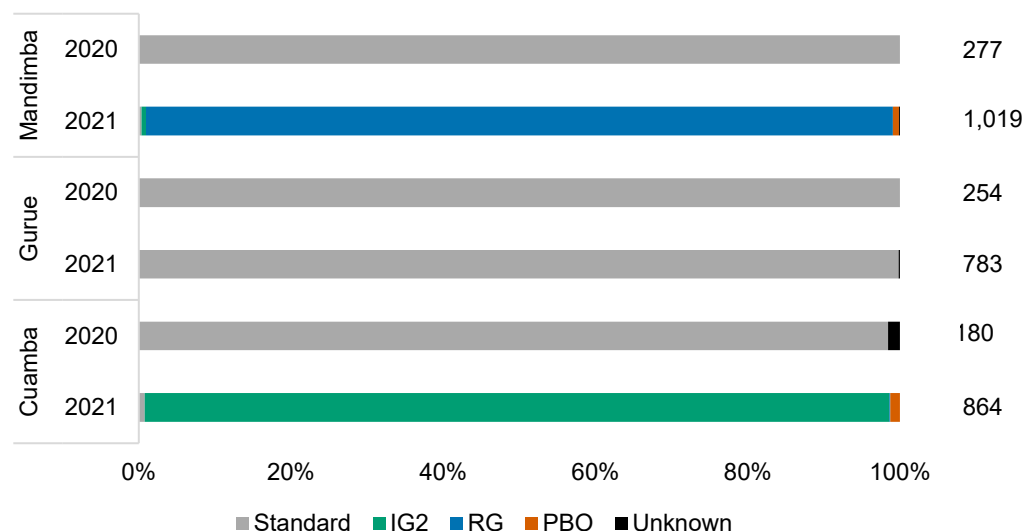
Abbreviations: IG2, Interceptor G2; ITN, insecticide-treated net; RG, Royal Guard.

The proportion of households that own one ITN for every two people significantly increased between the 2020 and 2021 surveys (Table MN3). Gurue had the highest proportion in both years (6.8% and 61.6%).

Table MN3. Proportion of households that own one ITN for every two people.

	2020	2021
Gurue (standard)	6.82%	61.58%
Cuamba (IG2)	6.57%	43.02%
Mandimba (RG)	3.04%	49.52%

Abbreviations: IG2, Interceptor G2; ITN, insecticide-treated net; RG, Royal Guard.

The success of the campaign is further illustrated in Figure MN4, which shows dramatic improvements in the average number of household members per ITN from before the campaign (2020) to after the campaign (2021).

Figure MN4. Average household size and average number of persons per ITN.
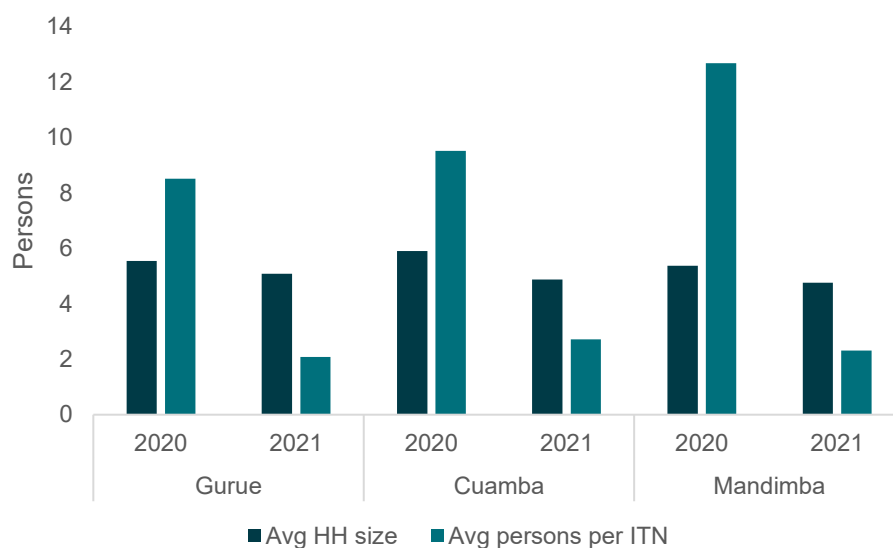
Abbreviations: HH, household; ITN, insecticide-treated net.

Retention of campaign nets received during the 2020 campaign was reported to be high, as greater than 96 percent of all ITNs households reported receiving in 2020 were still available during the 2021 survey (Table MN4).

Table MN4. Proportion of 2020 mass campaign ITNs reported to be lost for any reason.

	2021
Gurue (standard)	0.76%
Cuamba (IG2)	1.43%
Mandimba (RG)	3.78%

Abbreviations: IG2, Interceptor G2; RG, Royal Guard.

Bed net access and use

Bed net use, as measured by the proportion of household members reported to have slept under an ITN the night before the survey, also increased dramatically from 2020 to 2021 (Table MN5). As with general ITN ownership, gains observed in ITN use were uneven across the districts, with Gurue (standard) and Mandimba (RG) recording higher usage rates at 88.0 percent and 83.0 percent, respectively, than Cuamba (IG2) at 69.5 percent.

Table MN5. Proportion of total household members who slept under an ITN the previous night, by net type.

	2020	2021
Gurue (standard)	**n = 2,356**	**n =2,127**
Standard	23.56% (555)	88.01% (1,872)
Total	**23.56% (555)**	**88.01% (1,872)**
Cuamba (IG2)	**n = 2,426**	**n =2,131**
Standard	21.35% (518)	0.80% (17)
IG2	-	67.39% (1,436)
RG	-	0.09% (2)
PBO	-	1.17% (25)
Total	**21.35% (518)**	**69.45% (1,480)**
Mandimba (RG)	**n = 2,294**	**n = 2,001**
Standard	17.22% (395)	0.15% (3)
IG2	-	0.15% (3)
RG	-	82.46% (1,650)
PBO	-	0.40% (8)
Unknown	-	0.15% (3)
Total	**17.22% (395)**	**83.31% (1,667)**

Note: "n" signifies total number of household members in the district for that survey year. *Abbreviations*: IG2, Interceptor G2; ITN, insecticide-treated net; PBO, piperonyl butoxide; RG, Royal Guard.

ITN use given access was greater than 1.0 in all districts in 2021 (Table MN6), similar proportions of each ITN type were found hung in each district (Figure MN5), and the frequency of use of those nets was similar (Figure MN6), indicating that the main reason for lower usage rates in Cuamba was fewer nets per household acquired during the campaign (see also Appendix).

Table MN6. Population ITN access and bed net use given access.

	Gurue (standard)		Cuamba (IG2)		Mandimba (RG)	
	2020	**2021**	**2020**	**2021**	**2020**	**2021**
Population ITN access, % **(95% CI)**	23.1 (21.8–24.4)	85.7 (82.5–88.8)	21.0 (19.7–22.3)	64.8 (54.8–74.8)	16.4 (15.3–17.6)	75.5 (69.0–82.3)
Use given access*	0.99	1.02	0.92	1.05	1.03	1.08

*Use given access is calculated by dividing use (population that slept under a net the previous night) by access. Values over 1 are possible given that the calculation is a ratio. *Abbreviations:* CI, confidence interval; IG2, Interceptor G2; ITN, insecticide-treated net; RG, Royal Guard.

Figure MN5. Proportion of bed nets hung, stored, and not hung or stored.
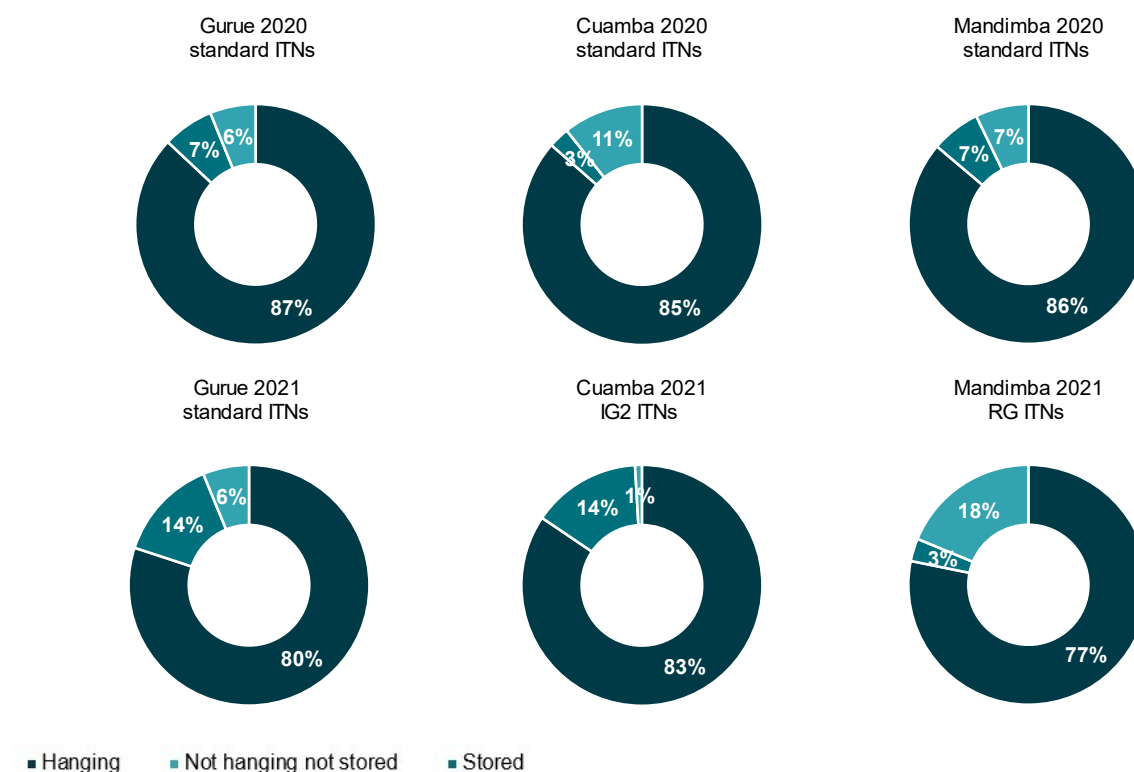
Gurue 2020 standard ITNs — 87%, 7%, 6%

Cuamba 2020 standard ITNs — 85%, 3%, 11%

Mandimba 2020 standard ITNs — 86%, 7%, 7%

Gurue 2021 standard ITNs — 80%, 14%, 6%

Cuamba 2021 IG2 ITNs — 83%, 14%, 1%

Mandimba 2021 RG ITNs — 77%, 3%, 18%

■ Hanging ■ Not hanging not stored ■ Stored

Abbreviations: IG2, Interceptor G2; ITN, insecticide-treated net; PBO, piperonyl butoxide.

Figure MN6. Proportion and frequency of bed nets used the previous week for 2021 survey, by district.
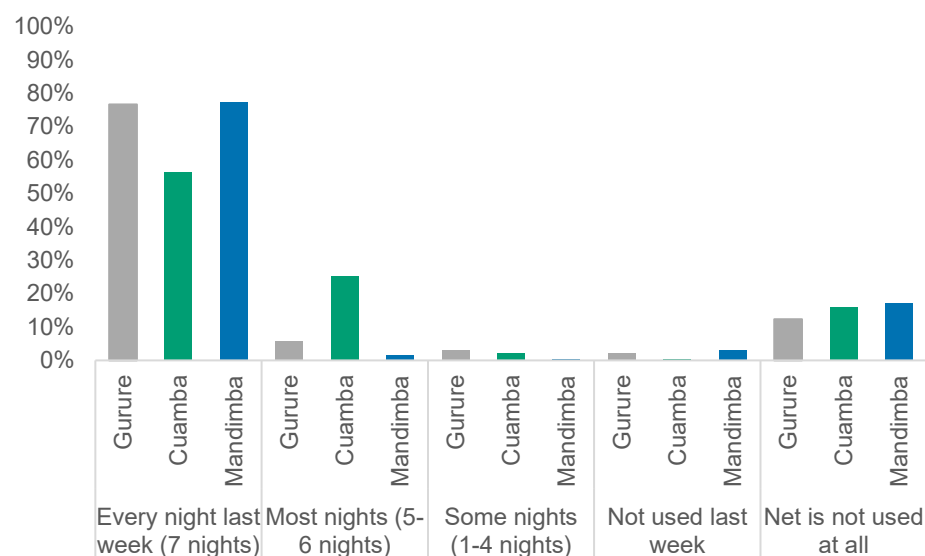
Finally, the dual-AI ITN types, both RG in Mandimba and IG2 in Cuamba, may be more likely to have been washed than the standard nets in Gurue during the first year of ownership (Table MN7).

Table MN7. Proportion of bed nets ever washed, by type.

		2020	**2021**
Gurue (standard)	Standard	89.89% (249/277)	50.99% (516/1,012)
Cuamba (IG2)	Standard	81.78% (202/247)	100.00% (6/6)
	IG2	-	72.98% (559/766)
Mandimba (RG)	Standard	88.83% (159/179)	33.33% (1/3)
	RG	-	74.88% (632/844)

Abbreviations: IG2, Interceptor G2; RG, Royal Guard.

Bed net characteristics

Figure MN7 shows that the vast majority of household ITNs encountered during the 2021 survey were received during the 2020 mass distribution campaign.

Figure MN7. Proportion of bed nets attained through each of four source types, by survey year and district.
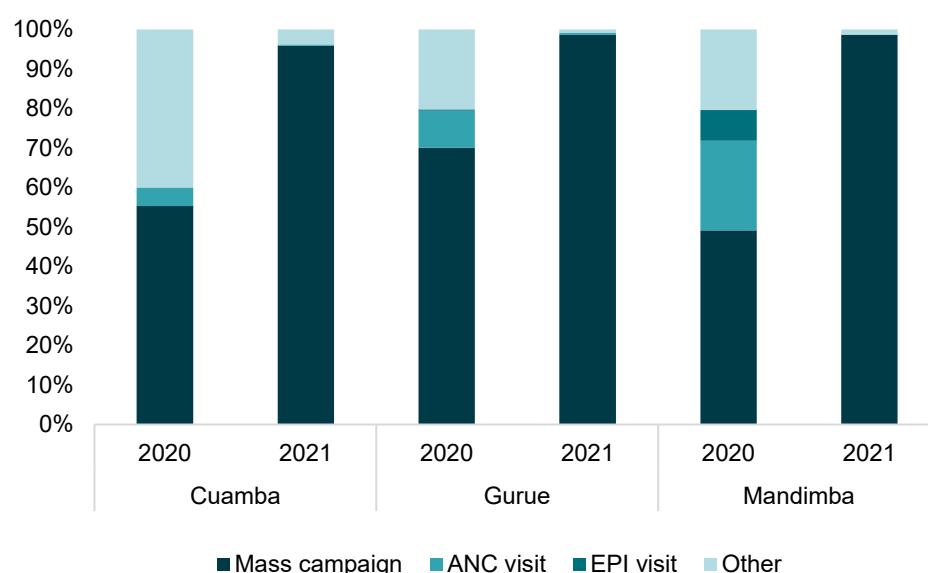
Abbreviations: ANC, antenatal care; EPI, Expanded Program on Immunization.

The proportion of campaign ITNs reported to have at least one hole during the 2021 survey was highest in Mandimba at 45.0 percent compared to Gurue at 3.5 percent and Cuamba at 2.8 percent (Table MN8). Values are only reported for 2021 since campaign ITNs had not been distributed at the time of the baseline cross-sectional survey in 2020.

Table MN8. Proportion of ITNs received during the 2020 mass campaign with reported holes, by type/district.

	2021
Gurue (standard)	3.49% (28)
Cuamba (IG2)	2.80% (26)
Mandimba (RG)	45.13% (380)

Abbreviations: IG2, Interceptor G2; ITN, insecticide-treated net; RG, Royal Guard.

Summary

In Northern Mozambique, coverage of ITNs across the three districts increased dramatically after the 2020 distribution campaign, and the average number of ITNs per house more than doubled to 1.8 in Cuamba (IG2), 2.4 in Gurue (standard), and 2.1 in Mandimba (RG). While each district reported some number of unknown and/or "spillover" ITNs of various types, the vast majority of ITNs encountered corresponded to the ITN type targeted for distribution in that district: in Gurue 99 percent of the nets were standard, in Cuamba 97 percent were IG2, and in Mandimba 98 percent were RG. These campaign results strengthen any associations between different district-level malaria transmission patterns and ITN types.

Use of ITNs varied across the districts, with over 82 percent of residents in Mandimba and Gurue reporting having slept under an RG or standard ITN, respectively, the previous night, while in Cuamba only 67 percent of residents reported sleeping under an IG2 the previous night. It will be important to

consider whether (and how) the lower ownership and use of nets in Cuamba may influence the interpretation of results in Northern Mozambique.

Population use given access to ITNs was greater than 1.0 in each district in 2021, and daily use of ITNs across the three districts was high: between 76 and 83 percent of respondents reported using ITNs daily (during the previous week). Furthermore, at one year post-distribution, the majority of ITNs were observed hanging up: 80 percent of standards in Gurue, 83 percent of IG2s in Cuamba, and 77 percent of RGs in Mandimba. Also in 2021, it was apparent that more than 95 percent of all ITNs encountered were sourced mostly from the mass campaign and that few additional nets were obtained through ANC or the private sector. At that time (approximately 10 months after distribution), very few standard (3.5 percent) or IG2 (2.8 percent) ITNs were reported to have any holes, but 45.0 percent of RG ITNs in Mandimba reported having at least one hole. Further analysis of data from the ongoing durability monitoring studies will provide more context for this observation and inform how to interpret the overall results.

Western Mozambique

Background

Study districts and ITN distribution

The Western Mozambique evaluation includes Chemba District (standard ITNs) in Sofala Province, Guro District (IG2 ITNs) in Manica Province, and Changara District (PBO ITNs) in Tete Province (Figure MW1). The high transmission season occurs from January through June. The Western Mozambique evaluation began in September 2020, and ITN distribution in pilot study districts was completed in November 2020 (Table MW1 and Figure MW2). Final reports on the mass distribution campaign results are expected from project partners in 2022.

2020 mass distribution campaign

Based on a high prevalence of malaria and suspected pyrethroid resistance, Manica Province was prioritized by the NMCP to receive IG2 ITNs. Standard ITNs were distributed in Sofala Province. Prior to the start of study activities, the opportunity to distribute PBO ITNs in a limited number of districts in Tete Province was identified, allowing for the inclusion of PBO nets in the NNP pilot evaluation—a priority for the NMCP.

The 2020 campaign was completed by November, one month after the baseline CSS. Further details describing the campaign and key outcome metrics will follow the completion of the final operations report.

Figure MW1. Map of the study districts in Western Mozambique.
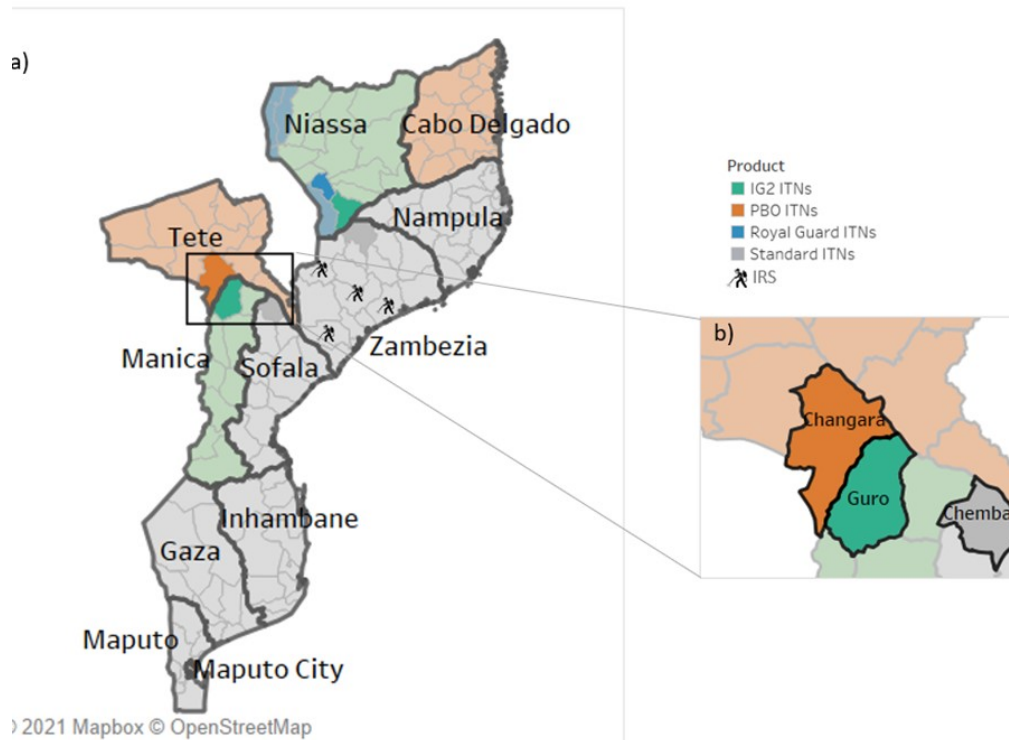
Note: (a) ITN distribution across Mozambique; (b) the three study districts. *Abbreviations*: IG2, Interceptor G2; IRS, indoor residual spraying; ITN, insecticide-treated net; PBO, piperonyl butoxide.

Table MW1. ITN campaign and survey dates.

	Distribution date	Baseline Survey (September 2020)	Year 1 Survey (September 2021)
Chemba (standard)	November 2020	2 months pre-distribution	10 months post-distribution
Guro (IG2)	November 2020	2 months pre-distribution	10 months post-distribution
Changara (PBO)	November 2020	2 months pre-distribution	10 months post-distribution

Abbreviations: IG2, Interceptor G2; ITN, insecticide-treated net; PBO, piperonyl butoxide.

Figure MW2. ITN distribution and transmission timeline.
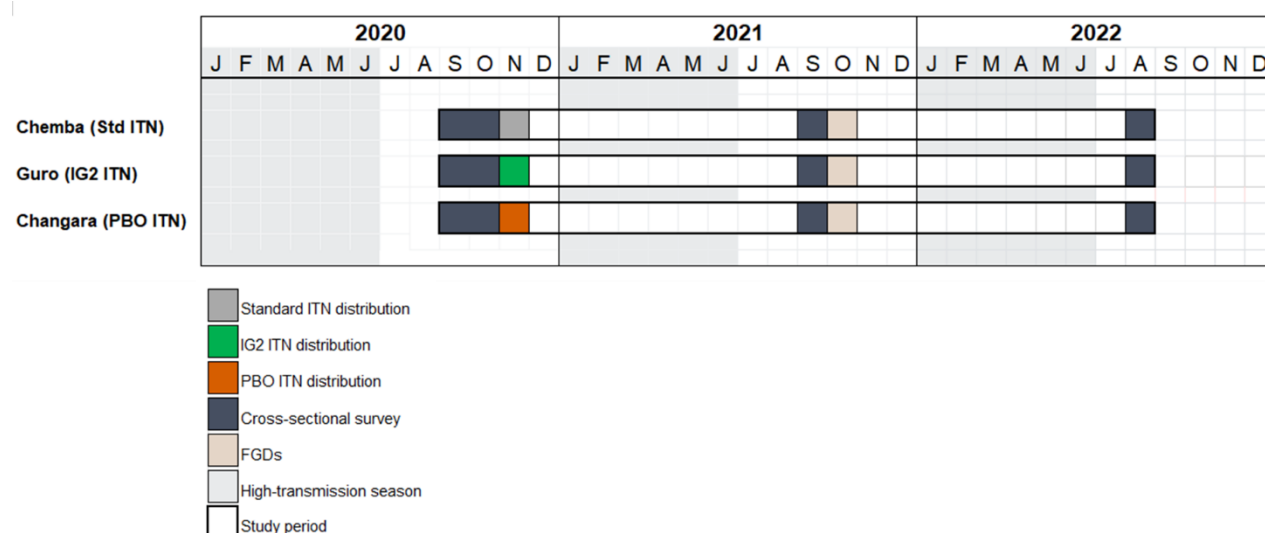
	2020	2021	2022
	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D
Chemba (Std ITN)			
Guro (IG2 ITN)			
Changara (PBO ITN)			

- Standard ITN distribution
- IG2 ITN distribution
- PBO ITN distribution
- Cross-sectional survey
- FGDs
- High-transmission season
- Study period

Abbreviations: FGD, focus group discussion; IG2, Interceptor G2; ITN, insecticide-treated net; PBO, piperonyl butoxide.

Bed net ownership

During the baseline survey in October 2020, prior to the distribution campaign, the number of ITNs encountered was relatively low—significantly less than 1.00 per household (Table MW2). Not surprisingly, the number of ITNs encountered after the campaign, during the 2021 survey, had increased substantially (more than threefold) in each district (Table MW2). While the increase in the number of ITNs per household was dramatic across all districts, results were somewhat variable, with Chemba District (standard) having the highest average number of ITNs per household at 3.08, followed by Guro District (IG2) at 2.51 and Changara District (PBO) at 2.32. Note that during the baseline CSSs in several communities, the net roster did not capture all ITNs within each household during ITN enumeration; therefore, for consistency Tables MW2 and MW5 consider the total number of nets reportedly owned by households rather than the number entered into the net roster during the household visit for the baseline figures.

Table MW2. Total number of ITNs found in surveyed households.

		2020	2021
Chemba (standard)	Total # ITNs	360	1,298
	Total # households	418	421
	Average # ITNs per household	0.86	3.08
Guro (IG2)	Total # ITNs	205	1,055
	Total # households	420	420
	Average # ITNs per household	0.49	2.51
Changara (PBO)	Total # ITNs	294	976
	Total # households	417	420
	Average # ITNs per household	0.71	2.32

Abbreviations: IG2, Interceptor G2; ITN, insecticide-treated net; PBO, piperonyl butoxide.

Figure MW3 presents the proportion of all ITNs encountered, by net type, and illustrates the success of the multiproduct campaign in distributing different ITN types to the different districts with high fidelity. Any ITN brand reported as "unknown" at baseline in 2020 was assumed to be standard since no other net type had been distributed in these districts. At Year 1 post-distribution, 98.8 percent of the ITNs in Chemba were standard, 97.2 percent of the ITNs in Guro were IG2, and 89.9 percent of the ITNs in Changara were PBO.

Figure MW3. Proportion of bed nets, by type.
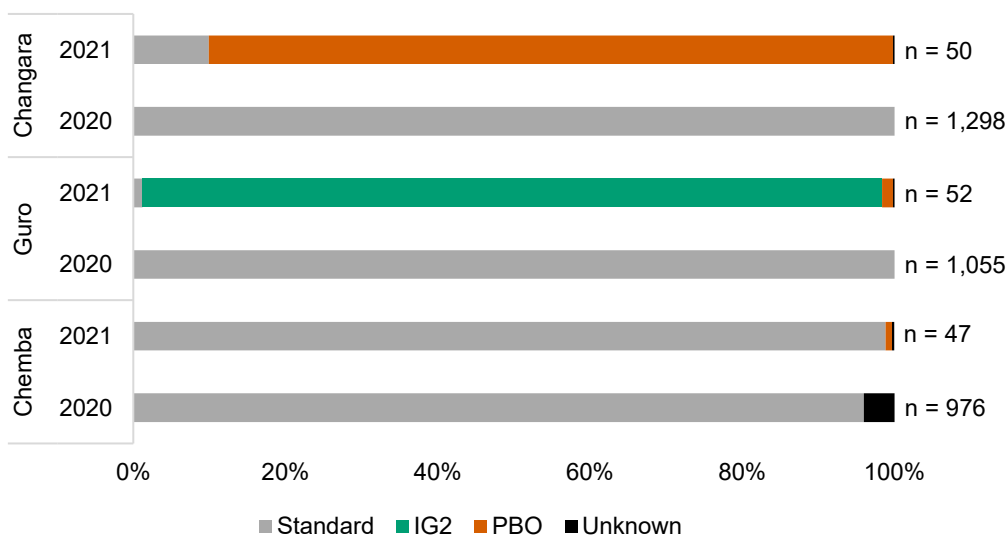
Abbreviations: IG2, Interceptor G2; PBO, piperonyl butoxide.

The number of households that own one ITN for every two people increased significantly from 2020 to 2021 following the net distribution campaign (Table MW3).

Table MW3. Proportion of households that own one ITN for every two people.

	2020	2021
Chemba (standard)	5.74%	61.76%
Guro (IG2)	4.05%	63.57%
Changara (PBO)	6.24%	59.76%

Abbreviations: IG2, Interceptor G2; ITN, insecticide-treated net; PBO, piperonyl butoxide.

The success of the campaign is further illustrated in Figure MW4, which shows dramatic improvements in the average number of household members per ITN before the campaign (2020) and after (2021).

Figure MW4. Average household size and average number of persons per ITN.
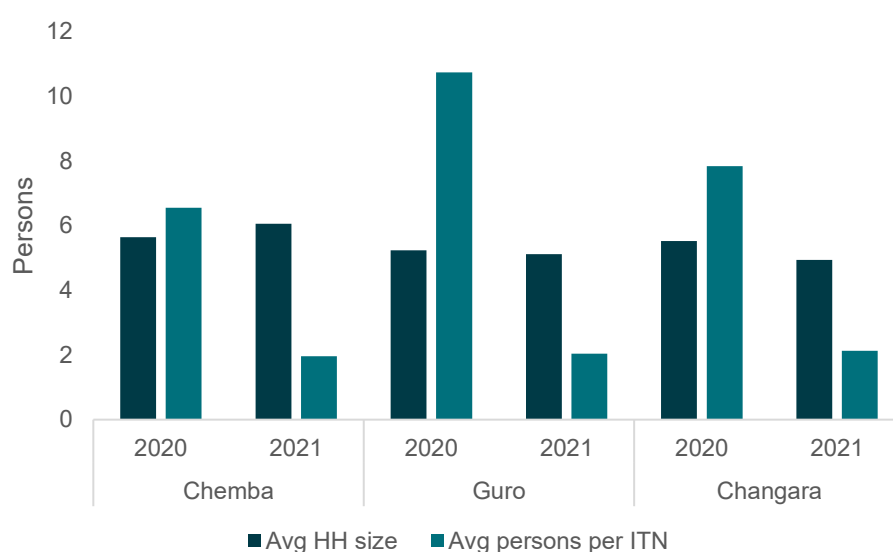
Abbreviations: HH, household; ITN, insecticide-treated net.

Household retention of 2020 campaign nets was reported to be high, as greater than 93 percent of all ITNs received during the campaign were encountered during the 2021 survey (Table MW4).

Table MW4. Proportion of 2020 mass campaign ITNs reported to be lost for any reason.

	2021
Chemba (standard)	1.64%
Guro (IG2)	0.48%
Changara (PBO)	6.39%

Abbreviations: IG2, Interceptor G2; PBO, piperonyl butoxide.

Bed net access and use

Bed net use, as measured by the proportion of household members reported to have slept under an ITN the night before the survey, also increased from 2020 to 2021 (Table MW5) and was similar in each

district: 91.8 percent in Chemba (standard), 95.2 percent in Guro (IG2), and 87.1 percent in Changara (PBO).

Table MW5. Proportion of total household members who slept under an ITN the previous night, by net type.

	2020	2021
Chemba (standard)	n = 2,358	n = 2549
Standard	4.41% (104)	90.51% (2,307)
PBO	-	1.02% (26)
Unknown	-	0.31% (8)
Total	4.41% (104)	91.84% (2,346)
Guro (IG2)	n = 2,200	n = 2,150
Standard	4.45% (98)	1.72% (37)
IG2	-	91.86% (1,975)
PBO	-	1.30% (28)
Unknown	-	0.28% (6)
Total	4.45% (98)	95.16% (2,046)
Changara (PBO)	n = 2,304	n = 2,373
Standard	4.90% (113)	7.77% (161)
PBO	-	79.35% (1,645)
Total	4.90% (113)	87.12% (1,806)

Note: "n" signifies total number of household members in the district for that survey year. *Abbreviations*: IG2, Interceptor G2; ITN, insecticide-treated net; PBO, piperonyl butoxide.

Additionally, ITN use given access was greater than 1.0 in 2021 in all districts (Table MW6), similar proportions of each ITN type were found hung in each district (Figure MW5), and the frequency of use of those nets was similar (Figure MW6) (see also the Appendix).

Table MW6. Population ITN access and bed net use given access.

	Chemba (standard)		Guro (IG2)		Changara (PBO)	
	2020	**2021**	**2020**	**2021**	**2020**	**2021**
Population ITN access, % (95% CI)	33.3 (32.1–34.7)	90.1 (87.1-92.4)	18.5 (17.2–19.8)	92.8 (90.4–94.7)	23.0 (21.8–24.2)	84.6 (80.5–88.0)
Use given access*	1.10	1.05	0.98	1.04	0.88	1.00

*Use given access is calculated by dividing use (population that slept under a net the previous night) by access. Values over 1 are possible given that the calculation is a ratio. *Abbreviations*: CI, confidence interval; IG2, Interceptor G2; ITN, insecticide-treated net; PBO, piperonyl butoxide.

Figure MW5. Proportion of bed nets hung, stored, and not hung or stored.
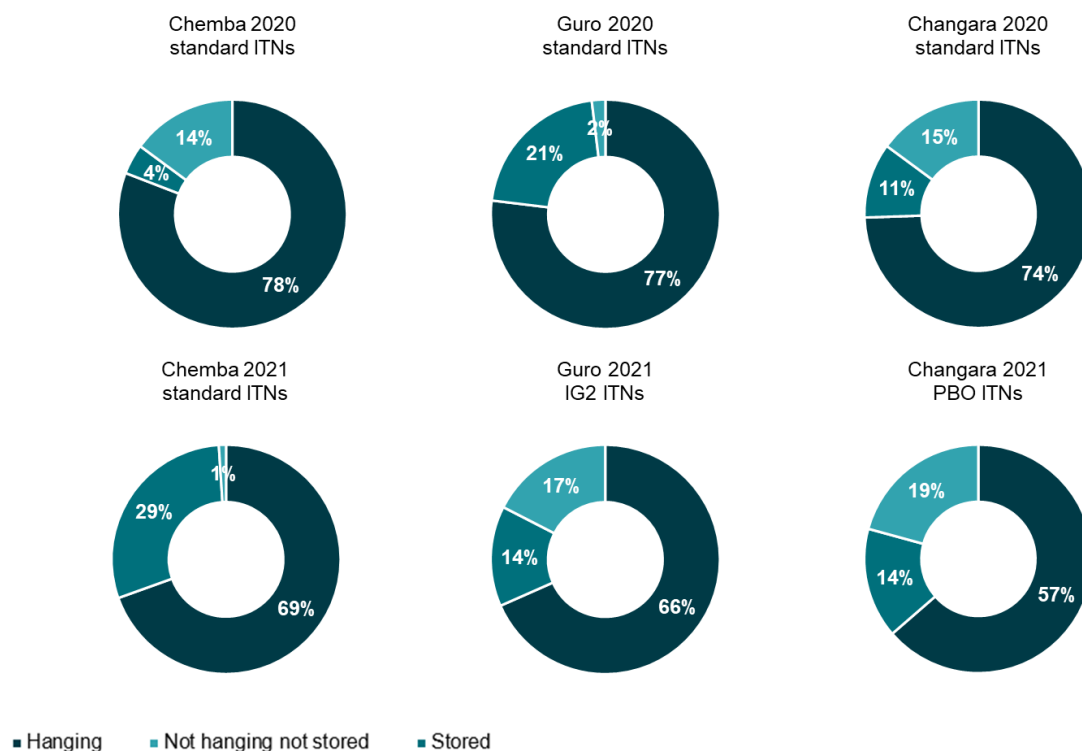
Abbreviations: IG2, Interceptor G2; ITN, insecticide-treated net; PBO, piperonyl butoxide.

Figure MW6. Proportion and frequency of bed nets used the previous week for 2021 survey, by district.
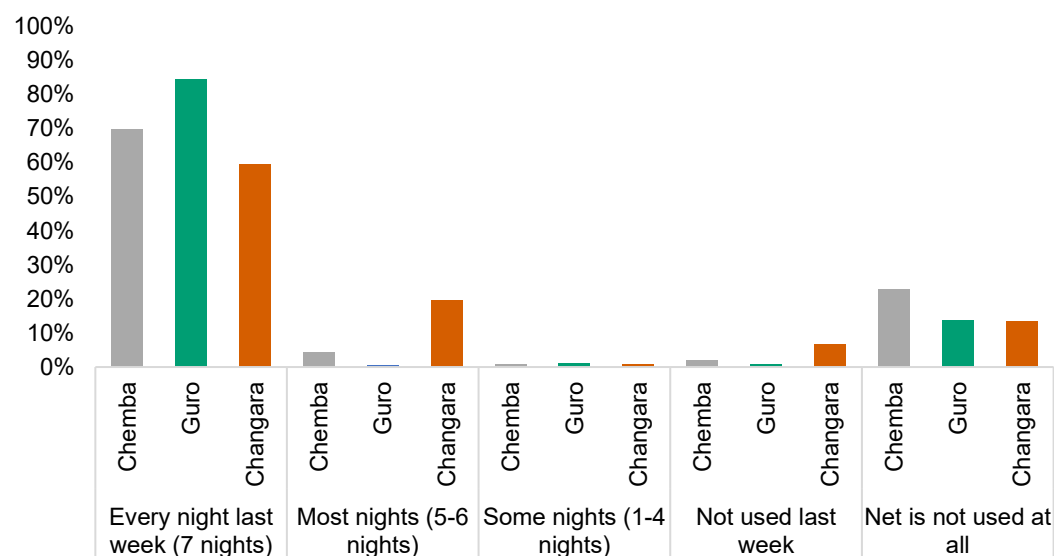
Finally, during the first year of ownership the majority of nets were washed, with PBO ITNs in Changara perhaps the most likely to have been washed overall than either standard ITNs in Chemba or IG2 ITNs in Guro (Table MW7).

Table MW7. Proportion of bed nets ever washed, by type.

		2020	2021
Chemba (standard)	Standard	91.67% (44/48)	66.09% (840/1,271)
Guro (IG2)	Standard	76.92% (40/52)	30.77% (4/13)
	IG2	-	59.02% (605/1,025)
Changara (PBO)	Standard	93.62% (44/47)	71.13% (69/97)
	PBO	-	71.03% (618/870)

Abbreviations: IG2, Interceptor G2; PBO, piperonyl butoxide.

Bed net characteristics

Figure MW7 shows that the vast majority of household ITNs encountered during the 2021 survey had been received during the 2020 campaign, though in 2021 the percentage of nets received from routine antenatal checkups was around 13 percent in Chemba.

Figure MW7. Proportion of bed nets attained through each of the four source types, by survey year and district.
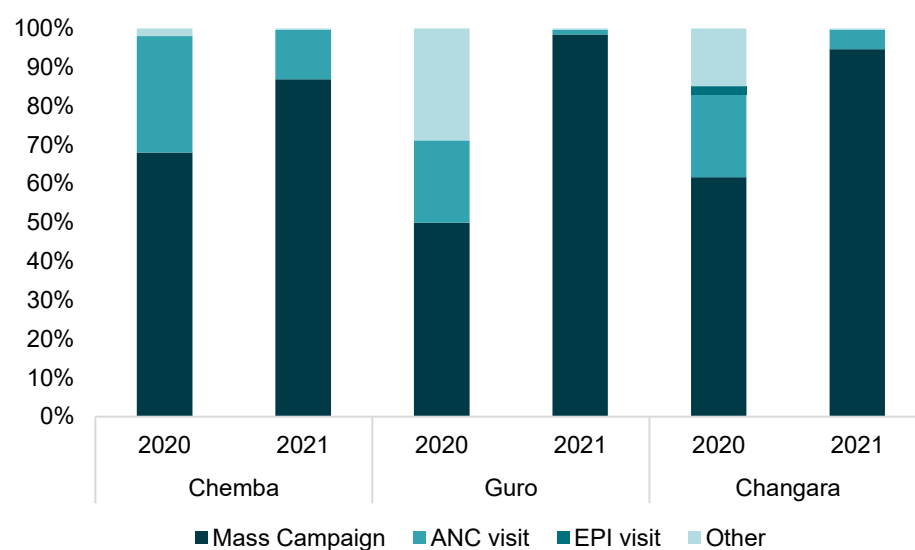
Abbreviations: ANC, antenatal care; EPI, Expanded Program on Immunization.

As shown in Table MW8, the proportion of 2020 campaign ITNs reported to have at least one hole was higher in Changara (21.3 percent) than in Chemba (6.1 percent) or Guro (4.2 percent). Values are only reported for 2021 since campaign ITNs had not been distributed at the time of the baseline cross-sectional survey in 2020.

Table MW8. Proportion of ITNs received during the 2020 mass campaign with reported holes, by type/district.

	2021
Chemba (standard)	6.13% (68)
Guro (IG2)	4.20% (43)
Changara (PBO)	21.29% (175)

Abbreviations: IG2, Interceptor G2; ITN, insecticide-treated net; PBO, piperonyl butoxide.

Summary

In Western Mozambique, coverage of ITNs across the three districts increased, as expected, after the 2020 distribution campaign, and the average number of ITNs per house more than tripled to 3.0 in Chemba (standard), 2.5 in Guro (IG2), and 2.3 in Changara (PBO). While each district reported some number of unknown and/or "spillover" ITNs of various types, the vast majority of ITNs encountered corresponded to the ITN type targeted for distribution in that district: in Chemba 99 percent of the nets were standard, in Guro 97 percent were IG2, and in Changara 90 percent were PBO. These campaign results strengthen any associations between different district-level malaria transmission patterns and ITN types.

Use of ITNs varied somewhat across the districts, with over 90 percent of residents in Chemba and Guro reporting having slept under a standard or IG2 ITN, respectively, the previous night, while in Changara around 80 percent of residents reported sleeping under a PBO ITN the previous night. It will be important

to consider whether (and how) the slightly lower use of nets in Changara may influence the interpretation of results in Western Mozambique.

Population use given access to ITNs was greater than 1.0 in each district in 2021, and daily use of ITNs across the three districts was high: between 60 and 84 percent of respondents reported using an ITN daily during the previous week. Also in 2021, it was apparent that more than 95 percent of all ITNs encountered were sourced mostly from the mass campaign. About two-thirds of all campaign ITNs were observed hanging up: 69 percent of standard in Chemba, 66 percent of IG2 in Guro, and 57 percent of PBO in Changara. At that time (approximately 11 months after distribution), very few standard (6.1 percent) or IG2 (4.2 percent) ITNs were reported to have any holes, but 21.0 percent of PBO ITNs in Changara reported having at least one hole. Further analysis of data from the ongoing durability monitoring studies will provide more context for this observation and will guide whether (and how) a suboptimal useful lifespan of ITNs in Changara also might influence interpretation of results.

Nigeria

Background

Pilot LGAs

The evaluation in Nigeria, which began October 2020, is taking place in two LGAs in Kwara State, Asa (IG2 ITNs) and Moro (RG ITNs), and two LGAs in Osun State, Ejigbo (standard ITNs) and Ife North (PBO ITNs). While Kwara and Osun experience year-round transmission, the highest transmission season occurs from July to November. The four study LGAs were chosen for their similarity in malaria prevalence, incidence, vector species composition, insecticide-resistance status, and general climate and geographic similarities—as well as consistencies in other planned malaria control interventions. Figure N1 provides a map of the study LGAs.

Figure N1. Map of the study LGAs in Nigeria.
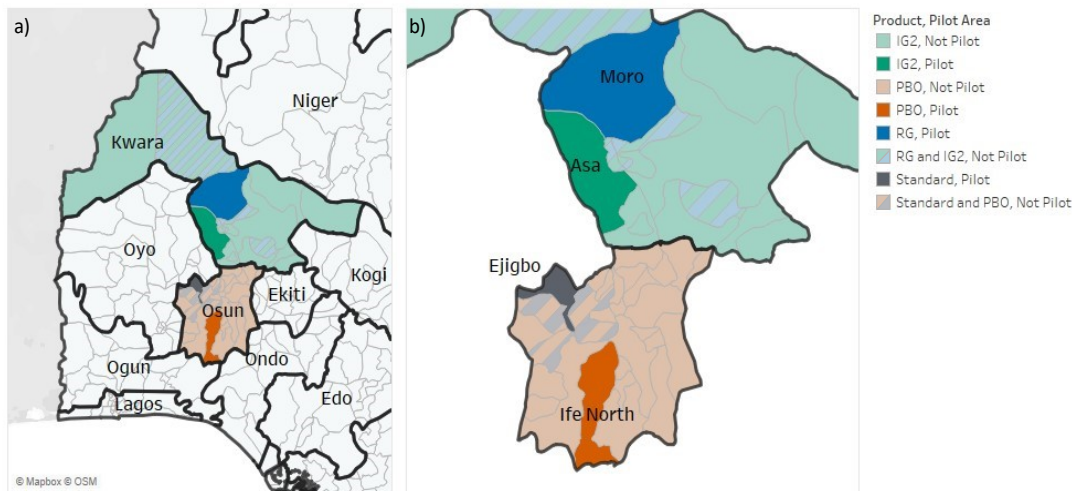
Note: (a) states included in the study; (b) ITN distribution in Kwara and Osun States, with pilot LGAs highlighted. *Abbreviations*: IG2, Interceptor G2; LGA, local government area; PBO, piperonyl butoxide; RG, Royal Guard.

ITN distribution and data collection

The ITN distribution occurred in November 2020 (Table N1 and Figure N2). The baseline CSS was in October 2020 immediately preceding the ITN distribution. Due to the introduction of seasonal malaria chemoprevention for children under 5 years old in Asa and Moro, future CSSs were moved to November to account for its impact.

Table N1. ITN campaign and survey dates.

	Distribution date	Baseline survey (October 2020)
Ejigbo (standard)	November 2020	1 month pre-distribution
Asa (IG2)	November 2020	1 month pre-distribution
Moro (RG)	November 2020	1 month pre-distribution
Ife North (PBO)	November 2020	1 month pre-distribution

Abbreviations: IG2, Interceptor G2; ITN, insecticide-treated net; PBO, piperonyl butoxide; RG, Royal Guard.

Figure N2. ITN distribution and transmission timeline.
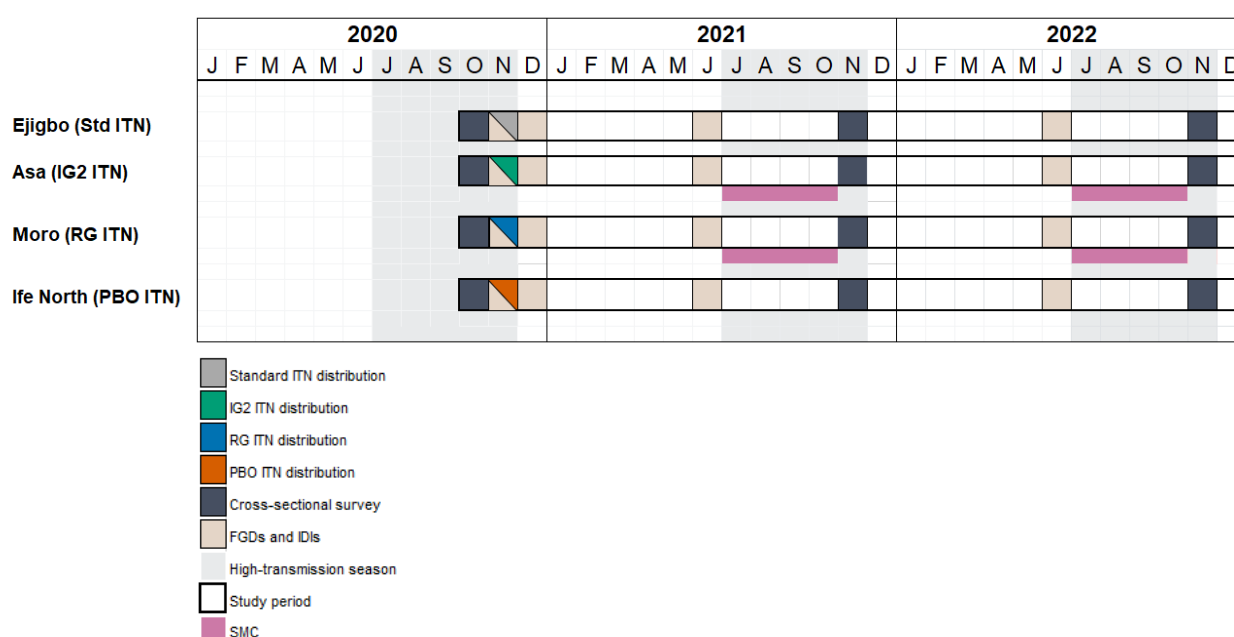
Abbreviations: FGD, focus group discussion; IDI, in-depth interview; IG2, Interceptor G2; ITN, insecticide-treated net; PBO, piperonyl butoxide; RG, Royal Guard, SMC, seasonal malaria chemoprevention.

2020 mass distribution campaign

A total of 2,297,831 ITNs were distributed in Kwara, and 3,087,090 ITNs were distributed in Osun. Additionally, 114,818 standard ITNs (Duranet) were delivered in Ejigbo; 146,463 PBO ITNs (Veeralin) were distributed in Ife North; 138,403 IG2 ITNs were distributed in Asa; and 99,906 RG ITNs were distributed in Moro.

Bed net ownership

Table N2 presents the number of household nets found in each LGA during the baseline CSS, with each LGA surveying a total of 420 households. At baseline, Ejigbo and Ife North had the highest number of nets reported, and Asa had the lowest number with only 33 nets.

Table N2. Total number of ITNs found in surveyed households.

		2020
Ejigbo (standard)	Total # ITNs	198
	Total # households	425
	Average # ITNs per household	0.47
Asa (IG2)	Total # ITNs	33
	Total # households	427
	Average # ITNs per household	0.08
Moro (RG)	Total # ITNs	148
	Total # households	421
	Average # ITNs per household	0.35
Ife North (PBO)	Total # ITNs	241
	Total # households	422
	Average # ITNs per household	0.57

Abbreviations: IG2, Interceptor G2; ITN, insecticide-treated net; PBO, piperonyl butoxide; RG, Royal Guard.

Standard ITNs were the majority of nets reported at baseline across all LGAs. Some PBO and RG ITNs were also recorded. While it is believed that the survey was entirely completed before the ITN distribution occurred, verification is needed, especially in Ife North, where the number of pre-distribution PBO ITNs was particularly high (11 percent of all ITNs). A significant number of recorded nets were not able to be identified by type (Figure N3).

Figure N3. Proportion of bed nets, by type.
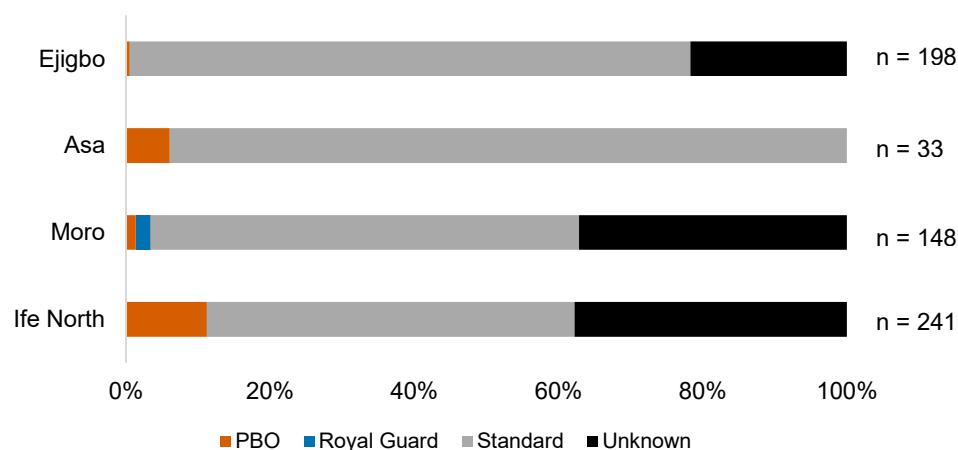
Abbreviation: PBO, piperonyl butoxide.

The proportion of households that own one ITN for every two people is low in all districts at 7.4% in Moro, 8.4% in Ejigbo, and 10.0% in Ife North (Table N3.). The proportion was lowest in Asa with less than 1% of households owning one ITN for every two people.

Table N3. Proportion of households that own one ITN for every two people.

	2020
Ejigbo (standard)	8.43%
Asa (IG2)	0.94%
Moro (RG)	7.35%
Ife North (PBO)	9.98%

Abbreviations: IG2, Interceptor G2; ITN, insecticide-treated net; PBO, piperonyl butoxide; RG, Royal Guard.

The average number of household members was similar across LGAs. Given the very low number of nets in Asa at baseline (33), there was only about 1 ITN for every 50 people across the LGA, while the figure was closer to 1 net per every 10 people in the other LGAs (Figure N4).

Figure N4. Average household size and average number of persons per ITN.
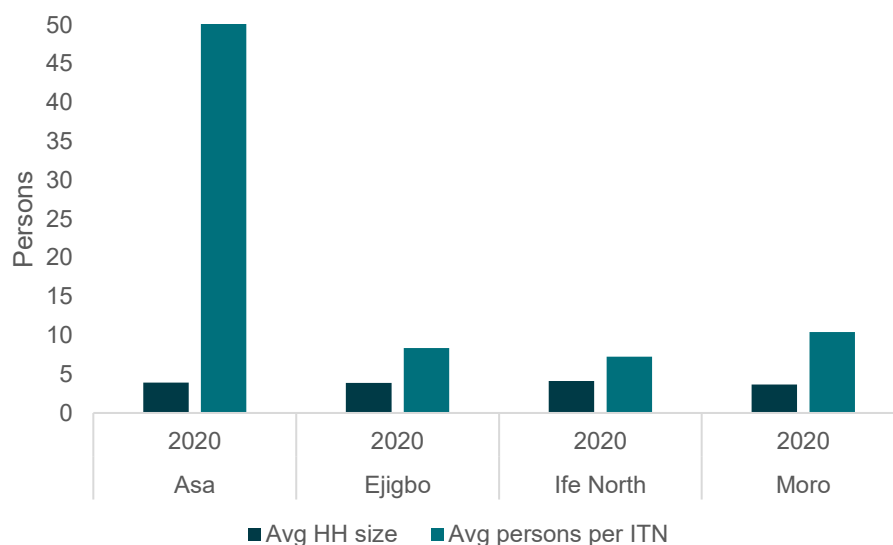
Abbreviations: HH, household; ITN, insecticide-treated net.

The proportion of 2020 mass campaign ITNs reported lost for any reason was not included in this report since the ITNs had not been distributed at the time of the baseline survey.

Bed net access and use

Population use of an ITN the night before the survey ranged from 3 percent in Asa to 24 percent in Ife North (Table N4). Participants of IDIs and FGDs reported seasonal variation in ITN use, with increased use of ITNs during wetter months compared to the dry season due to increased presence of mosquitos. Heat was also a strong driver for non-ITN use. Many participants reported not using ITNs during the dry season because it was too hot to use nets.

> *"During rainy seasons, there are plant, bushes, and stagnant [water], which breed mosquito[s] there. This will lead to increase in usage of bed net[s]."*
>
> —*FGD participant, Asa*

"When there is heat, we fold the net since we don't feel comfortable under the net due to the shortage in supply of the national grid during the period. As a result, mosquitoes come in."

—*Interviewee, Ejigbo*

Table N4. Proportion of total household members who slept under an ITN the previous night, by net type.

	2020
Ejigbo (standard)	**n = 1,654**
Standard	16.32% (270)
Unknown	3.45% (57)
Total	**19.77% (327)**
Asa (IG2)	**n = 1,671**
Standard	2.93% (49)
PBO	0.06% (1)
Total	**2.99% (50)**
Moro (RG)	**n = 1,544**
Standard	9.97% (154)
PBO	0.39% (6)
Royal Guard	0.39% (6)
Unknown	7.32% (113)
Total	**18.07% (279)**
Ife North (PBO)	**n = 1,743**
Standard	11.93% (208)
PBO	2.64% (46)
Unknown	9.70% (169)
Total	**24.27% (423)**

Note: "n" signifies total number of household members in the district for the 2020 survey. *Abbreviations*: IG2, Interceptor G2; ITN, insecticide-treated net; PBO, piperonyl butoxide; RG, Royal Guard.

Net use given access (Table N5) ranged from 0.68 in Asa to 1.05 in Moro. The high ratios in Moro and Ife North indicate a high level of bed net use when ITNs are available.

Table N5. Population ITN access and bed net use given access.

	Ejigbo (standard)	Asa (IG2)	Moro (RG)	Ife North (PBO)
Population ITN access, % (95% CI)	26.9 (25.2–28.5)	4.4 (3.6–5.2)	17.1 (15.6–18.5)	24.4 (22.8–26.0)
Use given access*	0.73	0.68	1.05	0.99

*Use given access is calculated by dividing use (population that slept under a net the previous night) by access. Values over 1 are possible given the calculation is a ratio. *Abbreviations:* CI, confidence interval; IG2, Interceptor G2; ITN, insecticide-treated net; PBO, piperonyl butoxide; RG, Royal Guard.

Figure N5 shows the percentage of bed nets found hanging, stored, and not hanging or stored in each LGA for the standard ITNs (as the most common net type at baseline). At the time of the baseline survey, a high proportion of the standard nets in each LGA were found hung. Ejigbo had the highest proportion of

standard ITNs that were stored, while Asa had the highest proportion of standard nets that were neither hung nor stored.

Figure N5. Proportion of bed nets hung, stored, and not hung or stored.
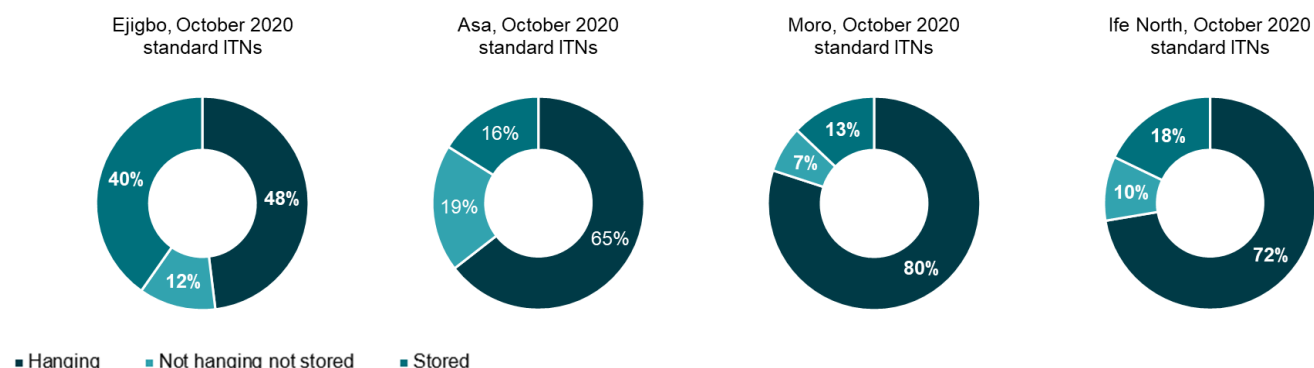
Abbreviation: ITN, insecticide-treated net.

Ife North reported the highest percentage of bed nets used every night in the previous week, while Asa had the lowest (Figure N6). The distribution of usage seems to indicate that a net is used consistently (every night or most nights) or not used at all rather than used sporadically.

Figure N6. Proportion and frequency of bed nets used the previous week for 2020 survey, by district.
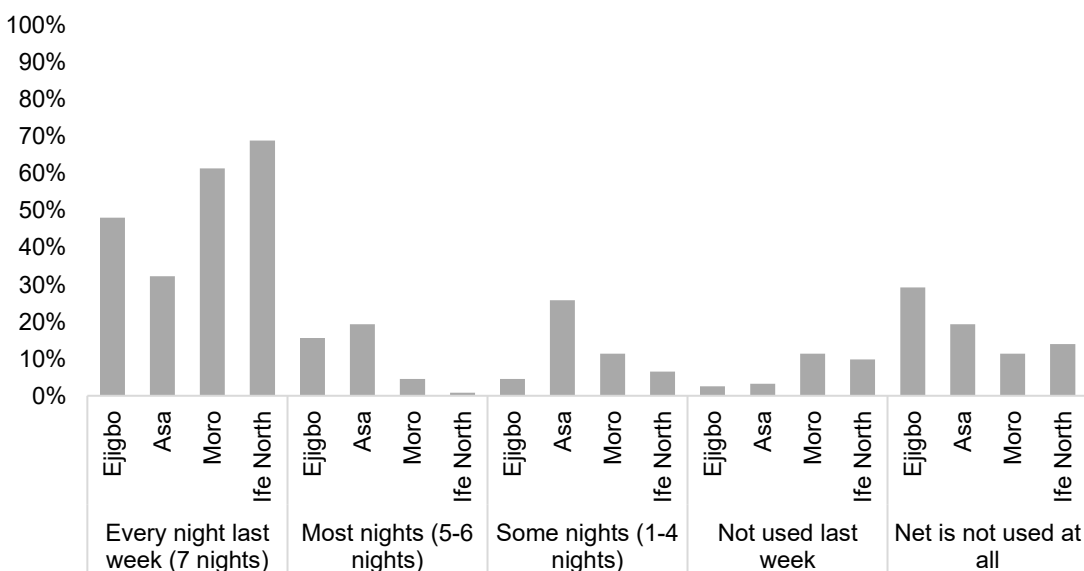
The percentage of standard ITNs reported to have been washed ranged from 56 percent to 71 percent across LGAs (Table N6). Among FGD and IDI participants, washing ITNs was common practice, but opinions varied on whether tears could be mended. While some described replacing or not using nets that

were torn, others repaired small tears or only repaired tears if they did not have a replacement net available.

> *"When it gets dirty, I wash it; but when it tears, I stop using the bed net."*
>
> *—Interviewee, Asa*

Table N6. Proportion of bed nets ever washed, by type.

		2020
Ejigbo (standard)	Standard	60.78% (93/153)
Asa (IG2)	Standard	70.97% (22/31)
Moro (RG)	Standard	56.82% (50/88)
Ife North (PBO)	Standard	60.16% (74/123)

Abbreviations: IG2, Interceptor G2; PBO, piperonyl butoxide; RG, Royal Guard.

Bed net characteristics

EPI and ANC visits were a significant source of the observed ITNs, given it had been three years since the previous campaign (Figure N7).

Figure N7. Proportion of bed nets attained through each of four source types, by district.
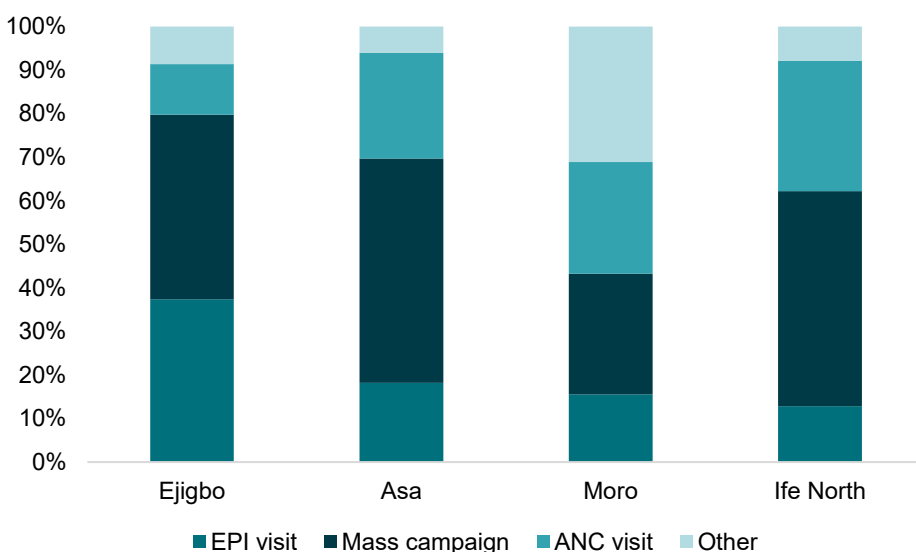
Abbreviations: ANC, antenatal care; EPI, Expanded Program on Immunization.

The proportion of ITNs received during the 2020 mass campaign with reported holes was not included in this report since the ITNs had not been distributed at the time of the baseline survey.

Summary

During the baseline CSS, households in each LGA were observed to have fewer than 1 ITN per household, on average. Ife North and Ejigbo had the highest number of nets, while Asa had the lowest number of nets (only 33 across 420 households). Most nets were standard nets.

Population use (i.e., the proportion of household residents sleeping under an ITN the night before the survey) ranged from 3 percent in Asa to 24 percent in Ife North. "Population use" is dependent upon the number of ITNs available, while "use given access" provides an estimate of the tendency of household members to use available ITNs. Use given access across all LGAs suggests that use of available nets is high, with the highest use given access in Moro (1.05) and Ife North (0.99) and lower ratios reported in Asa (0.68) and Ejigbo (0.73). This lower use tendency in Asa is also reflected in the frequency of reported use of nets: about half (or more) of all bed nets in Ejigbo, Moro, and Ife North reportedly were used every night in the previous week, while that was true for only about 30 percent of available nets in Asa. As it had been about three years since the last mass distribution in these LGAs, only a small proportion of nets were stored—most were either hanging or neither hung nor stored. Ejigbo had the highest percentage of ITNs not used at all (29 percent), while Asa had the highest proportion of ITNs (43 percent) that were used occasionally in the previous week (1 to 6 nights). Residents in each LGA reported that 55 percent or more of standard nets had been washed at some point.

The average ITN age was greater than 2.5 years in each LGA, with the highest average age found in Asa (44 months). This is consistent with the past campaign having occurred in 2017. While mass campaigns were a significant source of the bed nets, EPI and ANC visits were also common sources.

Rwanda

Background

Pilot districts

The Rwanda evaluation is taking place in three districts (Figure R1): Nyamagabe (standard), Ruhango (standard + indoor residual spraying [IRS]), and Karongi (IG2). Rwanda's central health implementation agency, the Rwanda Biomedical Center, with support from international partners, chose where to distribute various net types. In the higher-burden districts in the south and east, standard pyrethroid nets were distributed, along with use of IRS. In and around the capital city of Kigali, PBO ITNs were distributed, and the remaining districts were allocated either IG2 ITNs or standard ITNs. The pilot evaluation districts were selected based on their geographic proximity. Given that PBO ITNs were distributed in a noncomparable geographic area of the country, it was decided not to incorporate PBO ITN districts in this analysis.

Figure R1. Map of the study districts in Rwanda.
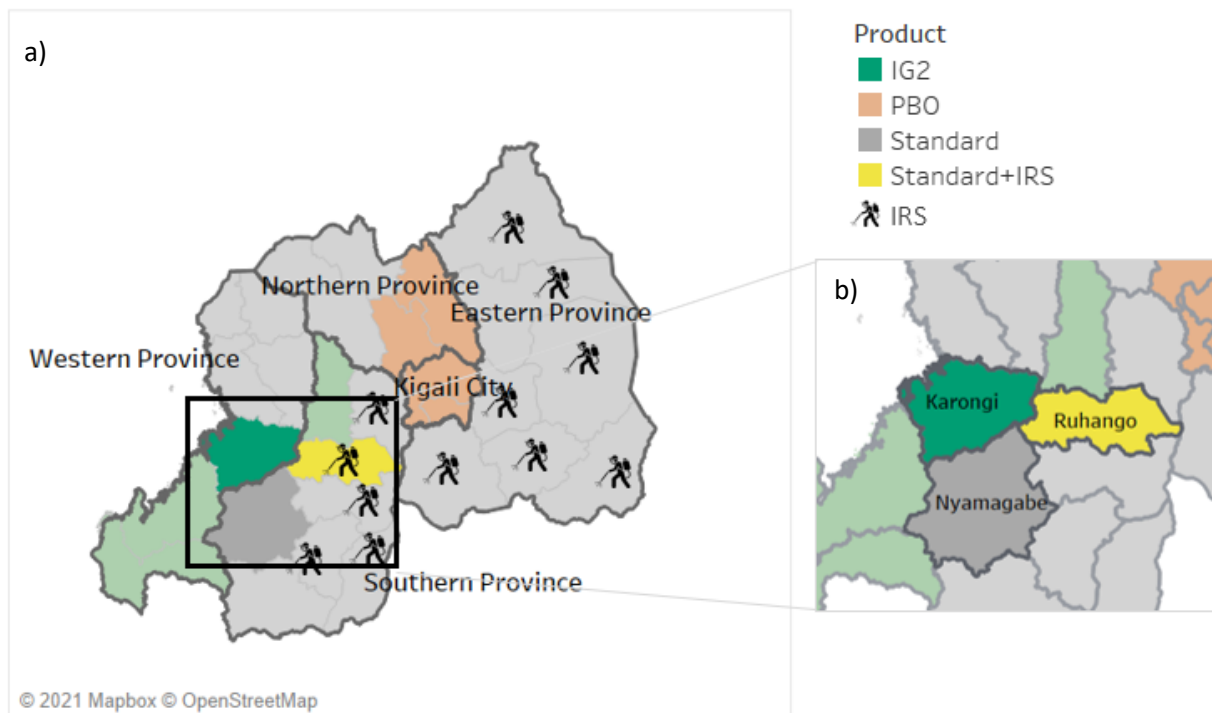
Note: (a) ITN distribution across five regions of Rwanda; (b) the three study districts. *Abbreviations*: IG2, Interceptor G2; IRS, indoor residual spraying; PBO, piperonyl butoxide.

ITN distribution and data collection

ITN distribution varied by district: standard ITNs were distributed first, in Nyamagabe and Ruhango, in February 2020, and then IG2 ITNs were distributed in Karongi in June 2020. IRS with Fludora® Fusion (Fludora is a registered trademark of Bayer Aktiengesellschaft) was implemented in Ruhango in October

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2019 and November 2020, followed by IRS with Actellic® 300 CS (Actellic is a registered trademark of Syngenta Limited) in October 2021, which is planned again for October 2022 (Figure R2).

The baseline survey was conducted in February 2020, and the Year 1 survey took place in December 2020. Table R1 shows the ITN distribution dates, the timing of each survey, and the months since distribution for each survey and district. Each ITN distribution campaign, the timing of the CSSs, Rwanda's two malaria transmission seasons, and Ruhango's IRS campaigns are shown in Figure R2.

Table R1. ITN campaign and survey dates.

	Distribution date	Baseline Survey (February 2020)	Year 1 Survey (December 2020)
Nyamagabe (standard)	February 2020	Distribution month	10 months post-distribution
Karongi (IG2)	June 2020	4 months pre-distribution	6 months post distribution
Ruhango (standard + IRS)	February 2020	Distribution month	10 months post distribution

Abbreviations: IG2, Interceptor G2; IRS, indoor residual spraying; ITN, insecticide-treated net.

Figure R2. ITN distribution and transmission timeline.
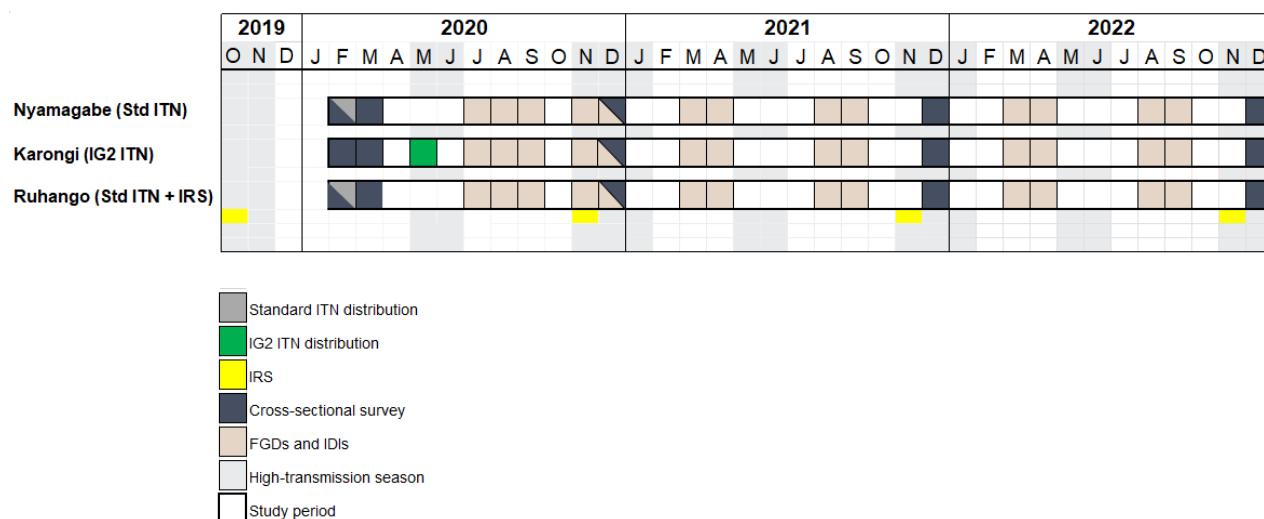
Abbreviations: FGD, focus group discussion; IDI, in-depth interview; IG2, Interceptor G2; IRS, indoor residual spraying; ITN, insecticide-treated net.

2020 mass distribution campaign

A total of 7,527,453 ITNs were procured for the 2020 mass distribution campaign, including 1.2 million IG2 ITNs. Prior to distribution, a needs assessment was conducted where each household reported the number of household members, number of sleeping spaces, and number of ITNs needed for full coverage. The assessment assumed that each ITN protects 2 people.

A total of 5,386,596 ITNs were distributed during the 2020 mass distribution campaign in Rwanda. In Karongi, 169,581 IG2 ITNs were distributed; in Nyamagabe 208,059 standard ITNs were distributed; and in Ruhango 189,544 standard ITNs were distributed. According to the Rwanda Biomedical Center's post-distribution report, 95.5 percent of assessed households received ITNs in Karongi, 103.8 percent in Nyamagabe, and 104.4 percent in Ruhango.

Bed net ownership

Although Nyamagabe and Ruhango had just received mass campaign nets prior to the February 2020 survey and Karongi had not yet received mass campaign nets, Karongi still had a comparable number of ITNs during the February 2020 survey. This indicates that older nets from previous campaigns were still available in Karongi households. During the December 2020 survey, completed 10 months after the February 2020 survey, there was a noticeable decline in the number of available ITNs across all districts, even in Karongi where mass campaign ITNs had been distributed 6 months earlier in June 2020 (Table R2).

Table R2. Total number of ITNs found in surveyed households.

		February 2020	December 2020
Nyamagabe* (standard)	Total # nets	366	337
	Total # households	150	150
	Average # nets per household	2.44	2.25
Karongi (IG2)	Total # nets	396	354
	Total # households	150	150
	Average # nets per household	2.64	2.36
Ruhango* (standard + IRS)	Total # nets	430	352
	Total # households	150	150
	Average # nets per household	2.87	2.35

*Nyamagabe and Ruhango received standard campaign nets shortly before the cross-sectional survey in February 2020. *Abbreviations:* IG2, Interceptor G2; IRS, indoor residual spraying; ITN, insecticide-treated net.

A portion of sampled nets were not identifiable by type and were therefore categorized as "unknown." Standard ITNs made up the majority of net types across all districts in February 2020, though there were some PBO ITNs found in each district. In the IG2 district of Karongi, during the December 2020 survey over 70 percent of the ITNs found were IG2s, and 20 percent were standard, reflecting a switch to the IG2 ITNs distributed during the 2020 mass campaign. Only five IG2 ITNs were found in non-IG2 districts in the December 2020 survey (Figure R3).

Figure R3. Proportion of bed nets, by type.
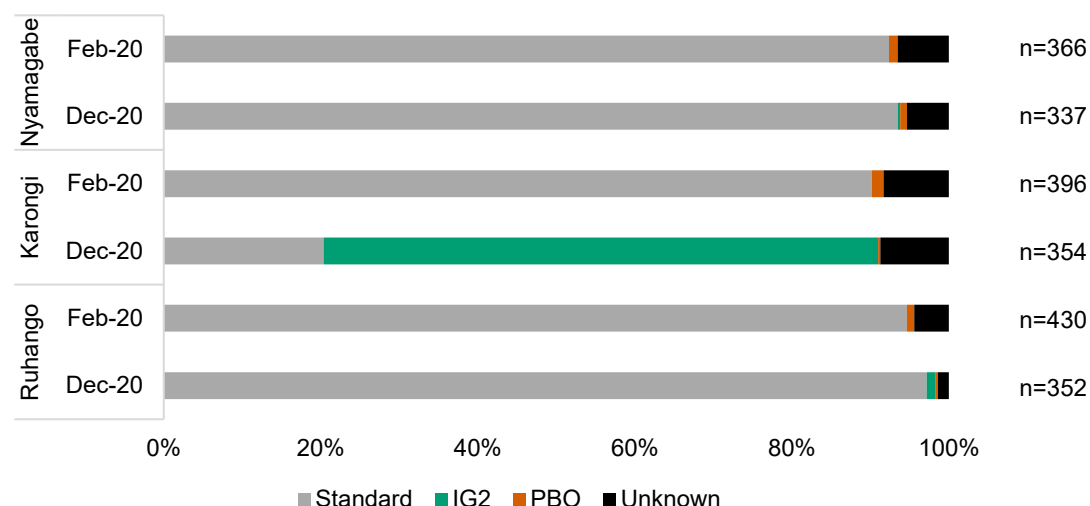
Note: Nyamagabe and Ruhango received standard campaign nets shortly before the cross-sectional survey of February 2020. *Abbreviations*: IG2, Interceptor G2; PBO, piperonyl butoxide.

The proportion of households that own one ITN for every two people (Table R3) was highest in Ruhango (75 percent) and lowest in Nyamagabe (69 percent) during the February 2020 survey. The difference between the highest and lowest districts widened during the December 2020 survey, with 71 percent of households owning one ITN for every two people in Karongi and 60 percent in Nyamagabe.

Table R3. Proportion of households that own one ITN for every two people.

	February 2020	**December 2020**
Nyamagabe (standard)	69.33%	60.00%
Karongi (IG2)	72.67%	71.33%
Ruhango (standard + IRS)	74.67%	70.00%

Abbreviations: IG2, Interceptor G2; IRS, indoor residual spraying; ITN, insecticide-treated net.

Across all districts and surveys, households averaged 4.3 persons each, with relative similarities across districts (Figure R4). During the February 2020 survey, the number of persons per ITN was highest in Nyamagabe at 1.71, followed by Karongi at 1.62 and Ruhango at 1.58. The number of persons per ITN rose in each district during the December 2020 survey, with the highest again being 1.96 persons per net in Nyamagabe, followed by 1.91 in Karongi and 1.72 in Ruhango.

Figure R4. Average household size and average number of persons per ITN.
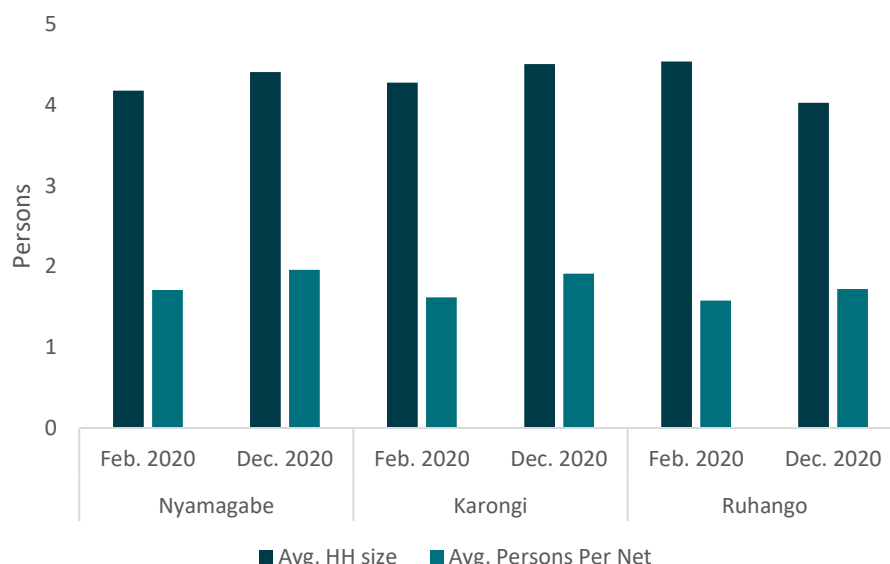
Abbreviations: HH, household; ITN, insecticide-treated net.

Data shown in Table R4 come from survey questions asking households to report how many ITNs were received during the 2020 mass campaign and how many of those nets were still in possession of the household. The number of "missing" ITNs was then calculated. Because Nyamagabe and Ruhango had just received their 2020 mass campaign nets in February 2020, and because Karongi had not yet received any of their campaign nets, the percentage of missing ITNs was not calculated for the February 2020 survey. By December 2020, 10 months after campaign net distribution, over 9.00 percent of campaign nets were missing in the standard-issued districts of Nyamagabe and Ruhango. During the December 2020 survey, 6 months after the mass campaign was completed, the IG2 district of Karongi reported 3.61 percent of its campaign nets as missing (Table R4).

Table R4. Proportion of 2020 mass campaign ITNs reported to be lost for any reason.

	December 2020
Nyamagabe (standard)	9.03%
Karongi (IG2)	3.61%
Ruhango (standard + IRS)	9.73%

Abbreviations: IG2, Interceptor G2; IRS, indoor residual spraying.

Bed net access and use

Population use (i.e., percentage of household members sleeping under an ITN the night before the survey) ranged from 68.2 percent in Karongi (February 2020) to 78.9 percent in Ruhango (December 2020). Population use was similar across districts during the February survey, with 70 percent in Nyamagabe, 68 percent in Karongi, and 73 percent in Ruhango, even though Karongi had not yet received its mass campaign distribution. For the December survey, population use was 10 percent

greater in Ruhango (standard + IRS) compared to Nyamagabe (standard only), and in Karongi (IG2), where ITNs had been distributed 6 months earlier, population use increased by about 2 percent, from 68.22 percent in February to 70.85 percent in December 2020.

In Nyamagabe and Ruhango, most household members (63.29 percent to 76.86 percent) slept under standard ITNs, though up to 6 percent of bed nets were of an unknown type. During the December 2020 survey in Karongi, 49.60 percent of household members slept under an IG2 ITN, 14.60 percent slept under a standard ITN, and 6.21 percent slept under an unknown bed net type. There was relatively little spillover of net types between districts. For example, during the December 2020 survey, five IG2 and five PBO ITNs were found in districts that had not been issued those types during the 2020 mass campaigns.

When ITNs were available, anthropological participants reported using them every day and throughout the year, in both the dry and rainy seasons. Table R5 summarizes study population use of ITNs.

Table R5. Proportion of total household members who slept under an ITN the previous night, by net type.

	February 2020	December 2020
Nyamagabe (standard)	**n = 627**	**n = 662**
IG2	-	0.15% (1)
Standard	64.59% (405)	63.29% (419)
PBO	0.80% (5)	0.30% (2)
Unknown	5.10% (32)	4.98% (33)
Total	**70.49% (442)**	**68.72 (455)**
Karongi (IG2)	**n = 642**	**n = 676**
IG2	-	49.56% (335)
Standard	59.81% (384)	14.64% (99)
PBO	2.18% (14)	0.44% (3)
Unknown	6.23% (40)	6.21% (42)
Total	**68.22% (438)**	**70.85% (472)**
Ruhango (standard + IRS)	**n = 681**	**n = 605**
IG2	-	0.83% (5)
Standard	69.90% (476)	76.86% (465)
PBO	0.29% (2)	0.17% (1)
Unknown	3.08% (21)	0.99% (6)
Total	**73.27% (499)**	**78.85% (477)**

Note: "n" signifies total number of household members in the district for that survey month. *Abbreviations*: IG2, Interceptor G2; IRS, indoor residual spraying; ITN, insecticide-treated net; PBO, piperonyl butoxide.

Net use given access was consistently over 0.80 across surveys and districts, indicating a high level of ITN use when available within a household (Table R6). This was also reflected in FGDs and IDIs.

> "We don't sleep under bed nets. And the reason is because we do not have [any]. If we had bed nets, we would be sleeping [under them]."

> —Interviewee, Karongi

Table R6. Population ITN access and bed net use given access.

	Nyamagabe (standard)		Karongi (IG2)		Ruhango (standard + IRS)	
	Feb 2020	Dec 2020	Feb 2020	Dec 2020	Feb 2020	Dec 2020
Population ITN access, % (95% CI)	81.8 (79.5–84.1)	80.7 (78.6–82.7)	82.2 (79.8–84.7)	86.1 (84.3–87.9)	88.1 (86.5–89.8)	88.6 (87.2–90.0)
Use given access*	0.86	0.85	0.83	0.82	0.83	0.89

*Use given access is calculated by dividing use (population that slept under a net the previous night) by access. Values over 1 are possible given the calculation is a ratio. *Abbreviations*: CI, confidence interval; IG2, Interceptor G2; IRS, indoor residual spraying; ITN, insecticide-treated net.

Figure R5 shows the percentage of bed nets found hanging, stored, and neither hanging nor stored in each district for the net type distributed during each district's previous mass campaign. At the time of the survey in February 2020, over 25 percent of standard ITNs across the three districts were being stored. At the time of the December 2020 survey, in Nyamagabe and Ruhango 63 percent and 59 percent of standard ITNs were hung, respectively, and in Karongi 59 percent of IG2 ITNs were hung. Between 17 and 30 percent of ITNs were being stored at the time of the December survey.

Figure R5. Proportion of bed nets hung, stored, and not hung or stored.
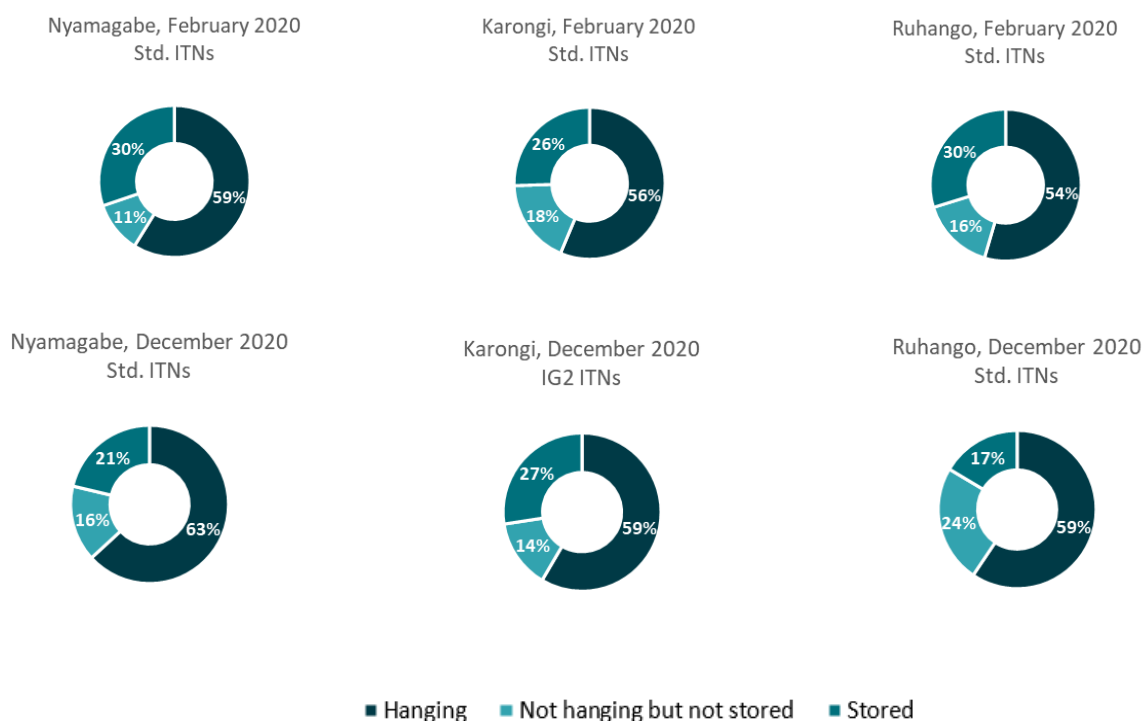
Abbreviations: IG2, Interceptor G2; ITN, insecticide-treated net.

Over 60 percent of ITNs across all districts were used every night the week prior to the December 2020 survey, while at least 18 percent were not used at all. (Figure R6).

Figure R6. Proportion and frequency of bed nets used the previous week for 2020 survey, by district.
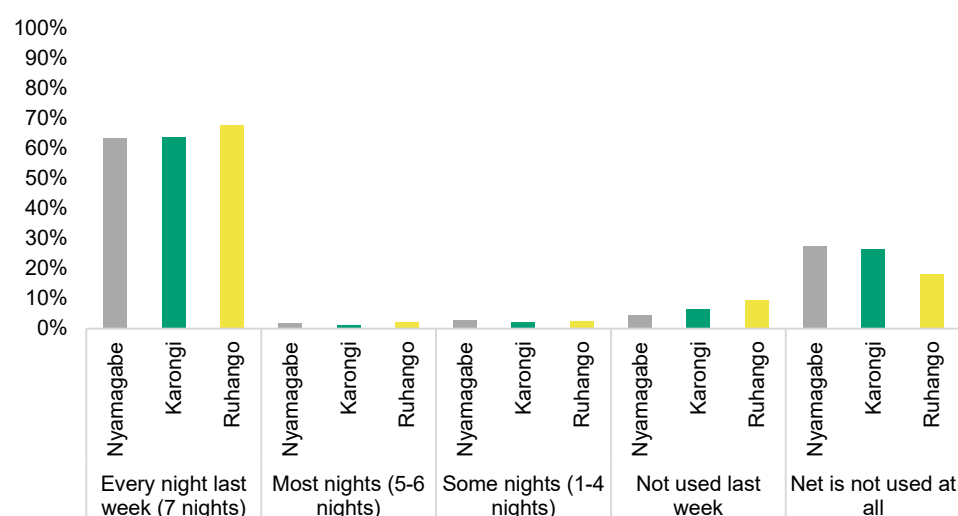
The percentage of ITNs reported to have been washed varied across districts and by net type (Table R7). In February 2020, roughly 25 percent of standard ITNs in Nyamagabe and Ruhango had been washed, with that percentage increasing to 45 percent and 51 percent, respectively, by the December 2020 survey, indicating that as nets age, they are more likely to be washed. In Karongi over 20 percent of IG2 nets had been washed at the time of the December survey.

Most people used similar procedures to wash their nets, though washing frequency varied widely across participants. Most reported washing nets whenever they appeared dirty, which ranged in intervals of a few weeks to a few months. Participants explained that washing frequency depended on factors such as exposure to dirt or smoke.

> *"If you live in a house which is not plastered or [has an] uncemented floor, it gets dirty quickly, at least within three months. . .. When you live in a house that has cemented floors and plastered walls, it takes long to get dirty."*
>
> *—FGD participant, Nyamagabe*

Table R7. Proportion of bed nets ever washed, by type.

		February 2020	December 2020
Nyamagabe (standard)	Standard	25.82% (87/337)	44.91% (119/265)
Karongi (IG2)	IG2	-	21.24% (41/193)
	Standard	31.73% (112/353)	65.63% (42/64)
Ruhango (standard + IRS)	Standard	24.75% (100/404)	51.00% (153/300)

Abbreviations: IG2, Interceptor G2; IRS, indoor residual spraying.

Bed net characteristics

Most ITNs in Rwanda are obtained through mass distribution campaigns. While some are obtained through ANC and immunization visits, these make up a small percentage of the total. Trends in ITN sources were similar across the pilot districts (Figure R7).

In some locations, IDI and FGD participants explained that government distribution campaigns were the only way most people could acquire bed nets and that they were unaware of any locations where they could buy them. Others expressed the intention of investigating whether pharmacies sold bed nets.

> *"There is no other way I can get [bed nets]. When bed nets are old before the government distributes other bed nets to us, we have nothing else to do; we just stay without bed nets."*
>
> *—FGD participant, Nyamagabe.*

Participants in FGDs and IDIs also reported receiving too few ITNs during the mass distribution campaigns.

> *"Most of the time, you find bed nets are few. For instance, in my home we have five beds, but we were given only three bed nets. They told me there were few; hence, they had to share them among all citizens sparingly so that at least all people may get some bed nets. Hence, you will find some of my family members who don't sleep under bed nets."*
>
> *—FGD participant, Karongi*

A few participants noted that the distribution campaigns did not happen regularly enough to replace old nets in time, and many described their current nets to be "very old" such that "they can't be used any longer." For example, one IDI participant in Karongi explained that the household had received one bed net more than three years ago and has not received any additional nets since, going on to describe the sole net as "really old—it has changed color and is even torn with many holes."

Figure R7. Proportion of bed nets attained through each of the four source types, by survey month and district.
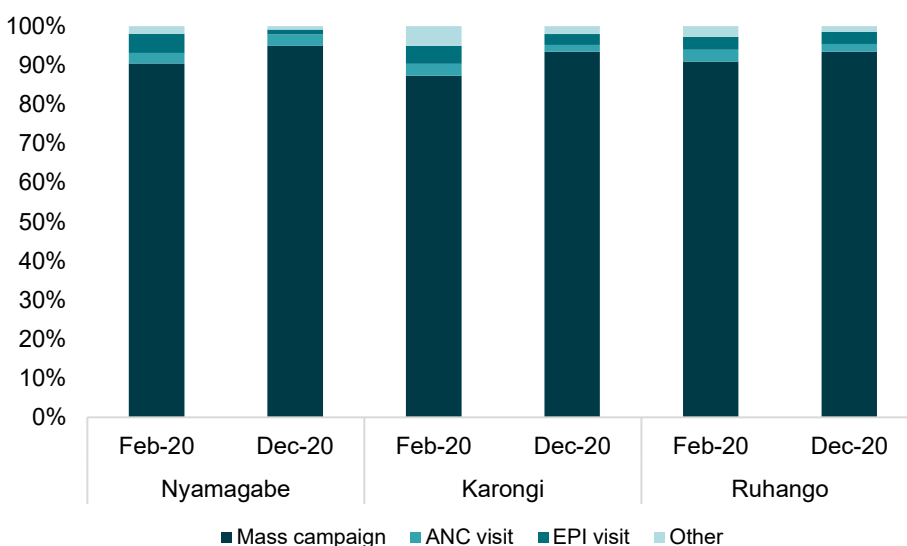
Abbreviations: ANC, antenatal care; EPI, Expanded Program on Immunization.

Respondents were asked whether each individual bed net received during the 2020 mass campaign ever had holes of any size (Table R8). Values are only reported for December 2020 since Ruhango and Nyamagabe had just recently received their nets and Karongi had not received any nets yet. In Ruhango and Nyamagabe (standard), the percentage of ITNs that had ever had holes varied, at 9.57 percent and 4.82 percent, respectively. In Karongi (IG2), where 2020 campaign nets were distributed 3 months after the standard-issued districts, 6.88 percent of surveyed ITNs had had a hole at some point. FGD and IDI

participants reported that nets were torn or damaged from catching on bed nails or the wood of the bed, and some reported mice as the cause of net damage.

There was variability in people's ability to repair holes. When nets were torn or damaged, some people repaired them using needle and thread. Some were motivated to mend their nets due to the lack of availability and/or affordability of nets, but there were also participants who did not know how, or did not think it possible, to mend a net.

> *"If my mosquito net is torn, I should mend it as I cannot afford a new net myself."*
>
> *—FGD participant, Karongi*
>
> *"There is no way you can repair it. [We] have to wait until they give us another one to replace the old one."*
>
> *—FGD participant, Nyamagabe*

Table R8. Proportion of ITNs received during the 2020 mass campaign with reported holes, by type/district.

	December 2020
Nyamagabe (Standard)	4.82% (11)
Karongi (IG2)	6.88% (13)
Ruhango (Standard + IRS)	9.57% (22)

Abbreviations: IG2, Interceptor G2; IRS, indoor residual spraying; ITN, insecticide-treated net.

Summary

Despite not yet having received 2020 mass campaign nets at the time of the February 2020 survey, surveyed households in Karongi reported a total of 396 ITNs, a comparable number to that found in Nyamagabe (366) and Ruhango (430), where households had just received their bed nets prior to the survey. This suggests that households in Karongi were still in possession of nets from the prior distribution campaign, despite it having occurred several years previously. Over 92 percent of all household ITNs across the three districts during the February 2020 survey were standard in type, although the ITNs identified as "unknown" due to missing labels were likely also to have been standard type. During the second survey in December 2020, over 70 percent of ITNs found in Karongi were IG2, while 20 percent were standard. ITNs of a type other than the type distributed during mass campaigns were rarely found within a district, as is evidenced by the fact that only five IG2s were found outside of the IG2 district of Karongi in December 2020. In Nyamagabe and Ruhango, 9 percent of the 2020 campaign nets were missing at the time of the December 2020 survey (10 months post-distribution), while in Karongi almost 4 percent had been lost (6 months post-distribution).

Population use (i.e., the proportion of residents sleeping under an ITN the night before the survey) ranged from 68 to 73 percent in February 2020 and from 68 to 79 percent in December 2020, though it was lowest in Karongi in February 2020, where mass campaign nets had not yet been distributed. Most people were sleeping under the type of net that had been distributed in their district during the most recent campaign, although almost 15 percent of surveyed household residents were sleeping under standard nets in Karongi in December 2020.

Net use given access was consistently over 0.80 across surveys and districts, indicating a high level of use when ITNs were available. The percentage of ITNs being stored during the February 2020 survey ranged from 26 percent in Karongi to 30 percent in both Ruhango and Nyamagabe. During the

subsequent December 2020 survey, the percentage of stored nets ranged from 17 percent in Ruhango to 27 percent in Karongi. At least 63 percent of ITNs across all districts were being used every night the week prior to the survey, while 18.15 percent (Ruhango), 26.51 percent (Karongi), and 27.33 percent (Nyamagabe) were not used at all.

During the December 2020 survey, Nyamagabe reported that almost 45 percent of its standard ITNs had been washed, Ruhango reported that 51 percent of its standard nets had been washed, and Karongi reported that 21 percent of its IG2 nets and 65 percent of its standard nets had been washed. Anthropological findings suggest that ITNs distributed during the 2020 mass campaign were being washed more frequently due to the shift in ITN color from the previous campaigns' blue, which disguised dirt more easily, compared to white.

Mass distribution campaigns are the primary source for obtaining ITNs across all districts, with 90 percent of all ITNs obtained from mass campaigns. ANC and immunization visits were also sources for acquiring bed nets, but these made up a small minority of total ITNs across the three districts. The percentages of ITNs received during the 2020 mass campaign that were reported to have holes are as follows: 4.82 percent in Nyamagabe (standard), 6.88 percent in Karongi (IG2), and 9.57 percent in Ruhango (standard + IRS).

Discussion and next steps

Discussion

In this supplement we report ITN ownership and use metrics, as well as ITN characteristics, like net source, across the five NNP pilot evaluations. ITN coverage, number of ITNs per household, ITN use the previous night, proportion of households with at least one ITN for every two people, and population use given access are key outcomes. Due to the variations in the stages of the study in each country, comparisons of these indicators are most useful between the different districts within each evaluation context.

Given the difference in timing of ITN distributions across pilot countries, the number of CSSs feeding into this report differs across settings. This report includes a baseline survey (2019) and two post-campaign surveys (2020 and 2021) for Burkina Faso, a baseline survey (September 2020) and the first post-campaign survey (September 2021) for Northern Mozambique, a baseline survey (October 2020) and a Year 1 survey (September 2021) for Western Mozambique, a baseline survey (October 2020, pre-distribution) for Nigeria, and a baseline survey (February 2020) and post-campaign survey (December 2020) for Rwanda.

As mentioned in the introduction, a primary reason for carefully considering the data presented in this ITN indicator supplement is to provide critical context when interpreting differences in malaria-prevention impact across the different study districts. So far, there do not appear to be many substantial differences in these ITN measures across relevant comparator districts. For example, the degree of ITN type "spillover" has, to date, been minimal—the majority of ITNs encountered during household surveys corresponded to the ITN type targeted for distribution in that district. If this trend remains consistent, associations between district-level malaria transmission patterns and ITN types will be stronger.

Nonetheless, there are some important variations in ITN indicators that will need to be considered carefully in any final analysis. For example, use of ITNs varied somewhat across districts in Northern Mozambique in 2021, with over 82 percent of residents in Mandimba and Gurue reporting having slept under an RG or standard ITN the previous night, respectively, while in Cuamba only 67 percent of residents reported sleeping under an IG2. It will be important to consider whether (and how) the lower use of nets in Cuamba may influence the interpretation of results in Northern Mozambique. Similarly, in Burkina Faso, reported population use (i.e., sleeping under an ITN the night prior to the survey) for 2021 was significantly lower (at 37 percent) in Gaoua, the standard ITN comparator district, than in Banfora (83 percent), which received IG2 ITNs, or Orodara (84 percent), which received PBO ITNs. It is interesting to note that even within each district, not all ITNs being used were of the same type. In Banfora in 2021, for example, even though 83 percent of the population slept under any net the previous night, only 65 percent were sleeping under an IG2 (i.e., 77 percent of the ITNs in use were IG2s, with not all ITNs received from the distribution campaign). Given the high baseline malaria prevalence in Nigeria, the data generated from the November 2021 survey one year post-distribution will be key in understanding whether indicators such as population use have improved after ITN distributions across the LGAs. In Rwanda, the data presented here show somewhat less variation across districts, but it will be important to monitor overall ITN use in this low-burden setting.

Next steps

Data collection is ongoing in each study district within the four study countries and will continue through the end of the pilots in 2022. The forthcoming surveys will provide more time points for each indicator across the districts, showing whether (and how) these metrics may change over time following ITN distributions. Analysis also is ongoing, and results from this supplement will be incorporated into the final analysis and interpretation of ITN effectiveness and cost-effectiveness. Anthropology findings will be especially important for providing further understanding of the barriers to and facilitators of ITN access and use, especially in Asa LGA in Nigeria and Gaoua District in Burkina Faso. ITN indicators found to be significant in univariate analyses will be included in the multivariate models for evaluating the effectiveness of bed nets in each district.

Appendix. Additional ITN indicators by country

Burkina Faso

Appendix Table BF1. Proportion of bed nets hung, stored, and not hung or stored, by type.

			2019	2020	2021
Gaoua (standard)	IG2	Hanging	-	-	-
		Stored	-	-	-
		Not hanging not stored	-	-	-
	PBO	Hanging	-	-	-
		Stored	-	-	-
		Not hanging not stored	-	-	-
	Standard	Hanging	54.61% (148)	69.89% (188)	87.57% (162)
		Stored	24.35% (66)	20.82% (56)	9.19% (17)
		Not hanging not stored	10.70% (29)	2.97% (8)	2.16% (4)
	Unknown	Hanging	5.90% (16)	4.09% (11)	0.54% (1)
		Stored	1.11% (3)	2.23% (6)	0.54% (1)
		Not hanging not stored	3.32% (9)	-	-
	Total		**100.00% (271)**	**100.00% (269)**	**100.00% (185)**
Banfora (IG2)	IG2	Hanging	-	63.49% (313)	61.79% (325)
		Stored	-	16.43% (81)	6.46% (34)
		Not hanging not stored	-	2.23% (11)	9.13% (48)
	PBO	Hanging	-	0.41% (2)	0.38% (2)
		Stored	-	0.20% (1)	-
		Not hanging not stored	-	-	-
	Standard	Hanging	58.58% (215)	9.94% (49)	5.70% (30)
		Stored	3.27% (12)	-	0.57% (3)
		Not hanging not stored	4.09% (15)	0.41% (2)	2.85% (15)
	Unknown	Hanging	27.52% (101)	4.87% (24)	6.65% (35)
		Stored	4.09% (15)	1.01% (5)	0.38% (2)
		Not hanging not stored	2.45% (9)	1.01% (5)	6.08% (32)
	Total		**100.00% (367)**	**100.00% (493)**	**100.00% (526)**
Orodara (PBO)	IG2	Hanging	-	6.08% (1)	-
		Stored	-	-	-
		Not hanging not stored	-	-	-
	PBO	Hanging	19.94% (135)	52.97% (259)	68.42% (312)
		Stored	36.63% (248)	17.38% (85)	11.40% (52)
		Not hanging not stored	1.62% (11)	0.82% (4)	2.63% (12)
	Standard	Hanging	28.06% (190)	15.95% (78)	10.96% (50)
		Stored	2.22% (15)	1.43% (7)	1.32% (6)
		Not hanging not stored	3.10% 21)	0.20% (1)	0.22% (1)
	Unknown	Hanging	5.47% (37)	7.98% (39)	3.95% (18)

			1.77% (12)	2.04% (10)	0.88% (4)
		Stored	1.77% (12)	2.04% (10)	0.88% (4)
		Not hanging not stored	1.18% (8)	1.02% (5)	0.22% (1)
	Total		**100.00% (677)**	**100.00% (489)**	**100.00% (456)**

Abbreviations: IG2, Interceptor G2; PBO, piperonyl butoxide.

Appendix Table BF2. Proportion and frequency of bed nets used the previous week for 2019, 2020, 2021 surveys.

	2019	**2020**	**2021**
Gaoua (standard)			
IG2	-	-	-
Every night last week (7 nights)	-	-	-
Most nights (5–6 nights)	-	-	-
Some nights (1–4 nights)	-	-	-
Not used last week	-	-	-
Net is not used at all	-	-	-
Standard	**n=206**	**n=240**	**n=176**
Every night last week (7 nights)	45.63% (94)	53.75% (129)	54.55% (96)
Most nights (5–6 nights)	5.83% (12)	15.83% (38)	19.32% (34)
Some nights (1–4 nights)	4.37% (9)	7.50% (18)	19.32% (34)
Not used last week	34.47% (71)	9.17% (22)	2.84% (5)
Net is not used at all	9.71% (20)	13.75% (33)	3.98% (7)
PBO	-	-	-
Every night last week (7 nights)	-	-	-
Most nights (5–6 nights)	-	-	-
Some nights (1–4 nights)	-	-	-
Not used last week	-	-	-
Net is not used at all	-	-	-
Unknown	**n=25**	**n=15**	**n=2**
Every night last week (7 nights)	56.00% (14)	40.00% (6)	50.00% (1)
Most nights (5–6 nights)	16.00% (4)	33.33% (5)	-
Some nights (1–4 nights)	12.00% (3)	6.67% (1)	-
Not used last week	12.00% (3)	6.67% (1)	-
Net is not used at all	4.00% (1)	13.33% (2)	50.00% (1)
Banfora (IG2)			
IG2	-	**n=405**	**n=407**
Every night last week (7 nights)	-	83.21% (337)	77.64% (316)
Most nights (5–6 nights)	-	6.91% (28)	12.29% (50)
Some nights (1–4 nights)	-	0.25% (1)	2.95% (12)
Not used last week	-	2.72% (11)	0.74% (3)
Net is not used at all	-	6.91% (28)	6.39% (26)
Standard	**n=238**	**n=51**	**n=48**
Every night last week (7 nights)	94.12% (224)	100.00% (51)	97.92% (47)
Most nights (5–6 nights)	2.10% (5)	-	-
Some nights (1–4 nights)	1.26% (3)	-	-

Not used last week	2.52% (6)	-	-
Net is not used at all	-	-	2.08% (1)
PBO	**-**	**n=3**	**n=2**
Every night last week (7 nights)	-	66.67% (2)	100.00% (2)
Most nights (5–6 nights)	-	-	-
Some nights (1–4 nights)	-	-	-
Not used last week	-	33.33% (1)	-
Net is not used at all	-	-	-
Unknown	**n=124**	**n=32**	**n=69**
Every night last week (7 nights)	89.52% (111)	75.00% (24)	85.51% (59)
Most nights (5–6 nights)	0.81% (1)	9.38% (3)	1.45% (1)
Some nights (1–4 nights)	-	3.13% (1)	1.45% (1)
Not used last week	4.84% (6)	-	5.80% (4)
Net is not used at all	4.84% (6)	12.50% (4)	5.80% (4)
Orodara (PBO)			
IG2	**-**	**n=1**	**-**
Every night last week (7 nights)	-	-	-
Most nights (5–6 nights)	-	-	-
Some nights (1–4 nights)	-	-	-
Not used last week	-	-	-
Net is not used at all	-	100.00% (1)	-
Standard	**n=222**	**n=86**	**n=57**
Every night last week (7 nights)	87.84% (195)	86.05% (74)	82.46% (47)
Most nights (5–6 nights)	2.70% (6)	2.33% (2)	3.51% (2)
Some nights (1–4 nights)	-	2.33% (2)	1.75% (1)
Not used last week	7.21% (16)	3.49% (3)	7.02% (4)
Net is not used at all	2.25% (5)	5.81% (5)	5.26% (3)
PBO	**n=165**	**n=348**	**n=376**
Every night last week (7 nights)	78.79% (130)	69.25% (241)	76.33% (287)
Most nights (5–6 nights)	-	2.87% (10)	7.98% (30)
Some nights (1–4 nights)	1.21% (2)	1.15% (4)	0.53% (2)
Not used last week	7.88% (13)	5.75% (20)	4.79% (18)
Net is not used at all	12.12% (20)	20.98% (73)	10.37% (39)
Unknown	**n=51**	**n=53**	**n=22**
Every night last week (7 nights)	82.35% (42)	71.70% (38)	68.18% (15)
Most nights (5–6 nights)	-	-	4.55% (1)
Some nights (1–4 nights)	-	1.89% (1)	13.64% (3)
Not used last week	13.73% (7)	1.89% (1)	9.09% (2)
Net is not used at all	3.92% (2)	24.53% (13)	4.55% (1)

Abbreviations: IG2, Interceptor G2; PBO, piperonyl butoxide.

Northern Mozambique

Appendix Table MN1. Proportion of bed nets hung, stored, and not hung or stored, by type.

			2020	2021
Gurue (standard)	Standard	Hanging	87.00% (241)	79.88% (814)
		Stored	6.86% (19)	13.74% (140)
		Not hanging, not stored	6.14% (17)	6.18% (63)
	Unknown	Hanging	-	-
		Stored	-	0.20% (2)
		Not hanging, not stored	-	-
	Total		**100.00% (277)**	**100.00% (1019)**
Cuamba (IG2)	Standard	Hanging	85.10% (217)	0.77% (6)
		Stored	2.75% (7)	-
		Not hanging, not stored	10.59% (27)	-
	IG2	Hanging	-	82.63% (647)
		Stored	-	14.30% (112)
		Not hanging, not stored	-	0.89% (7)
	RG	Hanging	-	0.13% (1)
		Stored	-	-
		Not hanging, not stored	-	-
	PBO	Hanging	-	1.02% (8)
		Stored	-	0.26% (2)
		Not hanging, not stored	-	-
	Unknown	Hanging	0.39% (1)	-
		Stored	-	-
		Not hanging, not stored	1.18% (3)	-
	Total		**100.00% (255)**	**100.00% (783)**
Mandimba (RG)	Standard	Hanging	86.19% (156)	0.12% (1)
		Stored	6.63% (12)	0.23% (2)
		Not hanging, not stored	7.18% (13)	-
	IG2	Hanging	-	0.23% (2)
		Stored	-	-
		Not hanging, not stored	-	0.35% (3)
	RG	Hanging	-	76.74% (663)
		Not hanging, not stored	-	3.01% (26)
		Stored	-	18.40% (159)
	PBO	Hanging	-	0.58% (5)
		Stored	-	0.23% (2)
		Not hanging, not stored	-	-
	Unknown	Hanging	-	0.12% (1)
		Stored	-	-
		Not hanging, not stored	-	-
	Total		**100.00% (181)**	**100.00% (864)**

Abbreviations: IG2, Interceptor G2; PBO, piperonyl butoxide; RG, Royal Guard.

Appendix Table MN2. Proportion and frequency of bed nets used the previous week for 2020 and 2021 surveys.

	2020	2021
Gurue (standard)		
Standard	**n = 273**	**n = 1006**
Every night (7 nights)	74.36% (203)	76.64% (771)
Most nights (5–6)	9.89% (27)	5.86% (59)
Some nights (1–4)	6.59% (18)	2.98% (30)
Not used last week	5.86% (16)	2.19% (22)
Net is not used at all	3.30% (9)	12.33% (124)
Unknown	**n = 0**	**n = 0**
Every night (7 nights)	-	-
Most nights (5–6)	-	-
Some nights (1–4)	-	-
Not used last week	-	-
Net is not used at all	-	100.00% (2)
Cuamba (IG2)		
Standard	**n = 245**	**n = 6**
Every night (7 nights)	74.69% (183)	83.33% (5)
Most nights (5–6)	8.57% (21)	16.67% (1)
Some nights (1–4)	6.94% (17)	-
Not used last week	6.94% (17)	-
Net is not used at all	2.86% (7)	-
IG2	**n = 0**	**n = 765**
Every night (7 nights)	-	56.47% (432)
Most nights (5–6)	-	25.10% (192)
Some nights (1–4)	-	2.09% (16)
Not used last week	-	0.52% (4)
Net is not used at all	-	15.82% (121)
RG	**n = 0**	**n = 1**
Every night (7 nights)	-	-
Most nights (5–6)	-	-
Some nights (1–4)	-	100.00% (1)
Not used last week	-	-
Net is not used at all	-	-
PBO	**n = 0**	**n = 9**
Every night (7 nights)	-	55.56% (5)
Most nights (5–6)	-	33.33% (3)
Some nights (1–4)	-	-
Not used last week	-	-
Net is not used at all	-	11.11% (1)
Unknown	**n = 3**	**n = 0**
Every night (7 nights)	-	-

Most nights (5–6)	-	-
Some nights (1–4)	-	-
Not used last week	-	-
Net is not used at all	100.00% (3)	-
Mandimba (RG)		
Standard	**n = 178**	**n = 3**
Every night (7 nights)	75.84% (135)	33.33% (1)
Most nights (5–6)	6.74% (12)	-
Some nights (1–4)	1.12% (2)	-
Not used last week	14.61% (26)	-
Net is not used at all	1.69% (3)	66.67% (2)
IG2	**n = 0**	**n = 5**
Every night (7 nights)	-	40.00% (2)
Most nights (5–6)	-	-
Some nights (1–4)	-	-
Not used last week	-	60.00% (3)
Net is not used at all	-	-
RG	**n = 0**	**n = 842**
Every night (7 nights)	-	77.43% (652)
Most nights (5–6)	-	1.66% (14)
Some nights (1–4)	-	0.48% (4)
Not used last week	-	3.21% (27)
Net is not used at all	-	17.22% (145)
PBO	**n = 0**	**n = 7**
Every night (7 nights)	-	71.43% (5)
Most nights (5–6)	-	-
Some nights (1–4)	-	-
Not used last week	-	-
Net is not used at all	-	28.57% (2)
Unknown	**n = 0**	**n = 1**
Every night (7 nights)	-	100.00% (1)
Most nights (5–6)	-	-
Some nights (1–4)	-	-
Not used last week	-	-
Net is not used at all	-	-

Abbreviations: IG2, Interceptor G2; PBO, piperonyl butoxide; RG, Royal Guard.

Western Mozambique

Appendix Table MW1. Proportion of bed nets hung, stored, and not hung or stored, by type.

			2020	2021
Chemba (standard)	Standard	Hanging	77.55% (38)	68.72% (892)
		Stored	4.08% (2)	29.12% (378)
		Not hanging, not stored	14.29% (7)	1.00% (13)
	PBO	Hanging	-	0.69% (9)
		Stored	-	0.15% (2)
		Not hanging, not stored	-	-
	Unknown	Hanging	-	0.08% (1)
		Stored	-	0.15% (2)
		Not hanging, not stored	4.08% (2)	0.08% (1)
	Total		**100.00% (49)**	**100.00% (1298)**
Guro (IG2)	Standard	Hanging	76.92% (40)	1.14% (12)
		Stored	21.15% (11)	0.09% (1)
		Not hanging, not stored	1.92% (1)	-
	IG2	Hanging	-	66.45% (701)
		Stored	-	13.74% (145)
		Not hanging, not stored	-	16.97% (179)
	PBO	Hanging	-	1.23% (13)
		Stored	-	0.19% (2)
		Not hanging, not stored	-	-
	Unknown	Hanging	-	0.19% (2)
		Stored	-	-
		Not hanging, not stored	-	-
	Total		**100.00% (52)**	**100.00% (1055)**
Changara (PBO)	Standard	Hanging	74.47% (35)	7.17% (70)
		Stored	10.64% (5)	1.33% (13)
		Not hanging, not stored	14.89% (7)	1.43% (14)
	PBO	Hanging	-	57.17% (558)
		Stored	-	14.04% (137)
		Not hanging, not stored	-	18.65% (182)
	Unknown	Hanging	-	
		Stored	-	0.20% (2)
		Not hanging, not stored	-	
	Total		**100.00% (47)**	**100.00% (976)**

Abbreviations: IG2, Interceptor G2; PBO, piperonyl butoxide.

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Appendix Table MW2. Proportion and frequency of bed nets used the previous week for 2020 and 2021 surveys.

	2020	2021
Chemba (standard)		
Standard	n = 48	n = 1269
Every night (7 nights)	68.75% (33)	69.90% (887)
Most nights (5–6)	12.50% (6)	4.41% (56)
Some nights (1–4)	6.25% (3)	0.79% (10)
Not used last week	4.17% (2)	2.05% (26)
Net is not used at all	8.33% (4)	22.85% (290)
PBO	-	n = 11
Every night (7 nights)	-	36.36% (4)
Most nights (5–6)	-	45.45% (5)
Some nights (1–4)	-	-
Not used last week	-	-
Net is not used at all	-	18.18% (2)
Unknown	n = 2	n = 4
Every night (7 nights)	-	50.00% (2)
Most nights (5–6)	50.00% (1)	-
Some nights (1–4)	-	-
Not used last week	50.00% (1)	-
Net is not used at all	-	50.00% (2)
Guro (IG2)		
Standard	n = 49	n = 13
Every night (7 nights)	73.47% (36)	92.31% (12)
Most nights (5–6)	-	-
Some nights (1–4)	2.04% (1)	-
Not used last week	20.41% (10)	
Net is not used at all	4.08% (2)	7.69% (1)
IG2	n = 0	n = 1025
Every night (7 nights)	-	84.39% (865)
Most nights (5–6)	-	0.29% (3)
Some nights (1–4)	-	0.98% (10)
Not used last week	-	0.68% (7)
Net is not used at all	-	13.66% (140)
PBO	n= 0	n = 15
Every night (7 nights)	-	86.67% (13)
Most nights (5–6)	-	-
Some nights (1–4)	-	-
Not used last week	-	-
Net is not used at all	-	13.33% (2)
Unknown	n = 0	n = 2
Every night (7 nights)	-	100.00% (2)
Most nights (5–6)	-	-
Some nights (1–4)	-	-

Not used last week	-	-
Net is not used at all	-	-
Changara (PBO)		
Standard	**n = 47**	**n = 97**
Every night (7 nights)	65.96% (31)	56.70% (55)
Most nights (5–6)	10.64% (5)	18.56% (18)
Some nights (1–4)	14.89% (7)	1.03% (1)
Not used last week	4.26% (2)	9.28% (9)
Net is not used at all	4.26% (2)	14.43% (14)
PBO	**n = 0**	**n = 874**
Every night (7 nights)	-	59.61% (521)
Most nights (5–6)	-	19.45% (170)
Some nights (1–4)	-	0.80% (7)
Not used last week	-	6.75% (59)
Net is not used at all	-	13.39% (117)
Unknown	**n = 0**	**n = 1**
Every night (7 nights)	-	-
Most nights (5–6)	-	-
Some nights (1–4)	-	-
Not used last week	-	-
Net is not used at all	-	100.00% (1)

Abbreviations: IG2, Interceptor G2; PBO, piperonyl butoxide.

Nigeria

Appendix Table N1. Proportion of bed nets hung, stored, and not hung or stored, by type.

			2020
Ejigbo (standard)	Standard	Hanging	37.37% (74)
		Stored	31.31% (62)
		Not hanging not stored	9.09% (18)
	PBO	Stored	0.51% (1)
	Unknown	Hanging	14.14% (28)
		Stored	5.05% (10)
		Not hanging not stored	2.53% (5)
	Total		**100.00% (198)**
Asa (IG2)	Standard	Hanging	60.61% (20)
		Stored	15.15% (5)
		Not hanging not stored	18.18% (6)
	PBO	Hanging	6.06% (2)
	Total		**100.00% (33)**
Moro (RG)	Standard	Hanging	45.95% (68)
		Stored	7.43% (11)
		Not hanging not stored	4.05% (6)
		Unknown	2.03% (3)

	RG	Hanging	2.03% (3)
	PBO	Hanging	1.35% (2)
	Unknown	Hanging	27.03% (40)
		Stored	9.46% (14)
		Not hanging not stored	0.68 (1)
	Total		**100.00% (148)**
Ife North (PBO)	Standard	Hanging	36.93% (89)
		Stored	9.13% (22)
		Not hanging not stored	4.98% (12)
	PBO	Hanging	8.30% (20)
		Stored	2.49% (6)
		Not hanging not stored	0.41% (1)
	Unknown	Hanging	30.71% (74)
		Stored	4.56% (11)
		Not hanging not stored	2.49% (6)
	Total		**100.00% (241)**

Abbreviations: IG2, Interceptor G2; PBO, piperonyl butoxide; RG, Royal Guard.

Appendix Table N2. Proportion and frequency of bed nets used the previous week for 2020 survey.

	2020
Ejigbo (standard)	
Standard	**n = 154**
Every night (7 nights)	48.05% (74)
Most nights (5–6)	15.58% (24)
Some nights (1–4)	4.55% (7)
Not used last week	2.60% (4)
Net is not used at all	29.22% (45)
PBO	**n = 1**
Every night (7 nights)	-
Most nights (5–6)	-
Some nights (1–4)	-
Not used last week	-
Net is not used at all	100.00% (1)
Unknown	**n = 41**
Every night (7 nights)	60.98% (25)
Most nights (5–6)	-
Some nights (1–4)	9.76% (4)
Not used last week	7.32% (3)
Net is not used at all	21.95% (9)
Asa (IG2)	
Standard	**n =31**
Every night (7 nights)	32.26% (10)
Most nights (5–6)	19.35% (6)
Some nights (1–4)	25.81% (8)

Not used last week	3.23% (1)
Net is not used at all	19.35% (6)
PBO	**n = 2**
Every night (7 nights)	50.00% (1)
Most nights (5–6)	-
Some nights (1–4)	-
Not used last week	-
Net is not used at all	50.00% (1)
Moro (RG)	
Standard	**n = 88**
Every night (7 nights)	61.36% (54)
Most nights (5–6)	4.55% (4)
Some nights (1–4)	11.36% (10)
Not used last week	11.36% (10)
Net is not used at all	11.36% (10)
Royal Guard	**n = 3**
Every night (7 nights)	100.00% (3)
Most nights (5–6)	-
Some nights (1–4)	-
Not used last week	-
Net is not used at all	-
PBO	**n = 2**
Every night (7 nights)	100.00% (2)
Most nights (5–6)	-
Some nights (1–4)	-
Not used last week	-
Net is not used at all	-
Unknown	**n = 55**
Every night (7 nights)	60.00% (33)
Most nights (5–6)	5.45% (3)
Some nights (1–4)	7.27% (4)
Not used last week	7.27% (4)
Net is not used at all	20.00% (11)
Ife North (PBO)	
Standard	**n = 122**
Every night (7 nights)	68.85% (84)
Most nights (5–6)	0.82% (1)
Some nights (1–4)	6.56% (8)
Not used last week	9.84% (12)
Net is not used at all	13.93% (17)
PBO	**n = 27**
Every night (7 nights)	77.78% (21)
Most nights (5–6)	-
Some nights (1–4)	-

Not used last week	-
Net is not used at all	22.22% (6)
Unknown	**n = 91**
Every night (7 nights)	78.02% (71)
Most nights (5–6)	-
Some nights (1–4)	3.30% (3)
Not used last week	8.79% (8)
Net is not used at all	9.89% (9)

Abbreviations: IG2, Interceptor G2; PBO, piperonyl butoxide; RG, Royal Guard.

Rwanda

Appendix Table R1. Proportion of bed nets hung, stored, and not hung or stored, by type.

			February 2020	December 2020
Nyamagabe (standard)	IG2	Hanging	-	-
		Stored	-	0.30% (1)
		Not hanging not stored	-	-
	PBO	Hanging	0.82% (3)	0.30% (1)
		Stored	0.27% (1)	0.30% (1)
		Not hanging not stored	-	0.30% (1)
	Standard	Hanging	54.37% (199)	59.23% (199)
		Stored	27.87% (102)	19.94% (67)
		Not hanging not stored	10.11% (37)	14.58% (49)
	Unknown	Hanging	4.10% (15)	3.87% (13)
		Stored	1.09% (4)	0.89% 3)
		Not hanging not stored	1.37% (5)	0.30% (1)
	Total		**100.00% (366)**	**100.00% (336)**
Karongi (IG2)	IG2	Hanging	-	41.19% (145)
		Stored	-	19.32% (68)
		Not hanging not stored	-	9.94% (35)
	PBO	Hanging	1.52% (6)	0.28% (1)
		Stored	-	-
		Not hanging not stored	-	-
	Standard	Hanging	50.76% (201)	15.34% (54)
		Stored	22.98% (91)	3.13% (11)
		Not hanging not stored	16.41% (65)	1.99% (7)
	Unknown	Hanging	5.05% (20)	7.67% (27)
		Stored	1.26% (5)	1.14% (4)
		Not hanging not stored	2.02% (8)	-
	Total		**100.00% (396)**	**100.00% (352)**
Ruhango (standard + IRS)	IG2	Hanging	-	0.86% (3)
		Stored	-	0.29% (1)
		Not hanging not stored	-	-
	PBO	Hanging	0.70% (3)	0.29% (1)

		Stored	0.23% (1)	-
		Not hanging not stored	-	-
	Standard	Hanging	51.63% (222)	57.88% (202)
		Stored	28.14% (121)	16.05% (56)
		Not hanging not stored	14.88% (64)	23.50% (82)
	Unknown	Hanging	2.79% (12)	0.86% (3)
		Stored	0.47% (2)	-
		Not hanging not stored	1.16% (5)	0.29% (1)
	Total		**100.00% (430)**	**100.00% (349)**

Abbreviations: IG2, Interceptor G2; IRS, indoor residual spraying; PBO, piperonyl butoxide.

Appendix Table R2. Proportion and frequency of bed nets used the previous week for 2020 surveys.

	February 2020	December 2020
Nyamagabe (standard)		
IG2	**-**	**n=1**
Every night last week (7 nights)	-	100.00% (1)
Most nights (5–6 nights)	-	-
Some nights (1–4 nights)	-	-
Not used last week	-	-
Net is not used at all	-	-
Standard	**n=336**	**n=311**
Every night last week (7 nights)	56.55% (190)	63.34% (197)
Most nights (5–6 nights)	0.60% (2)	1.93% (6)
Some nights (1–4 nights)	1.19% (4)	2.89% (9)
Not used last week	6.85% (23)	4.50% (14)
Net is not used at all	34.82% (117)	27.33% (85)
PBO	**n=4**	**n=3**
Every night last week (7 nights)	75.00% (3)	33.33% (1)
Most nights (5–6 nights)	-	-
Some nights (1–4 nights)	-	-
Not used last week	-	-
Net is not used at all	25.00% (1)	66.67% (2)
Unknown	**n=24**	**n=18**
Every night last week (7 nights)	62.50% (15)	66.67% (12)
Most nights (5–6 nights)	-	5.56% (1)
Some nights (1–4 nights)	4.17% (1)	5.56% (1)
Not used last week	12.50% (3)	11.11% (2)
Net is not used at all	20.83% (5)	11.11% (2)
Karongi (IG2)		
IG2	**-**	**n=249**
Every night last week (7 nights)	-	63.86% (159)
Most nights (5–6 nights)	-	1.20% (3)
Some nights (1–4 nights)	-	2.01% (5)
Not used last week	-	6.43% (16)
Net is not used at all	-	26.51% (66)

Standard	n=355	n=72
Every night last week (7 nights)	54.37% (193)	72.22% (52)
Most nights (5–6 nights)	0.85% (3)	2.78% (2)
Some nights (1–4 nights)	1.69% (6)	1.39% (1)
Not used last week	5.07% (18)	6.94% (5)
Net is not used at all	38.03% (135)	16.67% (12)
PBO	**n=6**	**n=1**
Every night last week (7 nights)	100.00% (6)	100.00% (1)
Most nights (5–6 nights)	-	-
Some nights (1–4 nights)	-	-
Not used last week	-	-
Net is not used at all	-	-
Unknown	**n=32**	**n=31**
Every night last week (7 nights)	59.38% (19)	80.65% (25)
Most nights (5–6 nights)	-	-
Some nights (1–4 nights)	-	-
Not used last week	6.25% (2)	6.45% (2)
Net is not used at all	34.38% (11)	12.90% (4)
Ruhango (standard + IRS)		
IG2	**-**	**n=4**
Every night last week (7 nights)	-	75.00% (3)
Most nights (5–6 nights)	-	-
Some nights (1–4 nights)	-	-
Not used last week	-	-
Net is not used at all	-	25.00% (1)
Standard	**n=401**	**n=336**
Every night last week (7 nights)	53.37% (214)	67.86% (228)
Most nights (5–6 nights)	1.00% (4)	2.08% (7)
Some nights (1–4 nights)	0.50% (2)	2.38% (8)
Not used last week	4.74% (19)	9.52% (32)
Net is not used at all	40.40% (162)	18.15% (61)
PBO	**n=4**	**n=1**
Every night last week (7 nights)	50.00% (2)	100.00% (1)
Most nights (5–6 nights)	-	-
Some nights (1–4 nights)	-	-
Not used last week	25.00% (1)	-
Net is not used at all	25.00% (1)	-
Unknown	**n=19**	**n=4**
Every night last week (7 nights)	52.63% (10)	100.00% (4)
Most nights (5–6 nights)	5.26% (1)	-
Some nights (1–4 nights)	5.26% (1)	-
Not used last week	10.53% (2)	-
Net is not used at all	26.32% (5)	-

Abbreviations: IG2, Interceptor G2; IRS, indoor residual spraying; PBO, piperonyl butoxide.