



VECTOR)WORKS

U.S. President's Malaria Initiative

Scaling Up Vector Control for Malaria Prevention

Durability Monitoring of LLIN in Myanmar

*36 month Assessment Report
April 2019*



1 Executive Summary

This report details results from the 36-month follow-up of long-lasting insecticidal net (LLIN) durability monitoring in Myanmar, a study funded by PMI/USAID. The prospective three-year study monitors the physical and insecticidal durability and mean survival of two brands of LLINs, distributed by NMCP Myanmar. The primary objectives of the study are to assess and compare the physical and insecticidal durability of two LLIN brands, and to identify major determinants of field performance.

Two LLIN brands (PermaNet 2.0 and DawaPlus 2.0) were distributed via a mass campaign in 32 villages of Tamu Township in December 2015. A baseline durability monitoring assessment was conducted in June 2016, the 12-month assessment was carried out in December 2016, 24-month assessment in December 2017, and this 36-month assessment was done in December 2018. Out of 290 households enrolled at baseline, 242 households could be reassessed after 36 months, with 13 households being lost to follow-up and 35 households lost their cohort nets.

At this 36-month assessment, 25.2% of households in the PermaNet 2.0 site and 33.1% in DawaPlus 2.0 site reported ever storing food in the sleeping room. More or less equal proportions of households in both sites mentioned always cooking in the sleeping room, i.e. 12.2% in PermaNet 2.0 site and 9.7% in DawaPlus 2.0 site. Rodents were observed in the last 6 months, which were 79.1% and 65.3% of households in the PermaNet 2.0 site and the DawaPlus 2.0 site, respectively.

Across both sites, 83.2% of cohort nets were used on a mat or ground. The number of cohort nets observed hanging loose was similar at both the PermaNet 2.0 site (67.6%) and the DawaPlus site (63.9%). The proportion of cohort nets that had ever been washed was almost the same in both PermaNet 2.0 site (85.1%) and DawaPlus 2.0 site (88.0%). There were 10.5% of cohort nets in PermaNet 2.0 site and 8.3% of cohort nets in the DawaPlus 2.0 site that were dried on the fence or bush after being washed.

More cohort nets in the PermaNet 2.0 site (48.9%) were used the previous night than those at the DawaPlus 2.0 site (33.5%). Similarly, 47.2% of cohort nets in PermaNet 2.0 site and 31.9% of those in DawaPlus 2.0 site were reportedly used every night in the past week.

There was no significant difference in overall attrition between PermaNet 2.0 site (33.4%) and DawaPlus 2.0 site (35.2%), with the main cause of attrition being nets were given away for 24.4% of PermaNet 2.0 nets and 24.6% of DawaPlus 2.0 nets. Only 7.8% of PermaNet 2.0 and 8.5% of DawaPlus 2.0 nets had been discarded due to wear and tear.

The survival estimate of the cohort nets was slightly lower in the DawaPlus 2.0 site (78.2%) than in the PermaNet 2.0 site (84.6%), but the difference was not statistically significant. In cone bio-assays, the proportion of DawaPlus 2.0 nets that met WHO optimal effectiveness criteria was lower than those of PermaNet 2.0 nets (3.3% vs 10%). Furthermore, 86.7% of PermaNet 2.0 nets met minimal effectiveness criteria while 76.7% of DawaPlus 2.0 nets met this criterion.

Chemical residue analysis from 36-month data collection indicate that a mean of 1.10 g/kg deltamethrin were found on the DawaPlus 2.0 samples (loading dose 2.0 g/kg) compared to 0.97 g/kg for the PermaNet 2.0 (loading dose 1.4g/kg) samples. These results are similar to chemical residue analysis performed after 24 months, where DawaPlus 2.0 samples had a mean of 1.17 g/kg and Dawa Plus 2.0 had a mean of 0.99 g/kg.

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2 Acknowledgements

This work is made possible by the generous support of the American people through the United States Agency for International Development (USAID) and the U.S. President's Malaria Initiative under the terms of USAID/JHU Cooperative Agreement No: AID-OAA-A-14-00057. The contents do not necessarily reflect the views of USAID, PMI or the United States Government. Moreover, PSI appreciated the National Malaria Control Program, Vector Borne Disease Control Program, and Department of Food and Drug Administration, Ministry of Health and Sports for their support to the study. Township Medical Officers and Basic Health Staffs from Tamu Township as well as community members who were involved in the study are also noted for their kind contribution in the study.

3 Background

Utilization of Long-Lasting Insecticidal Nets (LLINs) is an effective malaria prevention measure in Myanmar that provides personal protection and reduces malaria transmission. The Myanmar National Malaria Control Program (NMCP) aims to achieve universal coverage with LLINs for populations in malaria transmission areas. LLINs are free for targeted populations through mass campaigns and continuous distribution channels with locally appropriate SBCC/IEC approaches to promote correct and effective usage of LLINs. The NMCP and malaria implementing partners are distributing LLINs to cover the entire population who are residing at the established settlements such as villages, IDP camps and prisons. The mobile migrant population has also been provided with LLINs, but coverage with LLINs among this population is still limited¹.

The target rate for a large sized LLIN is 1.8 persons per net, in line with WHO standards, while one single sized net is distributed per migrant person. According to the malaria micro-stratification plan, the distribution of LLINs will be prioritized for static and mobile populations based on risk stratification areas, labeled as strata 3a, 3b and 3c. In 2015, 100% LLIN scale-up was achieved for the target population in stratum 3a areas with the support from GF-NFM, RAI, PMI-USAID and 3MDG. In 2017, LLINs were distributed to farming communities, forest workers, gem/gold miners, pregnant women, development project employees, agriculture and plantation site workers, and employees from camps associated with commercial projects within malaria risk strata 3b and 3c¹.

Continuous distribution focuses on making LLINs accessible to high-risk individuals and groups in malaria endemic areas to maintain coverage between mass distributions in targeted communities. The frequency of these LLIN distributions depends on the expected lifespan of LLINs procured, and the effective LLIN lifespan is 3 to 5 years depending on the type of LLIN distributed and its handling. The factors determining LLIN durability need to be considered to achieve universal coverage of LLIN for effective protection of malaria.

¹ National Plan for Malaria Elimination in Myanmar 2016-2030, Ministry of Health and Sports, Myanmar

Factors including washing frequency, detergent usage during washing, cooking location, type of cooking fuel and net care behaviors are associated with LLIN durability and insecticidal integrity of LLIN².

In this context the importance of net durability and the “average useful life” of a net is increasingly recognized as one of the critical factors a malaria program needs to know as it determines the frequency at which nets need to be replaced and the type of net to be procured. This is reflected in the WHO guidelines for monitoring of LLINs in the field, which recommends that countries routinely monitor net durability³.

In 2013, WHO released additional technical guidance outlining how the actual physical survival can be estimated and the median survival time calculated from multiple data points. This has facilitated a number of studies that apply this new methodology measuring performance of different LLINs in different locations. The results suggest that the physical durability of similar products may vary significantly, and differences are largely driven by environmental and behavioral factors. Similarly, this study aims to provide evidence for the NMCP and stakeholders to help in future LLIN distribution in Myanmar.

4 Methods

4.1 Site

PSI is conducting the study in Tamu Township, Sagaing Region, which is an area of Myanmar with high malaria transmission potential⁴. This site was selected because two brands of LLIN were distributed there during the mass campaign of December 2015, allowing the baseline assessment to be carried out within six months, and it has minimal difficulties in logistics, security, and accessibility.

4.2 Brands monitored

Two LLIN brands were included in the study (DawaPlus 2.0 and PermaNet 2.0). Both are 100-denier polyester LLINs treated with deltamethrin. The only difference between the sites was the brand of LLIN distributed. The local team from the NMCP ensured that only designated LLINs brands were distributed to respective sites.

4.2.1 Pre-shipment testing

All LLINs procured with donors funds are subject to pre-shipment quality control, examining all parameters determined by WHOPES. Two LLIN brands were included in the study (DawaPlus 2.0 and PermaNet 2.0). Pre-shipment testing from the manufacturers and conformance testing from USAID DELIVER Project confirmed the compliance of both LLIN brands on all physical and chemical product quality parameters (mesh size, dimensional stability on washing, netting burst strength, and total deltamethrin content).

² WHO policy and practice Monitoring the durability of LLIN

<http://www.searo.who.int/publications/journals/seajph/seajphv3n1p81.pdf>

³ WHO: Guidelines for monitoring the durability of long-lasting insecticidal mosquito nets under operational conditions http://apps.who.int/iris/bitstream/10665/44610/1/9789241501705_eng.pdf

⁴ Annual parasite incidence (API) of Tamu Township in 2015 was 1.66 and 1.19 in 2016 according to NMCP.

4.3 Design summary

This study follows guidance from PMI for LLIN durability monitoring (www.durabilitymonitoring.com), this is a prospective study following a cohort of LLINs distributed through a mass campaign in December 2015. During the campaign, 7,000 DawaPlus 2.0 and 7,000 PermaNet 2.0 were distributed in 32 villages of Tamu Township in December 2015. Within six months following the mass campaign, a representative sample of campaign nets from the study location was identified through a cluster household survey with all campaign nets from consenting households forming the study cohort. Households were selected using simple random sampling from household lists established on the day of the survey. The sample included 15 clusters for each brand of LLIN. A cluster referred to a village or a section of village with a size of 50-200 households. From each cluster, 10 households were selected, resulting in a total sample of 300 households (150 households per brand). The sample size was targeted at detecting a deviation of 10-11%-points from the expected 50% survival after three years comparing the brands.

All campaign nets in each study household were labeled with a unique identifier at baseline and their presence and physical condition were assessed at baseline and 12-, 24-, and 36-month follow up. Net use and attitude were also assessed at each follow-up visit.

At the 12-month and 24-month assessments, sub-samples of campaign nets were selected for insecticide effectiveness testing (bio-assays). In addition, chemical residue testing was conducted at the 24-month assessment. At the 36-month assessment, sub-samples of cohort LLINs were randomly selected for both bio-assays and chemical residue testing.

4.4 Field work

The PSI Myanmar research department conducted a refresher field team training from November 27th to 3rd December 2018, prior to the field data collection. The training covered the study design and protocol, sampling procedures, previous results, questionnaires, and hole assessments.

The data collection team was comprised of one field monitoring supervisor and four field teams deployed from PSI Myanmar, each team comprising a team leader and two data collectors. The field teams were supported by local staff from NMCP and Ministry of Health and Sports. In total, data collection lasted 14 days.

For insecticidal assessment, field teams collected two cohort nets per cluster using systematic random sampling from the list of remaining cohort nets at 24-month assessment, resulting in 60 in total. If the household refused or a selected net was not found, they selected and collected another random cohort net.

Bio-assay assessment was conducted at VBDC laboratory in Yangon in accordance with WHO guidelines. Chemical residue testing on the same nets was carried out at the laboratory of Department of Food and Drug Administration in Nay Pyi Taw.

4.5 Data management

Data collection was done via Android tablets using Open Data Kit (ODK) software, offline version. Every household was visited by three interviewers for questionnaire and hole measurement. One interviewer conducted the questionnaire with the tablet and used a notebook to record the answers, especially for open-ended questions. At the same time, the other two team members performed hole measurement for

the cohort LLINs. Then, they checked the entered data in the tablet before leaving the household. The datasets were then exported to Stata format. All data cleaning and analysis was done using Stata version 14.2.

4.6 Analysis

All analysis followed the guidelines on data preparation, cleaning, and management, which were developed by VectorWorks and Tropical Health. Slight adjustments and modifications were made to the syntax files to reflect the study design in Myanmar, and all the changes were documented. For continuous variables arithmetic means were used to describe the central tendency and the t-test for comparison of groups for normally distributed data. Otherwise, median and non-parametric tests were used. Proportions were compared by contingency tables and the Chi-squared test used to test for differences in proportions. Wealth index was computed at the household level using principal component analysis (PCA). The variables for household amenities, assets, livestock, and other characteristics that are related to a household's socioeconomic status were used for the computation.

Household attitudes towards care and repair were measured using Likert score questions; these are summarized by recoding the four-level Likert scale to have a value of -2 for "strongly disagree", -1 for "disagree", +1 for "agree" and +2 for "strongly agree". These attitude scores for each respondent were then summed and divided by the number of statements to calculate an overall attitude score for which 0 represents a neutral result and positive values a positive result. Respondents were asked various questions regarding their action on net supply and use, and about net care and repair. For calculation of confidence intervals around estimates, the intra- and between-cluster correlation has been taken into account.

Bio-assay assessments of 60 collected nets were conducted in VBDC laboratory, Yangon. From each collected net, a piece of 30x30cm was cut from the five sites (roof, four sides). The test used was the cone assay. For the tests insectary-raised, 2-5 day old, unfed females of a pyrethroid sensitive strain were used (*Aedes aegypti* (Rockefeller) strain). No wild-caught mosquitoes were used. Five mosquitoes at a time were introduced into WHO cones and four cones applied simultaneously onto the net sample with a three-minute exposure of the vectors. After exposure, females were grouped into batches of 20 in 200 mL plastic cups and maintained at $28^{\circ}\text{C} \pm 2^{\circ}\text{C}$ and $50\% \pm 10\%$ relative humidity with honey solution provided. For each series a control was run with no exposure and results were used if control mortality was less than 5%. Numbers of mosquitoes knocked down were recorded at 30 and 60 minutes and knock down rate at 60 minutes (KD60) calculated. Percentage mortalities were recorded after 24 hours using immediate and delayed mortality as defined by WHO guidelines. For each collected net, the percentage of mosquitoes knocked down at 60 minutes after exposure (KD60), and percentage mortality after 24 hours were calculated.

Chemical residue testing of Deltamethrin for 60 collected nets (30 each for PermaNet 2.0 and DawaPlus 2.0) were conducted in pharmaceutical chemical laboratory, Department of Food and Drug Administration (DFDA), Nay Pyi Taw, Myanmar (ISO/IEC 17025: 2017 accredited laboratory). From each collected net, a piece of 30x30cm was cut from the five sites (roof, four sides) for chemical residue testing. The testing was performed according to the reference method: determination of deltamethrin content by High-Performance Liquid Chromatography (HPLC) (CIPAC/LN/(M)/3). It was carried out using the calibrated Agilent Infinity 1260 HPLC system and the deltamethrin British Pharmacopoeia (BP) reference standards. A total of 300 tests (5

pieces per net) were conducted, and the average remaining concentration for each net was calculated in g/kg unit. Then, the average remaining percentage of deltamethrin was calculated against the factory reference values: 1.4 g/kg for PermaNet 2.0 and 2.0 g/kg for DawaPlus 2.0.

4.7 Ethical Clearance

Ethical clearance was obtained from the Institutional Review Board (IRB) of Johns Hopkins University (JHU), Baltimore, USA (IRB No. 6970), and Ethical Review Committee of Department of Medical Research, Ministry of Health and Sports, Myanmar (Ethics/DMR/2016/046A). Extension of local ethical approval was applied to Ethical Review Committee of Department of Medical Research yearly, and approval for this round was received on December 2018 (Ethics/DMR/2016/046E/2018). Respective extension from JHU IRB was also obtained.

5 Results

In this 36-month assessment, nine households were lost to follow-up, out of 272 households still active after 24 months. Out of 263 interviewed households, only 242 households still had cohort nets (Figure 1a). The knowledge and attitude scores on net handling were similar in all four rounds of assessment. The overall attrition rate increased to 34.2% from 19.9% in the baseline, mostly due to nets being given away (24.5%). Regarding physical integrity, 93.2% of cohort nets present for 36-month follow-up were still in serviceable condition. The proportion of nets surviving in serviceable condition, including nets discarded due to wear and tear, dropped to 81.7% in this assessment.

5.1 Sample

All 272 active households from the previous 24-month assessment were revisited. In this assessment, 13 households moved away and were lost to follow-up (Figure 1a and 1b). Out of 582 cohort nets recruited at the baseline, 426 nets (73.2%) were still present at the households, 18 nets (3.1%) were used by family members elsewhere, and 16 nets (2.75%) were not found at home for unknown reasons in this assessment. Moreover, 56 (9.6%) nets were discarded, 38 (6.5%) nets were given away, 12 (2.1%) nets were lost for unknown reasons, and 16 (2.7%) nets were lost from 13 households that moved away (Figure 5 and 6).

Figure 1a: Follow-up status of households recruited at baseline at PermaNet 2.0 Site

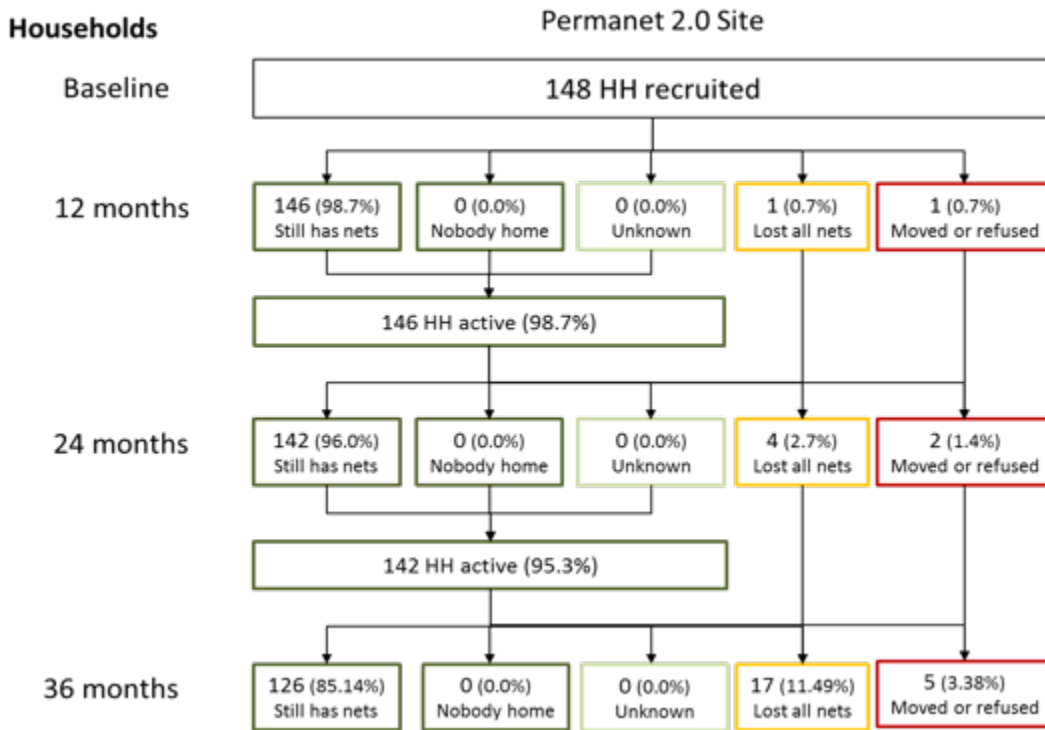
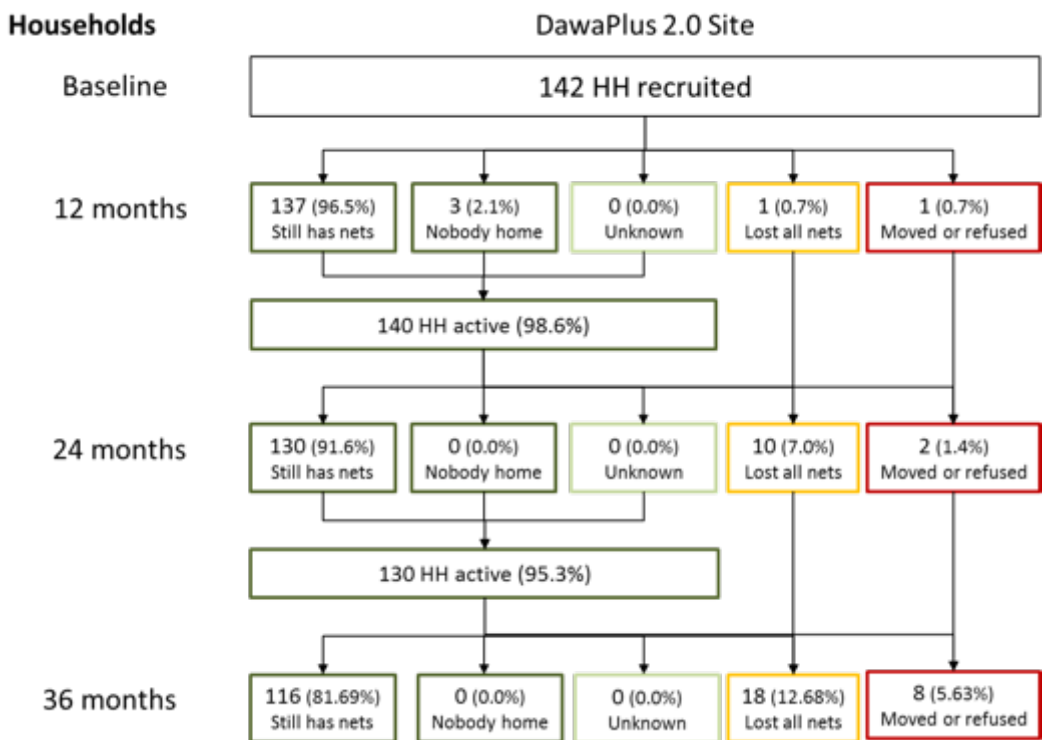


Figure 1b: Follow-up status of households recruited at baseline at DawaPlus 2.0 Site



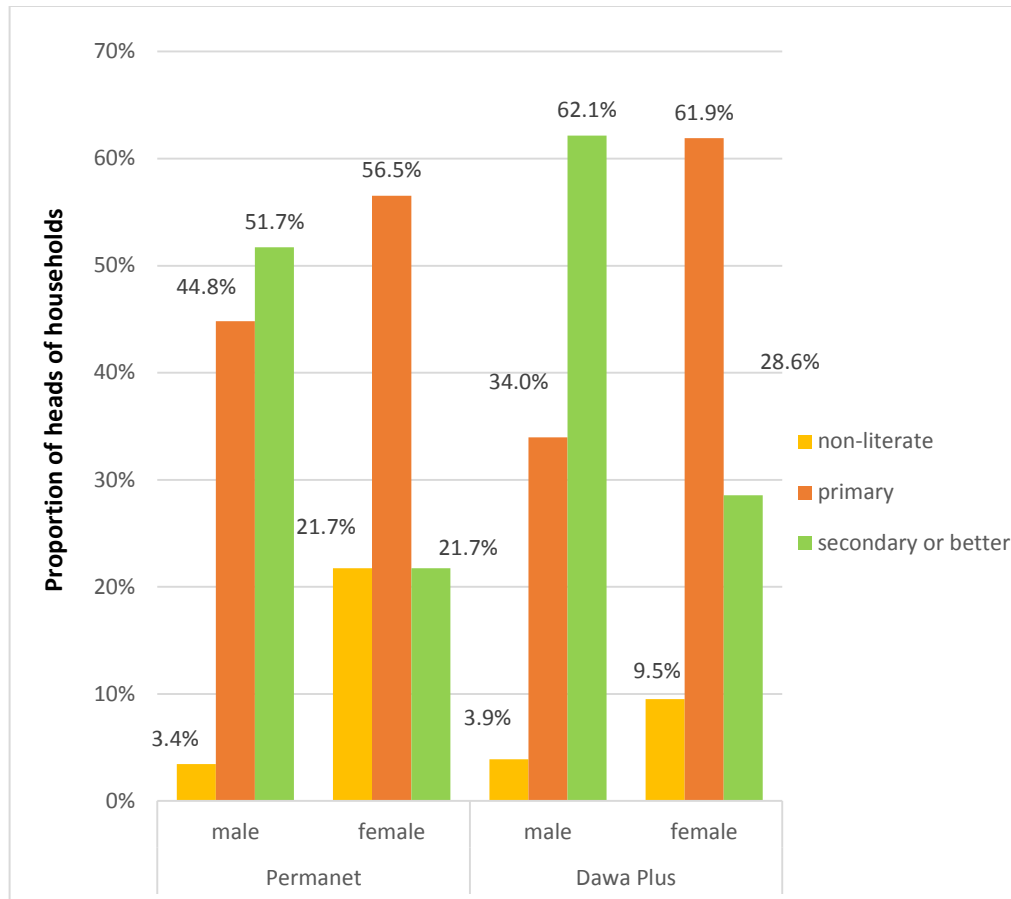
5.2 Socio-Demographic characteristics

Comparing those households that participated in the baseline and 36 month surveys (N=263) the data was explored for any demographic or socio-economic changes during the three years of the study.

Average number of household members remained constant in Tamu with 5.6 in the baseline and 5.4 in the 36-month survey. The proportion of households headed by females slightly increased from 11.8% to 16.7% in the 36-month survey. As would be expected, the mean age of the heads of household increased about three years during the study. Mean age was 51 years in PermaNet 2.0 site and 50.2 years in DawaPlus 2.0 site at the time of the 36 month survey. Population structure as measured by the proportion of children less than five years of age also did not change much over time and was 10.4% in the baseline and 9.0% in the 36-month survey.

Educational status of the head of household also did not change over time. However, it was significantly lower for females than males in both sites ($p < 0.001$). There were a few differences between two sites, with slightly higher educational status of female household heads in the DawaPlus 2.0 site (Figure 2a).

Figure 2a: Educational status of heads of household by gender and site



For socio-economic indicators there was no remarkable change in the three years of the durability monitoring for those households that were included in the baseline as well as 36-month survey for both sites. The only significant change was an increase in access to safe water in PermaNet 2.0 site from 23.0% in the baseline to 49.6% in the 36-month assessment (Table 1).

Between the two sites, all indicators on socio-economic status of the households in PermaNet 2.0 and DawaPlus 2.0 sites were similar. This situation was best shown by the ownership of livestock and access to land for horticulture or agriculture (Figure 2b).

Figure 2b: Economic resources of households by site at 36 months survey

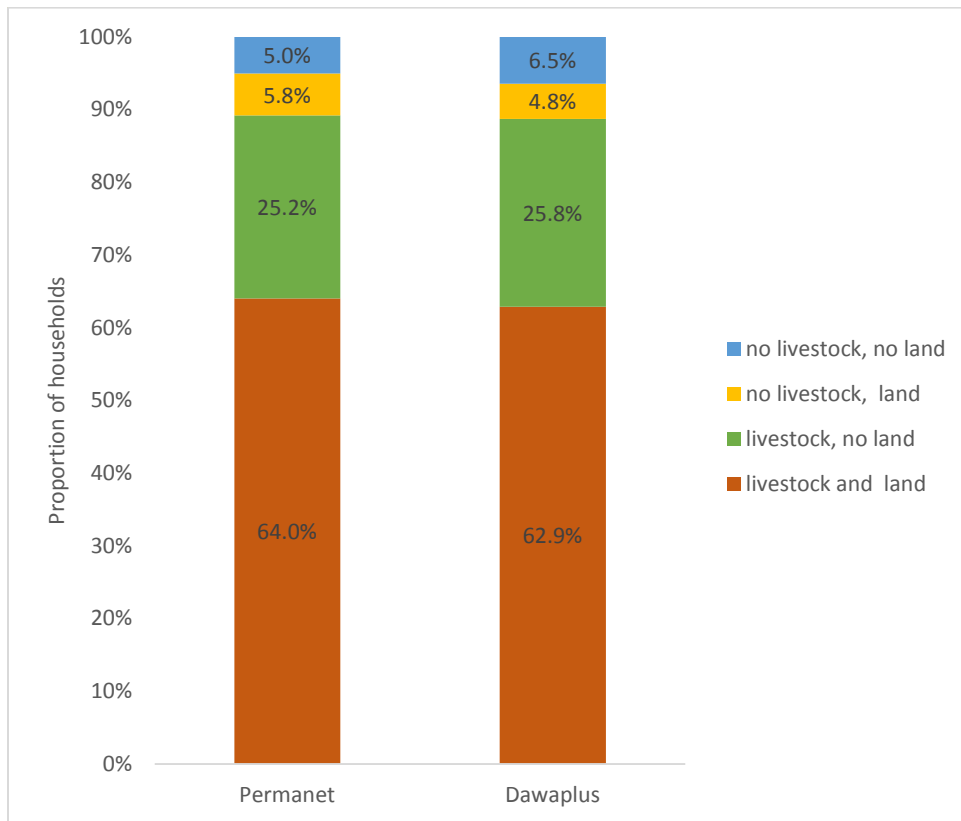


Table 1: Household characteristics and assets (N=263)

Variable and site	Baseline	36 months
PermaNet 2.0		
Roof (sheets/tile)	58.3%	68.4%
Cooking fuel (firewood)	74.1%	91.4%
Access to safe water	23.0%	49.6%
Access to latrine	99.3%	99.3%
Radio	27.3%	19.4%
Mobile phone	82.7%	87.8%
Any transport	71.2%	78.4%
Animal husbandry	91.4%	89.2%
DawaPlus 2.0		
Roof (sheets/tile)	60.5%	71.0%
Cooking fuel (firewood)	83.1%	82.3%
Access to safe water	43.6%	40.3%
Access to latrine	98.4%	99.2%
Radio	32.3%	22.6%
Mobile phone	77.4%	82.3%
Any transport	78.2%	80.7%
Animal husbandry	90.3%	88.7%
Total		
Roof (sheets/tile)	59.3%	69.2%
Cooking fuel (firewood)	78.3%	87.1%
Access to safe water	32.7%	45.3%
Access to latrine	98.9%	99.2%
Radio	29.7%	20.9%
Mobile phone	80.2%	85.2%
Any transport	74.5%	79.5%
Animal husbandry	90.9%	89.0%

5.3 Determinants of Durability

Factors that have previously been shown to be associated with net durability were explored; these can be divided into those regarding environmental factors, net handling and knowledge and attitudes toward nets and net care and repair. In Table 2, factors immediately involving the sleeping place environment in comparison to baseline, 12-month, 24-month and 36-month assessments were shown. Food storage in the sleeping room, always cooking in the sleeping room and rodents observed in last 6 months decreased in this assessment from 24-month assessment (Table 2).

Table 1: Household risk factors

Variable and site	Baseline	12 months	24 months	36 months
PermaNet 2.0	N=148	N=147	N=146	N=139
Ever store food in sleeping room	56.8%	55.1%	37.0%	25.2%
Cook in sleeping room				
never	73.7%	84.4%	87.7%	83.5%
sometimes	1.4%	1.4%	2.1%	4.3%
always	25.0%	14.3%	10.3%	12.2%
Rodents observed (last 6 m)	69.6%	77.6%	82.2%	79.1%
DawaPlus 2.0	N=142	N=138	N=140	N=124
Ever store food in sleeping room	62.0%	61.6%	49.3%	33.1%
Cook in sleeping room				
never	82.4%	81.9%	85.0%	87.1%
sometimes	2.1%	2.2%	2.9%	3.2%
always	15.5%	15.9%	12.1%	9.7%
Rodents observed (last 6 m)	62.7%	79.0%	80.0%	65.3%
Total	N=290	N=285	N=286	N=263
Ever store food in sleeping room	59.3%	58.3%	43.0%	28.9%
Cook in sleeping room				
never	77.9%	83.2%	86.4%	85.2%
sometimes	1.7%	1.8%	2.5%	3.8%
always	20.3%	15.1%	11.2%	11.0%
Rodents observed (last 6 m)	66.2%	78.3%	81.1%	72.6%

Similar to the baseline, 12-month and 24 month assessment, the majority of campaign nets were hung over a mat or the ground (Figure 3). Durability risk factors involving the handling of the nets are shown in Table 3. Letting cohort nets hang loose without folding or tying up was as high as 83.1% in baseline and decreased to 52.4% in the 12-month assessment and 39.4% in 24-month assessment but increased again to 66.3% in the 36-month assessment. The proportion of cohort nets ever washed increased from 13.6% in the baseline to 56.7% at 12 months, 79.7% at 24 months and 86.4% at 36 months. Median wash frequency within the past 6

months of data collection and the use of a detergent were similar in all three assessments. Drying of washed nets on the bush/fence can cause damage. In comparison with the 24 month assessment, the proportion of households that practiced such behavior increased in this assessment (10.3% in baseline, 16.6% at 12-month, 6.6% at 24-month and 9.5% at 36-month), but was similar to earlier data collection rounds.

Figure 3: Main type of sleeping place for campaign nets if used

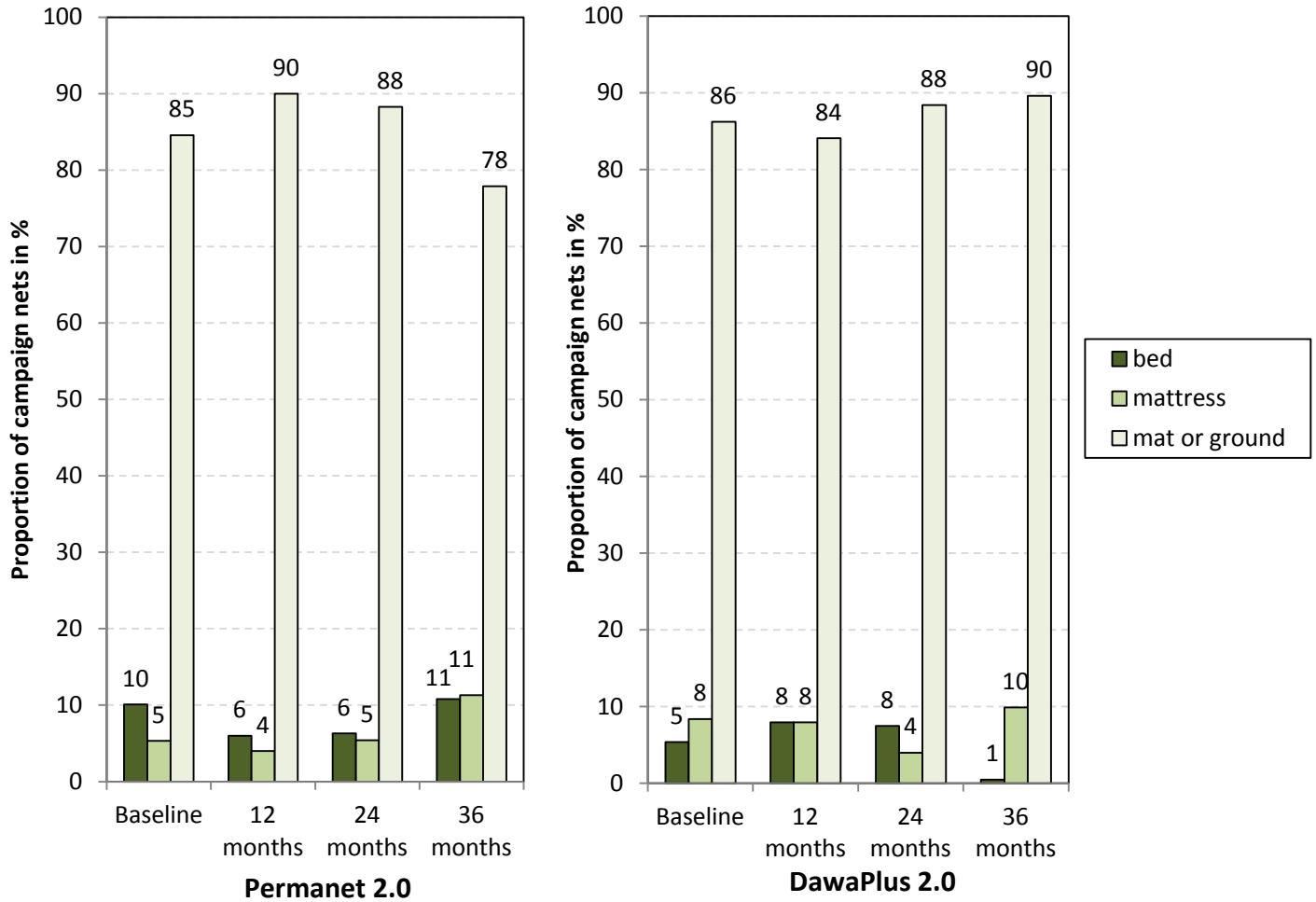


Table 3: Handling of campaign nets

Variable and Site	Baseline	12 months	24 months	36 months
PermaNet 2.0				
Hanging nets folded or tied*	12.2%	43.1%	56.0%	32.4%
Hanging nets NOT folded or tied*	87.8%	56.9%	44.0%	67.6%
Net ever washed**	10.5%	56.6%	78.5%	85.1%
Net dried on fence or bush***	9.1%	9.9%	7.4%	10.5%
Median washed last 6 m***	1	1	1	1
Used detergent/bleach for wash***	90.9%	93.2%	93.0%	93.5%
DawaPlus 2.0				
Hanging nets folded or tied*	22.4%	53.1%	67.8%	36.1%
Hanging nets NOT folded or tied*	77.6%	46.9%	32.2%	63.9%
Net ever washed**	17.2%	56.8%	81.3%	88.0%
Net dried on fence or bush***	11.1%	24.6%	5.6%	8.3%
Median washed last 6 m***	1	1	1	1
Used detergent/bleach for wash***	95.6%	95.5%	98.3%	97.0%
Total				
Hanging nets folded or tied*	16.9%	47.4%	60.6%	33.7%
Hanging nets NOT folded or tied*	83.1%	52.6%	39.4%	66.3%
Net ever washed**	13.6%	56.7%	79.7%	86.4%
Net dried on fence or bush***	10.3%	16.6%	6.6%	9.5%
Median washed last 6 m***	1	1	1	1
Used detergent/bleach for wash***	93.6%	94.3%	95.4%	95.1%

Baseline: *N=307 (only hanging): **N=582 (all campaign nets): *** N=78 (only ever washed)

12 Months: *N=264 (only hanging): **N=522 (all campaign nets): *** N=296 (only ever washed)

24 Months: *N=231 (only hanging): **N=493 (all campaign nets): *** N=393 (only ever washed)

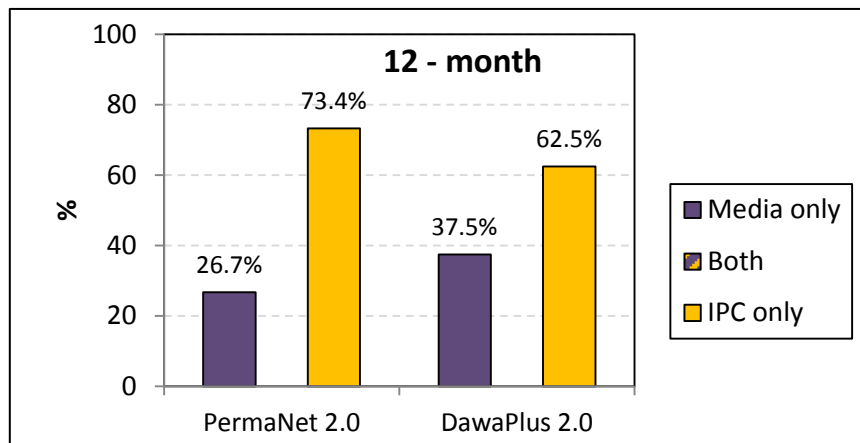
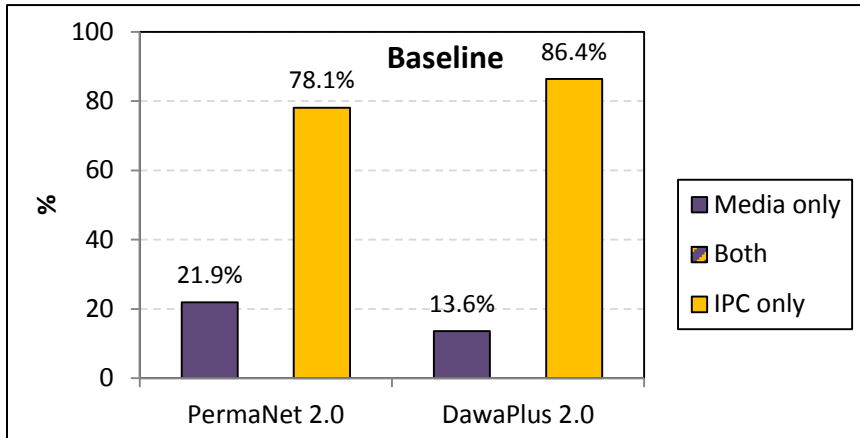
36 Months: *N=172 (only hanging): **N=426 (all campaign nets): *** N=368 (only ever washed)

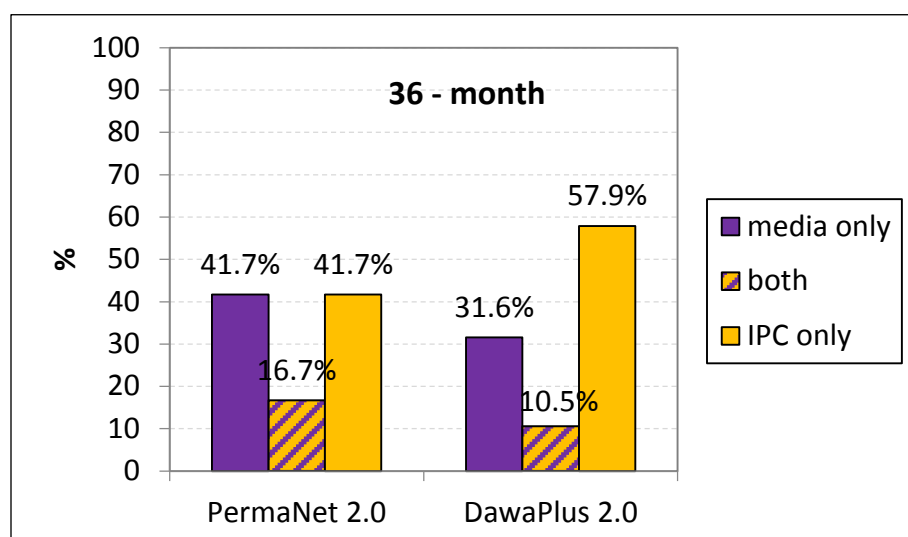
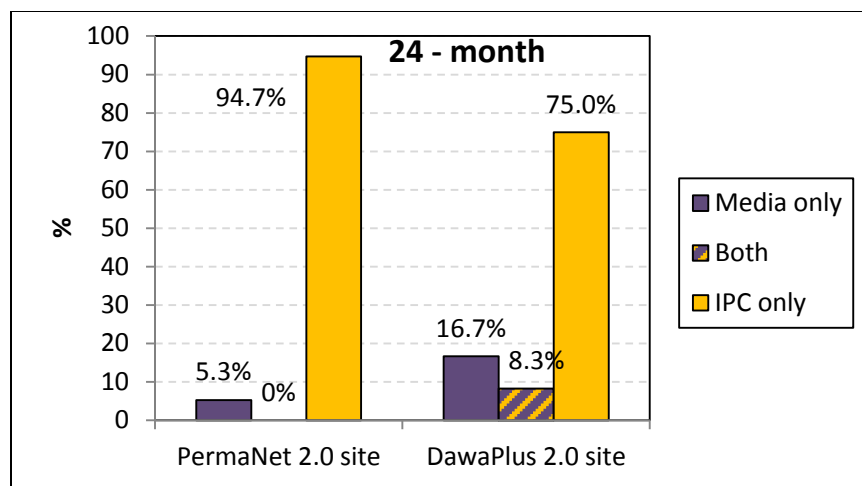
Overall exposure to net related messages within the past six months slightly decreased from 18.6% in the baseline to 16.4%, but increased in this round compared with the 24-month (10.8%) (Table 4). Among those who reported exposure to messages, the source of information came mainly from interpersonal communicators (IPC) (48.8%), from the media (37.2%), and from both IPC and media, (14.0%). The proportion of households that received messages from IPC fluctuated across four assessments in both sites (Figure 4).

Table 2: Exposure to messages on nets in the last six months

Variable and site	Baseline	12 months	24 months	36 months
PermaNet 2.0	N=148	N=147	N=146	N=139
Any exposure last 6m	21.6%	10.9%	13.0%	17.3%
Mean information sources (if exposed)	1	1	1	1
Type of media				
media only	21.9%	26.7%	5.3%	41.7%
both	0.0%	0.0%	0.0%	16.7%
IPC only	78.1%	73.3%	94.7%	41.7%
Exposure by wealth tertile				
Highest	32.7%	15.4%	13.2%	20.0%
Middle	10.4%	6.4%	11.1%	18.4%
Lowest	20.8%	10.4%	14.6%	13.3%
DawaPlus 2.0	N=142	N=138	N=140	N=124
Any exposure last 6m	15.5%	12.3%	8.6%	15.3%
Mean information sources (if exposed)	1	1	1	1
Type of media				
media only	13.6%	37.5%	16.7%	31.6%
both	0.0%	0.0%	8.3%	10.5%
IPC only	86.4%	62.5%	75.0%	57.9%
Exposure by wealth tertile				
Highest	15.0%	15.0%	6.8%	23.3%
Middle	13.5%	13.5%	2.0%	12.8%
Lowest	18.0%	8.7%	17.4%	9.5%
Total	N=290	N=285	N=286	N=263
Any exposure last 6m	18.6%	11.6%	10.8%	16.4%
Mean information sources (if exposed)	1	1	1	1
Type of media				
media only	18.5%	32.3%	9.7%	37.2%
both	0.0%	0.0%	3.2%	14.0%
IPC only	81.5%	67.7%	87.1%	48.8%
Exposure by wealth tertile				
Highest	25.0%	15.2%	10.3%	21.6%
Middle	12.0%	10.1%	6.3%	15.9%
Lowest	19.4%	9.6%	16.0%	11.5%

Figure 4. Types of information sources if any exposure in the previous six months





Respondents were asked what messages they were able to recall pertaining to net care and use. Recall of the message “used net (every) night” and “net prevents malaria” increased in this fourth assessment compared with the previous ones. The message, “repair net”, showed an increasing trend overall. However, “care for net” decreased compared to baseline, 12-month and 24-month assessment. Overall attitude scores on nets and net care/repair were still highly positive for more than half of the respondents in both sites (Table 5).

Table 5: Attitudes towards nets and care & repair

Variable and site	Baseline	12 months	24 months	36 months
PermaNet 2.0				
Recalled “use net (every) night”	59.4%	56.3%	47.4%	70.8%
Recalled “nets prevent malaria”	12.5%	25.0%	5.3%	25.0%
Recalled “care for net”	28.1%	56.3%	52.6%	25.0%
Recalled “repair net”	3.1%	6.3%	10.5%	12.5%

Attitude score nets				
mean	1.3	1.26	1.33	1
% with score >1	69.6%	65.3%	71.9%	51.8%
Attitude score care & repair				
mean	1	0.93	1.02	1.35
% with score >1	50.0%	49.0%	53.4%	71.9%
DawaPlus 2.0				
Recalled “use net (every) night”	72.7%	64.7%	75.0%	63.2%
Recalled “nets prevent malaria”	22.7%	11.8%	8.3%	26.3%
Recalled “care for net”	22.7%	52.9%	41.7%	42.1%
Recalled “repair net”	4.5%	11.8%	8.3%	10.5%
Attitude score nets				
mean	1.3	1.23	1.41	1.04
% with score >1	68.3%	61.6%	74.3%	54.0%
Attitude score care & repair				
mean	1.08	0.96	1.05	1.49
% with score >1	61.3%	47.8%	53.6%	75.8%
Total				
Recalled “use net (every) night”	64.8%	60.6%	58.1%	67.4%
Recalled “nets prevent malaria”	16.7%	18.2%	6.5%	25.6%
Recalled “care for net”	25.9%	54.6%	48.4%	32.6%
Recalled “repair net”	3.7%	9.1%	9.7%	11.6%
Attitude score nets				
mean	1.3	1.25	1.37	1.02
% with score >1	69.0%	63.5%	73.1%	52.9%
Attitude score care & repair				
mean	1.04	0.95	1.04	1.42
% with score >1	55.5%	48.4%	53.5%	73.8%

There was a steady increase in the proportion of households which reportedly ever had holes in their nets, with an exception of a non-significant drop in at the 12-month assessment, to 68.9% and 74.1% in both in 24-month and 36-month assessment, respectively (Table 6). The proportion of households that reported that they had ever discussed care and repair of nets doubled from baseline in 12-month, 24-month and 36-month assessments (Baseline=21%, 12 months=44.2%, 24 months=50.7% and 36 months=39.5%). Among the households with reported prior experience of holes in their nets, proportions of households that had ever repaired the holes slightly rose in this assessment.

Similar to the previous assessments, stitching was the main method of net repair (95.4%), and holes were repaired by one of the household members. Major reported reasons for not repairing holes (N = 108) were not having time (51.9%), and holes being too small (20.4%).

Among all observed cohort nets with any holes, proportion of nets with repairs increased to 32.2%, from 25.5% at 24-month assessment.

Table 3: Household experience with care and repair of any nets and actual repairs made in damaged campaign nets

Variable and site	Baseline	12 months	24 months	36 months
PermaNet 2.0				
Ever experienced holes in net	54.1%	49.7%	67.8%	76.3%
Ever discussed care and repair	18.9%	39.5%	49.3%	33.1%
Ever repaired (if had holes)*	53.8%	54.8%	37.4%	49.1%
Damaged campaign nets repaired (if had holes in hole assessment)**	15.9%	37.1%	25.2%	32.2%
DawaPlus 2.0				
Ever experienced holes in net	58.5%	48.6%	70.0%	71.8%
Ever discussed care and repair	23.2%	49.3%	52.1%	46.8%
Ever repaired (if had holes)*	43.4%	61.2%	40.8%	39.3%
Damaged campaign nets repaired (if had holes in hole assessment)**	18.2%	27.9%	25.9%	27.8%
Total	N=290	N=285	N=286	N=263
Ever experienced holes in net	56.2%	49.1%	68.9%	74.1%
Ever discussed care and repair	21.0%	44.2%	50.7%	39.5%
Ever repaired (if had holes)*	48.5%	57.9%	39.1%	44.6%
Damaged campaign nets repaired (if had holes in hole assessment)**	17.1%	32.8%	25.5%	30.1%

Baseline: *N=168 (If had holes): **N=88 (if had holes in hole assessment)

12 months: *N=140 (If had holes): **N=235 (if had holes in hole assessment)

24 months: *N=197 (If had holes): **N=314 (if had holes in hole assessment)

36 months: *N=195 (If had holes): **N=339 (if had holes in hole assessment)

5.4 Nets and Net Use

Across the four assessments, the proportion of cohort nets which were found hanging was slightly higher in PermaNet site than DawaPlus site. It was found that no nets were sealed in the package in both sites in this

assessment. The proportions of cohort nets that were used last night, and every night in the last week, decreased slightly in this round, particularly at the DawaPlus site. (Table 7).

Table 7: Hanging and use of campaign nets from cohort

Variable	Baseline	12 months	24 months	36 months
PermaNet 2.0				
Hanging	52.1%	52.8%	51.5%	47.2%
Taken down or stored	10.5%	44.8%	46.0%	52.8%
Still in package	37.5%	2.5%	2.6%	0.0%
Used last night	56.5%	52.5%	52.6%	48.9%
Used every night (last week)	52.4%	50.7%	51.8%	47.2%
DawaPlus 2.0				
Hanging	53.6%	47.9%	41.1%	31.9%
Taken down or stored	11.6%	51.3%	58.9%	68.1%
Still in package	34.8%	0.9%	0.0%	0.0%
Used last night	55.8%	48.3%	45.7%	33.5%
Used every night (last week)	51.7%	48.3%	44.8%	31.9%
Total	N=582	N=522	N=493	N=426
Hanging	52.8%	50.6%	46.9%	40.4%
Taken down or stored	11.0%	47.7%	51.7%	59.6%
Still in package	36.3%	1.7%	1.4%	0.0%
Used last night	56.2%	50.6%	49.5%	42.0%
Used every night (last week)	52.1%	49.6%	48.7%	40.4%

The proportion of non-cohort nets found hanging was similar to the 24-month assessment in PermaNet site, but it dropped slightly in DawaPlus site. The proportion of non-cohort nets usage also decreased in this assessment (Table 8).

Table 4: Hanging and use of non-cohort nets

Variable	Baseline	12 months	24 months	36 months
PermaNet 2.0				
Hanging	46.8%	36.2%	42.8%	41.2%
Taken down or stored	39.8%	44.6%	40.9%	45.8%
Still in package	3.2%	8.1%	15.3%	9.5%
Used last night	49.2%	38.2%	42.3%	37.9%
Used every night (last week)	46.0%	36.2%	40.6%	36.7%
DawaPlus 2.0				
Hanging	28.1%	34.6%	44.7%	38.2%

Taken down or stored	53.5%	46.4%	43.2%	39.3%
Still in package	7.5%	5.7%	10.1%	13.2%
Used last night	31.3%	36.5%	47.1%	41.0%
Used every night (last week)	30.2%	34.8%	44.0%	38.4%
Total				
Hanging	36.7%	35.4%	43.8%	39.6%
Taken down or stored	47.2%	45.5%	42.1%	42.4%
Still in package	5.5%	6.9%	12.7%	11.4%
Used last night	39.5%	37.4%	44.7%	39.5%
Used every night (last week)	37.4%	35.5%	42.3%	37.6%

The proportion of households that reportedly owned non-campaign nets was similar to the previous assessments. Moreover, almost one-third of households (27%), similar to the 12-month and 24-month assessments, reported that they received those non-campaign nets from the public sector, a marked increase from 9.7% at baseline. Other sources such as private sector or family, friends, or NGO were mentioned in more than half of the households (Table 9).

Table 5: Ownership of non-campaign nets and where households obtained them

Variable	Baseline	12 months	24 months	36 months
PermaNet 2.0				
Household has any other nets	100.0%	93.2%	93.2%	94.2%
Source public sector	8.8%	30.6%	33.6%	21.6%
Source private sector	77.7%	74.8%	69.2%	74.1%
Source family, friends, NGO	41.9%	42.2%	41.8%	54.7%
DawaPlus 2.0				
Household has any other nets	100.0%	92.8%	94.3%	100.0%
Source public sector	10.6%	37.0%	34.3%	33.1%
Source private sector	81.0%	81.2%	80.0%	87.9%
Source family, friends, NGO	52.8%	37.0%	50.7%	55.7%
Total	N=290	N=285	N=286	N=263
Household has any other nets	100.0%	93.0%	93.7%	97.0%
Source public sector	9.7%	33.7%	33.9%	27.0%
Source private sector	79.3%	77.9%	74.5%	80.6%
Source family, friends, NGO	47.2%	39.7%	46.2%	55.1%

There was an increase in the proportion of cohort nets used only by adults from 50.8% in baseline to 55.3% at 12 months, 60.7% at 24 months and 68.2% at 36 months. Consequently, the proportion of cohort nets used by only children, or children and adults decreased from the previous assessments (Table 10). There was a slight increase in usage of non-cohort nets by only children or children and adults (Table 11).

Table 10: Net users of Campaign net cohort

Variable	Baseline	12 months	24 months	36 months
PermaNet 2.0				
Children only*	2.2%	6.0%	4.2%	2.6%
Children + adults**	47.2%	42.0%	41.0%	36.5%
Adults only**	50.6%	52.0%	54.9%	60.9%
DawaPlus 2.0				
Children only*	2.0%	2.6%	2.0%	0.0%
Children + adults**	47.0%	37.7%	29.0%	18.8%
Adults only**	51.0%	59.7%	69.0%	81.3%
Total	N=327	N=264	N=244	N=179
Children only*	2.1%	4.5%	3.3%	1.7%
Children + adults**	47.1%	40.2%	36.1%	30.2%
Adults only**	50.8%	55.3%	60.7%	68.2%

* age 0-9 years; ** includes adolescents 10-19

Table 11: Net users of non-cohort nets

Variable	Baseline	12 months	24 months	36 months
PermaNet 2.0				
Children only*	2.2%	1.3%	0.6%	1.2%
Children + adults**	25.6%	29.8%	32.8%	32.5%
Adults only**	72.2%	68.9%	66.7%	66.3%
DawaPlus 2.0				
Children only*	3.1%	4.7%	1.0%	1.1%
Children + adults**	31.0%	32.4%	35.9%	38.4%
Adults only**	65.9%	62.8%	63.1%	60.5%
Total	N=322	N=299	N=369	N=353
Children only*	2.6%	3.0%	0.8%	1.1%
Children + adults**	27.8%	31.1%	34.4%	35.7%
Adults only**	69.6%	65.9%	64.8%	63.2%

* age 0-9 years; ** includes adolescents 10-19

5.5 Durability of campaign nets

The status of cohort nets recruited at baseline in each site were shown in the Figure 5 and Figure 6.

Figure 5: Status of cohort nets recruited at baseline [PermaNet 2.0 Site]

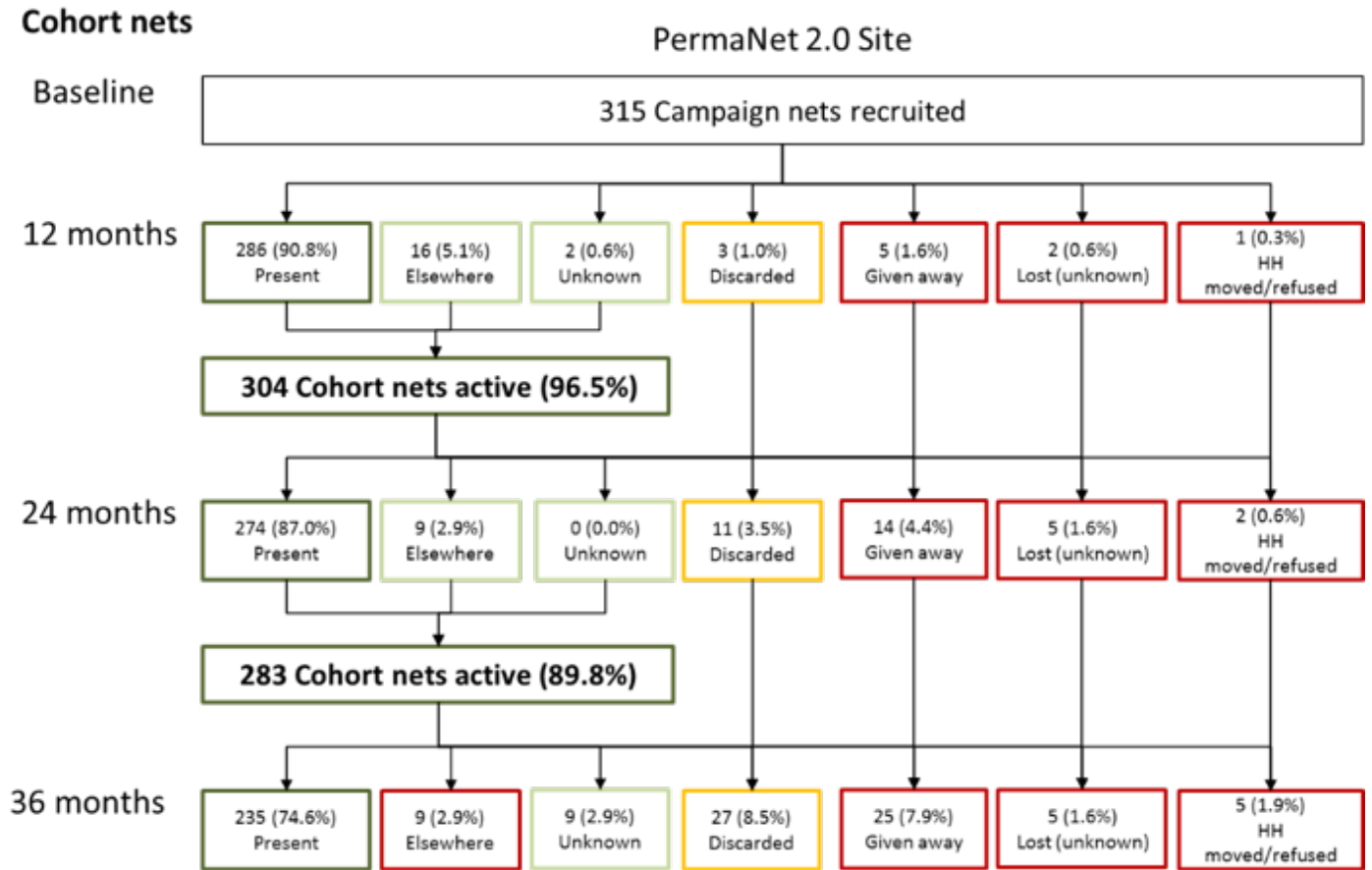
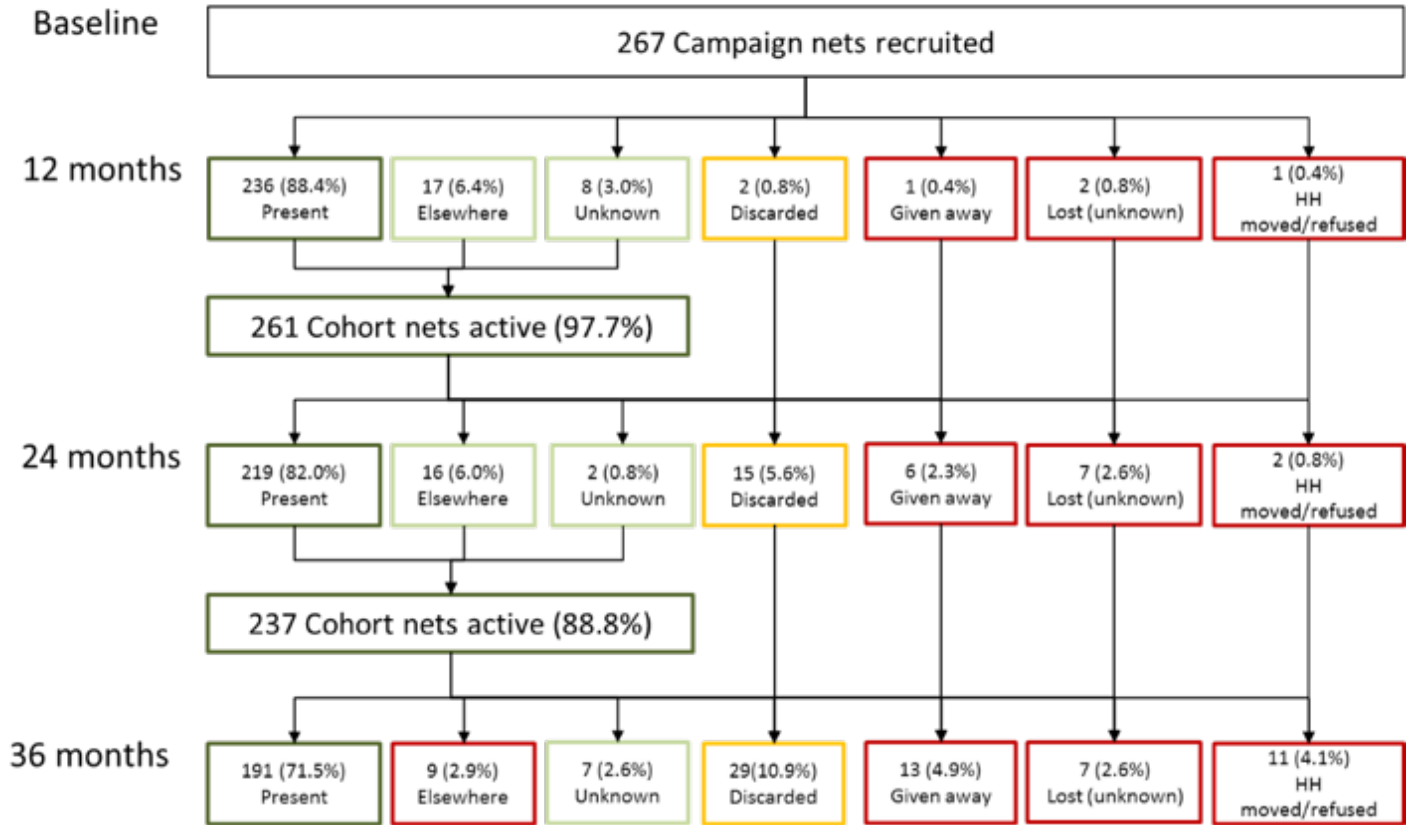


Figure 6: Status of cohort nets recruited at baseline in [DawaPlus 2.0 Site]

Cohort nets

DawaPlus 2.0 Site



Out of 739 nets distributed to the selected households during the campaign, a total of 582 cohort nets were recruited at the baseline assessment, and 426 were successfully followed up at 36-month assessment.

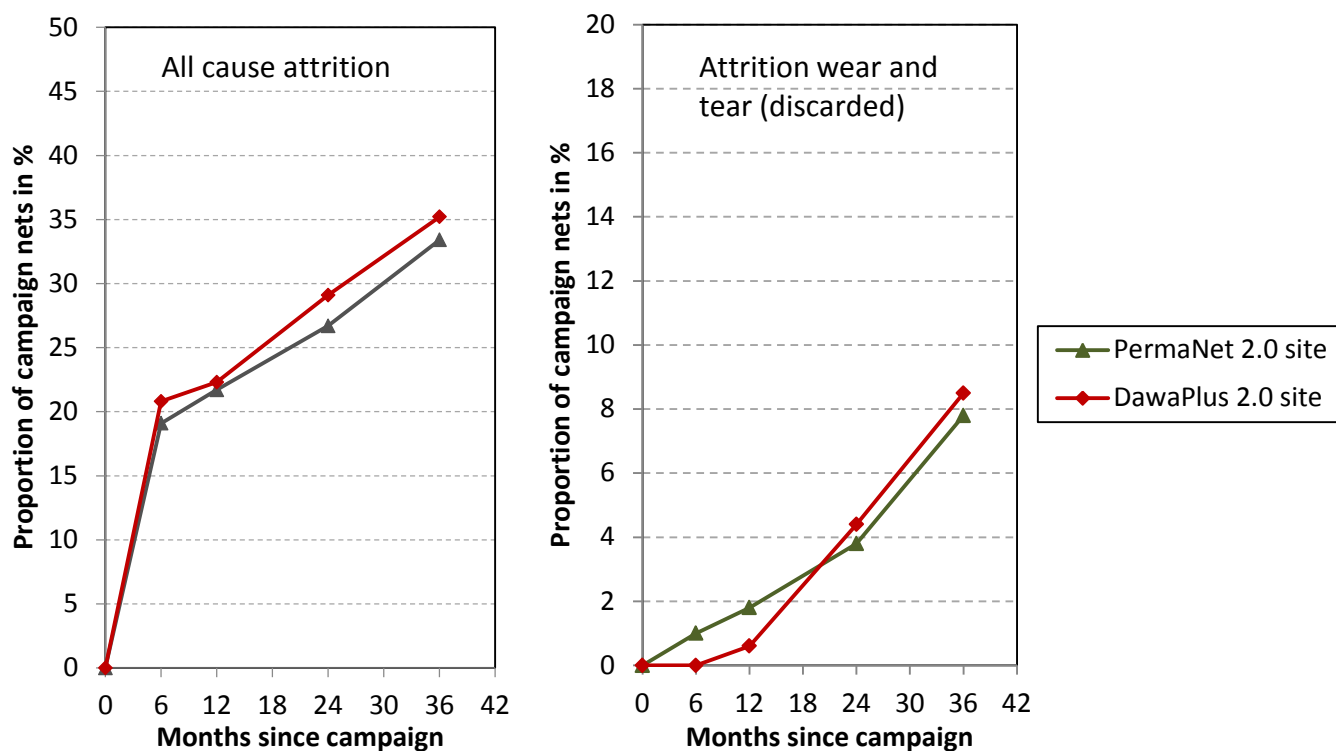
Overall attrition increased to 34.2% from 27.8% in the 24 month assessment, 21.9% in the 12 month assessment and 19.9% in the baseline. The major cause of attrition was due to the nets being given away (24.5%). Attrition due to wear and tear also increased to 8.1% from 4.1% at 24 months, 1.2% at 12 months and 0.5% at baseline (Table 12). There was no significant difference observed in both sites in terms of attrition and its causes.

Table 12: Attrition (including nets lost between campaign and baseline)

Variable	Campaign – baseline (N=739)	Campaign – 12 months (N=739)	Campaign – 24 months (N=739)	Campaign – 36 months (N=739)
PermaNet 2.0				
Given away	18.1%	19.4%	21.6%	24.4%
Discarded (wear & tear)	1.0%	1.8%	3.8%	7.8%
Unknown*	0.0%	0.5%	1.3%	1.3%
Total	19.1%	21.7%	26.7%	33.4%
DawaPlus 2.0				
Given away	20.8%	21.1%	22.6%	24.6%
Discarded (wear & tear)	0.0%	0.6%	4.4%	8.5%
Unknown*	0.0%	0.6%	2.1%	2.1%
Total	20.8%	22.3%	29.1%	35.2%
Total				
Given away	19.4%	20.2%	22.1%	24.5%
Discarded (wear & tear)	0.5%	1.2%	4.1%	8.1%
Unknown*	0.0%	0.5%	1.6%	1.6%
Total	19.9%	21.9%	27.8%	34.2%

*Lost (unknown reason)

Figure 1: Trends in all cause attrition and wear and tear (discarded nets) since distribution



In this assessment, 426 labelled cohort nets were observed. Among these nets, 79.6% had any holes at the time of the survey which is a marked increase from 15.1% at baseline, 45% at 12 months, and 63.7% at 24 months (Table 13). Overall, 66.7% of cohort nets were in good condition, which was a decrease from 96.9% in baseline, 88.7% at 12-month and 77.3% at 24-month assessment. The drop was more pronounced in the DawaPlus site (Baseline=94.4%, 12 months=84.3%, 24 months=68%, 36 months=57.1%). Similarly, the increase in the number of nets that were too torn and consequent decrease in the number of nets in serviceable conditions was more prominent in the DawaPlus site (Table 13).

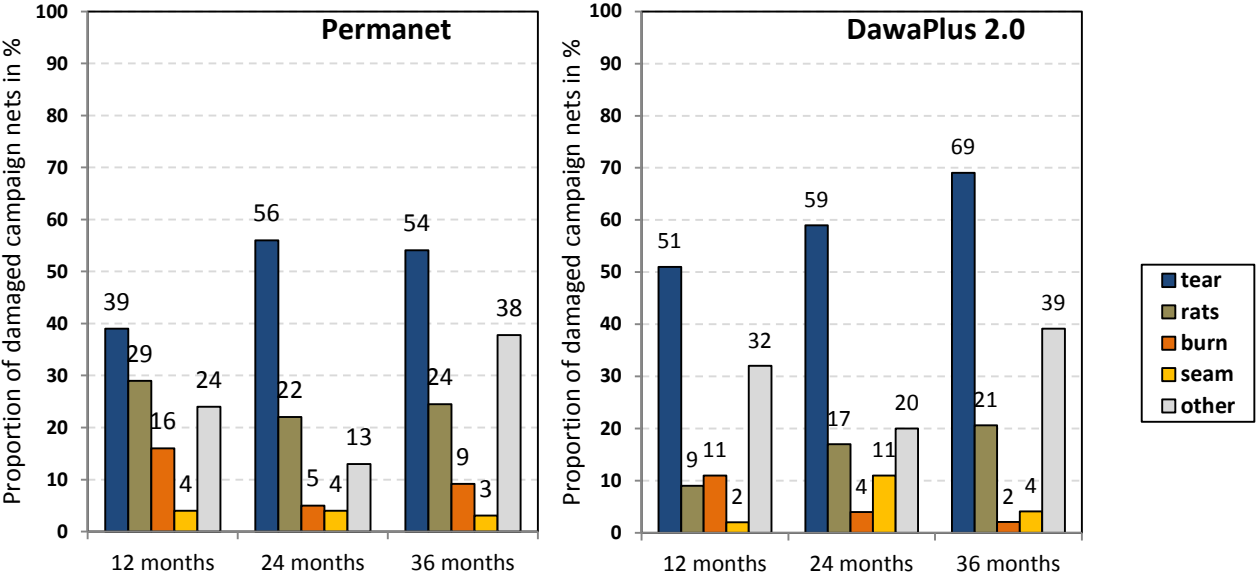
Table 13: Physical condition (integrity) of surviving cohort nets (pHI=proportionate Hole Index)

Variable	Baseline	12 months	24 months	36 months
PermaNet 2.0	N=315	N=286	N=274	N=235
Any holes	14.0%	43.4%	61.0%	76.6%
Median PHI (if any hole)	3.5	4	26	30.5
Good (pHI<64)	99.1%	92.3%	84.7%	74.5%
Too torn (pHI>642)	0.0%	1.1%	2.9%	4.3%
Serviceable (pHI≤642)	100.0%	98.9%	97.1%	95.7%
DawaPlus 2.0	N=267	N=236	N=219	N=191
Any holes	16.5%	47.0%	67.1%	83.3%
Median pHI (if any hole)	24.5	25	54	67
Good (pHI<64)	94.4%	84.3%	68.0%	57.1%

Too torn (pHI>642)	0.4%	3.0%	6.9%	9.9%
Serviceable (pHI≤642)	99.6%	97.0%	93.2%	90.1%
Total	N=582	N=522	N=493	N=426
Any holes	15.1%	45.0%	63.7%	79.6%
Median pHI (if any hole)	23	19	33.5	43
Good (pHI<64)	96.9%	88.7%	77.3%	66.7%
Too torn (pHI>642)	0.2%	1.9%	4.7%	6.8%
Serviceable (pHI≤642)	99.8%	98.1%	95.3%	93.2%

The reported causes of damage were categorized into damage mechanisms and shown in Figure 8, stratified by site. The highest reported damage mechanism was “tear” across both sites and both assessments, followed by ‘rats’, ‘burn’, and ‘seam’. Other reported damage mechanisms included insects such as cockroaches.

Figure 2: Type of damage mechanisms reported for damaged campaign nets (multiple responses)

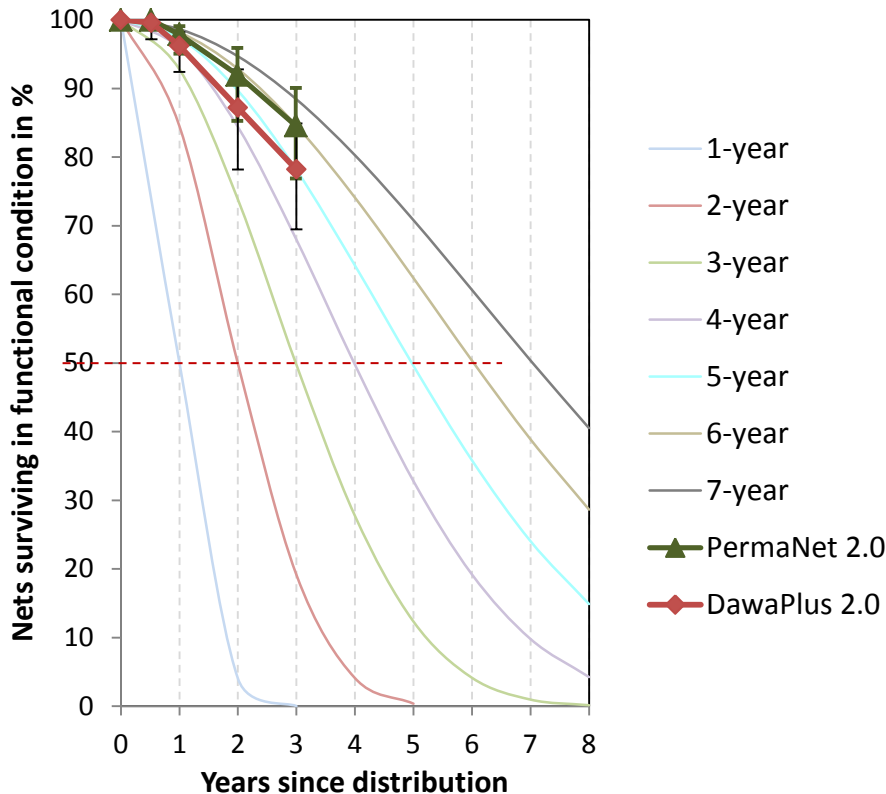


The estimate of campaign nets surviving in serviceable condition was calculated as a combination of attrition and integrity (Table 14). The proportion of nets surviving in serviceable condition showed gradual decrease across four rounds (Baseline=99.8%, 12 months= 97.2%, 24 months=89.9%, 36 months=81.7%). The estimated survival of cohort nets was slightly lower in the DawaPlus site than the PermaNet site (Table 14 & figure 9).

Table 146: Nets surviving in serviceable condition (including nets discarded before baseline)

Variable	Baseline	12 months	24 months	36 months
PermaNet 2.0				
Survival estimate	100.0%	97.9%	92.0%	84.6%
95% CI	-	95.1% - 99.1%	85.3% - 95.9%	76.9% - 90.1%
Only nets ever used				
Survival estimate	100.0%	97.6%	91.4%	84.8%
95% CI	-	94.4% - 99.0%	83.3% - 95.8%	77.0% - 90.3%
DawaPlus 2.0				
Survival estimate	99.6%	96.2%	87.2%	78.2%
95% CI	97.2% - 99.9%	92.4% - 98.2%	78.2% - 92.8%	69.5% - 84.9%
Only nets ever used				
Survival estimate	99.4%	95.5%	87.4%	77.6%
95% CI	95.7% - 99.9%	91.4% - 97.7%	77.7% - 93.2%	68.4% - 84.7%
Total				
Survival estimate	99.8%	97.2%	89.9%	81.7%
95% CI	98.7% - 99.9%	95.0% - 98.4%	84.8% - 93.4%	76.1% - 86.2%
Only nets ever used				
Survival estimate	99.7%	96.7%	89.6%	81.5%
95% CI	97.9% - 99.9%	94.3% - 98.1%	83.8% - 93.4%	75.8% - 86.2%

Figure 3: Estimated net survival in serviceable condition with 95% confidence intervals



5.6 Bio-assay Assessment

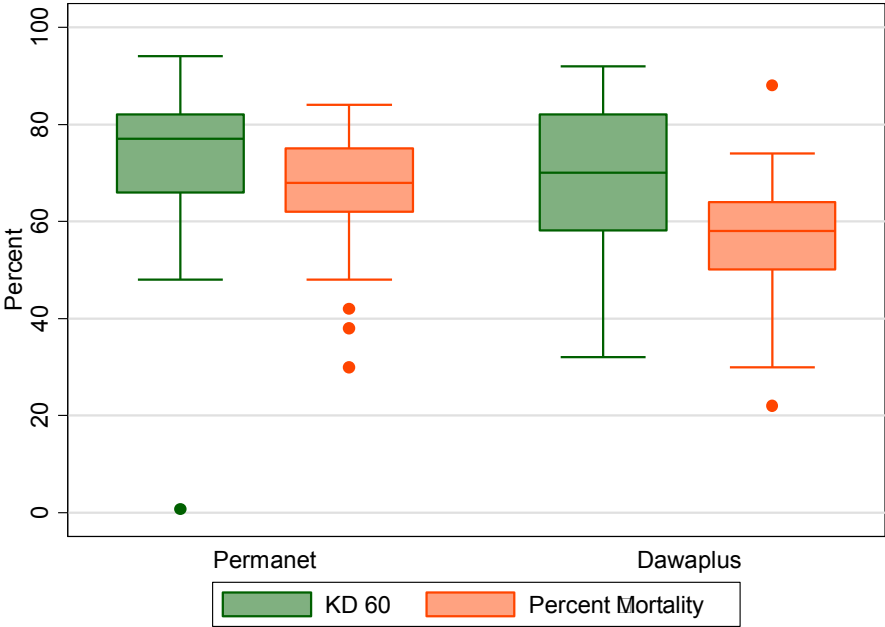
The bio-assay assessment of the two net-brands has been done since the 12-month assessment. The mean and median values for each net brand are shown in table 15 and figure 10. The efficacy of DawaPlus nets was slightly lower than PermaNet nets in this assessment (median KD60: 70% Vs 77%; median 24-hour Mortality: 58% Vs 68%). Only 3.3% of DawaPlus 2.0 nets met WHO optimal effectiveness criteria (24hr mortality \geq 80% or KD60 \geq 95%) whereas 10% of PermaNet nets did so after 36 months. 86.7% of PermaNet nets and 76.7% of DawaPlus nets met minimal effectiveness criteria (24hr mortality \geq 50% or KD60 \geq 75%). Overall, the optimal effectiveness estimate plummeted to 6.7% from 26.7% in the 24-month and 61.7% in the 12-month assessment.

Table 15: Results from bio-assays

Variable	12 months	24 months	36 months
PermaNet 2.0	N=30	N=30	N=30
Knock down 60 minutes			
Mean (95% CI)	80.8% (76.5-85.1%)	75.4% (70.2-80.6%)	72.3% (65.5-79.0%)
Median (IQR)	82% (74.0-88.0%)	76% (70.0-82.0%)	77.0% (66.0-82.0%)
Mortality 24 hours			
Mean (95% CI)	84.2% (80.1-88.3%)	76.7% (71.7-81.8%)	66.2% (60.8-71.6%)
Median (IQR)	87.5% (79.0-91.0%)	74% (68.0-86.0%)	68.0% (62.0-75.0%)
Optimal effectiveness			
Estimate (95% CI)	73.3% (54.1-86.5%)	40% (20.8-62.9%)	10% (3.3-26.8%)
Minimal effectiveness			
Estimate (95% CI)	100.0%	100.0%	86.7% (69.9-94.8%)
DawaPlus 2.0	N=30	N=30	N=30
Knock down 60 minutes			
Mean (95% CI)	78% (73.1-82.9%)	56.7% (52.8-60.6%)	67.8% (60.7-74.8%)
Median (IQR)	78% (68-86%)	58%(52-66%)	70.0% (58.0-82.0%)
Mortality 24 hours			
Mean (95% CI)	75.8% (67.3-84.3%)	66.6% (62.9-70.3%)	57.0% (51.6-62.4%)
Median (IQR)	79.5% (62-90%)	70%(60-76%)	58.0% (50.0-64.0%)
Optimal effectiveness			
Estimate (95% CI)	50% (29.4-70.6%)	13.3% (5.2-30.1%)	3.3% (0.4 - 21.6%)
Minimal effectiveness			
Estimate (95% CI)	90% (64.1-97.8%)	83.3% (66.8-92.6%)	76.7% (56.5-89.3%)
Total	N=60	N=60	N=60
Knock down 60 minutes			
Mean (95% CI)	79.4% (76.3-82.5%)	66.1% (61.3-70.9%)	70.0% (65.0-75.0%)

Median (IQR)	81.0% (72-87.5%)	68% (56-76%)	73.0% (61.0-82.0%)
Mortality 24 hours			
Mean (95% CI)	80.0% (75.3-84.7%)	71.7% (68-75.3%)	61.6% (57.4-65.8%)
Median (IQR)	84.0% (72.5-91.0%)	72% (66-80%)	64.0% (53.0-72.0%)
Optimal effectiveness			
Estimate (95% CI)	61.7% (46.6-74.8%)	26.7% (15.3-42.2%)	6.7% (2.5-16.8%)
Minimal effectiveness			
Estimate (95% CI)	95% (79.6-98.9%)	91.7%(81.3-96.5%)	81.7%(69.0-89.9%)

Figure 4: Results from WHO cone bio-assays: the box plot shows the median (horizontal line), Inter-Quartile-Range (box), adjacent values⁵ (whiskers) and outliers (circles)



At the 36-month assessment, sub-samples of the cohort nets were randomly selected for insecticidal effectiveness testing using bio-assays and chemical residue testing. Almost equal proportions of nets from both sites were hung, folded, or tied. However, the sleeping place for the majority of nets in DawaPlus site was over a mat or the ground while half of them in PermaNet site were so. Regarding net users, all DawaPlus nets were used by adult only whereas PermaNet LLINs were used by adults only, or adolescents, or young child and adults (Table 16).

Table 16: Variables related to handling of bio-assay test nets

⁵ Adjacent values: +/- 1.5 * Inter-Quartile-Range

Variable	12 months	24 months	36 months
PermaNet 2.0	N=30	N=30	N=30
Location found			
hanging loose	46.7%	46.7%	30.0%
hanging folded/tied	13.3%	16.7%	16.7%
Hanging folded/tied if hanged	22.2%	26.3%	35.7%
Type of sleeping place			
bed	13.3%	3.3%	13.3%
mattress	0.0%	3.3%	23.3%
mat/ground	73.3%	93.3%	50.0%
Net users*			
young child only	11.8%	17.9%	0.0%
young child + adult	52.9%	32.1%	6.3%
older child, adolescent	5.9%	10.7%	37.5%
adult only	29.4%	39.3%	56.3%
DawaPlus 2.0	N=30	N=30	N=30
Location found			
hanging loose	40.0%	23.3%	16.7%
hanging folded/tied	33.3%	46.7%	10.0%
Hanging folded/tied if hanged	45.5%	66.7%	37.5%
Type of sleeping place			
bed	6.7%	3.3%	0.0%
mattress	3.3%	0.0%	13.3%
mat/ground	80.0%	96.7%	80.0%
Net users*			
young child only	4.6%	8.0%	0.0%
young child + adult	54.6%	32.0%	0.0%
older child, adolescent	4.6%	8.0%	0.0%
adult only	36.4%	52.0%	100.0%
Total	N= 60	N=60	N=60
Location found			
hanging loose	43.3%	35.0%	23.3%
hanging folded/tied	23.3%	31.7%	13.3%
Hanging folded/tied if hanged	35.0%	47.5%	36.4%
Type of sleeping place			
bed	10.0%	3.3%	6.7%
mattress	1.7%	1.7%	18.3%
mat/ground/grass	76.7%	95.0%	65.0%
Net users*			
young child only	7.7%	13.2%	0.0%
young child + adult	53.9%	32.1%	4.0%
older child, adolescent	5.3%	9.4%	24.0%
adult only	33.3%	45.3%	72.0%

*In 24 month: Permanet = 28, DawaPlus = 25, Total = 53

*In 36 month: Permanet = 16, DawaPlus = 9, Total = 25

Variables related to net use are shown in Table 17. Net usage was lower for DawaPlus LLINs than for PermaNet LLINs. Overall usage was the similar to all cohort nets in the study. In both sites, about 25% of households reported seasonal use of LLINs (use mainly/only in rainy season).

Table 17: Variables related to use of bio-assay test nets

Variable	12 months	24 months	36 months
PermaNet 2.0	N=30	N=30	N=30
Used last night	56.7%	66.7%	53.3%
Use last week			
every night	56.7%	63.3%	56.7%
most nights(5-6)	0.0%	0.0%	0.0%
some nights(1-4)	3.3%	6.7%	3.3%
not used	40.0%	30.0%	26.7%
Never Used	-	-	13.3%
Seasonal use			
equally rain and dry	53.3%	66.7%	60.0%
mainly rain	33.3%	20.0%	26.7%
rain only	0.0%	13.3%	0.0%
Not used at all	-	-	13.0%
Not used at rainy season	-	-	0.0%
DawaPlus 2.0	N=30	N=30	N=30
Used last night	73.3%	63.3%	30.0%
Use last week			
every night	70.0%	63.3%	30.0%
most nights(5-6)	3.3%	0.0%	3.3%
some nights (1-4)	6.7%	3.3%	3.3%
not used	20.0%	33.3%	53.3%
Never used	-	-	10.0%
Seasonal use			
equally rain and dry	66.7%	83.3%	53.3%
mainly rain	20.0%	3.3%	20.0%
rain only	3.3%	13.3%	6.7%
Not used at all	-	-	16.7%
Not used at rainy season	-	-	3.3%
Total	N= 60	N=60	N=60
Used last night	65.0%	65.0%	41.7%
Use last week			
every night	63.3%	63.3%	43.3%
most nights(5-6)	1.7%	0.0%	1.7%
some nights (1-4)	5.0%	5.0%	3.3%
not used	30.0%	31.7%	40.0%

Never used	-	-	11.7%
Seasonal use			
equally rain and dry	60.0%	75.0%	56.7%
mainly rain	26.7%	11.7%	23.3%
rain only	1.7%	13.3%	3.3%
Not used at all	-	-	15.0%
Not used at rainy season	-	-	1.7%

Regarding variables related to net washing, the proportion of bioassay nets ever washed, and the number of washes, were the same as those of cohort nets, and there was also no difference between the sites. More than 90 % of bioassay nets were washed with detergents at the 36-month assessment (Table 18).

Table 18: Variables related to washing of bio-assay test nets

Variable	12 months	24 months	36 months
PermaNet 2.0	N=30	N=30	N=30
Ever washed	60.0%	93.3%	83.3%
Washes last 6 month (all)			
Mean	1.2	1.6	1.1
Median	1	1.5	1
Washes last 6 month (if washed)			
Mean	12.9	1.8	1.1
Median	2	2	1
Soap used			
country soap bar	0.0%	3.6%	12.0%
detergent or bleach	100.0%	96.4%	88.0%
mix	0.0%	0.0%	0.0%
DawaPlus 2.0	N=30	N=30	N=30
Ever washed	66.7%	90%	83.3%
Washes last 6 month (all)			
Mean	1.1	1.5	1.0
Median	1	1	1
Washes last 6 month (if washed)			
Mean	6.7	1.6	1.0
Median	1	1	1
Soap used			
country soap bar	0.0%	3.7%	0.0%
detergent or bleach	100.0%	96.3%	96.0%
mix	0.0%	0.0%	4.0%
Total	N=60	N=60	N=60
Ever washed	63.3%	91.7%	83.3%
Washes last 6 month (all)			
Mean	1.15	1.6	1.02
Median	1	1	1

Washes last 6 month (if washed)			
Mean	9.6	1.7	1.02
Median	2	1	1
Soap used			
country soap bar	0.0%	3.6%	6.0%
detergent or bleach	100.0%	96.4%	92.0%
mix	0.0%	0.0%	2.0%

5.7 Chemical Residue Analysis

LLIN collected 36 months after the 2015 mass campaign were submitted to chemical residue analysis at the DFDA lab in Naypyidaw, Myanmar. The mean deltamethrin content found in DawaPlus 2.0 nets was 1.10 g/kg from an initial loading dose of 2.0 g/kg, or 55.0% of the original loading dose. For the PermaNet 2.0 samples, the mean deltamethrin content was 0.97 g/kg from an initial loading dose of 1.4 g/kg. This represents 69.3% of the loading dose.

Figure 11: Results from chemical residue analysis: the graph shows the mean chemical residue content of each net as a proportion of the loading dose (2.0 g/kg for DawaPlus 2.0 and 1.4 g/kg for PermaNet 2.0).

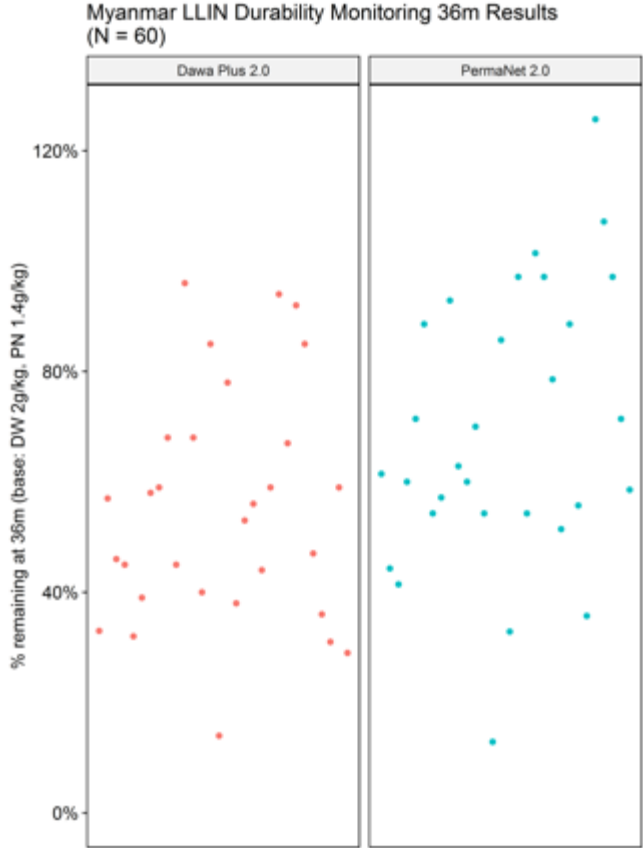
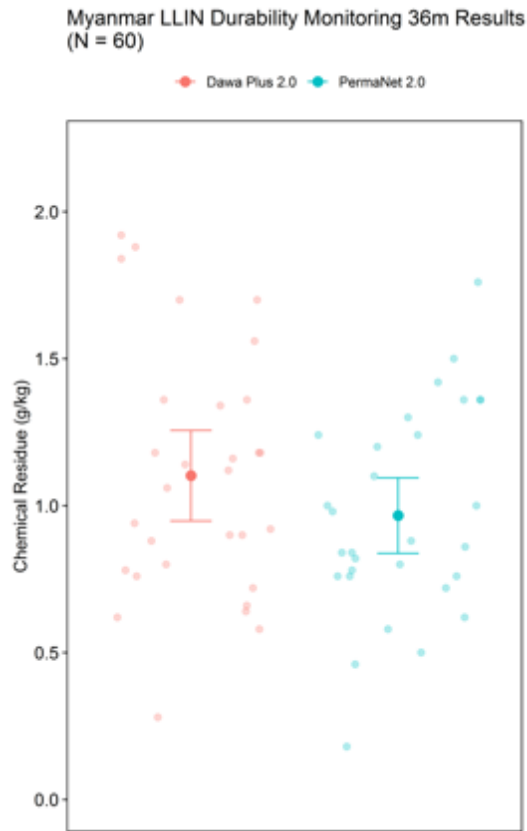


Figure 12: Results from chemical residue analysis: the plot shows chemical residue (g/kg) for individual pieces of 30 DawaPlus 2.0 and 30 PermaNet 2.0 LLIN collected 36 months after distribution in Myanmar



Summary and Conclusion

This report describes the 36 month assessment results of the LLIN durability study. In this round of follow-up assessment, 263 households out of 290 households enrolled at the baseline were interviewed. Among them, 242 households still had any cohort net in their household. Overall, 35 (12.1%) households lost all of their cohort nets and 13 (4.5%) households moved away from the study sites. Regarding the nets, out of 582 nets recruited at the baseline, 426 (73.2%) could be observed in this assessment. Among the original recruited cohort nets, 18 (3.1%) nets were taken elsewhere by family members, 16 (2.7%) not available for follow-up due to unknown reasons, 56 (9.6%) were discarded, 38 (6.5%) were given away, 12 (2.1%) were lost according to the respondent, and 16 (2.7%) nets were loss-to-follow-up due to household movement.

Food storage in sleeping rooms, always cooking in a sleeping room and rodents observed in the last 6 months reportedly decreased in this assessment. Similar to the previous assessments, the majority of campaign nets were used over a mat or the ground. The number of cohorts nets hung loosely without being folded or tied up decreased from 83.1% in baseline to 52.6% at 12 months, 39.4% at 24 months but increased again to 66.3% at 36 months. The proportion of cohort nets ever washed increased from 13.6% in the baseline, to 56.7% at 12-month assessments, 79.7% at 24-month assessments and 86.4% at 36-month assessments. In all assessments, median wash frequency within the past 6 months of data collection was the same, and the use of detergent to wash nets was consistently very high. The proportion of households that dried washed nets on a bush or fence slightly increased in this assessment compared to the 24 months assessment (10.3% in baseline, 16.6% in 12 month, 6.6% in 24 month, and 9.5% in 36 month).

The proportion of households which reportedly ever had any holes in their nets increased to 74.1% in this assessment from 56.2% in the baseline, 49.1% at 12 months and 68.9% at 24 months. Among the households which reportedly ever experienced holes in their nets, the proportion of households that had ever repaired the holes slightly rose again in this assessment. Similar to the previous assessments, stitching was the main method of net repair (95.4%). Major reported reasons for not repairing holes (N = 108) were not having time (51.9%), and holes being too small (20.4%). Among all observed cohort nets with any holes, the proportion of nets with repairs increased to 30.1% from 25.5% at the 24-month assessment.

Among the observed cohort nets, 79.6% had any holes at the time of the survey, which was a marked increase from 15.1% in the baseline, 45.0% in the 12-month assessment and 63.7% in the 24-month assessment. Overall, 66.7% of cohort nets were in good condition, which was a decrease from 96.9% at baseline, 88.7% at 12-month assessment, and 77.3% at the 24-month assessment. The drop was more pronounced in the DawaPlus site (Baseline=94.4%, 12 month=84.3%, 24 month=68%, 36 month=57.1%). Similarly, the increase in the number of nets that were too torn and consequent decrease in the number of nets in serviceable conditions were more prominent in the DawaPlus site (95.7% of PermaNet vs. 90.1% of DawaPlus). The major reported mechanisms of damage on nets were “tear”, “rats” and “burn”. When discarded nets were included in the analysis, 84.6% of PermaNet nets were still serviceable compared to 78.2% for DawaPlus. However, this difference was not statistically significant.

Across data collection rounds, the proportion of cohort nets which were found hanging was similar in the PermaNet site and fluctuated in the DawaPlus site. The proportions of cohort nets that were used last night or every night in the last week decreased slightly in this assessment. There was an increase in proportion of cohort nets used only by adults from 50.8% in baseline to 55.3% in 12 month, 60.7% in 24 month, and 68.2%

in 36 month. Consequently, the proportion of cohort nets used by only children or children and adult decreased.

Overall attrition of cohort nets increased to 34.2% from 27.8% in the 24-month assessment, 21.9% in the 12-month assessment and 19.9% at baseline. The major cause of attrition was due to nets being given away (24.5%). Attrition due to wear and tear also increased to 8.1% from 4.1% at 24-month, 1.2% at 12-month and 0.5% at baseline. The estimated survival estimate of cohort nets in serviceable condition, which was a function of attrition and physical integrity, dropped to 81.7%, from 89.9% at 24-month, 97.2% at 12-month, and 99.8% at baseline.

The bio-assays were conducted for 12, 24 and 36 month assessments. The bio-efficacy measures of DawaPlus nets were lower than PermaNet nets in this assessment (Median KD60: 70% Vs 77%; Median 24 hour Mortality: 58% Vs 68%). Only 3.3% of DawaPlus 2.0 nets met WHO optimal effectiveness criteria whereas 10% of PermaNet nets did so. 86.7% of PermaNet nets and 76.7% of DawaPlus nets met the minimal effectiveness criteria. Overall, the optimal effectiveness estimate dropped to 6.7% from 26.7% and 61.7% in the previous assessments.

Regarding handling of bio-assay nets, the proportion of bioassay nets ever washed, and the number of washes were similar to those of other cohort nets in the study, and there was no notable difference between the sites. More than 90 % of bioassay nets were washed with detergents at the 36-month assessment.

Chemical residue analysis from 36-month data collection indicate that a mean of 1.10 g/kg deltamethrin were found on the DawaPlus 2.0 samples (loading dose 2.0 g/kg) compared to 0.97 g/kg for the PermaNet 2.0 (loading dose 1.4g/kg) samples. These results are very similar to chemical residue analysis performed after 24 months, where DawaPlus 2.0 samples had a mean of 1.17 g/kg and Dawa Plus 2.0 samples had a mean of 0.99 g/kg.

In summary, the 36-month assessment of cohort nets was successful, with only thirteen households lost to follow-up. Most of the cohort LLINs (81.7%) were still surviving in physically functioning condition up to this point. However, insecticidal effectiveness, according to bioassays, was less than optimal.