



ZIMBABWE ASSISTANCE PROGRAM IN MALARIA

FINAL NET DURABILITY STUDY REPORT

DURABILITY MONITORING OF LONG-LASTING
INSECTICIDAL NETS AT THE 36-MONTH PERIOD IN
MALARIA-ENDEMIC REGIONS OF ZIMBABWE

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ABBREVIATIONS AND ACRONYMS

LLIN	Long-Lasting Insecticidal Net
LTFU	Lost To Follow-Up
NIHR	National Institute of Health Research
NMCP	National Malaria Control Program
pHI	Proportionate Hole Index
PMI	President's Malaria Initiative
PSI	Population Services International
SBCC	Social and Behavior Change Communication
WHO	World Health Organization
ZAPIM	Zimbabwe Assistance Program in Malaria

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1. EXECUTIVE SUMMARY

The Zimbabwe Assistance Program in Malaria (ZAPIM) implemented this assessment as part of a three-year study of the durability of long-lasting insecticidal net (LLINs), in collaboration with Zimbabwe's National Malaria Control Program (NMCP) and National Institute of Health Research (NIHR). This study seeks to provide information to the NMCP, the United States President's Malaria Initiative (PMI), ZAPIM and other malaria stakeholders about the longevity of LLIN fabric integrity, LLIN survivorship/attrition rates, and bioefficacy and chemical content of LLINs. The study also intends to support the establishment of household practices for net care and repair. NIHR conducted bioassays to measure LLIN bioefficacy, and Wallon Laboratory in Belgium conducted insecticide residual testing, also referred to as chemical residue analysis or chemical analysis, to determine LLIN chemical content.

OVERVIEW OF THE NET DURABILITY STUDY

The LLIN Durability Study was a prospective, longitudinal study of a cohort of randomly selected LLINs (1,000 DawaPlus 2.0 and 1,000 DuraNet) distributed through a school-based mini-mass campaign in September 2015. ZAPIM conducted follow-up assessments of the LLINs at month 6, 18, 24, and 36 using the same methodology, with only minimal changes to the questionnaire. For the purposes of this three-year study, data collected at month 6 is considered the baseline. The assessments were conducted in 12 malaria-endemic districts in Mashonaland Central and Mashonaland West Provinces. The districts included differing malaria sociodemographic and ecological profiles: rural, commercial farming, peri-urban, and mining. This report details the final assessment findings at month 36 and also provides comparative key findings across the study periods to-date: month 6, month 18, month 24, and month 36.

ZAPIM targeted 893 households for the final, month 36 assessment sample. Of these, ZAPIM interviewed 823 households (92% of the target) and found 574 surviving LLINs (those available in the household at the time of the survey that had been distributed during the school-based mini-mass campaign). Of the surviving LLINs, 310 were DawaPlus 2.0 nets and 264 DuraNet LLINs. ZAPIM results included several outcome measures involving attrition, fabric integrity, survivorship, chemical content, and bioassay results. Where significance testing could be conducted, it was based on a 10% level of significance and a confidence interval of 90%.

ATTRITION, FABRIC INTEGRITY, AND SURVIVORSHIP OF LLINs AT FINAL ASSESSMENT POINT, MONTH 36

ZAPIM calculated cumulative net all-cause attrition—defined as the proportion of LLINs lost for any reason (excluding those lost to follow-up (LTFU) or “censored”—that is, removed for insecticidal and durability testing) divided by the original cohort LLINs. Cumulative net all-cause attrition was 45% at month 36, the final assessment time point, up from 32% at month 24 and 22% at month 18. DuraNet showed a slightly higher attrition rate—47% compared with 43% for DawaPlus 2.0 at month 36. LLIN all-cause attrition was highest in the commercial farming sector (53%), and lowest in the mining sector (34%).

ZAPIM also assessed the fabric integrity of the 574 surviving LLINs at month 36, through several measures. First, ZAPIM used the proportionate hole index (pHI) to determine the proportion of nets in serviceable condition, that is, nets deemed “good” or “acceptable” (pHI score of ≤ 642), among those nets not LTFU. ZAPIM found that, overall, 74% of the surviving LLINs at month 36 were in serviceable condition, compared with 80% at month 24, and 84% at month 18. Over three-fourths (78%) of DawaPlus nets were in serviceable condition at month 36, compared with 70% of 264 DuraNet LLINs ($p=0.036$). ZAPIM then assessed the fabric integrity of the surviving LLINs by sector and found that the decrease in serviceable nets across the period was most marked in the rural sector-- 97.7% serviceable nets at baseline, falling to 68% at month 36 ($p=0.003$). The mining sector observed the least change, and maintained the highest proportion of serviceable nets at the end of the assessment period.

ZAPIM conducted several calculations related to survivorship. For one, ZAPIM calculated cumulative survivorship in serviceable condition, that is, the proportion of the original cohort LLINs still present in the household and with a pHI score of ≤ 642 at the time of the month 36 survey. This measure necessarily excludes from the numerator any LLINs that had been lost for any reason, including nets destroyed, discarded, repurposed, given away, used elsewhere, or stolen, or whose outcome was unknown (i.e., LTFU or censored). The denominator includes all surviving and attrited nets, which includes those destroyed, repurposed or given away. Cumulatively, the proportion of surviving, serviceable LLINs at month 36 was 65%, a significant decline from the initial assessment period: 97% ($p=0.001$). Survivorship of serviceable LLINs at this specific time point differed by brand—68% for DawaPlus 2.0 and 61% for DuraNet ($p=0.042$). The final estimated median survival at month 36 (a calculated value representing the length of time after which 50% of the nets are estimated to survive) was 4.7 years for DawaPlus 2.0, and 3.8 years for DuraNet.

BIOASSAYS AND CHEMICAL CONTENT ANALYSIS AT MONTH 36

ZAPIM conducted bioassays and chemical content analysis of 47 DuraNet and 50 DawaPlus 2.0 LLINs to assess their bioefficacy and chemical content (insecticide residue). Through bioassays, ZAPIM found that 85% of the DuraNet and 4% of the DawaPlus 2.0 LLINs were optimally effective based on the level of mortality ($p=0.001$). Through chemical analysis, ZAPIM found that six (13%) DuraNet and five (10%) DawaPlus 2.0 LLINs had the recommended target dose of 4.44-7.25g/kg and 1.50-2.50g/kg, respectively ($p=0.755$).

COMPARATIVE KEY FINDINGS AT MONTHS 6, 18, 24, AND 36

Compared across the four study periods, the response rate—defined as the number of households accessed by the survey teams compared with those targeted—was lowest at baseline and at 36 months. The response rate was 92% (target $n=2,000$) at month 6, 94% (target $n=1,834$) at month 18, 95% (target $n=1,227$) at month 24, and 92% at month 36, when ZAPIM interviewed 823 households of the 893 households targeted. Table 1 below summarizes study parameters and LLINs across the four study periods.

TABLE I: SUMMARY OF STUDY PARAMETERS AND NETS OVER STUDY PERIODS

Time Point/ Phase	A Targeted Households	B Households LTFU	C Households Accessed (C/A)	D Surviving Nets (D/(C-F))	E Attrited Nets (E/(C-F))	F Nets Lost (F/C)	Censored Nets (removed for insecticidal and durability testing)
Month 6	2,000	166	1,834 (92.0%)	1,722 (99.8%)	4 (0.2%)	108 (5.9%)	0 (Removed from separate cohort—105 nets)
Month 18	1,834	108	1,726 (94.1%)	1,329 (96.2%)	53 (3.8%)	344 (19.9%)	102
Month 24	1,227*	57	1,170 (95.4%)	990 (94.3%)	60 (5.7%)	120 (10.3%)	97
Month 36	893*	70	823 (92.2%)	574 (87.5%)	82 (12.5%)	167 (20.3%)	97

LTFU: households that could not be accessed.

Attrited nets—destroyed, discarded, or repurposed.

Nets lost—given away, used elsewhere, stolen, sold, or do not know (removed from denominator).

*New target households in month 24 and 36, due to the 102 nets censored from survived nets in month 18 (i.e., 1,329-102) and 97 nets censored from survived nets in month 24 (i.e., 990-97), respectively.

Surviving nets—defined as nets originally distributed to households and still present at the time of the visit—decreased over the study period. Accordingly, the percentage of attrited nets (i.e., nets destroyed, discarded or repurposed) in assessed households increased over the study period. It should be noted that a separate cohort of nets originally intended to be the sampling frame for testing were unavailable after the baseline study (month 6), thus the last column in Table I represents nets that were purposefully censored, that is, needed to be removed for bioassays and insecticidal testing.

Fabric integrity was highest in the mining sector at each data collection time point: 99% at baseline, 90% at month 18, 85% at month 24, and 74% at month 36. At baseline, fabric integrity was lowest in the commercial farming sector (95%), but the subsequent assessment points saw the peri-urban sector having the lowest fabric integrity (79%, 74%, and 67%, respectively at months 18, 24, and 36).

Compared to the baseline, cumulative survivorship significantly decreased with each subsequent time interval. As seen in Table 2, at baseline, 97% of surviving LLINs were in serviceable condition, compared with 65% at month 36, the final time point ($p=0.001$). Cumulative survivorship was 81% at month 18, 75% at month 24 ($p=0.001$). By brand, 97% of surviving DawaPlus 2.0 and DuraNet LLINs were in serviceable condition at baseline, with decreases at month 18 (83% and 79%, respectively), month 24 (76% and 73%, respectively), and month 36 (68% and 61%, respectively).

TABLE 2: SUMMARY OF SURVIVING NETS IN SERVICEABLE CONDITION OVER THE STUDY PERIODS

Period	Brand of LLIN	Number of Nets in Serviceable Condition	All Surviving and Attrited Cohort Nets	Percentage of Surviving Nets in serviceable condition
Month 6	DawaPlus 2.0	844	869	97.1%
	DuraNet	834	857	97.3%
Total		1,678	1,726	97.2%
Month 18	DawaPlus 2.0	592	713	83.0%
	DuraNet	526	669	78.6%
Total		1,118	1,382	80.9%
Month 24	DawaPlus 2.0	454	595	76.3%
	DuraNet	334	455	73.4%
Total		788	1,050	75.0%
Month 36	DawaPlus 2.0	241	353	68.3%
	DuraNet	184	303	60.7%
Total		425	656	64.8%

According to bioassay results, 90% of DawaPlus 2.0 LLINs achieved optimal effectiveness of greater than or equal to 80% at baseline, declining to 53% at month 18, 42% at month 24, and just 4% at the final three-year assessment time point of month 36. In contrast, DuraNet LLINs maintained optimal effectiveness across all four study points: 91% at baseline, 98% at month 18, 89% at month 24, and, finally, 85% at month 36. That said, the optimal effectiveness mostly decreased with each study time point for both net brands, with DawaPlus 2.0 losing optimal effectiveness more quickly than DuraNet. Similarly, the results of the chemical analyses show that DawaPlus 2.0 also lost chemical content faster than DuraNet. The proportion of DawaPlus 2.0 nets with the required minimum target dose of 1.5g/kg decreased from 46% at month 6 to 12% at month 18, down to 6% at month 24, slightly rebounding to only 10% at the final three-year time point. In contrast, the measured chemical content of DuraNet was 78% at month 6, 38% at month 18, 33% at month 24, and 13% at month 36.

Overall, the study has shown that LLINs undergo physical and chemical efficacy changes over time, with differences by sector, brand, placement, and behaviors. The study, accordingly, recommends six measures to improve the planning and implementation of future LLIN distribution campaigns and optimize the efficacy and longevity of the LLINs.

- I. Reconsider the planned distribution-replacement cycle, as the chemical content of both net brands decreased over time, and had fallen below the threshold for minimal effectiveness dose by month 24. There was more degradation with the DawaPlus 2.0 brand than DuraNet. DawaPlus 2.0 clearly no longer provided the required protective effect of killing mosquitoes after 24 months.

- II. Assess the physical integrity of nets in correlation with their chemical content to best recommend net replacement intervals. This study showed the median *survival* of both LLIN brands to be around 3.8 to 4.7 years, which is in line with the current lifecycle of mass distribution campaigns every three years. However, the *chemical potency* of either LLIN brand is lost much earlier than at three years, at about month 24. Further research and assessments are needed to better define the effective life of an LLIN and the most appropriate replacement cycles. In the meantime, continuous distribution should also follow mass distribution campaigns to identify and replace unserviceable nets and ensure the overall effectiveness of an LLIN program.
- III. Implement a program of teaching and encouraging good net handling, care, and use to increase LLIN longevity. The study notes an almost complete lack of LLIN repairs, as well as accidental destruction as the main reason for all-cause LLIN attrition, suggesting an opportunity to improve the effectiveness of LLIN programs through education.
- IV. The observed high attrition rate underscores the need for routine net distributions *after* mass campaigns, to replace lost nets and those damaged beyond repair. Social and behavior change communication (SBCC) can further complement routine net distributions with information about the utility of nets and the importance of net care and use. LLIN replacement cycles, and supportive interventions like SBCC, in the country must be evidence-based for effective control and prevention of malaria.
- V. As Zimbabwe continues to scale up LLIN coverage, it needs accurate information about LLIN durability in a variety of settings. Monitoring enables programs to identify (and ideally replace) nets that perform below expectations, and gives useful feedback to manufacturers to improve their products. Country-specific information should be collected and used to guide NMCP and PMI procurement and programmatic decisions. This information should be generated as quickly and routinely as possible to inform decisions on how to replace failing LLINs before they compromise the efficacy of the intervention.
- VI. For future LLIN monitoring efforts, investigate whether nets reported as being used by family members elsewhere i.e. outside the household that had originally received them still exist and are in use.

2. INTRODUCTION

The World Health Organization (WHO) recommends universal LLIN coverage as an effective way to reduce malaria in transmission areas, including most of sub-Saharan Africa. Malaria prevention with LLINs has seen a tremendous increase in sub-Saharan Africa in recent years. Many countries have now achieved high ownership coverage of LLINs and are approaching the WHO universal coverage target: one net for every two people or one net per sleeping space for at-risk populations. LLINs are manufactured either by using pre-treated material such as polyethylene or by coating the netting with insecticide during production. The insecticide pyrethroid is used in treated LLINs procured by NMCPs, due to its relative safety for humans, rapid knockdown rates, and rapid killing effect on malaria-carrying mosquitoes (Zaim et al., 2000).

To achieve and maintain high LLIN coverage, programs need data on net durability and average useful life. These are critical elements in malaria control programs, as they determine the frequency of net replacement (WHO, 2011). LLIN manufacturers claim that mosquito nets last an average of three years; some indicate a useful life of up to five years. However, information regarding the durability of LLINs under field conditions is not readily available.

WHO guidelines recommend routine monitoring of LLINs for:

- Fabric integrity (the extent of physical damage)
- Bio-efficacy (the chemical's killing effect on vector mosquitoes at a particular point)
- Chemical content (how much insecticide is on the net at a particular point)
- Survival/attrition (nets still available at the household level after distribution that are in serviceable condition)

WHO guidelines (2011) recommend assessing the physical LLIN fabric integrity using the pHI. The pHI scoring uses the number and size of holes in a net. Bioefficacy testing uses known pure breed species of *Anopheles* mosquitoes (in our case, laboratory-bred female *Anopheles arabiensis*) and exposes them to LLIN materials from different parts of the net. Then, knockdown times at 30 to 60 minutes and mortality rates of *Anopheles* mosquitoes 24 hours after exposure to LLINs measure the efficacy of the netting material. Chemical content analysis extracts insecticide content from net samples to measure the amount of insecticide still on the net. Lastly, 2013 WHO technical guidance outlines how to estimate the actual physical survival of nets and the median survival time calculated from multiple data points.

2.1 BACKGROUND

In Zimbabwe, the mainstay of malaria prevention has been vector control through the use of indoor residual spraying and promotion of LLINs. Since 2010, financial support from PMI and the Global Fund for AIDS, Tuberculosis, and Malaria (Global Fund) has enabled the NMCP to scale up the use of LLINs. Currently, NMCP, with support from partners, promotes LLINs in 35 of the 47 malaria-risk districts (cf. malaria-endemic study districts) with the aim of attaining universal access. The Global Fund and PMI supported mass LLIN distribution campaigns in 2013, 2014, and 2016. In 2015, the NMCP, through Population Services International (PSI), conducted a mini-campaign targeting pupils in grades three and

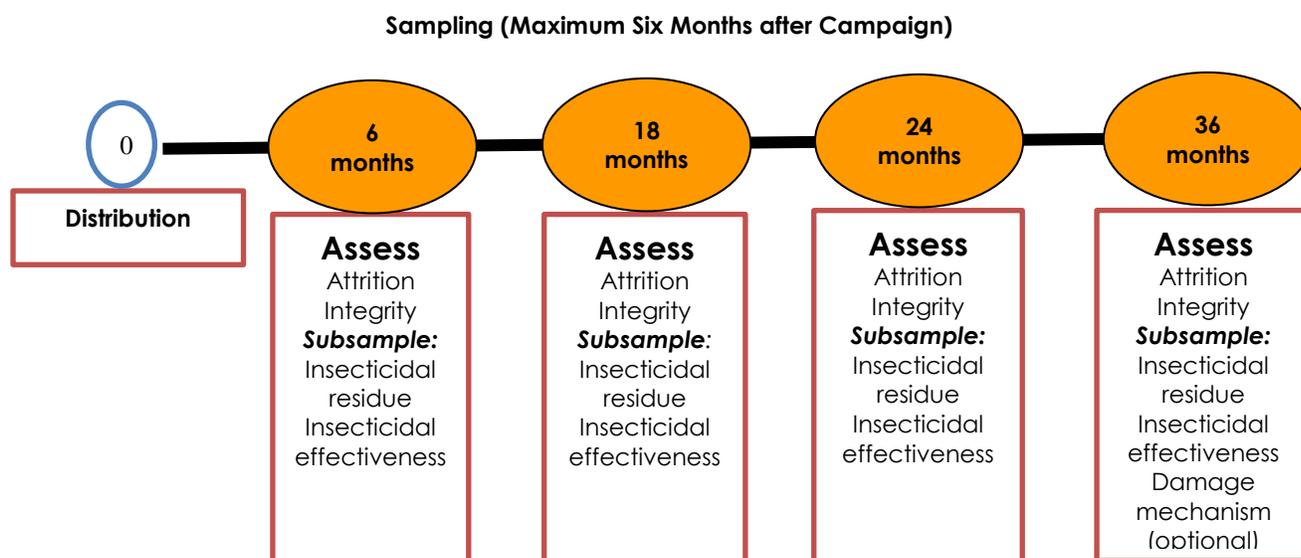
six in 12 districts of Mashonaland Central and Mashonaland West Provinces. The NMCP and PSI chose these districts because they represent different malaria epidemiological patterns and socioecological disparities.

In 2016, NMCP and partners initiated a net durability study to establish the following:

- Longevity of the LLIN-fabric integrity
- Survival/attrition rate
- Bioefficacy of the LLINs over time
- Chemical content over time

The durability study uses a prospective longitudinal study approach in which ZAPIM identifies nets at the time of distribution and then follows them at regular intervals from 6 months up to 36 months. Specifically, this study randomly selected 2,000 LLINs (1,000 DawaPlus 2.0 and 1,000 DuraNet) from a master list of the school-based mini-campaign and followed up with this cohort at each prospective monitoring time point over the three year period. Evidence suggests that prospective follow-up of a cohort of nets is a suitable method for determining attrition and the decline in fabric integrity and insecticidal activity of the product over time. We summarize the study in Figure 1.

FIGURE 1: LLIN DURABILITY MONITORING STUDY OVERVIEW



This net durability study focuses on LLINs distributed by PSI to pupils who were in grade six in 2015. The geographic focus is 12 districts in Mashonaland Central and Mashonaland West Provinces: Bindura, Centenary, Guruve, Hurungwe, Kariba, Mbire, Makonde, Mazowe, Mt. Darwin, Rushinga, Shamva and Zvimba. PSI distributed two brands of LLINs, DawaPlus 2.0 and DuraNet.

Using WHO guidelines, PSI and ZAPIM assessed the physical durability of the LLINs using the pHl at months 6, 18, 24 and 36 after distribution. The month 12 assessment was deferred to month 18 to ensure the smooth handover of the study from PSI to ZAPIM.

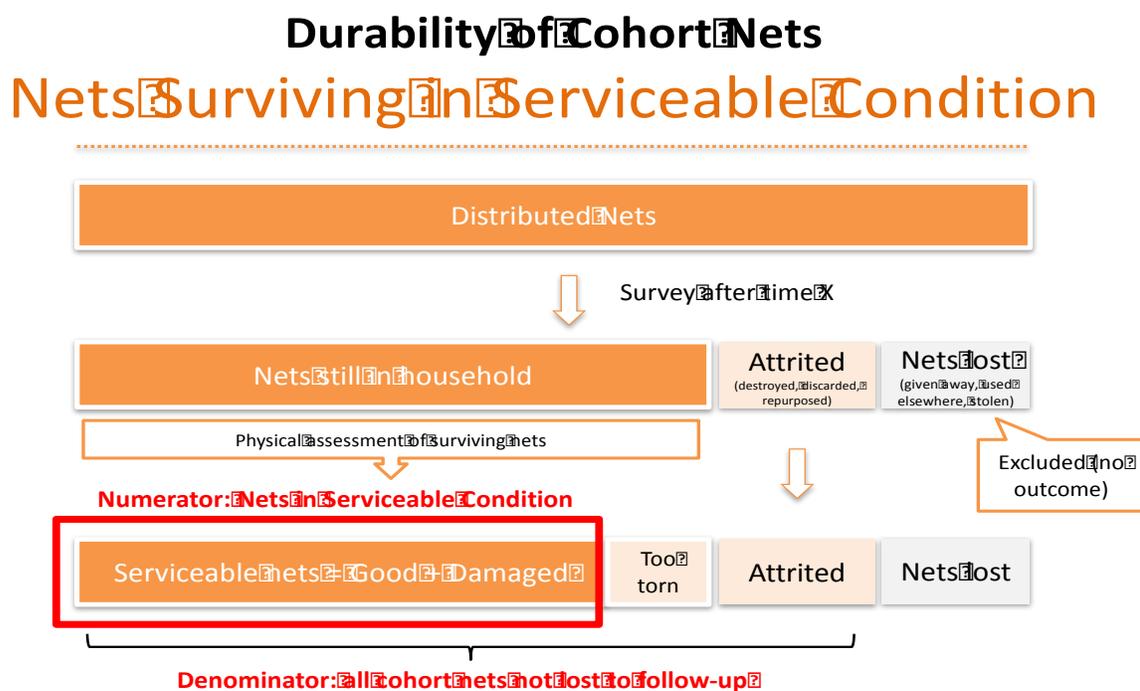
2.2 OBJECTIVES OF THE FINAL (MONTH 36) ASSESSMENT

The objectives of the final assessment at month 36 were to:

1. Assess the physical durability (survivorship, attrition, and integrity) and insecticidal activity and content of DawaPlus 2.0 and DuraNet LLINs in 12 malaria-endemic districts in Mashonaland Central and Mashonaland West Provinces in Zimbabwe over the entire study (36-month) period.
2. Compare the physical durability (survivorship, attrition, and integrity) of DawaPlus 2.0 and DuraNet LLINs across different priority sectors (commercial farming, mining, peri-urban, and rural), and identify major determinants of field performance.
3. Describe major behavioral aspects of net care and repair and their impact on overall net durability (survivorship, physical durability, and insecticidal activity).
4. Assess the impact of socioeconomic factors on LLIN performance in different priority sectors (commercial farming, mining, peri-urban, and rural settlements).

This report details the findings of the month 36 assessment as well as comparative findings across the four study monitoring intervals to date: baseline (month 6), month 18, month 24, and month 36. The framework for determining the proportion of LLINs surviving in serviceable condition is displayed in Figure 2. Where applicable, we present the findings of the month 36 assessment using this format.

FIGURE 2: FRAMEWORK FOR DETERMINING THE PROPORTION OF LLINs SURVIVING IN SERVICEABLE CONDITION



durability testing, leaving 893 nets in households to be targeted at month 36. The breakdown of the 893 households targeted in each sector was as follows:

- Commercial farming: 198
- Mining: 197
- Peri-urban: 210
- Rural: 288

To maximize the assessment response rate, ZAPIM visited each household at least three times before deeming the respondent unavailable for interview. ZAPIM located 823 households in this final round of the study.

3.2 QUESTIONNAIRE

ZAPIM administered a structured questionnaire to heads of households (Appendix D). The questionnaire was similar to the one used for the previous assessment time points, except that, based on experience gained during the month 24 assessment, ZAPIM reverted to the month 18 version of the questionnaire for the month 36 assessment. This restored a few questions and rephrased others to improve data quality. None of these changes substantially altered the content of the questionnaire.

The questionnaire collected the following basic information:

- Household characteristics (to identify factors potentially associated with net damage)
- Status of LLINs received by sixth graders from the mini-campaign, and identification of any new nets obtained from any source after the campaign
- Exposure to care and repair messages
- Net care and repair behavior
- Presence or absence of mini-campaign nets (received by sixth graders) and reasons for loss, if applicable
- Assessment of existing mini-campaign nets, including use patterns (e.g., location, type of sleeping place, and users of the net), recalled damage mechanisms, washing and drying habits, and physical assessment of holes and repairs on each net
- Assessment of any other net in the household's possession (i.e., nets not from the mini-campaign)

ZAPIM programmed the questionnaire in the SurveyToGo software and configured it on smartphones for data collection. Research assistants could choose either English or Shona when administering the questionnaire. As a backup mechanism, ZAPIM configured the smartphones to automatically upload all completed interviews on the SurveyToGo server. ZAPIM synchronized data to the server at the end of each day or interview for enhanced security, quality assurance, and data protection. In cases where research assistants had data synchronization challenges, the team leaders, supervisors, and ZAPIM team members were always available to provide assistance.

3.3 TRAINING AND FIELD WORK

3.3.1 TRAINING

The training of 40 research assistants, 10 district team leaders, and two provincial supervisors took place on February 4-6, 2019. The research assistants were Environmental Health Technicians and

Environmental Health Officers. Team leaders were District Environmental Health Officers and selected Environmental Health Officers. The provincial supervisors were Provincial Field Officers. ZAPIM facilitated the training with technical assistance from the NMCP and NIHR.

The training sessions covered the following areas:

- Background of the LLIN Durability Study and reasons for undertaking the study
- Research ethics
- Experiences from the month 24 assessment—good practices, challenges, lessons learned, and recommendations
- Interviewing techniques and field procedures
- Detailed review of the questionnaire content and instructions, and mock interviews between participants in the classroom
- Review of all consent forms, including the processes of informed consent, storage, and safety for consent forms
- Hole counting, including practical sessions
- Roles and responsibilities of supervisors, team leaders, and research assistants during the survey
- Use and maintenance of smartphones, including administration of the questionnaire using smartphones and troubleshooting

In addition to the above topics, ZAPIM trained team leaders and supervisors in methods of data quality control and effective field work coordination.

Throughout the training, ZAPIM reminded participants to follow local community norms and customs during their field work, and to be sensitive to the different cultures in the areas of operation.

3.3.2 FIELD WORK

Each of the 12 districts had one team leader, and the 40 research assistants were split between the districts. The two provincial supervisors had overall responsibility for supervising the district teams in the provinces. A National Coordination Team comprising two ZAPIM Technical Specialists, an NMCP Assistant Vector Control Officer, and an NIHR Laboratory Scientist provided technical and logistical support to the supervised field teams in all the districts.

Data collection took place from February 7 to February 16, 2019. The research assistants completed daily tracker or summary sheets with the district team leaders, which were then sent to the provincial and national supervisors. Research assistants transferred completed interviews from their smartphones to the SurveyToGo server daily. From the server, the ZAPIM team could easily identify whose data had not been transferred, and immediately assist field staff. To facilitate communication and monitoring, each research assistant had a unique identification number.

3.4 BIOASSAYS AND CHEMICAL CONTENT ANALYSIS

NIHR conducted bioassays using the standard WHO cone bioassay method. Wallon Laboratory, based in Belgium, conducted insecticide residual testing, also known as chemical residue analysis or chemical analysis, using gas or high-performance liquid chromatographic methods to determine insecticide levels in the LLIN fabric.

3.5 ETHICAL CONSIDERATIONS

The Medical Research Council of Zimbabwe and Abt Associates' Institutional Review Board approved the survey. The research assistants obtained informed written consent from the head of the household or respondent before administering the questionnaire. Guardians of all children between 15 and 17 years of age also provided signed consent before they participated in the interviews. ZAPIM did not interview any children under 15 years of age, even if they were heads of household. All respondents retained a copy of the consent form. ZAPIM used household identifiers only for locating and identifying households. At the analysis level, ZAPIM removed the identifiers, eliminating any link with household data.

3.6 DATA PROCESSING AND ANALYSIS

ZAPIM staff ensured the transfer of data from the smartphones to the SurveyToGo software before it was edited, cleaned, and tabulated. ZAPIM staff then exported the data to Microsoft Excel for easy checking of any inconsistencies. Once the team was satisfied with the quality of the data, they exported it from MS Excel to STATA Version 14, and SPSS Statistics 24 for analysis. Where appropriate, the team used the two-sample t-test to compare the statistical difference between the means of the two groups with a 10% level of significance and confidence interval of 90%. This was in accordance with the approved protocol.

3.7 QUALITY CONTROL AND ASSURANCE

ZAPIM used a variety of complementary quality control measures and checks to ensure that the data and findings were of high quality. Some of the controls included the following:

- Training: All participants involved in the study received comprehensive training to strengthen their capacity in their designated area of focus. All research assistants, district team leaders, and provincial supervisors received training on the data collection tools at one central location, which ensured sharing of the same information and understanding of the survey objectives, instruments, and expected survey output.
- Field team supervision: District team leaders, provincial supervisors, and national supervisors oversaw the field teams, using supervisory checklists, observing the interviews, and visiting interviewed households for spot checks.
- Field reviews: Research assistants and team leaders reviewed interviews in the field before the research assistants synchronized them. This procedure aided collection of quality data and achievement of high household response rates.

Figure 3 summarizes the quality assurance activities in terms of general timing and flow of non-overlapping steps. ZAPIM organized these steps into three stages, as reflected in the rest of the document: pre-data collection, data collection, and post-data collection.

FIGURE 3: SUMMARY OF QUALITY ASSURANCE ACTIVITIES



3.8 LIMITATIONS OF THE STUDY

ZAPIM conducted the study during the rainy season and during school days. It was therefore not possible to interview some targeted households, since they were always busy in the fields. In some instances, the research assistants could not access the targeted households, because the rivers had flooded. In other cases, entire households had permanently relocated elsewhere. The research teams were also not able to follow up on some LLINs because beneficiaries had them at boarding school or other places where they attended schools far from the study location. Other nets were locked in a room at the time of data collection.

4. RESULTS

4.1 SAMPLE COVERAGE

Of the 893 households selected for the sample, ZAPIM successfully interviewed 823 (92.2%) households, including households that had relocated to nearby areas. The number of households interviewed in each sector was as follows:

- Rural: 288 households
- Peri-urban: 210 households
- Commercial farming: 198 households
- Mining: 197 households.

The majority of respondents were spouses of heads of household (47%), followed by the head of household (37.5%). The remaining respondents (15.2%) were any other family members aged 18 years and above. ZAPIM found no children aged 15-17 years to be heading households, and interviewed none.

TABLE 3: SUMMARY OF STUDY PARAMETERS AND NETS OVER STUDY PERIODS

Time Point/ Phase	A Targeted Households	B Households LTFU	C Households Interviewed (C/A)	D Survived Nets (D/(C-F))	E Attrited Nets (E/(C-F))	F Nets Lost (F/C)	Censored Nets (removed for insecticidal and durability testing)
Month 6	2,000	166	1,834 (92.0%)	1,722 (99.8%)	4 (0.2%)	108 (5.9%)	0 (Removed from separate cohort— 105 nets)
Month 18	1,834	108	1,726 (94.1%)	1,329 (96.2%)	53 (3.8%)	344 (19.9%)	102
Month 24	1,227*	57	1,170 (95.4%)	990 (94.3%)	60 (5.7%)	120 (10.3%)	97
Month 36	893*	70	823 (92.2%)	574 (69.7%)	82 (12.5%)	167 (20.3%)	97

Attrited nets—destroyed, discarded, or repurposed.

Nets lost—Given away, used elsewhere, stolen, sold, or do not know (removed from denominator).

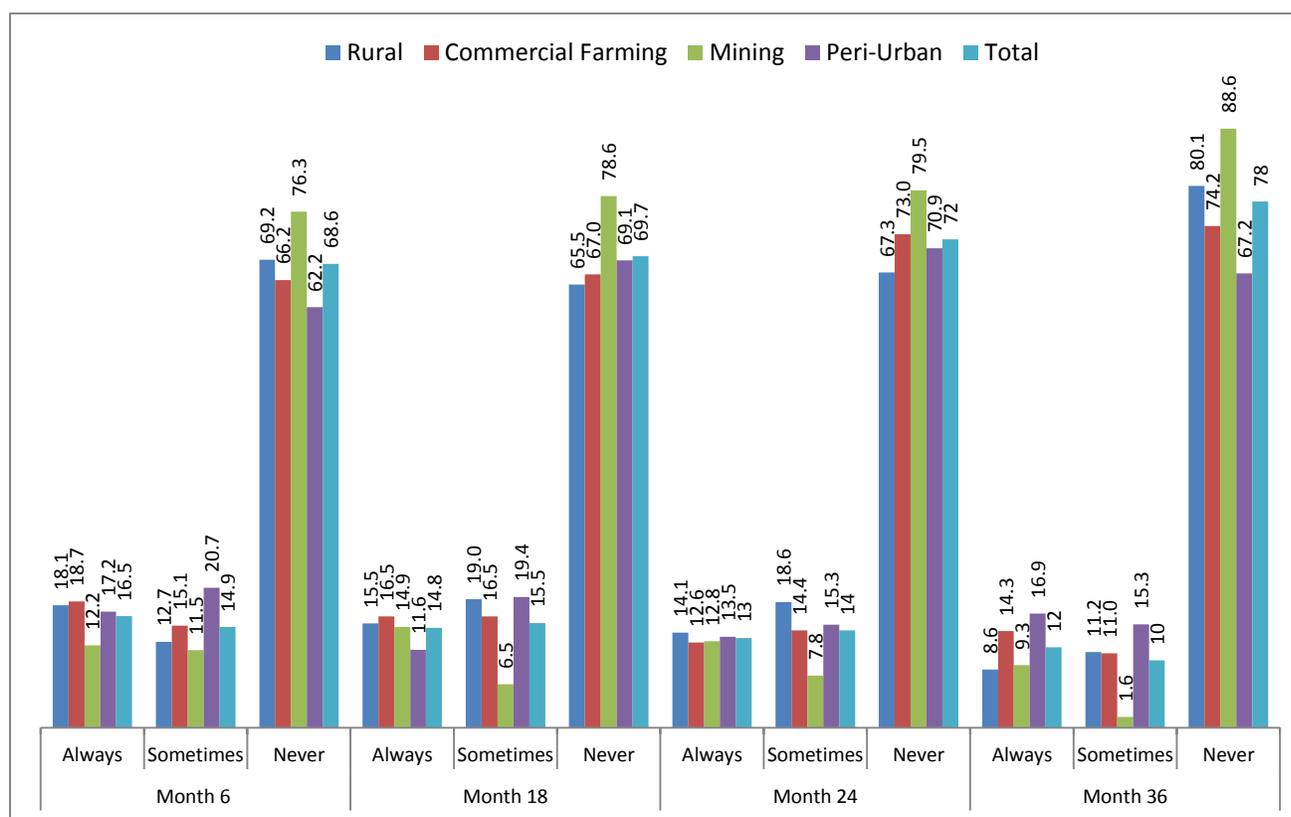
*New target households in month 24, and 36, due to the 102 nets censored from survived nets in month 18 (1,329-102) and 97 nets censored from survived nets in month 24 (990-97), respectively.

As outlined in Table 1, an average of 93% of targeted households were successfully interviewed across the four assessment time points, with a range between 92% and 95%. At month 36, ZAPIM interviewed 823 households, of which 574 had an LLIN that survived. Ninety-seven (97) LLINs—47 DuraNet and 50 DawaPlus 2.0—were subsequently tested for insecticidal durability testing using bioassays.

4.2 CHARACTERISTICS OF HOUSEHOLDS SURVEYED

Figure 4 illustrates the frequency of cooking in a room that was also used for sleeping, according to sector. Overall, 22% of households interviewed at month 36 reported that they sometimes or always cooked in a room that was also used for sleeping, compared with 31%, 30%, and 28% at months 6, 18, and 24, respectively. Though highest in the peri-urban sector at this final month 36 time point (32%), this practice had been consistently highest in the mining sector at previous survey time points (24% at month 6, 21% at month 18, and 21% at month 24).

FIGURE 4: PERCENTAGE OF HOUSEHOLDS BY FREQUENCY OF COOKING IN A SLEEPING ROOM (6, 18, 24, AND 36 MONTHS), NET DURABILITY STUDY AT MONTH 36, 2019, ZIMBABWE



ZAPIM also collected data on whether households stored food or crops in any of the rooms used for sleeping. Overall, 55% of all households interviewed at month 36 said they stored food or crops in any of the rooms used for sleeping, compared with 68%, 64%, and 61% at months 6, 18 and 24, respectively.

ZAPIM also asked respondents and observed whether the windows of their houses were fly-screened. This was an additional question added at the month 18 assessment and beyond. Fly-screening was not a common practice across the four sectors at all durability monitoring intervals for which this question was posed. At all data collection points and within all four sectors, fewer than 5% of households indicated that their windows were not fly-screened, with only 4% of households reporting fly-screened windows at month 36. Approximately 46% of respondents at month 18 and 41% at month 24 were not aware that using fly screens for their windows was a possible intervention. At month 36, this lack of awareness fell to 35% of respondents. Among those that knew about fly-screening but did not

implement this practice, popular reasons at month 36 included not having money to buy the screens (33% of respondents), not knowing how to do it (18% of respondents), and that the house was company-owned or rented (6% of respondents). A small percentage of respondents (1%) said that there was no need for fly-screening because they already use mosquito nets.

4.2.1 LLINS MONITORED ACCORDING TO BRAND

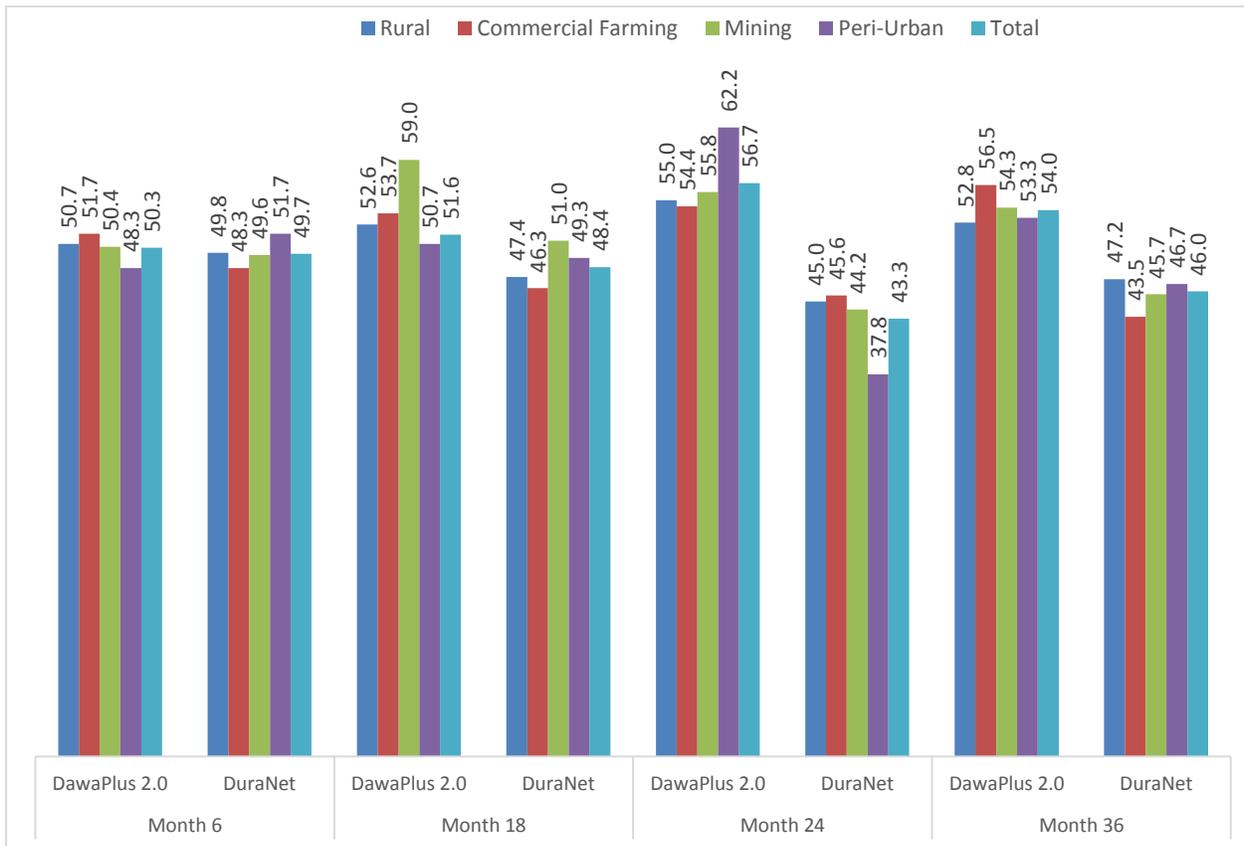
At all durability monitoring intervals, ZAPIM found more DawaPlus 2.0 than DuraNet LLINs available for monitoring. Two thousand households were enrolled in the study at the outset. Of the 990 LLINs that survived at month 24, 561 (57%) were DawaPlus 2.0 and 429 (43%) were DuraNet. In the final durability assessment at month 36, ZAPIM found 574 nets in the 823 households that were successfully interviewed. Of these 574 nets that had survived at month 36, 310 (54%) were DawaPlus, while 264 (46%) were DuraNet. The sections below explain in more detail the reasons for the decline from month 6 to month 36, and provide a detailed analysis of net survival and attrition at month 36. Table 4 and Figure 5 show the distribution of LLINs by brand monitored at months 6, 18, 24 and 36 by district (Table 2) and by sector.

TABLE 4: DISTRIBUTION OF LLINS MONITORED AT MONTHS 6, 18, 24 AND 36 BY BRAND AND DISTRICT, NET DURABILITY STUDY AT MONTH 36, 2019, ZIMBABWE

Period	Province	District	DawaPlus 2.0	DuraNet	Total	%	
			Number of Nets			Dawa	DuraNet
Month 6	Mashonaland Central	Bindura	128	109	237	54.0	46.0
		Guruve	91	60	151	60.3	39.7
		Mazowe	97	141	238	40.8	59.2
		Mbire	38	36	74	51.4	48.6
		Mt Darwin	50	61	111	45.0	55.0
		Muzarabani	95	96	191	49.7	50.3
		Rushinga	1	13	14	7.1	92.9
		Shamva	88	78	166	53.0	47.0
	Mashonaland West	Hurungwe	106	101	207	51.2	48.8
		Kariba	9	9	18	50.0	50.0
		Makonde	111	110	221	50.2	49.8
		Zvimba	109	97	206	52.9	47.1
	Total			923	911	1,834	50.3
Month 18	Mashonaland Central	Bindura	93	73	166	56.0	44.0
		Guruve	73	40	113	64.6	35.4
		Mazowe	82	98	180	45.6	54.4
		Mbire	32	28	60	53.3	46.7
		Mt Darwin	46	50	96	47.9	52.1
		Muzarabani	61	64	125	48.8	51.2
		Rushinga	1	12	13	7.7	92.3
		Shamva	68	60	128	53.1	46.9
	Mashonaland West	Hurungwe	73	62	135	54.1	45.9
		Kariba	9	5	14	64.3	35.7
Makonde		81	84	165	49.1	50.9	

Period	Province	District	DawaPlus 2.0	DuraNet	Total	%	
			Number of Nets			Dawa	DuraNet
		Zvimba	67	67	134	50.0	50.0
	Total		686	643	1,329	51.6	48.4
Month 24	Mashonaland Central	Bindura	74	62	136	54.4	45.6
		Guruve	58	16	74	78.4	21.6
		Mazowe	78	61	139	56.1	43.9
		Mbire	25	20	45	55.6	44.4
		Mt Darwin	48	20	68	70.6	29.4
		Muzarabani	56	43	99	56.6	43.4
		Rushinga	0	11	11	0.0	100.0
		Shamva	49	50	99	49.5	50.5
	Mashonaland West	Hurungwe	55	42	97	56.7	43.3
		Kariba	9	1	10	90.0	10.0
		Makonde	63	56	119	52.9	47.1
		Zvimba	46	47	93	49.5	50.5
		Total		561	429	990	56.7
Month 36	Mashonaland Central	Bindura	51	36	87	58.6	41.4
		Guruve	28	12	40	70.0	30.0
		Mazowe	42	40	82	51.2	48.8
		Mbire	20	12	32	62.5	37.5
		Mt Darwin	20	20	40	50.0	50.0
		Muzarabani	27	35	62	43.5	56.5
		Rushinga	0	6	6	0.0	100.0
		Shamva	24	20	44	54.5	45.5
	Mashonaland West	Hurungwe	26	23	49	53.1	46.9
		Kariba	5	5	10	50.0	50.0
		Makonde	39	26	65	60.0	40.0
		Zvimba	28	29	57	49.1	50.9
		Total		310	264	574	54.0

FIGURE 5: PERCENTAGE DISTRIBUTION OF LLINS AT MONTHS 6, 18, 24 AND 36 BY BRAND AND SECTOR, NET DURABILITY STUDY AT MONTH 36, 2019, ZIMBABWE



4.3 ALL-CAUSE ATTRITION

For the purposes of this study (and as outlined in Figure 5 above), all-cause attrition is defined as the proportion of LLINs destroyed, discarded, or repurposed, as well as those lost for any reason including those given away, used elsewhere, or stolen. Table 5 compares the findings at months 6, 18, 24, and 36.

TABLE 5: LLIN ALL-CAUSE ATTRITION AT MONTHS 6, 18, 24 AND 36 BY DISTRICT, NET DURABILITY STUDY AT MONTH 36, 2019, ZIMBABWE

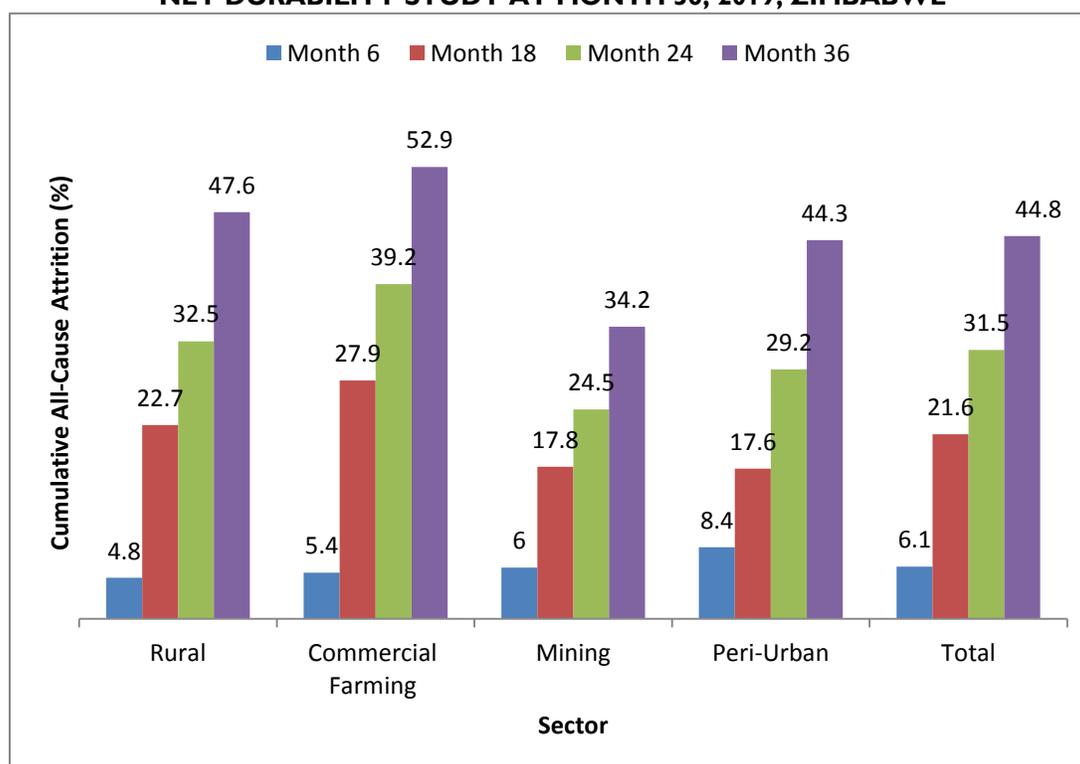
Period	Province	District	Total Number of Households Monitored	Number of LLINs No Longer in Household	Percentage All-Cause Attrition
Month 6	Mashonaland Central	Bindura	237	27	11.4
		Guruve	151	0	0.0
		Mazowe	238	29	12.2
		Mbire	74	0	0.0
		Mt Darwin	111	0	0.0
		Muzarabani	191	4	2.1
		Rushinga	14	0	0.0
		Shamva	166	0	0.0
		Hurungwe	207	0	0.0
	Mashonaland West	Kariba	18	0	0.0
		Makonde	221	0	0.0
		Zvimba	206	52	2.5
	Total			1,834	112
Cumulative Total			1,834	112	6.1
Month 18	Mashonaland Central	Bindura	220	54	24.5
		Guruve	142	29	20.4
		Mazowe	225	45	20.0
		Mbire	73	13	17.8
		Mt Darwin	112	16	14.3
		Muzarabani	180	55	30.6
		Rushinga	15	2	13.3
		Shamva	159	31	19.5
		Mashonaland West	Hurungwe	188	53
	Kariba		18	4	22.2
	Makonde		225	60	26.7
	Zvimba		169	35	20.7
	Total			1,726	397
Cumulative Total			1,834	397	21.6
Month 24	Mashonaland Central	Bindura	149	13	8.7
		Guruve	103	29	28.2
		Mazowe	160	21	13.1
		Mbire	48	3	6.3
		Mt Darwin	87	19	21.8
		Muzarabani	113	14	12.4
		Rushinga	12	1	8.3
		Shamva	115	16	13.9
		Mashonaland West	Hurungwe	126	29
	Kariba		10	0	0.0
	Makonde		149	30	20.1

Period	Province	District	Total Number of Households Monitored	Number of LLINs No Longer in Household	Percentage All-Cause Attrition
		Zvimba	98	5	5.1
		Total	1,170	180	15.4
		Cumulative Total	1,834	577	31.5
Month 36	Mashonaland Central	Bindura	116	29	25.0
		Guruve	61	21	34.4
		Mazowe	117	34	29.1
		Mbire	36	4	11.1
		Mt Darwin	61	20	32.8
		Muzarabani	88	26	29.5
		Rushinga	9	2	22.2
		Shamva	69	25	36.2
	Mashonaland West	Hurungwe	77	27	35.1
		Kariba	10	0	0.0
		Makonde	99	34	34.3
		Zvimba	80	23	28.8
			Total	823	245
		Cumulative Total	1,834	822	44.8

A constant denominator of the number of LLINs monitored from month 6 was used to calculate the cumulative all-cause attrition for each of the three subsequent time points. To prevent double-counting, the attrited nets at month 6 were excluded from the numerator when calculating cumulative all-cause attrition from month 18 onward, since the same nets had been inadvertently included in the target households at the month 18 assessment. Net cumulative all-cause attrition thus increased from month 18 (22%) to month 24 (32%) ($p=0.195$). It further increased from 32% at month 24 to 45% at month 36 ($p=0.794$). It is important to note that at the 10% level of significance and 90% confidence interval, the net all-cause attrition was not significantly different from one round to the next. However, the 23 percentage-point difference in attrition from month 18 to month 36 was statistically significant ($P=0.089$).

ZAPIM conducted further analysis to establish net attrition by sector, shown in Figure 6.

FIGURE 6: CUMULATIVE ALL-CAUSE ATTRITION AT MONTHS 6, 18, 24, AND 36 BY SECTOR, NET DURABILITY STUDY AT MONTH 36, 2019, ZIMBABWE



There was an increase in LLIN cumulative all-cause attrition in all sectors across all time points, as seen in Figure 6 above. From month 24 to the final month-36 time point, LLIN cumulative all-cause attrition was highest in the commercial farming sector (53%), followed by the rural sector (48%). It was lowest in the mining sector.

Table 6 compares cumulative all-cause attrition by brand of LLIN from month 6 to month 36.

TABLE 6: CUMULATIVE ALL-CAUSE ATTRITION (%) BY BRAND OF LLIN AT MONTHS 6, 18, 24 AND 36, NET DURABILITY STUDY AT MONTH 36, 2019, ZIMBABWE

Brand of LLIN	LLIN Cumulative All-Cause Attrition at Month 6	LLIN Cumulative All-Cause Attrition at Month 18	LLIN Cumulative All-Cause Attrition at Month 24	LLIN Cumulative All-Cause Attrition at Month 36
DawaPlus 2.0 (n= 923)	5.2%	19.5%	29.3%	42.9%
DuraNet (n= 911)	6.9%	23.7%	33.7%	46.8%
Total (n= 1,834)	6.1%	21.6%	31.5%	44.8%

As table 4 above shows, LLIN attrition was marginally higher for DuraNet than Dawa 2.0 at all assessment time points, but did not differ significantly by brand at month six ($p=0.284$) nor at the final time point ($p=0.391$). From month 18 to the final assessment time point, the difference in attrition between both brands stayed relatively constant at about 4 percentage points, and this difference was not significant ($p=0.198$). However, cumulative all-cause attrition was significantly different for each brand between month 6 and month 36 (DawaPlus 2.0- $p=0.007$; DuraNet- $p=0.005$)

4.3.1 REASONS FOR ALL-CAUSE LLIN ATTRITION

ZAPIM asked households that no longer had the cohort LLIN to indicate what had happened to it. Except for the month 6 assessment time point, the most common reason given for a net's absence at each time interval was that family members elsewhere were using it. Family members elsewhere were reported to be using 12% ($n=823$) of the nets at month 36, 6% ($n=1,170$) at month 24, and 13% ($n=1,726$) at month 18. This was a common reason across the four sectors at all intervals of durability monitoring. Only 2.0% cited the same reason at month 6, with the most common reason at that time point being that the net had been given away (permanently) to relatives (2.9%).

Other common reasons cited at month 36 included the net having been thrown away (6%), do not know (4%), and net destroyed accidentally (3.0%). Table 7 shows the reasons households gave for missing nets at months 6, 18, 24, and 36.

TABLE 7: REASONS FOR MISSING AND ATTRITED LLIN AT MONTHS 6, 18, 24, AND 36, NET DURABILITY STUDY AT MONTH 36, 2019, ZIMBABWE

Reasons	Month 6		Month 18		Month 24		Month 36	
	Number of LLINs	% (n=1,834)	Number of LLINs	% (n=1,726)	Number of LLINs	% (n=1,170)	Number of LLINs	% (n=823)
Nets lost								
Used by family members elsewhere	35	1.9	227	13.1	74	6.3	97	11.8
Net was given away to relatives	53	2.9	46	2.6	17	1.5	23	2.8
Net was given away to others	11	0.6	29	1.7	4	0.3	3	0.4
Net was stolen	4	0.2	17	1.0	9	0.8	12	1.5
Net was sold	1	0.1	1	0.1	0	0.0	-	-
Subtotal	104	5.7	320	18.5	104	8.9	135	16.0
Nets attrited (due to wear and tear)								
Net was destroyed accidentally	4	0.2	24	1.4	26	2.2	25	3.0
Net was thrown away	0	0.0	22	1.3	31	2.6	50	6.1
Material used for other purpose	0	0.0	7	0.4	3	0.3	7	0.9
Subtotal	4	0.2	53	3.1	60	5.1	82	10.0
Do not know	4	0.2	24	1.4	16	1.4	32	3.8
Subtotal	4	0.2	24	1.4	16	1.4	32	3.8
Total	112	6.1	397	23.0	180	15.4	249	29.8

4.3.2 ATTRITION DUE TO WEAR AND TEAR

A cohort of nets were reported as taken out of use because they were too worn and therefore thrown away, destroyed, or used for other purposes. Table 7 above shows this attrition due to wear and tear at baseline, month 18, month 24, and month 36.

The proportion of cohort nets that were reported lost due to wear and tear increased significantly from 0.2% at baseline to 3.1% at month 18 ($p=.042$). There was a further increase to 5.1% at month 24 ($p=0.83$) and to 10.0% at month 36 ($p=0.66$).

4.4 PHYSICAL ASSESSMENT OF LLINS

Fabric integrity results are presented by district, sector, and brand of net based on three integrity condition categories: good, acceptable, and torn. Further, nets deemed “good” and “acceptable” are collectively considered “serviceable.” ZAPIM assessed fabric integrity in all nets available for assessment by looking at the level of damage (number of holes and repairs), and by counting and classifying the number of holes (including tears in the netting and split seams) by location and size. ZAPIM classified holes into the following categories from WHO guidelines: smaller than a thumb (0.5-2cm), larger than a thumb but smaller than a fist (>2-10cm), larger than a fist but smaller than a head (>10-25cm), and larger than a head (>25cm). ZAPIM ignored holes less than 0.5cm. ZAPIM recorded any evidence of repairs to the net fabric and the type of repair; repairs were not considered holes.

To calculate the pHI, ZAPIM multiplied the number of holes in each category by a category weight: $pHI = \# \text{ size 1 holes} + (\# \text{ size 2 holes} \times 23) + (\# \text{ size 3 holes} \times 196) + (\# \text{ size 4 holes} \times 576)$.

Thus, using the pHI:

- Good = total hole surface area $<0.01\text{m}^2$ or $pHI < 64$
- Acceptable = total hole surface area $\leq 0.1\text{m}^2$ or $pHI = 65-642$
- Torn = total hole surface area $>0.1\text{m}^2$ or $pHI > 642$
- Serviceable nets = Good + Acceptable

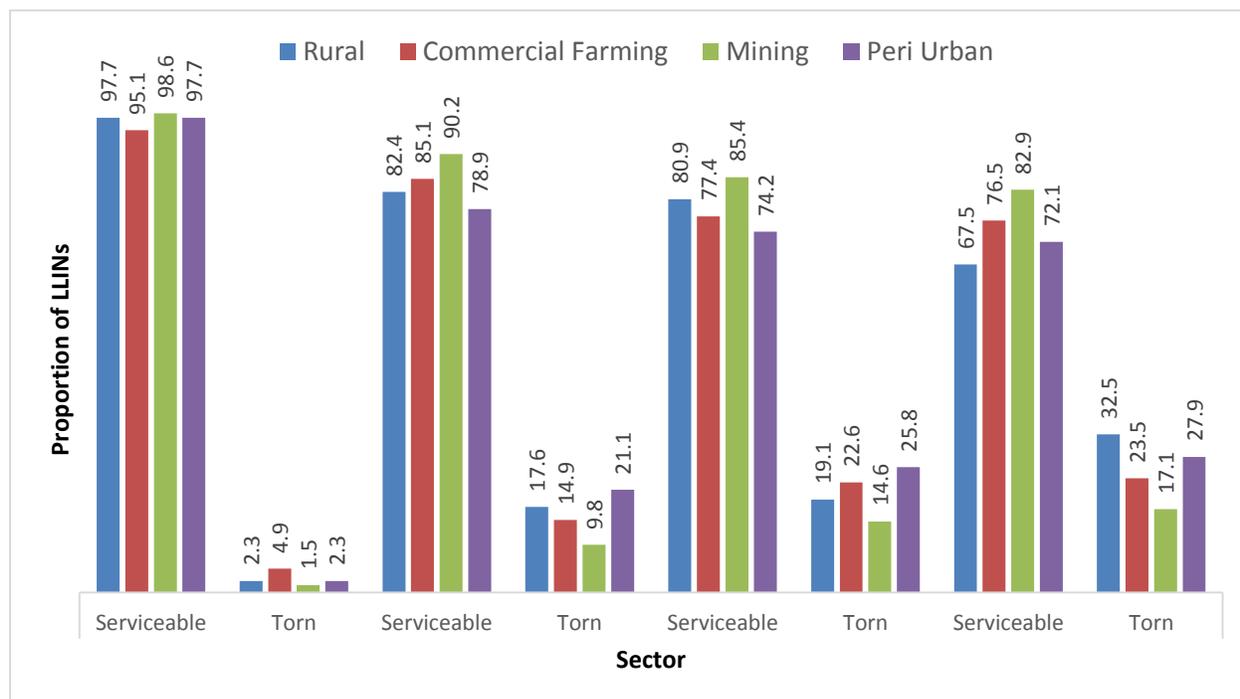
ZAPIM assessed 574 LLINS (310 DawaPlus 2.0 and 264 DuraNet) for fabric integrity at the final time point, month 36. Of these, 265 LLINs (46%) fell into the good category, 160 LLINs (28%) were acceptable, and 149 LLINs (26%) fell into the torn category. Thus, overall, 74% of the LLINs assessed were still serviceable compared with 80% at month 24 ($p=0.013$). Table 8 shows the fabric integrity at months 6, 18, 24, and 36 by brand of LLIN, and compares the results from all time points, represented as a percentage of all survived nets at that specific time point.

TABLE 8: PHYSICAL ASSESSMENT RESULTS AT MONTHS 6, 18, 24, AND 36, NET DURABILITY STUDY AT MONTH 36, 2019, ZIMBABWE

Period	Brand of LLIN	pHI Category				Total
		Good = pHI<64	Acceptable = pHI = 65-642	Serviceable = Good + Acceptable	Torn = pHI>642	
Month 6	DawaPlus 2.0	808	36	844	28	869
	%	93.1	3.9	97.0	3.0	100.0
	DuraNet	797	37	834	27	857
	%	93.0	4.0	97.0	3.0	100.0
	Total	1,642	73	1,678	55	1,726
	%	93.0	4.0	97.0	3.0	100.0
Month 18	DawaPlus 2.0	441	151	592	94	686
	%	64.3	22.0	86.3	13.7	100.0
	DuraNet	404	122	526	117	643
	%	62.8	19.0	81.8	18.2	100.0
	Total	845	273	1,118	211	1,329
	%	63.6	20.5	84.1	15.9	100.0
Month 24	DawaPlus 2.0	327	127	454	107	561
	%	58.3	22.6	80.9	19.1	100.0
	DuraNet	236	98	334	95	429
	%	55.0	22.8	77.9	22.1	100.0
	Total	563	225	788	202	990
	%	56.9	22.7	79.6	20.4	100.0
Month 36	DawaPlus 2.0	150	91	241	69	310
	%	48.4	29.4	77.7	22.3	100.0
	DuraNet	115	69	184	80	264
	%	43.6	26.1	69.7	30.3	100.0
	Total	265	160	425	149	574
	%	46.2	27.9	74.0	26.0	100.0

By brand at month 36, over three-fourths (78%) of DawaPlus LLINs were in serviceable condition, compared with 70% of DuraNet LLINs (p=0.036) This can be compared with the baseline (month 6), where there was no difference in the fabric integrity of the two brands—97% of both DawaPlus 2.0 and DuraNet LLINs were still serviceable. The proportion of LLINs in the torn category increased from 20% at month 24 to 26% at month 36. ZAPIM conducted further analysis to determine the fabric integrity of the nets according to sector, as shown in Figure 7.

FIGURE 7: PHYSICAL ASSESSMENT OF NETS AT MONTHS 6, 18, 24, AND 36 BY SECTOR, NET DURABILITY STUDY AT MONTH 36, 2019, ZIMBABWE



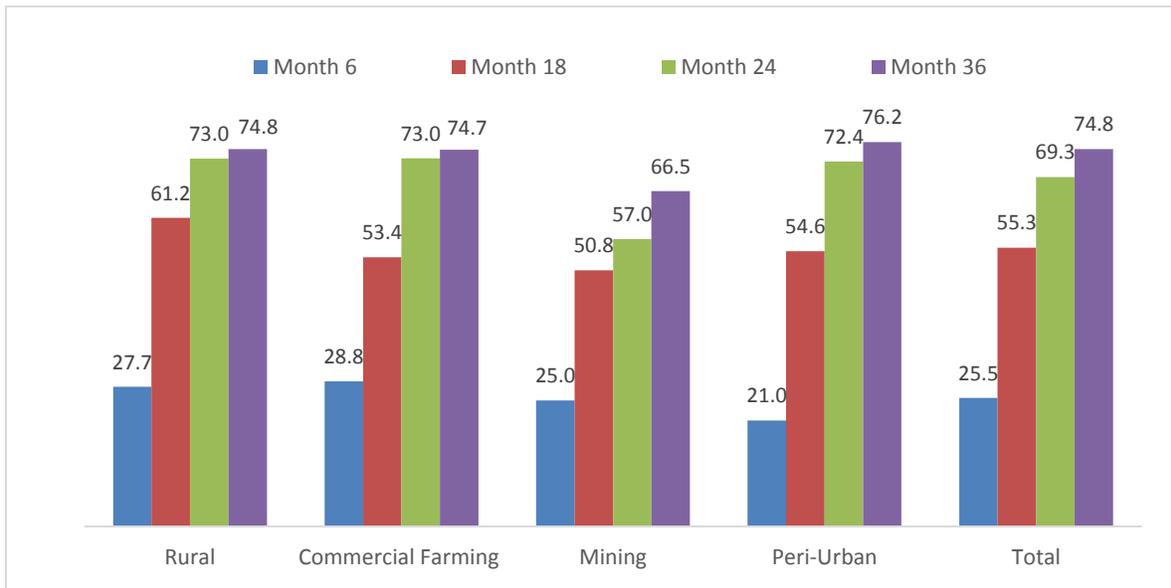
*Note: “Serviceable” combines all “good” and “acceptable” nets.

Figure 7 shows that across all sectors, the percentage of serviceable nets progressively decreased at each assessment period. The decrease in serviceable nets across the period was most marked in the rural sector, falling from 97.7% serviceable at baseline to 67.5% serviceable—a 30.2 percentage-point decrease ($p=0.003$). The mining sector consistently demonstrated the least change in the proportion of survived nets that were serviceable over the assessment period; the number fell by 19.4 percentage points, from 95.1% at baseline to 75.7% at month 36.

4.5 NET CARE AND REPAIR

ZAPIM collected data from households on whether there were holes in the nets owned, how the holes had occurred, and whether nets had been repaired. At month 36, 75% of all households had holes in their nets, compared with 69% at month 24, 55% at month 18, and 26% at baseline. Further analysis examined this net hole pattern by sector at the various assessment time points—at months 6, 18, 24, and 36 by sector (Figure 8).

FIGURE 8: PERCENTAGE OF HOUSEHOLDS WITH HOLES IN LLINS AT MONTHS 6, 18, 24, AND 36 BY SECTOR, NET DURABILITY STUDY AT MONTH 36, 2019, ZIMBABWE



Across all sectors, the proportion of households with holes in their nets increased at each progressing time point. The period between month 6 and month 18 saw the greatest increase (almost 30 percentage points), with the number doubling during the 12-month interval. Over the assessment period, the mining sector recorded the lowest ending percentage of households with holes in the nets they own (67%), and the peri-urban sector recorded the highest. In the month 36 assessment, the three major contributing factors for holes in the nets as cited by the households were: caught on edge or nail (34%), pulled and torn on corner (30%), and damaged by rats or mice (21%). These were the same top three reasons cited at month 6, month 18, and month 24.

In month 36, about 50%, of households with holes in their nets had ever tried to repair any of the holes or had them repaired by someone else over the previous 6 months. This was a higher percentage than in months 24 and 18 (39% and 41% of households, respectively). Table 9 shows the reasons households gave for not repairing nets.

TABLE 9: REASONS FOR NOT REPAIRING LLINS AT MONTHS 6, 18, 24, AND 36, NET DURABILITY STUDY AT MONTH 36, 2019, ZIMBABWE

Reasons	Month 6		Month 18		Month 24		Month 36		Overall
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Percentage
Holes are not big enough to repair	104	57.8	124	21.8	103	20.6	46	14.9	24.2
Don't know how to repair	19	10.6	110	19.3	89	17.8	51	16.5	17.3
No time	7	3.9	94	16.5	127	25.4	65	21.0	18.8
Not necessary	6	3.3	88	15.5	64	12.8	56	18.1	13.7
Not possible	1	0.6	61	10.7	61	12.2	35	11.3	10.1
No materials to repair	6	3.3	33	5.8	26	5.2	17	5.5	5.3
Don't know	26	14.4	18	3.2	13	2.6	8	2.6	4.2
Other	11	6.1	41	7.2	17	3.4	31	10.0	6.4
Total	180	100.0	569	100.0	500	100.0	309	100.0	100.0

Overall, across all time points, the most cited reason for not repairing nets was that the holes were not big enough to repair. This was cited more frequently during the earlier assessment rounds in month 6 and 18. The next most cited reason overall was that the respondents had no time to do any repairs, which was the most cited reason at the latter assessment periods. Not knowing how to repair holes was cited by about 17% of all respondents overall, and 14% and 10% , respectively felt it was not necessary, or was impossible, to repair torn nets.

4.6 CUMULATIVE SURVIVORSHIP OF SERVICEABLE LLINS

The study assessed the proportion of nets surviving in serviceable condition, calculated as the proportion of nets in serviceable condition among those nets not LTFU (see Figure 2). Table 10 compares the proportion of nets surviving in serviceable condition at baseline, month 18, month 24, and month 36.

TABLE 10: PROPORTION OF CUMULATIVE NETS SURVIVING IN SERVICEABLE CONDITION AT MONTH 6, 18, 24, AND 36, BY BRAND OF LLIN, NET DURABILITY STUDY AT MONTH 36, 2019, ZIMBABWE

Period	Brand of LLIN	Number of Nets in Serviceable Condition	All Surviving and Attrited Cohort Nets	Percentage of Surviving Nets in serviceable condition
Month 6	DawaPlus 2.0	844	869	97.1%
	DuraNet	834	857	97.3%
Total		1,678	1,726	97.2%
Month 18	DawaPlus 2.0	592	713	83.0%
	DuraNet	526	669	78.6%
Total		1,118	1,382	80.9%
Month 24	DawaPlus 2.0	454	595	76.3%
	DuraNet	334	455	73.4%
Total		788	1,050	75.0%
Month 36	DawaPlus 2.0	241	353	68.3%
	DuraNet	184	303	60.7%
Total		425	656	64.8%

There was a statistically significant cumulative decline in the proportion of LLINs surviving in serviceable condition over the course of the study. The proportion of cumulative nets surviving in serviceable condition decreased from 80.9% at month 18 to 75% at month 24 ($p=0.001$), and further to 64.8% at the final time point ($p<.001$). In addition, at this final time point, cumulative nets surviving in serviceable condition differed by brand—68% for DawaPlus 2.0 and 61% for DuraNet ($p=0.042$). The number of surviving and attrited LLINs from the initial 2000 which were remaining at each assessment period was used as the denominator for calculating the cumulative attrition at that point. All nets lost (nets given away, used elsewhere, or stolen), deemed LTFU, and for which respondents reported the status of the LLIN as “do not know” were excluded from the denominator. Additionally, as stated earlier, due to unavailability of a separate cohort for bioassays and chemical analysis after the month 6 baseline, 102, 97, and 97 nets respectively at months 18, 24, and 36, were purposefully included in the assessments and then removed for bioassays and insecticidal testing at each time point respectively. These LLINs were also removed from the denominator for all surviving and attrited cohort LLINs.

4.7 MEDIAN SURVIVORSHIP OF SERVICEABLE LLINS

The median survival was calculated for both types of nets—i.e., the amount of time after which 50% of the nets are estimated to survive. This was calculated using the formula below:

$$t_m = t_1 + \frac{(t_2 - t_1) * (p_1 - 50)}{(p_1 - p_2)}$$

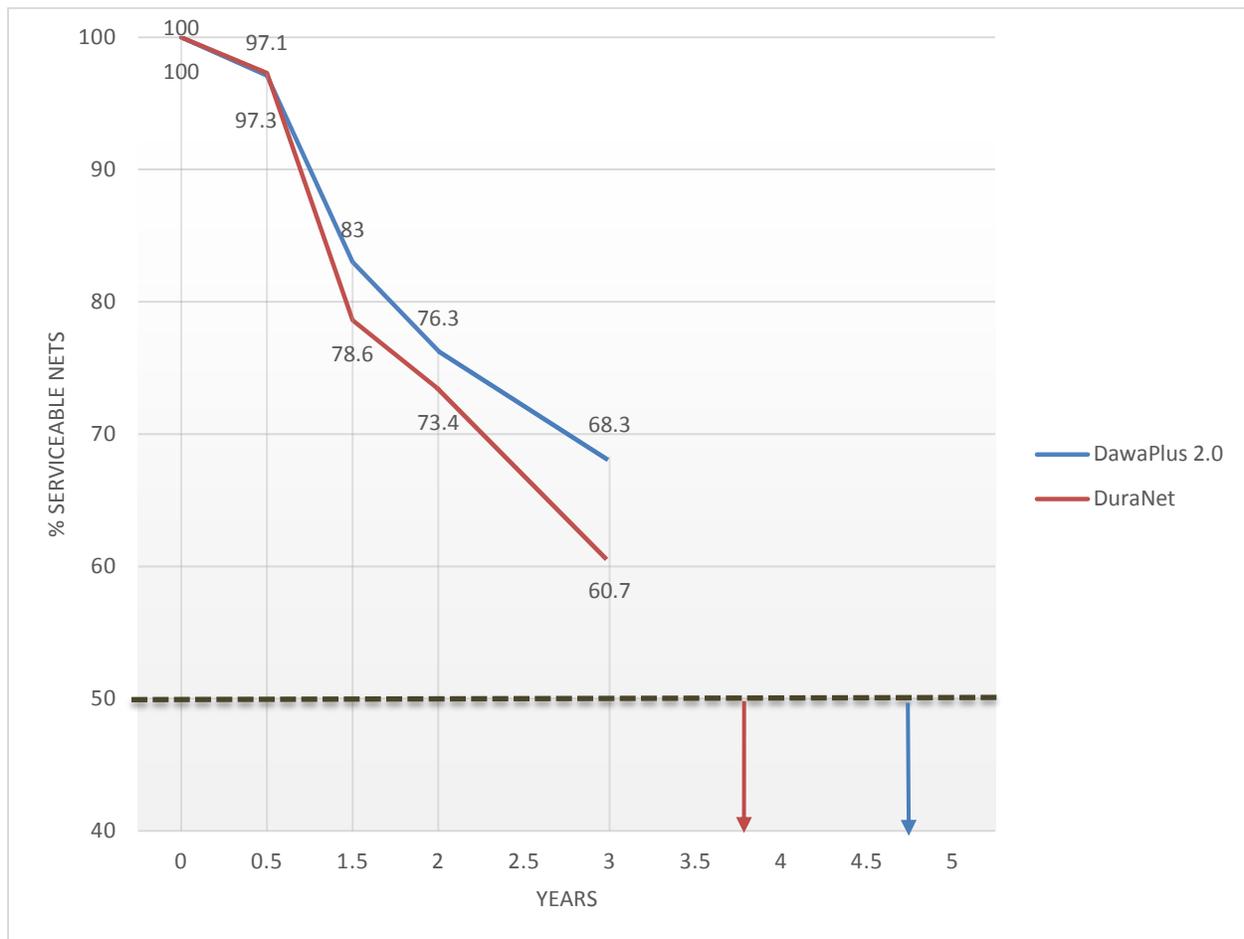
- t_m= median survival
- t₁= first time point (years since distribution)
- t₂= second time point
- p₁= functional survival at t₁
- p₂= functional survival at t₂

Table 11 and Figure 9 below show that at baseline (month 6), the median survival estimations were highest, at 8.6 years and 9.3 years respectively for DawaPlus 2.0 and DuraNet. This indicates the projected length of time that 50% of respective distributed nets would remain serviceable. The estimate was 4.4 and 3.5 years respectively in month 18, and 4.2 and 3.8 years respectively in month 24. At month 36, the final time point, the estimated median net survival was 4.7 years for DawaPlus 2.0 and remained at 3.8 years for DuraNet.

TABLE 11: MEDIAN SURVIVAL FOR MONTHS 6, 18, AND 24

Brand of LLIN	Month 6	Month 18	Month 24	Month 36
DawaPlus 2.0	8.6	4.4	4.2	4.7
DuraNet	9.3	3.5	3.8	3.8

FIGURE 9: PROPORTION OF DAWAPLUS 2.0 AND DURANET LLINS SURVIVING IN SERVICEABLE CONDITION AT MONTH 6, 18, 24, AND 36, NET DURABILITY STUDY AT MONTH 36, 2019, ZIMBABWE



4.8 DETERMINANTS OF LLIN FIELD PERFORMANCE

ZAPIM asked various questions to assess the condition and performance of the LLINs in the field. The questions included the location of the net, type of sleeping place where the net was mostly used, net use the night before the survey, number of nights of net use the previous week, net washing frequency, and the type of soap used for the last wash. All these questions have a bearing on the condition and performance of the LLINs. Table 12 below shows the proportion of study LLINs at a given location during each study interval.

TABLE 12: STATUS OF SURVIVING CAMPAIGN NET FROM COHORT AT MONTH 6, 18, 24, AND 36, NET DURABILITY STUDY AT MONTH 36, 2019, ZIMBABWE

Variable	Month 6	Month 18	Month 24	Month 36
Inside house hanging and folded up or tied	49.3%	43.6%	33.4%	35.5%
Inside house hanging loose over sleeping place	19.2%	23.1%	23.2%	25.4%
Stored away unpacked	14.6%	15.6%	22.2%	19.5%
Not hanging and also not stored*	11.0%	11.9%	12.4%	15.0%
Outside hanging loose over a sleeping place	0%	2.5%	5.6%	1.9%
Stored away still in package	5.9%	2.2%	1.7%	0.9%
On the washing line	0%	1.1%	1.5%	0%

* “Not hanging and also not stored” refers to nets that were visible though not hung during the time of the assessment.

Overall, across the assessment period, more nets were found over sleeping spaces (hanging inside the house or over outdoor sleeping places), but this proportion decreased over time with each assessment period. At the final assessment point, over 35% of nets were inside the house hanging and folded up or tied, compared with 33% in month 24 and nearly half (49%) at baseline. An increasing share of survived nets at each assessment period were either stored away unpacked (20% at endline compared with 15% at baseline), or not hanging but not stored, i.e., 15% at endline compared with 11% at baseline. One in five nets among survived nets at the final assessment point was found to be stored away still in its package.

At all assessment points, the reed mat and the bed and mattress were the most common sleeping places for which the net was used. Net use with the reed mat was more prevalent than with the bed and mattress in the earlier assessment periods—43% versus 26% in month 6, and 43% versus 39% respectively in month 18. Conversely, in the latter two assessment periods, net use with the bed and mattress was more common than with the reed mat—i.e., 42% versus 40% in month 24, and 45% versus 33% at the final assessment in month 36. Across all time periods, the least popular sleeping space for which nets were used was sleeping outside and sleeping on the grass (0.2% each at baseline and 0.2% at endline).

Similar to in earlier months, at the endline assessment point, the use of a reed mat was most common in the rural sector (40% of all reed mats reported in the study were used there), but the bed and mattress was the most common sleeping place among all rural sector respondents. The reed mat was least common in the peri-urban sector (16% of respondents used one at month 18, and then 18% at month 24), except that at month 36 it was least common in the mining sector (14% of those respondents used it). At month 36, in the households with nets, 56% of these nets had been slept under by any person the previous night.

Sixty-six percent (66%) of study nets were reported as having ever been washed as of the month 36 assessment, compared with 88% at month 24, 84% at month 18, and 6% at baseline.

4.9 BIOASSAY AND CHEMICAL ANALYSIS RESULTS

4.9.1 BIOASSAY RESULTS

The WHO cone bioassay method measures the knockdown and mortality rates of susceptible mosquitoes after exposure to LLINs. NIHR used a laboratory-reared susceptible female *Anopheles arabiensis* strain in all bioassays. The WHO recommendation for definitions of effectiveness of LLINs based on bioassay results is, according to Kilian et al., 2008:

- Minimal effectiveness: KD60 \geq 75.0% or mortality \geq 50.0%
- Optimal effectiveness: KD60 \geq 95.0% or mortality \geq 80.0%

Table 13 illustrates the effectiveness levels of LLINs on the basis of bioassays at months 6, 18, 24 and 36 when tested against laboratory-bred *An. arabiensis* mosquitoes.

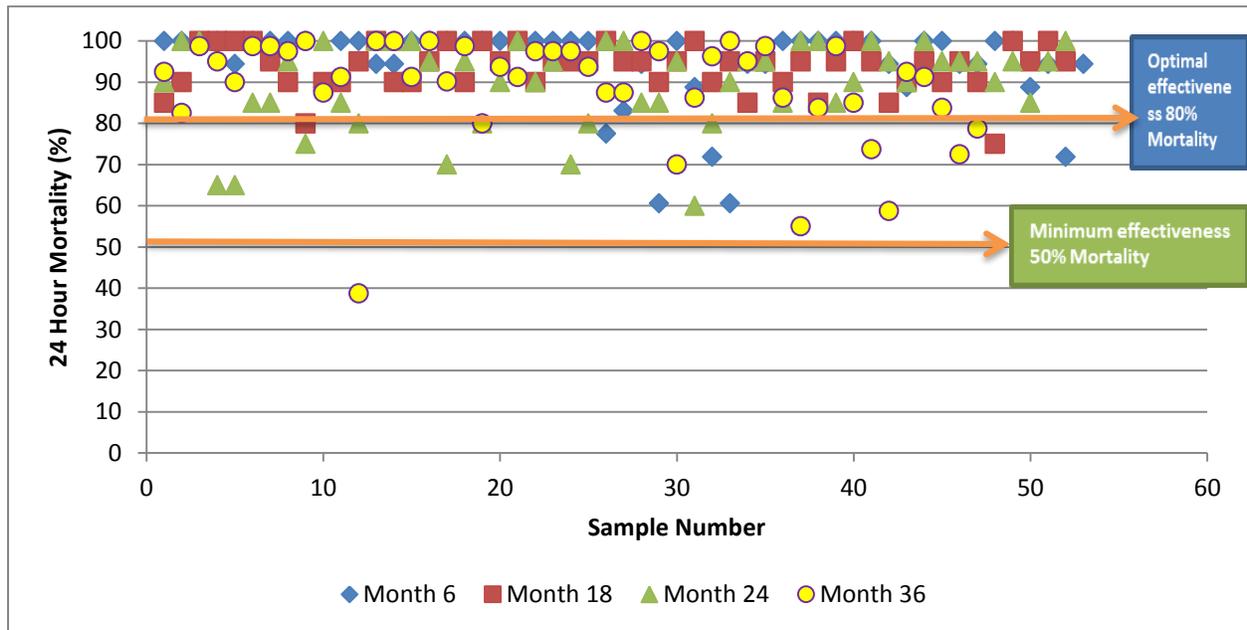
TABLE 13: EFFECTIVENESS LEVELS OF LLINs ON THE BASIS OF MONTHS 6, 18, 24 AND 36 BIOASSAYS WHEN TESTED AGAINST LABORATORY-BRED AN. ARABIENSIS MOSQUITOES, NET DURABILITY STUDY AT MONTH 36, 2019, ZIMBABWE

Period	Brand of Net	Minimal Effectiveness		Optimal Effectiveness	
		KD60* \geq 75%	Mortality \geq 50%	KD60* \geq 95%	Mortality \geq 80%
6 months	DawaPlus 2.0 (n=52)	46 (88.5%)	51 (98.1%)	13 (25.0%)	47 (90.4%)
	DuraNet (n=53)	53 (100.0%)	53 (100.0%)	52 (98.1%)	48 (90.6%)
18 months	DawaPlus 2.0 (n=49)	33 (67.3%)	49 (100.0%)	5 (8.2%)	26 (51.0%)
	DuraNet (n=53)	50 (96.0%)	52 (100.0%)	14 (26.4%)	51 (98.1%)
24 months	DawaPlus 2.0 (n=45)	33 (73.3%)	44 (97.8%)	7 (15.6%)	19 (42.2%)
	DuraNet (n=52)	46 (88.5%)	52 (100.0%)	9 (17.3%)	46 (88.5%)
36 months	DawaPlus 2.0 (n=50)	19 (38.0%)	10 (20.0%)	3 (6.0%)	2 (4.0%)
	DuraNet (n=47)	46 (97.9%)	46 (97.9%)	43 (91.4%)	40 (85.1%)

*KD60 = Knockdown of mosquitoes 60 minutes after exposure to treated nets.

ZAPIM conducted bioassays on 53 DuraNet LLINs at month 6, 53 at month 18, 52 at month 24, and 47 at month 36. ZAPIM also conducted bioassays on 52 DawaPlus 2.0 LLINs at month 6, 49 at month 18, 45 at month 24, and 50 at month 36. At month 36, 85% of DuraNet LLINs were optimally effective based on the level of mortality, a slight decline from 88.5% at month 24 ($p=0.775$). However, the optimal effectiveness at endline i.e. 85% was significantly different from the baseline of 91% ($p=0.018$). For DawaPlus 2.0, at month 36, 4.0% of LLINs were optimally effective based on the level of mortality, a significant decline from 42% at month 24 ($p<0.001$). At month 36, the optimal effectiveness of between both nets differed significantly (85% for DuraNet vs. 4.0% for DawaPlus, $p<.001$).

FIGURE 10: BIOASSAY RESULTS AT 24-HOURS ON DURANET LLINS, MONTHS 6, 18, 24 AND 36, NET DURABILITY STUDY AT 36 MONTHS, 2019, ZIMBABWE



As illustrated in Figure 10, at month 6, 48 DuraNet LLINs (91%) had a 24-hour mosquito mortality rate of at least 80% and above, while five (9%) had a rate below the WHO minimum standard of 80%. The mortality rates at month 6 ranged from 61% to 100%. Among bioassays conducted on 53 DuraNet LLINs at month 18, 52 (98%) resulted in 24-hour mosquito mortality of $\geq 80\%$; the range of mortality rates was 75% to 100%. At month 24, bioassays were conducted on 52 DuraNet LLINs. Of these, 46 (89%) had a 24-hour mortality rate of 80% and above; the range of mortality rates was 60% to 100%. At month 36, bioassays were conducted on 47 DuraNet LLINs, of which 40 (85%) resulted in 24-hour mosquito mortality of $\geq 80\%$. The mortality rates at month 36 ranged from 39% to 100%.

FIGURE 11: BIOASSAY RESULTS AT 24-HOURS ON DAWAPLUS 2.0 LLINS, MONTHS 6, 18, 24 AND 36, NET DURABILITY STUDY AT 36 MONTHS, 2019, ZIMBABWE

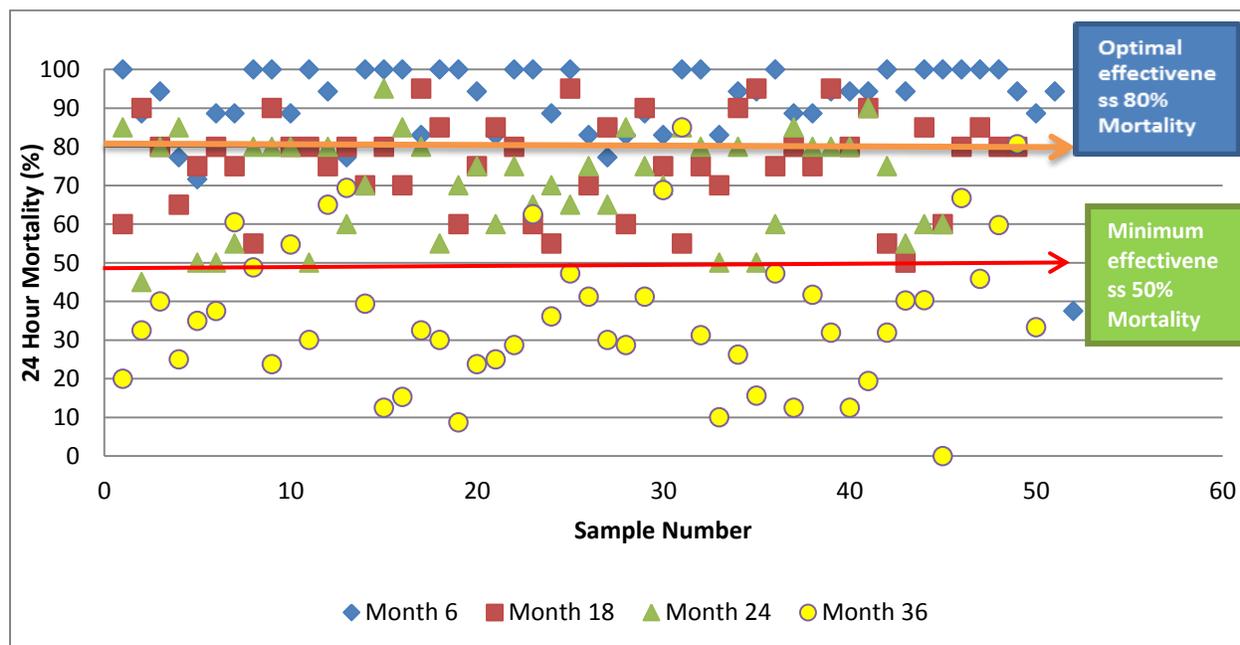


Figure 11 shows the bioassay results for DawaPlus 2.0 at months 6, 18, 24 and 36. At month 6, 47 (90%) of DawaPlus 2.0 LLINs had a 24-hour mosquito mortality rate of 80% or above, and five (10%) had mortality rates below 80%. The mortality rates at month 6 ranged from 38% to 100%. At month 18, ZAPIM tested 49 DawaPlus 2.0 nets. Of these, 26 (53%) had a 24-hour mosquito mortality rate of 80% or above, while 23 (47%) recorded mortalities below the optimal effectiveness rate of 80%; the range of mortality rates was 50% to 95%. At 24 months, 45 DawaPlus 2.0 LLINs were tested. Of these, 19 (42%) had a 24-hour mosquito mortality rate of 80% or above and 26 (58%) recorded mortalities below the optimal effectiveness of 80%; the range of mortality rates was 45% to 95%. At the endline of the study, month 36, bioassays were conducted on 50 DawaPlus 2.0 LLINs, of which 2 (4.0%) resulted in 24-hour mosquito mortality of $\geq 80\%$. The mortality rates at month 36 ranged from 0% to 85%.

4.9.2 CHEMICAL ANALYSIS RESULTS

ZAPIM also conducted chemical analysis using samples from the same nets used for bioassays at months 6, 18, 24 and 36. That is, chemical analysis was conducted on 53 DuraNet LLINs at month 6, 53 at month 18, 52 at month 24, and 47 at month 36. For the DawaPlus 2.0 nets, ZAPIM conducted chemical analysis on 52 at month 6, 49 at month 18, 45 at month 24, and 50 at month 36.

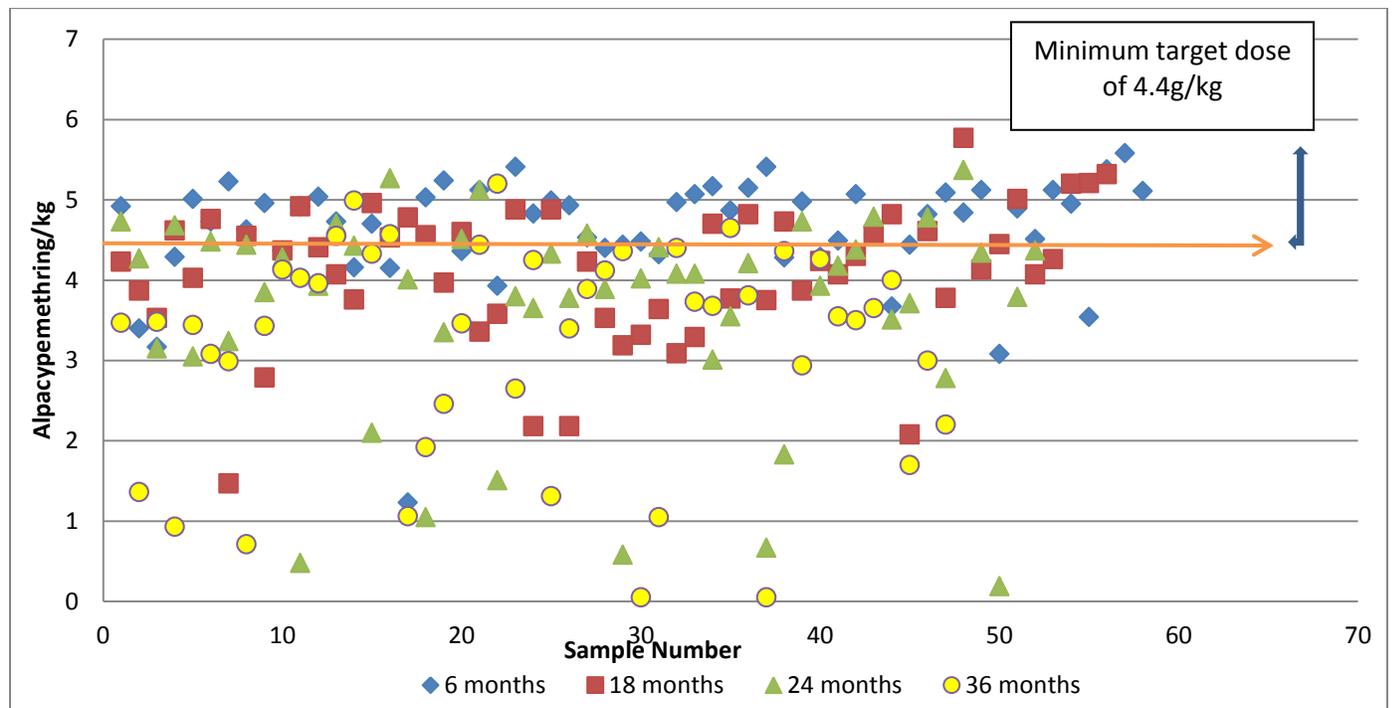
Chemical analysis followed WHO guidelines to measure actual levels of insecticide in the LLIN fabric. Walloon Laboratory used gas and high-performance liquid chromatographic methods for chemical analysis on DuraNet and DawaPlus 2.0 nets, respectively. The WHO recommendation for target dose range for each LLIN brand's active insecticide ingredient is:

- DuraNet (active ingredient: alpha-cypermethrin 5.8g/kg): 4.4-7.3g/kg according to the WHO specification 333452/LN/2, October 2014
- DawaPlus 2.0 (active ingredient: deltamethrin 2.0g/kg): 1.5-2.5g/kg according to the WHO specification 333/LN/2, January 2019

Overall, the difference in chemical content at month 36 endline differed significantly from month 6 baseline for the two brands, i.e., 10% at endline vs. 46% at baseline for DawaPlus 2.0 ($p<0.001$) and 13% at endline vs. 78% at baseline for DuraNet ($p<0.001$). DawaPlus 2.0 LLINs also showed earlier reductions in chemical content than DuraNet LLINs. The proportion of DawaPlus 2.0 LLINs with the required minimum target dose was only 46% at month 6 and decreased to 10% at month 36, compared with 78% and 13%, respectively, for DuraNet. At month 6, the difference in residual levels of insecticide in the LLIN fabric differed significantly by brand of net, i.e., 46% of DawaPlus 2.0 vs. 78% of DuraNet ($p=0.001$). However, at month 36, the difference by net type was not significant (10% of DawaPlus 2.0 vs. 13% of DuraNet, $p=0.755$)

Figures 12 and 13 display the chemical analysis results for DuraNet and DawaPlus 2.0, respectively, on the basis of chemical analysis at months 6, 18, 24 and 36.

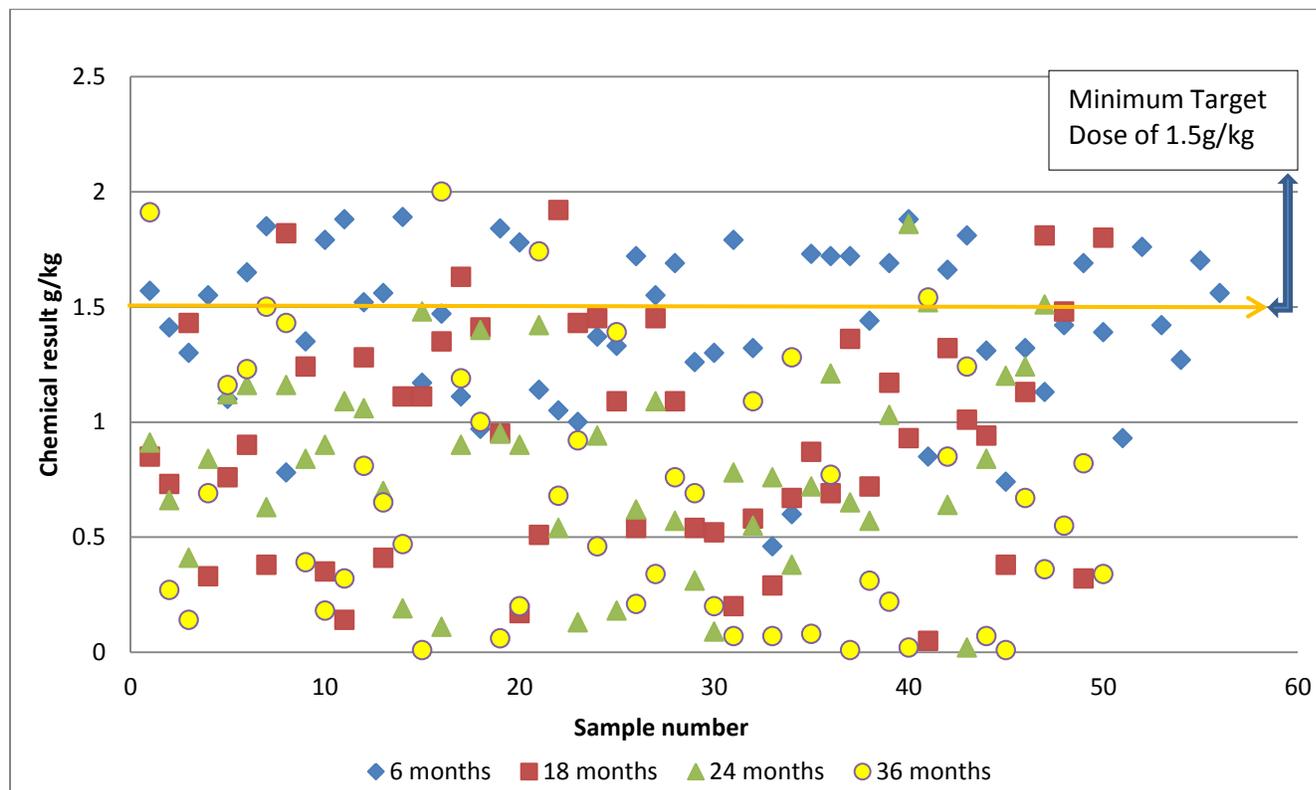
FIGURE 12: CHEMICAL ANALYSIS RESULTS FOR DURANET AT MONTHS 6, 18, 24 AND 36, NET DURABILITY STUDY AT 36 MONTHS, 2019, ZIMBABWE



The chemical analysis results (Figure 12) for DuraNet show that at month 6, 45 of the nets (77.6%) had a chemical content within the recommended target dose range of 4.44-7.25g/kg of alpha-cypermethrin, with 13 nets (22%) falling below the minimum target dose. The results ranged from 1.23g/kg to 5.47g/kg, with a mean of 4.62g/kg. This mean is above the minimum target dose. At month 18, ZAPIM analyzed 56 DuraNet LLINs. Of these, only 21 (38%) had the required target dose, and 35 (63%) had a dose below the minimum of 4.44g/kg. The range was 1.47g/kg to 5.77g/kg, with a mean of 4.15g/kg, below the minimum target dose. At month 24, 54 nets were analyzed. Of these, 18 (33%) had the recommended target dose range of 4.44-7.25g/kg, while 36 nets (67%) fell below the minimum. The range was from 0.19g/kg to 5.37g/kg, with a mean of 3.71g/kg. At month 36, 47 DuraNet LLINs were analyzed, of which 6 (13%) had the recommended target dose range of 4.44-7.25g/kg, while 41 (87%) had fallen below the minimum after three years of use. The range was <0.05g/kg to 5.20g/kg, with a mean of 3.20g/kg. Except in the month 24 assessment, the proportion of nets that had a chemical content within the

recommended target dose range of 4.44-7.25g/kg differed significantly at each progressive time point: it was 78% in month 6, versus 38% at month 18 ($p<0.001$); then it fell to 33% at month 24 ($p=0.693$), and finally it fell to 13% at the final assessment time point ($p=0.019$).

FIGURE 13: CHEMICAL ANALYSIS RESULTS FOR DAWAPLUS 2.0 LLINS AT MONTHS 6, 18, 24 AND 36, NET DURABILITY STUDY AT 36 MONTHS, 2019, ZIMBABWE



ZAPIM analyzed 56 DawaPlus 2.0 LLINs at month 6. Figure 12 shows that 26 (46%) nets were within the required minimum target dose range of 1.50-2.50g/kg, while 30 (54%) were below the minimum target dose of 1.50g/kg. The chemical content for DawaPlus 2.0 nets at month 6 ranged from 0.46 to 1.89g/kg, with a mean of 1.42g/kg, which is below the target dose. At 18 months, ZAPIM analyzed 50 nets. Of these, only 6 (12%) had the required target doses, and 44 (88%) had doses below the minimum. The range was 0.05-1.92g/kg, with a mean of 0.94g/kg. At month 24, ZAPIM analyzed 47 nets. Of these, only three (6.4%) had the minimum required target dose. A total of 44 nets (93%) had doses below the minimum of 1.50g/kg. The range at month 24 was 0.02-1.86g/kg, with a mean of 0.82g/kg, which is below the target dose. At month 36, 50 DawaPlus 2.0 nets were analyzed, of which 5 (10%) had the recommended target dose range of 1.50-2.50g/kg, while 45 nets (90%) fell below the minimum after 3 years of use. The range was <0.01g/kg to 2.00g/kg, with a mean of 0.67g/kg. Except in the month 18 assessment, the proportion of nets with the required minimum target dose range of 1.50-2.50g/kg of chemical content did not differ significantly at each progressive time point. It was 46% in month 6, vs. 12% at month 18 ($p<0.001$), then it fell to 6.4% at month 24 ($p=0.693$), and it finally rose to 10% at month 36 ($p=0.019$).

5. DISCUSSION

Cumulative net all-cause attrition increased from 6.1% at month 6 to 22% at month 18, 32% at month 24, and 45% at month 36. These results are comparable with findings from studies elsewhere. For example, Hassan et al. (2008) in Sudan reported an estimated 19% attrition after 18 months. Other studies report slightly higher rates of attrition, including 20% attrition in Uganda and Liberia after 12 months, 43% after 18 months in Benin, and 45% after 24 months in Sudan. In this assessment, respondents seemed to be aware that ZAPIM would monitor the nets after 18 months and therefore perhaps made an effort to keep them. If true, the attrition reported here might underestimate attrition in a similar population not being actively assessed. This assessment nonetheless revealed that 6.3% of LLINs were being used by family members elsewhere. Future LLIN monitoring efforts may need to investigate whether such patterns persist.

Using the pHI calculations, a higher proportion of DawaPlus 2.0 nets survived in serviceable condition compared with DuraNet at all durability monitoring intervals. At baseline, there was no difference in the fabric integrity between the two brands. This was expected, as six months is a short time for significant damage to occur. A high proportion of surveyed households at all durability monitoring intervals had not tried to repair their nets, nor to have them repaired by someone else, over the previous six months. This was attributed to very low knowledge and low recognition of the need to repair damaged nets. Low repair rates were also reported by Smith et al. (2017) in Ghana, Kilian et al. (2011) in Uganda, and Shirayama et al. (2007) in the Lao People's Democratic Republic, suggesting this may be a widespread issue. It is likely that repairing nets could significantly improve their longevity, and perhaps, by extension, encourage behavior that would prevent the nets from developing holes. The fact that the proportion of holes differed by net brand could be a measure of net construction quality or design, which would have a profound impact on program planning and procurement decisions.

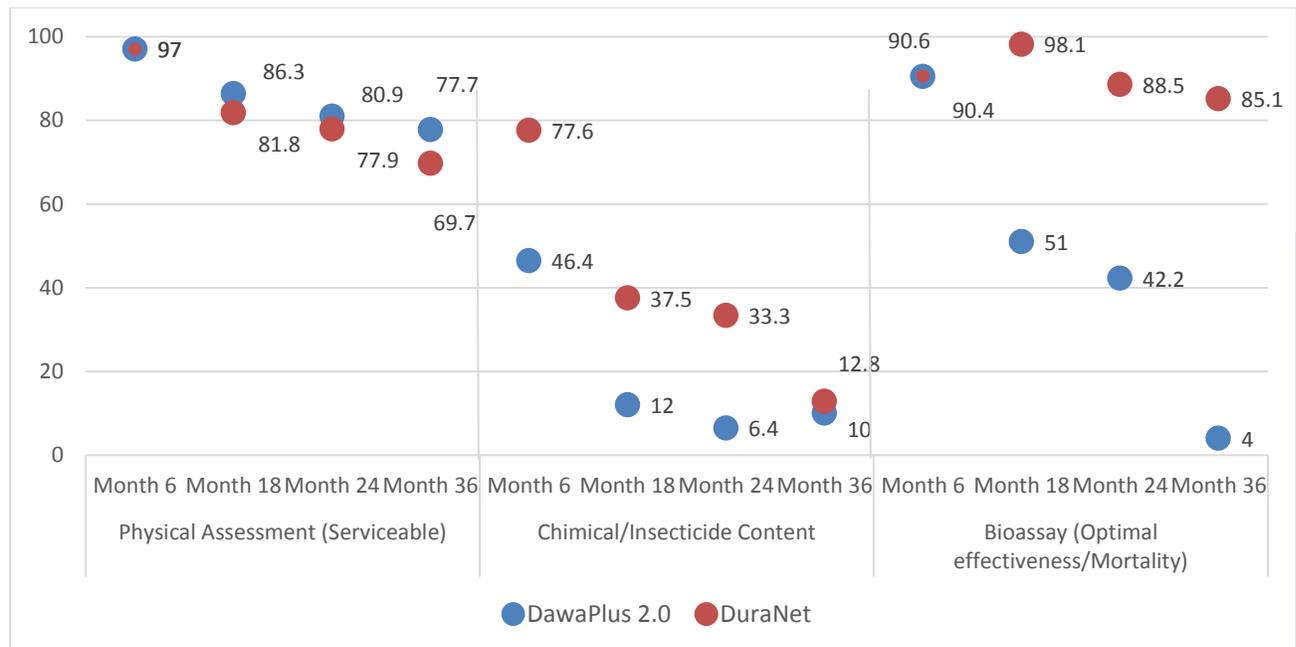
In looking at determinants of damage, this assessment revealed a number of factors associated with poverty. For example, a significant proportion of households indicated the reed mat as a common sleeping space (44% at baseline, 43% at month 18, 40% at month 24, and 33% at month 36). Use of the reed mat could make LLINs used to cover these sleeping spaces more prone to damage. The analysis also revealed behavioral aspects that could increase the likelihood of net damage, such as letting the net hang loose during the day (19% at baseline, 23% at month 18, 23% at month 24, and 25% at month 36), and not storing it properly when it was not in use (making it vulnerable to rodents or accidental damage). Other behavioral patterns included having food or crops stored in the same room, potentially increasing vulnerability to rodents (68% at baseline, 64% at month 18, 61% at month 24, and 55% at month 36), and the general attitude of the household towards net care and repair. Intensifying social and behavior change communication activities could improve repair-related attitudes and actions, and ultimately could improve net durability. The focus should therefore be on preventive behavior to protect nets from damage, such as folding or tying the net up every day, keeping children away from the nets except when the net is being used to protect the child, avoiding storing food or crops in the same room, and storing the net safely when it is not in use, as well as repairing holes. Although the practice of washing the nets improved from baseline (61%) to month 36 (66%), the frequency of washing remained

low at all durability monitoring intervals, with 25.9% of the nets having been washed only once at the month 36 time point.

Numerous factors affect LLIN durability and can have differing impacts in different settings. Given the number of factors and the variation between settings where they are distributed, it is not surprising that reliance on generalizations about how long nets last could be misleading, and likely overestimate durability. While refinement of the interpretation of pHI thresholds should continue, they do provide a much needed useful reference for real-time evaluation of LLIN interventions in the country and elsewhere.

LLIN durability monitoring also indicated a significant cumulative decline in the proportion of LLINs surviving in serviceable condition, from 97% at baseline (month 6) to 81% at month 18, 75% at month 24, and 65% at month 36. Results from this assessment demonstrate that from 6 to 36 months, a quantifiable pattern emerges regarding the main study parameters—physical deterioration of nets in the field, chemical content, and bioassay mortality (Figure 14). The DuraNet brand showed poorer cumulative survivorship and physical serviceability than DawaPlus 2.0. However, when subjected to laboratory analysis, DuraNet performed better than DawaPlus 2.0. Similarly, a greater proportion of DuraNet LLINs retained optimal effectiveness based on the level of mortality, and sustained the recommended targeted dose of chemical content over the course of this assessment.

FIGURE 14: LLIN DURABILITY STUDY PARAMETERS BY NET TYPE AT MONTHS 6, 18, 24 AND 36, NET DURABILITY STUDY AT 36 MONTHS, 2019, ZIMBABWE



It will be critical to compare the findings with the results on minimum knockdown levels and chemical potency before making a decision on which brand to prioritize and the recommended period for net replacement.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

- I. The DuraNet brand had lower survivorship and seemed to physically deteriorate faster than DawaPlus 2.0. However, when subjected to laboratory analysis for bioefficacy and chemical content, DuraNet performed better than DawaPlus 2.0. While physical and chemical analyses each show how effective nets are over time, these results demonstrate that determining which LLINs to deploy during LLIN distribution should take into account both analysis types.
- II. The results showed that with each study time point, LLIN fabric integrity decreases. After 36 months, 74% of LLINs not LTFU maintained their fabric integrity at a serviceable level. As fabric integrity continues to decline over time, reliance on ongoing serviceability of these LLINs in the three years after distribution and beyond may need to be reconsidered, especially considering the assessment findings that net repair behavior is limited.
- III. The level of continued chemical content (potency) of DuraNet LLINs after 36 months implies that repairing serviceable nets would contribute to their continued effectiveness in protection against malaria despite the loss of fabric integrity. This could be relevant for LLIN SBCC, as well as distribution planning.
- IV. Indicators of lower socioeconomic status (e.g., sleeping on a reed mat or on the ground) and certain behaviors (e.g., having loose-hanging nets during the day, and exposing nets to rodents due to poor storage practices in which nets are stored with food and crops) are associated with net damage. Respondents show limited knowledge of actions to prevent net damage and repair of holes.
- V. This study shows that LLIN survivorship declines over time, and within four years would be insufficient to maintain the levels of LLIN coverage needed for programmatic impact. This calls for interventions such as continuous distribution of nets.

This study contributes routine data on LLIN durability in a variety of settings and with a varied population. The findings suggest that, irrespective of sector, LLIN durability wanes over time, and that better washing and net repair practices could potentially extend the useful life of an LLIN.

6.3 RECOMMENDATIONS

Based on the above findings and conclusions, we present the following recommendations:

- I. Reconsider the planned distribution-replacement cycle, as the chemical content of both net brands decreased over time and had fallen below the threshold for minimal effectiveness dose by month 24. This effect was more elevated with the DawaPlus 2.0 brand than with DuraNet. DawaPlus 2.0 clearly no longer provided the required protective effect of killing mosquitoes after 24 months.
- II. Interpret the physical integrity of nets in conjunction with their chemical content to best recommend net replacement intervals. This study showed a median survival of both LLIN brands to be around 3.8 to 4.7 years, which is in line with the current lifecycle of mass distribution campaigns every three years. However, and as stated in the first point above, the chemical potency of either LLIN brand is lost much earlier than at three years, at about month 24. Further research and assessments are needed to better define the effective life of an LLIN and the most appropriate replacement cycles. In the meantime, continuous distribution should also follow mass distribution campaigns to identify and replace unserviceable nets and ensure the overall effectiveness of an LLIN program.
- III. Implement a program of teaching and encouraging good net handling, care, and use, to increase LLIN longevity. The study notes an almost complete lack of LLIN repairs, as well as accidental destruction, as the main reasons for all-cause LLIN attrition, suggesting opportunity to improve LLIN program effectiveness by educating the population on how to handle them.
- IV. The observed high attrition rate underscores the need for routine net distributions after mass campaigns, to replace lost nets and those damaged beyond repair. SBCC can further complement routine net distributions with information about the utility of nets and the importance of net care. LLIN replacement cycles, and supportive interventions like SBCC, in the country must be evidence-based for effective control and prevention of malaria.
- V. As Zimbabwe continues to scale up LLIN coverage, it needs accurate information about LLIN durability in a variety of settings. Monitoring enables programs to identify (and ideally replace) nets that perform below expectations, and gives useful feedback to manufacturers to improve their products. Country-specific information should be used to guide NMCP and PMI procurement and programmatic decisions. This information should be generated as quickly and routinely as possible to inform decisions on how to replace failing LLINs before they compromise the efficacy of the intervention.
- VI. For future LLIN monitoring efforts, investigate whether nets reported as being used by family members still exist elsewhere and are in use.

7. REFERENCES

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ANNEX A: DATA ANALYSIS FRAMEWORK

Research Objectives/ Domains	Questionnaire Section		Question	Analysis Notes
	Section	Sub-objective	Net Durability Study @ Month 36	
Household characteristics	Household characteristics	Demographics	Q01, Q05, Q15, Q16 Q17, Province, District, Type of Sector	<p>Type of respondent</p> <p>Calculate:</p> <ul style="list-style-type: none"> No. of households surveyed by province, district, and sector Proportion of respondents by type Proportion of households with windows fly-screened Proportion of households that store food or crops in any of the rooms used for sleeping Proportion of households that cook in a room used for sleeping Proportion of respondents that had seen rats or mice in the house or their traces in the last six months <p><i>Disaggregate by province, district, and type of sector</i></p>
Net care and repair	Net care and repair	Care and repair of nets	Q37, Q38, Q39, Q42, Q44	<ul style="list-style-type: none"> Proportion of households that have ever found any holes in the nets they own Tabulate the distribution of how the holes happened Proportion of households that have ever tried to repair any of these holes or get them repaired by someone else Tabulate the distribution of responses to the main reason holes were not repaired Tabulate the distribution of responses to the

Research Objectives/ Domains	Questionnaire Section		Question	Analysis Notes
	Section	Sub-objective	Net Durability Study @ Month 36	
				recommended way to wash a mosquito net Disaggregate by province, district, and type of sector
Campaign net included in monitoring	Campaign net included in monitoring	Net given to sixth grader	Q53, Q54, Q55, Q56, Q57, Q58, Q59, Q60, Q61, Q62, Q63, Q64, Q65, Q66, Q67, Q68, Q69, Q70, Q71, Q72, Q73, Q74, Q75, Q76, Q77, Q78, Q79, Q80	<ul style="list-style-type: none"> • Proportion of households whose net is still present • Calculate distribution of type/brand of nets • Tabulate the response trends for reasons for missing net • Tabulate the distribution of responses to what the material was used for if used for other purpose • Tabulate the response trends for reasons for not keeping the net • Tabulate the response trends for where the net being monitored was found • Tabulate the distribution of responses to type of sleeping place the net has mostly been used for • Proportion of nets slept under by any person last night • Tabulate the response trends for reasons for not sleeping under the net last night • Tabulate the response trends for “who used the net last night” • Tabulate trends in frequency of using the net in the previous week • Proportion of nets washed • Tabulate trends in frequency of washing nets in the last six months • Proportion of households that used each type of soap for the last wash • Tabulate the response trends for “where the net

Research Objectives/ Domains	Questionnaire Section		Question	Analysis Notes
	Section	Sub-objective	Net Durability Study @ Month 36	
				was dried” <i>Disaggregate by province, district, and type of sector</i>
				<ul style="list-style-type: none"> • Proportion of nets that have ever had holes • Tabulate the response trends for how the net had problem/s • Proportion of nets with holes size 1 (0.5-2 cm) • Proportion of nets with holes size 2 (2-10 cm) • Proportion of nets with holes size 3 (10-25 cm) • Proportion of nets with holes size 4 (larger than 25 cm) • Proportion of nets with repairs (hole fully closed) • Proportion of nets with partial repairs (hole reduced but still there) • Proportion of nets modified in any way • Tabulate the response trends for how the net was modified <i>Disaggregate by province, district, and type of sector</i>

APPENDIX B: DAILY SUMMARY ACTIVITY FORM

DAILY SUMMARY NET DURABILITY STUDY ACTIVITIES (for Team Leaders) ELS: 01

DATE: _____ PROVINCE: _____ DISTRICT: _____

VILLAGE/FARM/LOCATION: _____ NO. OF RESEARCH ASSISTANTS IN TEAM: _____ TEAM NUMBER _____

VARIABLES	NAME OF RESEARCH ASSISTANT (*indicate name of research assistant and his/her # below)						Total
1. No. of households Visited: HHV							
2. No. of households interviewed: HHI							
3. No of households which refused: HHR							
4. No of LLINs seen/observed: LLINs							
5. No of study LLINs found: SLLINF							
7. No. of households revisited: HHRV							
8. Issues/Challenges encountered							
9. Issues/Challenges resolved							

Other Comments: _____

NAME OF TEAM LEADER _____ Signature _____ Date _____
 NAME OF SUPERVISOR _____ Signature _____ Date _____

APPENDIX C: CHECKLIST FOR DATA QUALITY MONITORING DURING DATA COLLECTION—SUPERVISORS

Checklist for data quality monitoring during data collection—supervisors

Net Durability Study November/December 2017 Form ELS 02

CATEGORY A: Field Monitoring

Date: _____

Location: _____

Name: _____

Designation: _____

I. Define the monitoring objective

<input type="checkbox"/>	Regular compliance for the study
<input type="checkbox"/>	Local authority support
<input type="checkbox"/>	Respondent's receptiveness
<input type="checkbox"/>	Supervisor's effectiveness
<input type="checkbox"/>	Data collector's effectiveness
<input type="checkbox"/>	Software functionality
<input type="checkbox"/>	Device (smartphone) functionality
<input type="checkbox"/>	Other

2. Local leader's participation

Willing to participate in the study

Attitude towards the study

Attitude towards Research Assistants

Support

Concern (if any)

3. Household's participation

Willingness to participate in the study

Positive attitude towards the study

Positive attitude towards Research Assistants

Openness in sharing information

Concern (if any)

4. Supervisor's/team leader's effectiveness

Evidence of presence in the field

Effectiveness in responding to issues whilst in the field _____

Evidence of data review

General support to Research Assistants

Concern (if any) _____

5. Data collector's effectiveness

Adherence to the study protocol

Attitude towards respondents

Use of the survey tool and smartphones

Fluency

Precision

Completeness

Concern (if any)

6. Software functionality

<input type="checkbox"/>	Is the survey version up-to-date?
<input type="checkbox"/>	Is the survey in the production mode?
<input type="checkbox"/>	Are the inbuilt data quality controls functional?
<input type="checkbox"/>	User credentials?
<input type="checkbox"/>	Does the survey complete?

Concerns

7. Device (smartphone) functionality

<input type="checkbox"/>	Are the devices up to standard?
<input type="checkbox"/>	Do the devices connect to the internet?
<input type="checkbox"/>	Do the devices Sync Survey?
<input type="checkbox"/>	Do the devices capture GPS coordinates?
<input type="checkbox"/>	Are the power banks functioning well?

Concerns

8. General observations and recommendations

APPENDIX D: NET DURABILITY STUDY QUESTIONNAIRE



ZIMBABWE LLIN Durability Monitoring Follow-up Survey 36 Months—Questionnaire

SPEAK TO THE HEAD OF THE HOUSEHOLD: Hello. My name isand I am working for ZAPIM/MOHCC. We are interviewing people here in-----[Name of Place] in order to obtain information on how long mosquito nets last under usage in your community over 3 years. We are intending to interview randomly selected households with children who were sixth graders in 2015 and who received LLINs in your area school for this study. With your permission we would like to interview one respondent in this household ideally the household head or caregiver.

We would like your permission to identify a respondent and begin the interview. [Note: Ensure formal consent (and assent if needed) process is done prior to interviewing the selected respondent].

I certify that the nature and purpose, the potential benefits and possible risks associated with participating in this research have been explained to the participant. Yes [] No []

Makadii. Ini ndinonzi..... uye ndinoshandira ZAPIM/ MoHCC. Tirikuita hurukuro nevanhu muno mudunhu renyu[-----] kuti tiwane ruzivo pamusoro pekuti mamosikito neti ekudzivirira Malaria achashandiswa mudunhu renyu kwemakore matatu anogara zvakadii . Tirikutarisira kuita hurukuro mudzimba dzatasarudza zvisina rusarura kuti dzive paongororo ino; Dzimba idzi dzinevana vaive

mugiredhi rechitanhatu (grade 6) gore ra2015 avovakawana mamosikito neti ekudzivirira malaria munharaunda ino. Mukatipa mvumo, tinokumbirawo kuita hurukuro nemunhu mumwechete pamusha uno. Munhu uyu anofanira kuve anotungamira kana anochengeta vana pamusha uno.

Tinokumbirawo mvumo yekusarudza achatipindura mibvunzo tichibva tatanga hurukuro yedu

Ndinotsinhira kuti ongororo ino, zvinangwa, zvingabatsire uye zvikanganiso zvinechekuita nekuve muongororo ino zvatsanangurwa kumuongororwi. Hongu [] Kwete []

IDENTIFICATION

Province: Mashonaland Central Mashonaland West (Tick Applicable)

District: Bindura Guruve Hurungwe Kariba Makonde Mazowe
 Mbire Mt Darwin Muzarabani Rushinga Shamva Zvimba
 (Tick Applicable)

Type of Sector: Rural Commercial Mining Peri-Urban (Tick Applicable)

Cluster Number

Net ID Number ← Enter this number at the top of each page

INTRODUCTION AND CONSENT

Go through the consent form together with the respondent

Respondent agrees to be interviewed.....	1	Go to Q01
Respondent does not agree to be interviewed.....	0	End

SECTION I: Household characteristics and net ownership

No	Question	Categories	Skip
I would first like to ask some questions about the household, characteristics of the house and possessions of the household Ndinoda kutanga nokubvunza mibvunzo inoenderana nemusha wenyu pamwe nemidziyo yamuinayo pamusha penyu			
Q01	Who is responding to this questionnaire? Ndiani ari kupindura mibvunzo iyi?	Head of household Spouse of head of household Other family member	1 2 3
Q02	Can the respondent read and write? Ari kupindura mibvunzo anogona kuverenga kana kunyora here?	Yes No Don't know (DK)	1 0 98
Q03	Has the respondent ever attended school? Arikupindura mibvunzo ino aka enda kuchikoro here?	Yes No Don't know (DK)	1 0 98
			No or DK ⇒Q05
Q04	What was the highest level of school the respondent attended? (Primary, Secondary, Higher) Ndechipi chinhanho chepamusoro mukudzidza chakasvikwa ne ari kupindura mibvunzo pamusha uno?	Primary Secondary Higher Don't know (DK)	1 2 3 98
Q05	What is the main material of the roof? Denga remba rakapfirirwa nei Observe and record without asking	Grass Thatch Zinc/Iron/Aluminum sheets Asbestos Tiles Cement Others specify	1 2 3 4 5 6 7
Q06	What is the main material of the walls? Madziro emba akavakwa nei? Observe and record without asking	Grass Mud Plastered Brick/Concrete Others specify	1 2 3 4 5
Q07	What is the main material of the floor? Pasi pemumba mamunogara pakavakwa kana kugadzirwa nei? Observe and record without asking	Earth or sand Clay/Dung Wood or bamboo Vinyl or paraquet Tiles or cement Others specify	1 2 3 4 5 6
Q08	Are the windows of your house fly screened? Ko mafafitera edzimba dzenyu aneruzhwa here runodzivirira kuti mamosokito asapinde mumba	Yes No	1 2
			Yes⇒Q11
Q09	If not have you ever thought about screening them? Makambofungawo nezvazvo here?	Yes No	1 2
Q10	What are the main reasons for not screening the windows and eaves of your house? Nezvipi zvikonzero zvakaita kuti musaise ruzhwa pamafafitera kana muchengo	I do not have money to buy the screens I do not know how to do it I did not know about this Others specify.....	1 2 3 4

No	Question	Categories	Skip
Q11	What type of screen is used Imhandoi yeruzhowa iri pamafafitera kana muchengo	Mosquito net material Wire screens Other specify.....	1 2 3
Q12	How many rooms does your household have? Musha wenyu une dzimba kana kuti makamuri mangani?	<input type="text"/> <input type="text"/>	
Q13	How many of these rooms are used for sleeping? Makamuri kana kuti dzimba ngani dzinoshandiswa pakurara?	<input type="text"/> <input type="text"/>	
Q14	How many sleeping places inside houses are used by this household (beds, mattresses, mats or rugs, etc)? Mune nzvimbo ngani dzamunoshandisa pakurara mumba menyu (Mubheda,bonde,etc)	<input type="text"/> <input type="text"/>	
Q15	How many sleeping places inside houses that are used by this household have LLINs (beds, mattresses, mats or rugs, etc)? Mune nzvimbo ngani dzamunoshandisa pakurara dziri mumba dzine mosikito neti	<input type="text"/> <input type="text"/>	
Q16	How many sleeping places which are outside including those at field sleeping places are used by this household? Mune nzvimbo ngani dzamunoshandisa pakurara dziri panze kusanganisira dziri kumunda	<input type="text"/> <input type="text"/>	0 ⇒ Q18
Q17	How many of these outside or field sleeping places have LLINs Inzvimbo ngani dzokurarira dziri panze kusanganisira neidzo dziri kumunda dzine mamosokito neti	<input type="text"/> <input type="text"/>	
Q18	Do you ever store food or crop in any of the rooms used for sleeping? Munochengata zvokudya kana zvirimwa here mune imwe yedzimba dzamunoshandisa kurara	Yes No Don't know	1 0 98
Q19	Do you ever cook in a room that is also used for sleeping? Munombo bikira muimba yamuno shandisa pakurara here?	Always Sometimes Never Don't know	1 2 3 98
Q20	What is the main source of drinking water? Mvura yekunwa munowanzoiwana kubva kupi?	Surface water (stream, river, lake, pond, irrigation channel) Rain water, gutter pipe Protected well (public or private) Public tube well or borehole Public tap or standpipe Piped into dwelling Other, specify: _____	1 2 3 4 5 6 7
Q21	What type of toilet facility is available to the household? Imhandoi yechimbuzi chinowanzoshandiswa nemhuri yepamusha uno?	No facility, bush or field Shared pit latrine Own pit latrine Shared Blair latrine Own Blair latrine Shared flush toilet Own flush toilet	1 2 3 4 5 6 7
Q22	What is the main energy source for cooking?	Firewood	1

No	Question	Categories		Skip
	Munonyanyo kushandisa mhando ipi yesimba kana moto?	Charcoal	2	
		Kerosene	3	
		Gas	4	
		Electricity	5	
		Other, specify: _____	6	
Q23	In the last 6 months, have you seen any rats or mice in your house or their traces (faeces or damage)? Pamwedzi mitanhatu yapfuura makamboonawo here makonzo, mbeva kana zviratidzo zvadzo zvinoti nhoko kana pakarumwa?	Yes	1	
		No	0	
		Don't know	98	
I would now like to ask some questions about the mosquito nets in your household Iko zvino tavekubvunza nezvemamosikito neti amuinawo?				
Q24	Does the household own any mosquito nets? Mune mamosokito neti here pamusha pano	Yes	1	No or DK ⇒Q26
		No	0	
		Don't know	98	
Q25	If yes, how many mosquito nets does the household have at this time including those outside or at the field? Mune mamosikito neti mangani parizvino kusanganisira ari panze neawo arikumunda? >> probe for any nets currently not in use	□ □		
Q26	How many nets did your household receive from the school based mini mass LLIN campaign held in September-October 2015 Makawana mamosikito neti mangani akauya nevana pachirongwa chekupa vana vechikoro mamosikito neti chakaitwa pakati pamwedzi ya September naOctober mugore ra 2015?	□ □		
Q27	Did your household obtain any mosquito nets since the school campaign from any other source? Makazombwana here mamwewo mamosikito neti kubva pakaitwa macampaigns emuzvikoro?	Yes	1	No or DK ⇒Q30
		No	0	
		Don't know	98	
Q28	How many nets did your household obtain (received or bought) in total since the campaign including those you may no longer have? Makawana mamosikito neti mangani kusanganisira neamukatenga kubva pakaitwa ma campaigns tichitarisawo nemamwe amusisina?	□ □		
Q29	Did you obtain any additional mosquito nets from the following sources? Makawana mamosokito neti mamwe here kubva kune zvinotevera?	Ante-natal care services	1	
		Mass campaign	2	
		Relatives or friends	3	
		Shop or pharmacy	4	
		Expanded Programme for Immunisation (EPI)	5	
		School based campaign	6	

No	Question	Categories		Skip
		Market or hawker	7	
		VHW Voucher system	8	
		Other specify	9	
Q30	In the last 6 months, did you receive any information on use and care and repair of your mosquito nets from any source? Pamwedzi mitanhatu yapfuura makambowana mashoko anoenderana nokushandiswa pamwe nekuchengetwa kwemamosikito neti here?	Yes	1	No or DK ⇒Q34
		No	0	
		Don't know	98	
Q31	What were the sources of that information? Mashoko aya makaawana nenzira dzipi >> multiple answers possible	Village Health Worker	1	
		Radio message or talk show	2	
		Song on the radio	3	
		Drama performance	4	
		Health worker	5	
		Community leader	6	
		Town announcer	7	
		Pharmacy or shop attendant	8	
		Family or friends	9	
		Mosque or church	10	
		Newspaper or TV	11	
		Other Specify:	12	
Q32	What was the content of the messages you heard/saw? Mashoko aya aitura nezvei? >> multiple answers possible	Use your net	1	
		Care for your net	2	
		Hang up your net	3	
		Sleep under your net every night	4	
		Nets prevent malaria	5	
		Repair your net	6	
		Other Specify:	7	
Q33	Did you discuss caring for or repairing your nets with your family? Makakurukura here maererano nokugadzirisa kwemamosikito neti anenge abvaruka?	Yes	1	
		No	0	
Q34	During which seasons are nets used by this household? Ko maneti ane mushonga munoashandisa mumwaka ipi?	Equally in rain and dry season	1	
		Mainly during the rain periods, at times also dry season	2	
		Only during the rain season	3	
		Not used at all	4	
		Don't know	98	

I am going to ask you about a series of actions you could take and I would like you to tell me how confident you are that you could actually do that action successfully. For each action, please tell me if you think it is Yes, No or Do not Know for each action

Iko zvino ndavekukubvunzai pamusoro pezvinhu zvamunogona kuita muchindiudza kuti munehushingi hwakadii kuita zvinhu izvi. Pachinhu chimwe nechimwe ndinoda kuti mundiudze kuti hongu munokwanisa, kana kuti hamukwanise zvachose kana kuti hamuzive

		Yes	No	Do not Know		Skip
Q35	Obtain enough bed nets for all your children. Kuwana mamosikito neti akakwana evana venyu vese	1	2	3		

Q36	Hang a bed net above your children's sleeping spaces. Kuisa mosikito neti pamusoro penzvimbo dzinorarwa nevana	1	2	3		
Q37	Obtain enough bed nets for pregnant women in my household. Kuwana mamosikito neti akakwana emadzimai akazvitakura mumba menyu.	1	2	3		
Q38	Would you hang a net outside including at field to sleep under Mungasungirira here neti renyu panze kana kumunda	1	2	3		
Q39	Protect yourself and your children from getting malaria. Kudzivirira imi pamwe chete nevana venyu kuchirwere chemalaria	1	2	3		
Q40	Save enough money to obtain bed nets for all your children. Kuchengeta mari inokwana kuti muwane mamosokito neti anokwana vana venyu vose	1	2	3		
Q41	Sleep under a bed net every night of the year. Kurara mumosikito neti usiku hwese gore rese	1	2	3		
Q42	Get all of your children to sleep under a bed net every night of the year. Kuita kuti vana vese varare mumosikito neti usiku umwe neumwe kwenguva dzose?	1	2	3		

SECTION 2: Net care and repair

No	Question	Categories	Skip
I would now like to ask some questions about the care for your nets Ndave kuda kukubvunzai nekuchengetedzwa kwemamosikito neti			
Q43	Have you ever experienced any holes in the nets you own? Ko mamosokito neti enyu akamboita maburi here?	Yes No	1 0 No⇒Q49
Q44	How did the hole(s) happen? Maburi aya akavapo sei? <i>>> check "1" for all options that apply, "0" if they don't</i>	Tore when got caught on edge or nail Was pulled and torn on corner Was burned by a candle or sparks Was caused by rats or mice Don't know Others specify	1 2 3 4 5 6
Q45	Over the last 6 months , have you ever tried to repair any of these holes or get them repaired by someone else? Pamwedzi mitanhatu yapfuura makamboedza kuvhara kana kusonesa maburi aya here?	Yes No	1 0 No⇒Q48
Q46	How were the holes repaired? Maburi aya akagadziriswa sei?	Stitched Knotted or tied Used a patch	1 2 3

No	Question	Categories			Skip
	>> check "1" for all options that apply, "0" if they don't	In another way		4	
Q47	Over the last 6 months, who repaired the holes on your net? Pamwedzi mitanhatu yapfuura ndiani akagadzira kana kusona maburi aive paneti renyu >> check "1" for all options that apply, "0" if they don't	Household member		1	all⇒Q49
		Tailor		2	
		Friend or relative (Not household member		3	
		Community volunteer		4	
		Other- Specify:		5	
Q48	What was the main reason for not repairing the holes on the net? Chikonzero chipi chakaita kuti mosikito neti renyu raive rave nemaburi risagadzirwe kana kusonwa?	No time for this		1	
		It is not necessary		2	
		Don't know how		3	
		Do not have materials to repair		4	
		Holes are not big enough to repair		5	
		It is not possible to repair holes		6	
		Other		7	
		Specify:			
		Don't know		98	
Q49	What if anything do you do at home to prevent nets from tearing or getting holes? Ndezvipi zvinhu zvamunoita pamusha penyu kuti mamosokito neti asabvaruke kana kuita maburi? >>Do not read the responses aloud. Probe twice with "Any other ways?" Usaverenge mhinduro shandisa dzimwe nzira Mark "1" for each response mentioned and "0" for those not	Keep away from children		1	
		Keep away from pests		2	
		Roll up or tie up when not in use		3	
		Handle nets with care		4	
		Do not soil with food		5	
		Keep away from flame or fire		6	
		Wash gently		7	
		Wash only when dirty		8	
		Inspect nets regularly for holes		9	
		Repair small holes quickly		10	
		It is not possible to prevent holes		11	
		Do nothing		12	
		Other- Specify:		13	
Q50	What is the recommended way to wash a mosquito net? Ndeipi nzira inokuridzirwa kuti muwache mamosokito neti nayo? >>Do not read the responses aloud. Probe twice with "Any other ways?" Mark "1" for each response mentioned and "0" for those not	Gently		1	
		In a basin		2	
		With mild soap		3	
		Only when dirty		4	
		No more than once every 3 months		5	
		Not in the stream		6	
		Other- Specify:		7	
I am going to read a series of statements to you and I would like you to tell me how much you agree with them. For each statement, please tell me if you are Agree, Disagree or Not Sure.					
Ndichaverenga mashoko akateedzana, ndonikumbira kuti mudi udze kuti hongu, munowirirana nepfungwa iyi kana kuti hamuwirirane nepfungwa iyi, kana kuti hamuzive					
		Agree	Disagree	Not Sure	
Q51	Mosquito nets are valuable Mamosokito neti akakosha	1	2	3	
Q52	There are actions I can take to make my net last long Pane zvinhu zvandinogona kuita kuti mosikito neti rangurirame kwenguva	1	2	3	

No	Question	Categories			Skip
	yakareba				
Q53	It is possible to repair holes in nets Hazvigoneke kusona kana kugadzira neti rinenge rabvaruka kana kuti rave nemaburi	1	2	3	
Q54	A repaired net can still be effective against mosquitoes Mosikito neti yakagadziriswa inokwanisa kudzivirira mamosikito	1	2	3	
Q55	Other people in this community can fix holes in their mosquito nets Vamwe vanhu vemunharaunda ino vanogadzira kana kusona maburi ari pama mosikito neti avo	1	2	3	
Q56	I do have time to repair a hole in my net Handina nguva yokusona buri rinenge raitika pamosikito neti yangu	1	2	3	
Q57	I can help protect my family from malaria by taking care of my net Ndinokwanisa kudzivirira mhuri yangu kubva kuchirwere chemalaria nokuchengetedza mosikito neti rangu	1	2	3	
Q58	I am confident I can repair holes immediately Ndinovimbao kuti ndinokwanisa kugadzira kana kusona nokuchimbida buri kana pakabvaruka pemosikito neti rangu	1	2	3	

SECTION 3: Campaign net included in monitoring

We would now like to inspect the mosquito net from the mini school campaign and ask some questions about it

No	Question	Mosquito net 1 (LLIN Given to Sixth Grader)	
Q59	Is the net still present? Richipo here mosikito neti iri?	Yes No	1 0 If yes, skip to Q64
Q60	How long did you have this net? Makanga mave nenguva yakadini muine mosikito neti iri? >> 00 for below 1 month >> 98 for "do not know"	<input type="text"/> <input type="text"/> Months Don't Know (DK)	98
Q61	(If the net is missing) Can you tell me what happened to the net? Mungandiudzawo here kuti chii chakaitika kumosikito neti iri?	Net was stolen Net was destroyed accidentally Net was sold Net was given away to relatives Net was given away to others Net was thrown away Material used for other purpose Used by family members elsewhere Other Specify Don't know (DK)	1 2 3 4 5 6 7 8 9 98
		If not 7⇒Q63 If 8, skip to Household Visit Section	

No	Question	Mosquito net I (LLIN Given to Sixth Grader)	
Q62	What was this material used for? Ko jira reneti iri makarishandisa kuitei >>Do not read the responses aloud >> multiple answers possible	Window/door/eave covering	1
		Protecting plants/seedlings	2
		Fishing	3
		Drying fish	4
		Bedding/padding	5
		Around latrine	6
		Patch other nets	7
		Cut up and used for various purposes	8
		Other Specify	9
		Don't know (DK)	98
Q63	Why did you not keep this net? Sei musina kuchengeta mosikito neti iri? >> enter first reason mentioned	Too many holes	1
		Too dirty	2
		Not needed	3
		Did not like the net	4
		Needed the money	5
		Other Specify	6
		Don't know (DK)	98
All ⇒ skip to Household Visit Section			
Q64	Where was the net found? Mosikito neti iri ranga riri pai?	Outside hanging loose over a sleeping place	1
		On the washing line	2
		Inside house hanging loose over sleeping place	3
		Inside house hanging and folded up or tied	4
		Not hanging but not stored	5
		Stored away unpacked	6
		Stored away still in package	7
Q65	What type of sleeping place has this net been used for mostly? Imhandoi yenzvimbo yekurara inowanzo shandiswa kana kuti inoshandiswa mosikito neti iri?	Bed and mattress	1
		Bed frame (sticks)	2
		Foam mattress	3
		Reed mat	4
		Grass	5
		Ground	6
		Never used	7
		Outside	8
Q66	Was this net slept under by any person last night? Pane munhu here akarara pasi pemosikito neti iri husiku hwapfuura?	Yes	1
		No	0
		Don't know (DK)	98
		Yes⇒Q68	
Q67	If no, why not? Sei risina kushandiswa?	The net is at the field	1
		No mosquitoes	2
		There is no malaria	3
		Too hot	4
		Don't like smell	5
		Feel "closed in"	6
		Net too old or torn	7
		Net too dirty	8
		Net not available last night (washing)	9
		Usual user(s) did not sleep here last night	10
		Net was not needed last night	11
		Other	12
		Don't know (DK)	98
All⇒Q69			
Q68	Who used the net last night? Ndiani akashandisa mosikito neti iri usiku hwapfuura?	Infant (<1 yr)	1
		Young child (1-4 yrs)	2
		Older child (5-9 yrs)	3
		Adolescent (10-19)	4
		Adult	5

No	Question	Mosquito net I (LLIN Given to Sixth Grader)	
		Don't know (DK)	98
Q69	How many nights has this net been used in the last week? Mosikito neti iri rashandiswa husiku hungani pavhiki radarika?	Every night (7 nights)	1
		Most nights (5-6)	2
		Some nights (1-4)	3
		Not used last week	4
		Net is not used at all	5
		Don't know (DK)	98
Q70	Has this net ever been washed? Mosikito neti iri rakambowachwawo here?	Yes	1
		No	0
		Don't know (DK)	98
			0 or 98⇒Q74
Q71	How many times has it been washed in the last 6 months? Mosikito neti iri rakawachwa kangani pamwedzi mitanhatu yadarika? >> enter "00" if none	<input type="text"/> <input type="text"/>	0 or 98⇒Q74
		Don't know (DK)	98
Q72	For the last wash, what soap was used? Parapedzisira kuwachwa imhandoi yesipo yakashandiswa	Soap bar	1
		Detergent (paste or powder etc)	2
		Bleach	3
		Washing soap	4
		Bathing soap	5
		None	6
		Don't know (DK)	98
Q73	Where was the net dried? Mosikito neti iri rakayanikwa pai?	Outside on the ground	1
		Outside on line	2
		Outside bush or fence	3
		Outside in a shade place	4
		Others specify	5
Q74	Has this net ever had any holes? Mosikito neti iri rakamboitawo maburi here?	Yes	1
		No	0
		Don't know (DK)	98
			0 or 98⇒Q76
Q75	(The net has problem) How did that happen? Izvi zvakaitika sei? >>tick all that apply	Torn on object	1
		Pulled and tore	2
		Burned by flame	3
		Rats or mice	4
		Seam came open	5
		In another way	6
		Do not know (DK)	98
Q76	Number of holes size 1 (0.5-2 cm)	<input type="text"/> <input type="text"/>	
Q77	Number of holes size 2 (2-10cm)	<input type="text"/> <input type="text"/>	
Q78	Number of holes size 3 (10-25 cm)	<input type="text"/> <input type="text"/>	
Q79	Number of holes size 4 (larger than 25 cm)	<input type="text"/> <input type="text"/>	

No	Question	Mosquito net I (LLIN Given to Sixth Grader)	
Q80	Number of repairs (hole fully closed)	<input type="text"/> <input type="text"/>	
Q81	Number of partial repairs (hole reduced but still there) Huwandu hweburi rakasonwa asi richiripo	<input type="text"/> <input type="text"/>	
Q82	Has the net been modified in any way? Ko neti iri raka shandurwa magadzirirwo aro here?	Yes	1
		No	0
		Don't know (DK)	98
		0 or 98⇒Q84	
Q83	How was it modified? Rakashandurwa sei?	Shape was changed	1
		Added to lengthen	2
		Added to reinforce	3
		Other	4
		Specify:	
Q84	What shape of a net do you prefer Mungada kuva nemosikito neti yemhandoi	Conical	1
		Rectangular	2
		No Preference	3
		Others specify	4
		Don't know (DK)	98
Q85	What colour of net do you prefer Mungada kuva nemosikito neti yeruvara rudzii?	Green	1
		White	2
		Blue	3
		Others specify	
Q86	Brand of Net	Dawa	1
		DuraNet	2

HOUSEHOLD VISIT

B1	Household visit details 0 = respondent not home 1 = respondent home , consented and interview completed 2=Home, consented and interview not completed 3 = respondent home but refuse 4 = moved away to unknown location	Visit 1	Visit 2	Visit 3
		<input type="text"/>	<input type="text"/>	<input type="text"/>
B2	Date of interview dd/mm/yyyy	<input type="text"/> <input type="text"/>	/ <input type="text"/> <input type="text"/>	/ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>
B3	Interviewer Code	Code <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>		
B4	Is the household still at the same location? If NO, enter new GPS coordinates below	Yes	No	
		1	0	
		Latitude:	<input type="text"/>	
		Longitude:	<input type="text"/>	
		decimal format		

***** END OF QUESTIONNAIRE *****

Thank the respondents for their time and cooperation.

Record time of starting interview : [] Record time of ending interview : []

Total time taken for the interview : [] minutes

INTERVIEWER NOTES: Please note any problems you had with completing the interview for this household.
