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ABCDR Study – Functional survival and methodologies for bio-efficacy testing

Sarah Moore on behalf of the ABCDR team:

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John Bradley, Albert Killian, William Kisinza, Jo Lines,
Hans Overgaard**



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**12th RBM-VCWG Meeting
Geneva, Switzerland**



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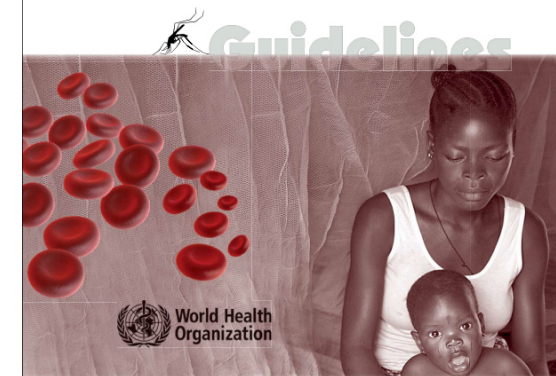


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- 8 districts in Tanzania – 3,420 households in 76 villages
- Prospective study (blinded):
 - Olyset (new knit)
 - PermaNet 2.0
 - Netprotect
- Compare durability over 3 years; mass campaign between year 2 and 3
- Attrition, physical degradation, bio-efficacy & chemical content

Guidelines for monitoring
the durability of long-lasting
insecticidal mosquito nets
under operational conditions



Study statistics

	2014 (Year 1)	2015 (Year 2)	2016 (Year 3)
Households interviewed	87.2% (2,962/3,398)	95.7% (2,834/2,962)	96.3% (2,730/2,834)
HH loss to follow up	12.8% (436/3,398)	4.3% (128/2,962)	3.7% (104/2,834)
ABCDR nets loss to follow up	8.3% (880/10,598)	7.2% (539/7,477)	10.4% (551/5,311)
Nets lost from households	23.1% (2,241/9,726)	23.5% (1,627/6,938)	39.0% (1,855/4,760)
Nets inspected for holes	82.5% (6,166/7,477)	90.1% (4,783/5,311)	86.7% (2,519/2,905)

Net loss

	2014 (Year 1)	2015 (Year 2)	2016 (Year 3)
Nets lost (any reason)	23.1% (2,238/9,726)	23.5% (1,625/6,938)	39.0% (1,855/4,760)
Attrition	3.2% (311/9,726)	13.5% (935/6,938)	29.3% (1,396/4,760)
Used elsewhere?	20.3% (1,972/9,726)	8.8% (608/6,938)	12.2% (582/4,760)

Hole counting

Category of Hole	Hole Size Description	Hole Size
Size 1	Smaller than a thumb (finger)	0.5 - 2 cm diameter
Size 2	Larger than a thumb but smaller than fist (hand)	2 - 10 cm diameter
Size 3	Larger than a fist but smaller than a head (head)	10 - 25 cm diameter
Size 4	Larger than a head	> 25 cm diameter





Geita District, Oct 2015. Photo credit: Lena Lorenz

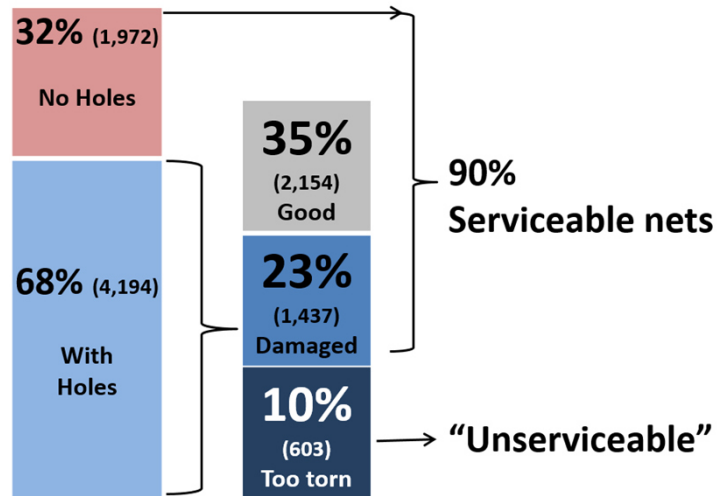
Namba ya utambulisho wa kaya _____

Namba ya chandarua _____

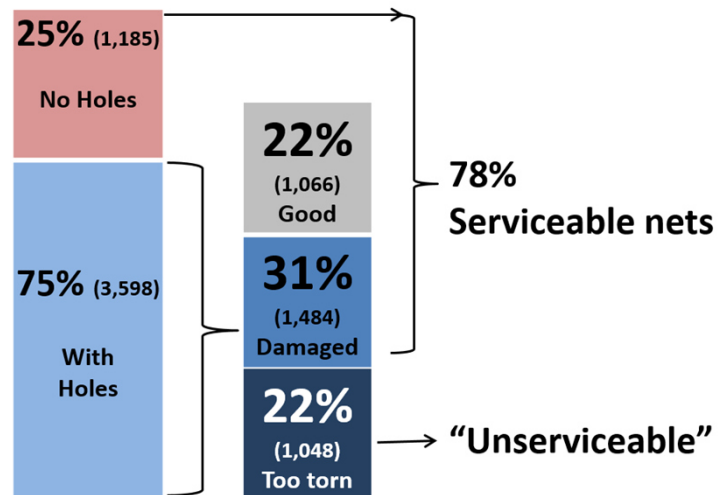
					TOTAL			
ZONE 1	5	10	15	20	Size 1	Size 2	Size 3	Size 4
Size 1	○○○○○	○○○○○	○○○○○	○○○○○				
Size 2	○○○○○	○○○○○	○○○○○	○○○○○				
Size 3	○○○○○	○○○○○	○○○○○	○○○○○				
Size 4	○○○○○	○○○○○	○○○○○	○○○○○				
ZONE 2	5	10	15	20	Size 1	Size 2	Size 3	Size 4
Size 1	○○○○○	○○○○○	○○○○○	○○○○○				
Size 2	○○○○○	○○○○○	○○○○○	○○○○○				
Size 3	○○○○○	○○○○○	○○○○○	○○○○○				
Size 4	○○○○○	○○○○○	○○○○○	○○○○○				
ZONE 3	5	10	15	20	Size 1	Size 2	Size 3	Size 4
Size 1	○○○○○	○○○○○	○○○○○	○○○○○				
Size 2	○○○○○	○○○○○	○○○○○	○○○○○				
Size 3	○○○○○	○○○○○	○○○○○	○○○○○				
Size 4	○○○○○	○○○○○	○○○○○	○○○○○				
ZONE 4	5	10	15	20	Size 1	Size 2	Size 3	Size 4
Size 1	○○○○○	○○○○○	○○○○○	○○○○○				
Size 2	○○○○○	○○○○○	○○○○○	○○○○○				
Size 3	○○○○○	○○○○○	○○○○○	○○○○○				
Size 4	○○○○○	○○○○○	○○○○○	○○○○○				
ROOF	5	10	15	20	Size 1	Size 2	Size 3	Size 4
Size 1	○○○○○	○○○○○	○○○○○	○○○○○				
Size 2	○○○○○	○○○○○	○○○○○	○○○○○				
Size 3	○○○○○	○○○○○	○○○○○	○○○○○				
Size 4	○○○○○	○○○○○	○○○○○	○○○○○				

Physical degradation

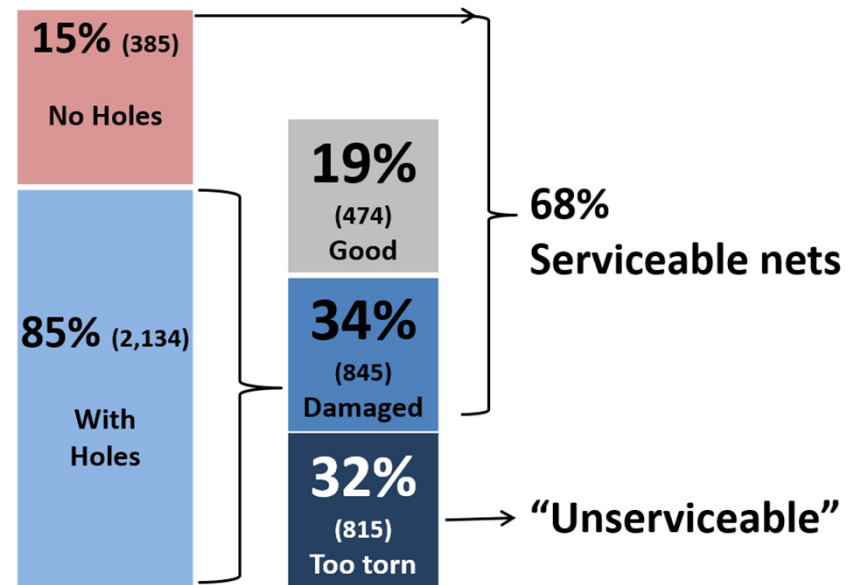
Year 1: Hole counts - 6,166 nets



Year 2: Hole counts - 4,783 nets

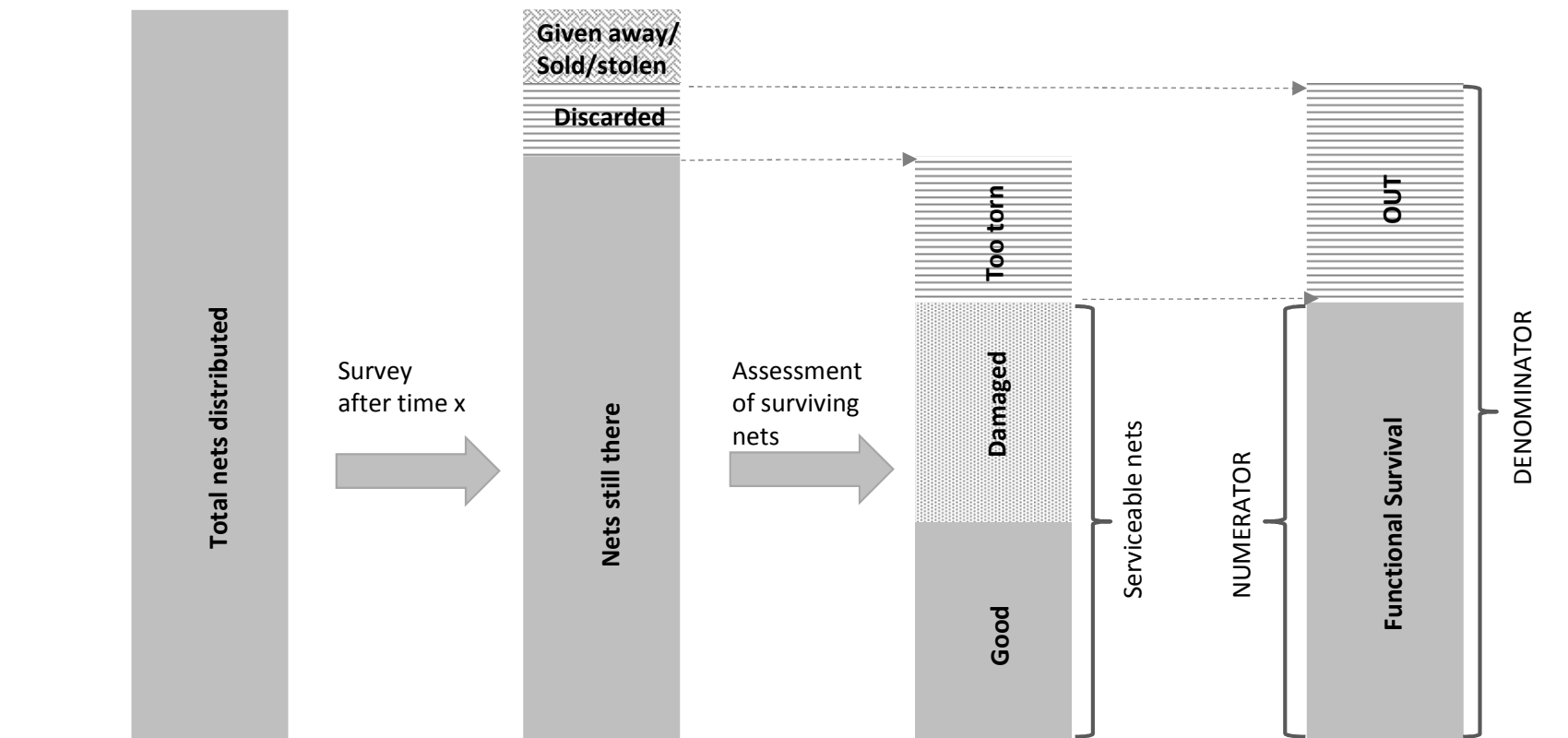


Year 3: Hole counts - 2,519 nets

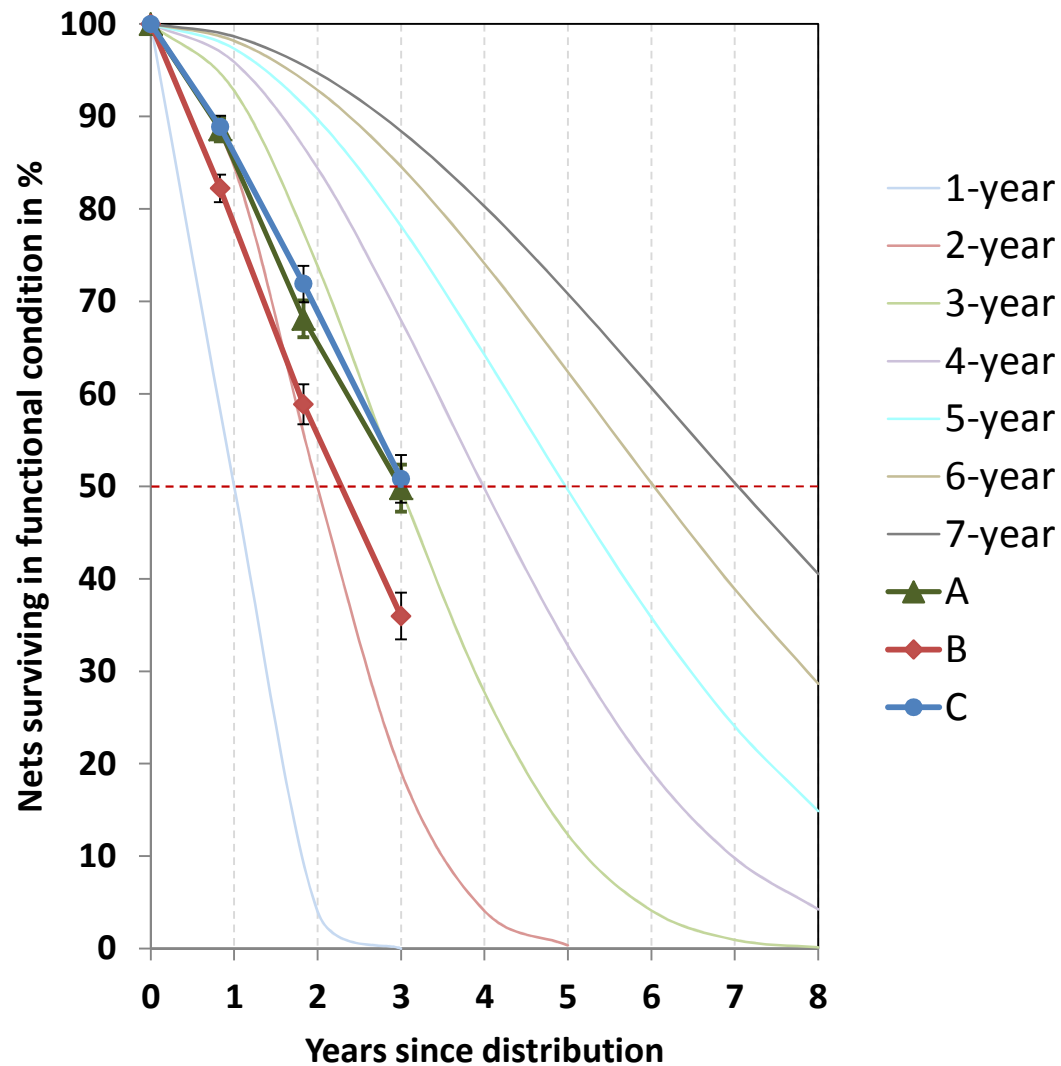


Category	pHI	Hole surface area
Good	0 - 64	<79 cm ²
Damaged	65 - 642	80–789 cm ²
Too torn	643+	>790 cm ²

Functional net survival



Functional survival



Tool developed by Albert Kilian for
USAID-Networks project



President's Malaria Initiative

Damage differs between products

Fabric integrity measured in three LLIN products across three years of field use in eight districts in Tanzania

Type 1 nets						Type 2 nets					Type 3 nets				
Survey (month)	%Nets with >=1 hole	Hole index		Hole area		%Nets with >= 1 hole	Hole index		Hole area		%Nets with >= 1 hole	Hole index		Hole area	
		Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)		Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)		Mean (SD)	Median (IQR)		
2014 (12)	70	193 (663)	15 (0-121)	237 (814)	18 (0 - 148)	60	183 (1252)	3 (0- 57)	225 (1537)	4 (0-70)	62	87 (327)	3.5 (0-44)	107 (402)	4 (0-54)
2015 (24)	83	523 (992)	142 (0-576)	642 (1218)	174 (0-707)	74	434 (1286)	53 (0-378)	532.96 (1578)	65 (0-464)	77	316 (791)	46 (0-250)	388 (971)	57 (0-307)
2016 (36)	91	1872 (4432)	491 (0-1595)	2298 (5440)	603 (0-1958)	85	1094 (2896)	244 (0-1025)	1343 (3555)	299 (0-1259)	88	1148 (3978)	169 (0-742)	1409 (4884)	208 (0-912)

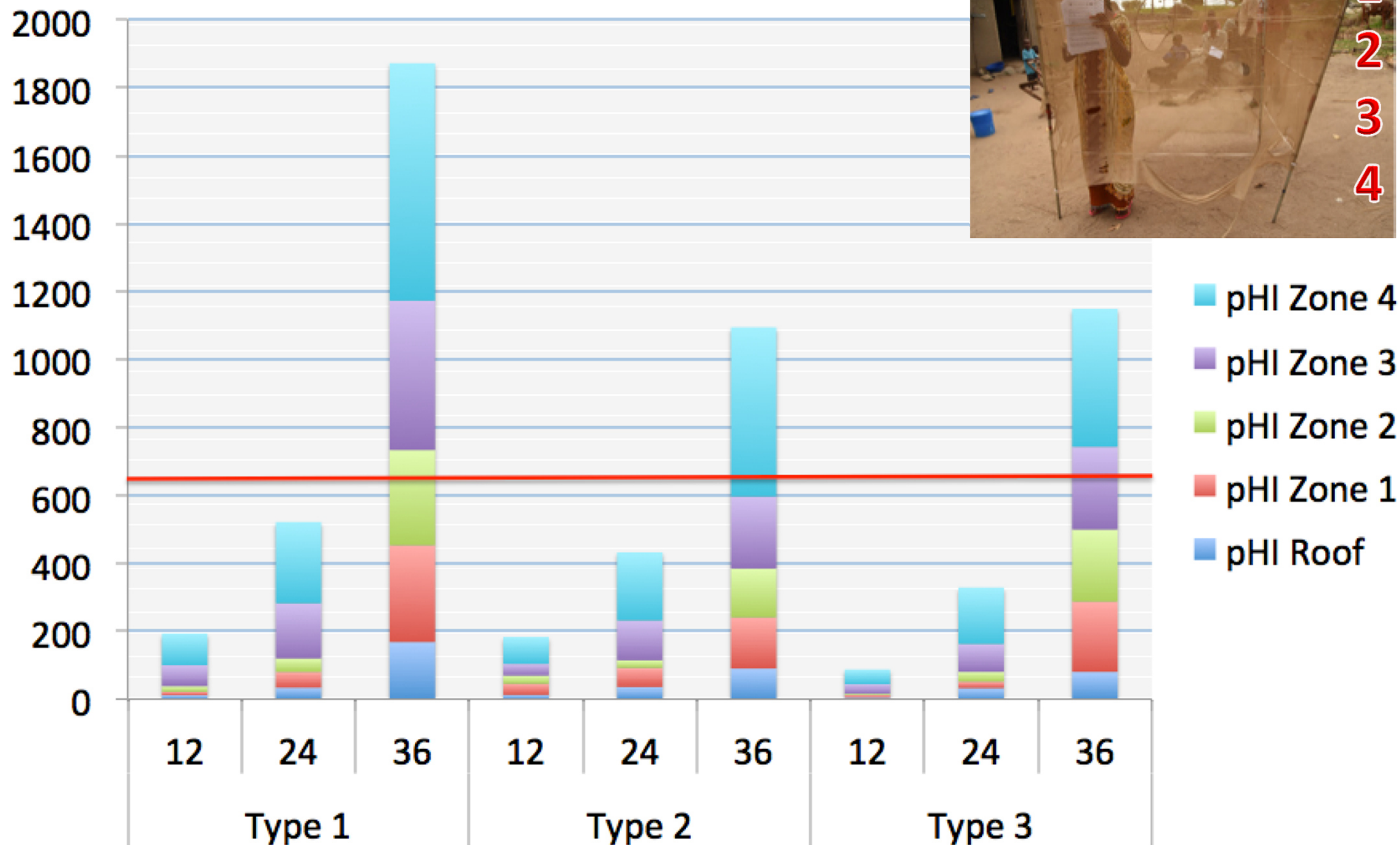
SD, Standard deviation; IQR, interquartile range

Category	pHI	Hole surface area
Good	0 - 64	<79 cm ²
Damaged	65 - 642	80–789 cm ²
Too torn	643+	>790 cm ²

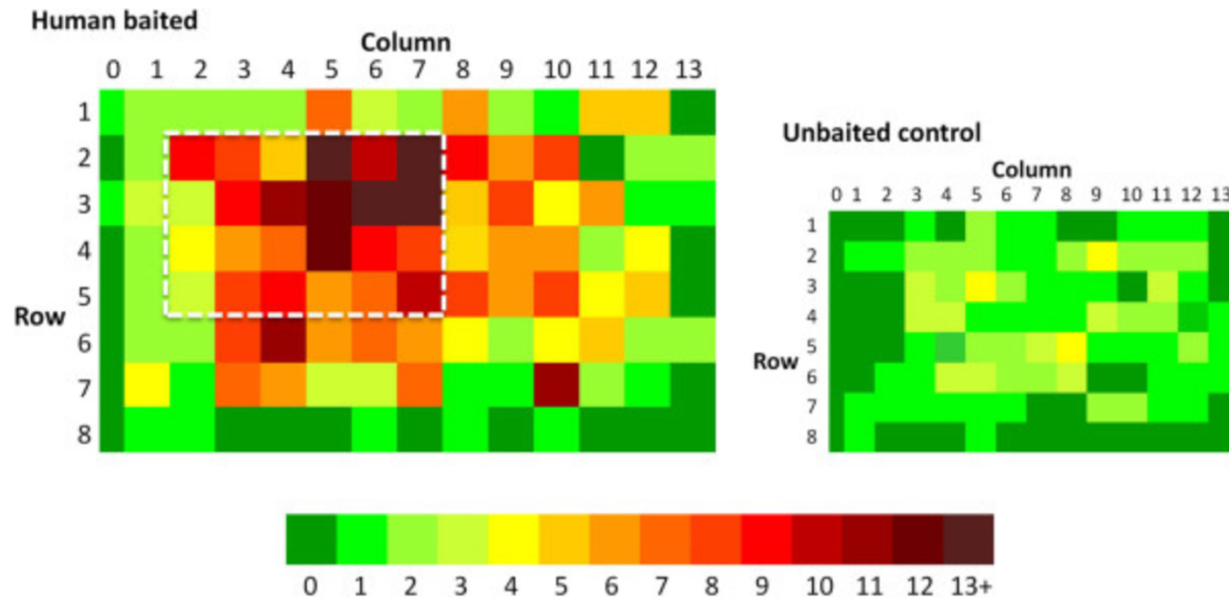
How are holes distributed?

Mean proportionate hole index by zone on the net

Mean pHI



What is the significance of hole location on net penetrability in aging LNs?

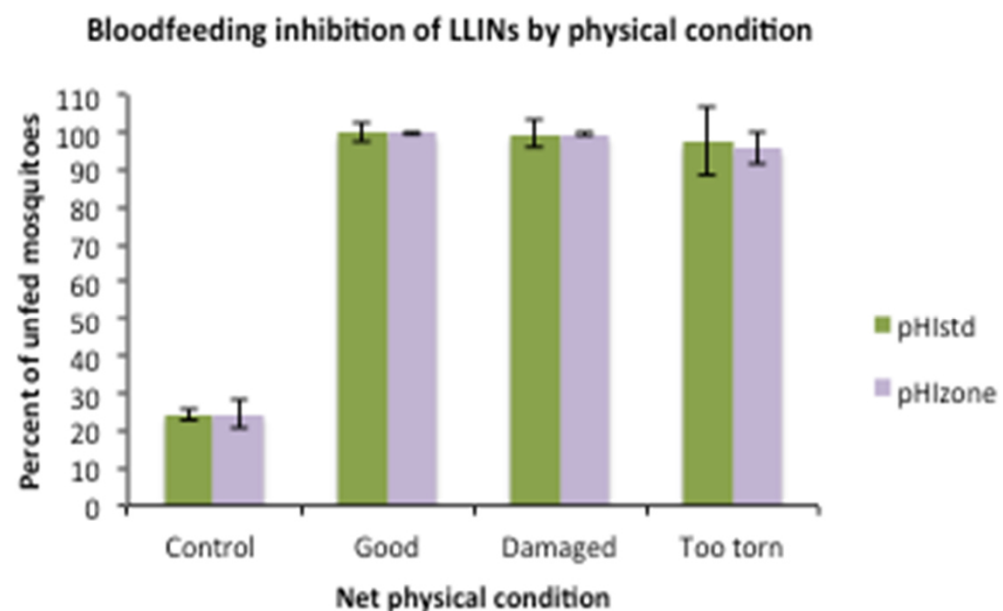
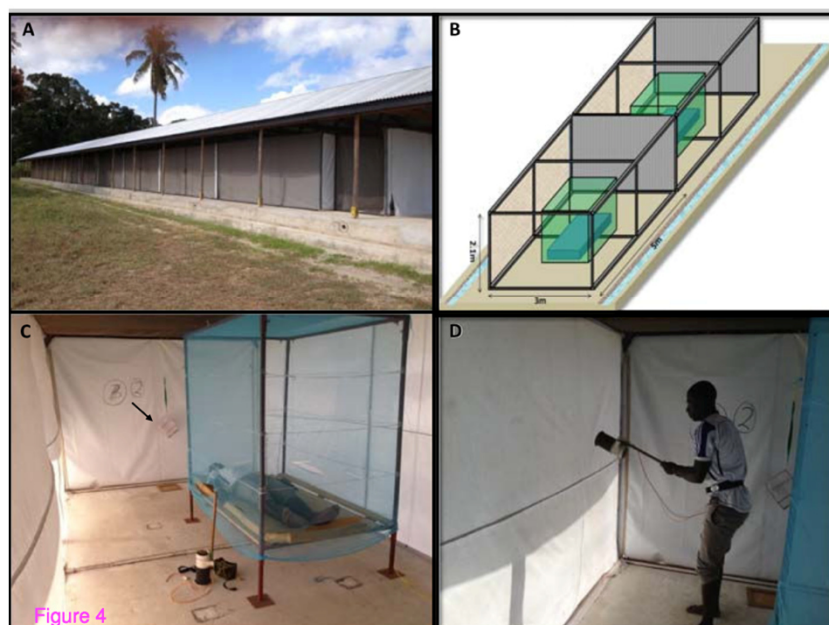


Density distribution of mosquitoes caught on the side surfaces of human-baited and unbaited control pitched nets. Data for both sides of the net are combined. Column numbers are shown relative to the sleeper's orientation (i.e., column 0 is always at the head). The hatched white rectangle in the human-baited net delineates the area where 44% of all mosquitoes were caught.

Lynd A, McCall PJ: **Clustering of host-seeking activity of *Anopheles gambiae* mosquitoes at the top surface of a human-baited bed net.** *Malar J* 2013, **12**:267.

Relative contribution of holed surface area of each hole size category to the overall holed surface area of two LLINs across three years of field use

	Type 1 nets			Type 2 nets		
	2014	2015	2016	2014	2015	2016
Size1 hole area	7.56 (3.9%)	16.1 (3.1%)	27.93 (1.3%)	6.68 (3.7%)	12.69 (2.9%)	19.49 (1.8%)
Size2 hole area	56.06 (28.7%)	128.8 (24.5%)	329.58 (15.9%)	34.69 (19%)	81.1 (18.7%)	183.52 (16.8%)
Size3 hole area	79.71 (40.8%)	186 (35.4%)	869 (41.8%)	64.38 (35.3%)	184.34 (42.6%)	432.83 (39.5%)
Size4 hole area	51.84 (26.6%)	194.6 (37%)	850.8 (41%)	76.86 (42.1%)	154.84 (35.8%)	459.54 (42%)
Overall hole surface area	195.17	525.41	2077.65	182.6	432.97	1095.39





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Mortality and blood-feeding success of *Anopheles gambiae* s.s. female mosquitoes in the ambient chamber test

	Control	Product 99	Product 88	Product 77
Collection nights		32		
<i>An gambiae</i> s.s. recaptured	1,910	2,641	2,579	2,451
Geometric mean recaptured/night	29.8 (29.5-30.2)	30.0 (30.0-30.0)	30.0 (29.9-30.0)	29.9 (29.7-30.0)
<i>An gambiae</i> s.s. inside net	801	32	36	55
Arithmetic mean inside net %	41.9 (37.6-46.1)	1.2 (0.3-2.2)	1.4 (0.5-2.3)	2.2 (0.8-3.6)
<i>An gambiae</i> s.s. blood fed	1,363	4	7	7
Arithmetic mean % blood fed	71.3 (67.1-75.5)	0.2 (0-0.3)	0.3 (0.1-0.5)	0.3 (0.0-0.6)
<i>An gambiae</i> s.s. dead at 24 hrs	178	2,616	2,477	2,183
Arithmetic mean % 24hr mortality	9.4 (7.4-11.4)	99.1 (98.6-99.5)	96.0 (92.8-99.3)	89.1 (86.1-92.0)

Data in brackets: 95% Confidence Intervals



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	Good	Damaged	Too Torn	TOTAL
“The net is still in a good condition ...”	71.2% (n=1,602)	25.9% (n=583)	2.9% (n=66)	n=2,251
“This net is beginning to fall apart...”	20.4% (n=303)	63.9% (n=949)	15.6% (n=232)	n=1,484
“This net is no longer usable...”	6.5% (n=68)	50.3% (n=527)	43.2% (n=453)	n=1,048

- Out of 2,617 nets, householder's attitude:

	Net still in good condition	Net beginning to fall apart	Net no longer usable
Type 1	25.0%	49.5%	25.5%
Type 2	34.3%	50.1%	15.6%
Type 3	32.9%	50.3%	16.7%
TOTAL	31.3%	50.0%	18.7%

- Out of 2,519 nets, for which holes were counted:

	WHO "good" pHI < 64	WHO "damaged" pHI 64-643	WHO "too torn" pHI > 643
Type 1	21.4%	28.3%	34.2%
Type 2	38.8%	37.4%	37.6%
Type 3	39.8%	34.3%	28.2%
TOTAL	34.1%	33.5%	32.4%

Update on government distribution

Household received any government nets in past 12 months

- 78.8% yes, 21.2% no

	No	Yes	Total
BAGAMOYO	43 (12.84%)	292 (87.16%)	335
GEITA	49 (14.58%)	287 (85.42%)	336
IRINGA	48 (16.61%)	241 (83.39%)	289
KAHAMA	70 (20.06%)	279 (79.94%)	349
KILOSA	30 (8.31%)	331 (91.69%)	361
KINONDONI	102 (88.7%)	13 (11.3%)	115
MBOZI	82 (23.1%)	273 (76.9%)	355
MUSOMA	94 (25.61%)	273 (74.39%)	367
Total	518 (20.66%)	1,989 (79.34%)	2,507

58.9% (3,209) of the additional nets were used for sleeping under, 41.1% (n=2,239) not used for sleeping under.

Reasons given for not using additional nets:

52.5% saved for future use

18.5% no mosquitoes

6.8% save for visitors

5.9% currently have enough nets

Also: user didn't sleep here, too hot, only used during rainy season...



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Next steps - analysis and write up

- “Durability” of 3 LLIN net products in Tanzania
 - Can we come up with a composite measure of ‘durability’ that adds bio-efficacy measures to functional survival?
 - Factors affecting ‘durability’
 - Is there a relationship between physical degradation in previous year and likelihood of net attrition the following year?
- Methodological work
 - Hole counting
 - Ambient chamber tests
 - New feeding inhibition bioassays
- Effect of a mass campaign on net retention and replacement
- Change in population access to and use of LLINs over time
- Net user and non-user characteristics of nets in differing physical conditions
- The case for net care and repair in Tanzania

Thank you!!!

