Does a torn long-lasting insecticidal net fail to protect children from malaria parasitemia? Data from two cross sectional surveys in Western Uganda

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Introduction

- Durability of long-lasting insecticidal nets (LLIN) is increasingly coming into focus since longer net survival is associated with significant public health savings
- However, there are very little data on the extent to which damages to an LLIN limit its protective effect
- Such knowledge is needed to determine the end of the "useful life" of an LLIN in the field

Methods

Study site
A comprehensive program to support malaria control is implemented in nine districts in Western Uganda with an estimated population of approximately 2.2 million. Interventions include distribution and promotion of long-lasting insecticidal nets (LLIN), community-based treatment of malaria and other childhood illnesses and introduction of laboratory confirmed diagnosis using rapid diagnostic tests.

Data collection
As part of the program evaluation representative , two-stage cluster sampling household surveys were carried out in October 2009 (baseline), July 2011 (midterm) and October 2012 (endline) that included assessment of malaria parasitemia and anemia in children under five with standard microscopy. In addition, at midterm and endline surveys one LLIN used by a child under five was assessed for its physical condition in a random sub-sample of households. Holes in the nets were counted in three size categories, namely 0.5-2 cm diameter, 2-10 cm and >10 cm.

Analysis
For the analysis of the physical condition of the nets a proportional Hole Index (pHI) was created by multiplying the number of holes in each size category by the weights 1, 23 and 196 respectively, reflecting the approximate ratio in hole sizes. Results were then categorized as shown in the table following most recent WHO guidance[1].

Table: Categorization of physical condition based on the proportionate Hole Index (pHI)

Category	pHI value range	Total hole surface area in cm²
Good	0-64	<100
Acceptable	65-642	100-1,000
Serviceable	0-642	<1,000
Torn	643+	>1,000

[1]WHO Guidance Note for Estimating the Longevity of Long-Lasting Insecticidal Nets in Malaria Control at http://www.who.int/malaria/publications/atoz/who_guidance_longevity_llins.pdf

Results

Figure 1: Area of study in Western Uganda

From a total sample of 1,598 (July 2011) and 3,938 (October 2012) households 592 and 1,313 LLIN were assessed for physical condition respectively. Of these nets 818 (43%) had been used the previous night by children under five for whom data on malaria parasitemia were also available. In July 2011, 76% of households had any LLIN and 64% in October 2012.

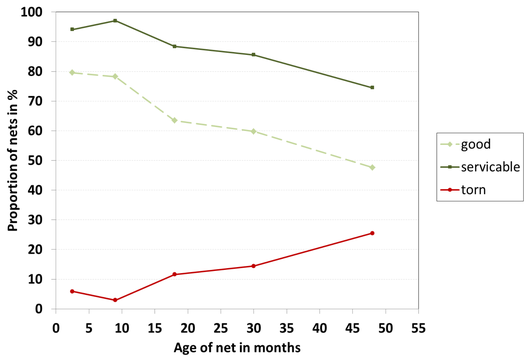

Figure 2: Physical condition of LN

Surveys were done between 18 and 30 months after a mass distribution of LLIN. Accordingly, 84% of LLIN were less than two years old and 3% older than three years at the first survey while these figures were 37% and 29% at the second. Figure 2 shows the deterioration of nets by age. The proportion of nets in serviceable condition (good or acceptable) decreased from 95% at age <6 months to 75% for nets three years or older.

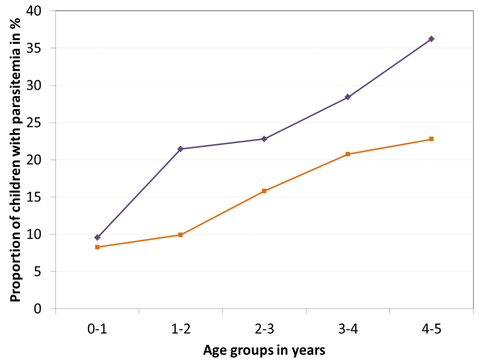

Figure 3: Change in age-specific parasitemia

Parasite rates in children 0-59 months of age decreased over time from 23% at the first survey to 15% in October 2012 with reduction in all age-groups except those less than one year (Figure 3). In both surveys parasite rates were higher in the districts in the North of the study area compared to the Southern part at higher altitude (30% vs. 10%, p<0.0001) and higher in the lowest two wealth quintiles (28% vs. 13%, p<0.0001).

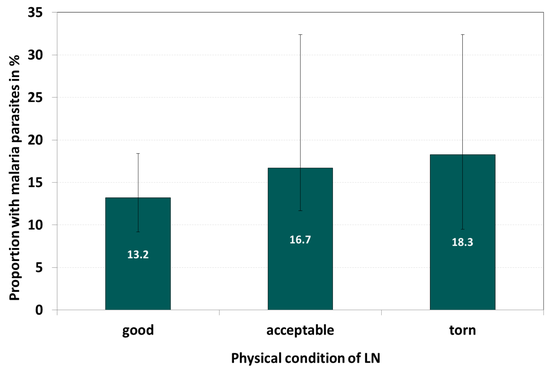

Figure 4: Parasitemia in children 0-59 months by physical condition of LN they used

Parasite rates of children increased slightly with the physical condition of the LLIN they used (Figure 4) being 13.2% (95%CI 9.2-18.4) for "good" nets, 16.7% (11.7-32.4) for "acceptable" and 18.3% (9.5-32.4) for "torn nets". This trend was independent of the two surveys and was not statistically significant (p=0.4).

In a logistic regression model of parasitemia child age showed to be a significant determinant with an Odds-Ratio (OR) of 1.3 per each additional year (p=0.01) as well as district (p<0.005), current fever (OR 3.5, p<0.005), wealthier households (p=0.04) and second vs. first survey (OR 0.55, p=0.04). However, no increased risk of parasitemia was found for "torn" LLIN (OR 1.0, p=0.9). Using parasite density above 5,000 parasites/µl or severe or moderate anemia also did not show increased risk for children using torn LLIN.

Discussion and conclusions

Data on the epidemiological impact of damaged nets or LN are scarce, with only three published studies all of which look at the parasitemia of children as a function of the condition of the net they used. These were done in The Gambia [1], Tanzania [2] and Equatorial Guinea [3] and only in the last [3] was there some evidence that damaged nets gave less protection than new nets, but the assessment of physical condition grouped all nets with any holes larger than 3.3 cm together as "torn".

These data suggest that, in the setting of Western Uganda with high level of community coverage, even seriously torn LN still provide sufficient protection for children, and nets are likely to be discarded before they lose their protective effect.

References
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