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Malaria infection risk and use of mosquito nets in the context of insecticide resistance in Uganda

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Key messages

- **Insecticide resistance is threatening the effectiveness of insecticide treated nets (ITNs) for malaria control.**
- **We investigated the level of personal protection provided by ITNs in two sites in Uganda where resistance of *Anopheles gambiae* s.s. against pyrethroids was detected.**
- **Individuals who slept under an ITN had significantly lower risk of malaria infection in both sites, one of which was also sprayed with bendiocarb.**
- **Proper use of ITNs is likely to provide individual protection from malaria infection but impact of resistance on community level protection requires further investigation.**

Introduction

Insecticide resistance in malaria vectors is a growing concern that threatens global efforts to control the disease. However, the magnitude of the impact of resistance on effectiveness of ITNs is not well understood.

In this study, we investigated the level of personal protection provided by ITNs in the presence of pyrethroid resistance, which was detected in *Anopheles gambiae* s.s. in a carbamate-sprayed site (Aduku, Apac District) and an unsprayed site (Butemba, Kyankwanzi District) in Uganda, by using data from repeated household surveys.

Methods

Four rounds of surveys* were carried out in the two sites during 2012-14 to study malaria transmission and assess impacts of interventions, as part of a multi-country project called Beyond Garki (www.beyondgarki.org). We compared malaria prevalence rates among individuals who used ITNs and those who did not use ITNs, while taking into account household and individual level characteristics that may modify the effect.

Multi-level statistical models were developed separately for each site to study the effects of the use of an ITN in the previous night before each survey, household socio-economic status (SES), living in a house with closed eaves, sex, age, and living in a sprayed house.

Results

- An average of 680 and 622 individuals were sampled per survey round in Aduku and Butemba, respectively (3.2 per household in both sites).
- Higher malaria prevalence rates were recorded in the unsprayed site (Butemba) (21.1%) than the sprayed site (Aduku) (7.0%) on average across the survey rounds (Figure 1). In both sites, 95% of the infections were due to *Plasmodium falciparum*, with the rest caused by *P. ovale* and *P. malariae*.
- Individuals who slept under an ITN had 37.4% (p=0.011) and 25.8% (p=0.024) lower risk of malaria infection than those who did not sleep under an ITN the previous night in Aduku and Butemba, respectively (Figure 2a, Table 1).
- Females had a 31.9% (p=0.023) and 19.2% (p=0.062) lower risk of infection compared to males in the two sites, respectively.
- Infection rates declined with increasing age in both sites.
- Individuals from households with high SES levels had a 44.3% (p=0.003) and 31.9% (p=0.010) lower risk of infection compared with those from households with lower SES levels in Aduku and Butemba, respectively.
- In Butemba, which was not under an indoor residual spraying (IRS) programme, individuals who lived in a house with closed eaves had 31.3% (p=0.013) lower risk than those who lived in a house with partially or fully open eaves, showing the importance of mosquito-proofing of houses. The effect of eaves was not observed in Aduku, indicating a community-level protection provided by IRS (Figure 2b).
- No significant difference was observed in prevalence rates among individuals living in sprayed and unsprayed houses in Aduku, which also indicated a community level protection.

Table 1: Results of mixed-effects logistic regression showing odds ratio (OR) of malaria infection for individuals with various characteristics

		OR	*p*	95% CI
Aduku - sprayed				
Age		0.98	0.001	0.97, 0.99
Sex	Male	1		
	Female	0.68	0.023	0.49, 0.95
ITN use	Not used	1		
	Used	0.63	0.011	0.44, 0.90
Wealth category	SES 1-2	1		
	SES 3-5	0.56	0.003	0.38, 0.82
Butemba - unsprayed				
Age		0.95	<0.001	0.94, 0.96
Sex	Male	1		
	Female	0.81	0.062	0.64, 1.01
ITN use	Not used	1		
	Used	0.74	0.024	0.57, 0.96
Wealth category	SES 1-2	1		
	SES 3-5	0.68	0.010	0.51, 0.91
Eaves of house	Open	1		
	Closed	0.69	0.013	0.51, 0.92

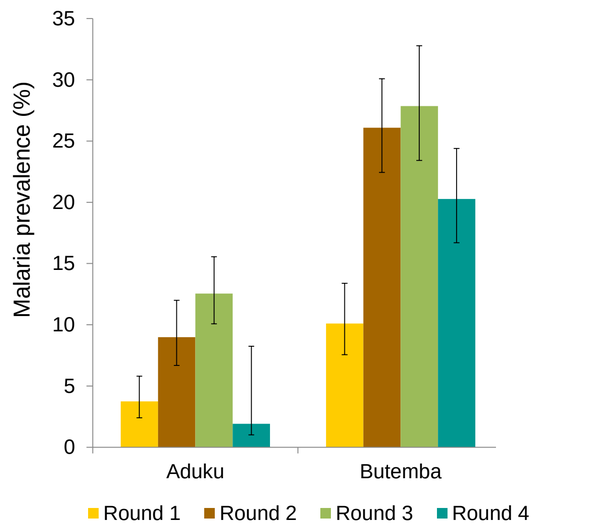

Figure 1: Malaria prevalence rates by survey round (error bars indicate 95% CI)

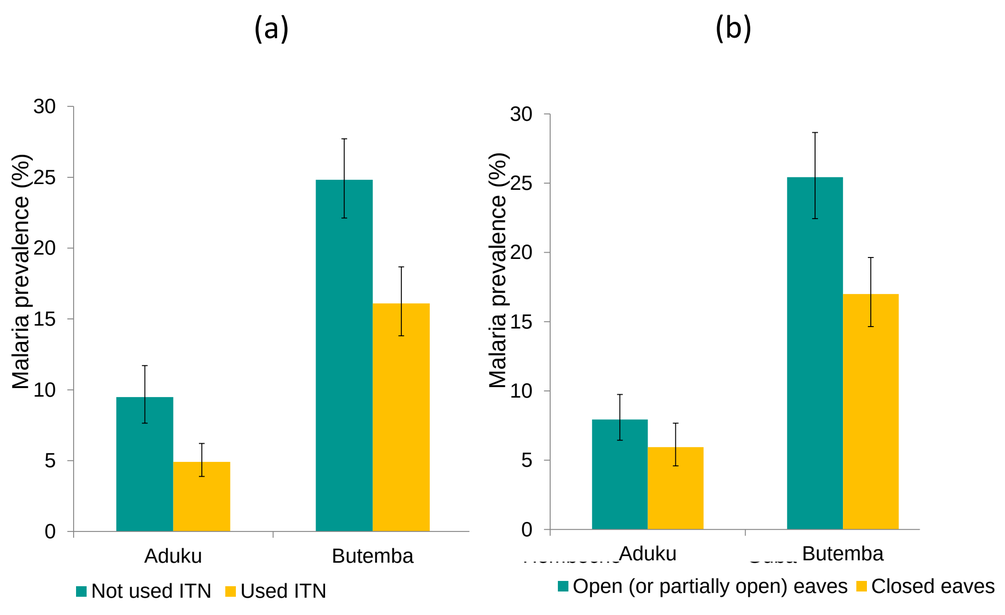

Figure 2: Differences in malaria prevalence by: (a) ITN use and (b) living in houses with (partially) open or closed eaves (error bars indicate 95% CI)

Conclusion

Proper use of ITNs is likely to provide individual protection from malaria infection in the study sites, but impact of resistance on community level protection requires further investigation.

***Survey rounds**: 1: Sep-Oct 2012, 2: Apr-May 2013, 3: Oct-Nov 2013, 4: Oct-Nov 2014

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