

Evaluation of field performance of insecticide-treated mosquito nets in north-western Burkina Faso

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ABSTRACT

Aims: The aim of the study was to evaluate the field performance of insecticide-treated mosquito nets in north-western Burkina Faso.

Study design: The study was a cross-sectional survey.

Place and Duration: The study took place between September and November 2008, towards the end of the rainy season, in rural north-western Burkina Faso

Methodology: Standard WHO bioassays were performed on field-collected ITNs from three areas of different insecticide pressure: semi-urban Nouna town, three villages with cotton agriculture, and three villages without cotton agriculture.

Results: The mean age of field-collected ITNs was 2.1 years. The mosquito mortality rate after 24 hours was 4% for the negative controls, 90% for the positive controls, and 73% for field-used ITNs. Differences in mosquito mortality between sub-areas disappeared after controlling for confounding variables.

Conclusion: This study provides evidence for deltamethrin being still effective in the study area despite ongoing insecticide pressure. However, deltamethrin resistance has been observed in other parts of the country and thus close surveillance of ITN efficacy is needed.

Keywords: ITN, LLIN, deltamethrin, synthetic pyrethroids, cotton culture, malaria control, *Anopheles gambiae*

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1. INTRODUCTION

Insecticide-treated mosquito nets (ITN) - in particular long-lasting insecticide treated nets (LLIN) - have become the dominating vector control tool in sub-Saharan Africa (SSA) (WHO 2009). Pyrethroid insecticides are the only class of insecticides approved for treating nets due to their high efficacy against *Anopheles* mosquitoes, low mammalian toxicity, and rapid breakdown in the environment (Mueller 2011; WHO 2006).

Mosquito resistance to pyrethroids has been reported from many countries of SSA (Santolamazza et al. 2008; Ranson et al. 2011; Abate et al. 2011). Resistance development has been associated with pyrethroid use in agriculture, in particular cotton production, but also with indoor residual spraying (IRS) programmes (Ranson et al. 2011; Chouaibou et al. 2008; Klinkenberg et al. 2008; Hargreaves et al. 2000; Maharaj et al. 2005). However, the impact of resistance development of malaria vectors against pyrethroids is currently not well understood (Ranson et al. 2011). Against this background, we undertook an evaluation of ITN field performance in Burkina Faso.

2. METHODOLOGY

The study took place in the study area of the Centre de Recherche en Santé de Nouna (CRSN) in north-western Burkina Faso, an area highly endemic for malaria (Mueller et al. 2001); ITN household coverage was 28% in 2007 (Mueller et al. 2001, 2007). Three different sub-areas were selected (Figure): 1. Nouna town, where insecticide use in households is known to be high (Okrah et al. 2002); 2. The villages Bagala, Dara, and Koro, where cotton agriculture was intensively practiced; 3. The villages Bourasso, Dima, and Kodougou, where cotton agriculture was not practiced.

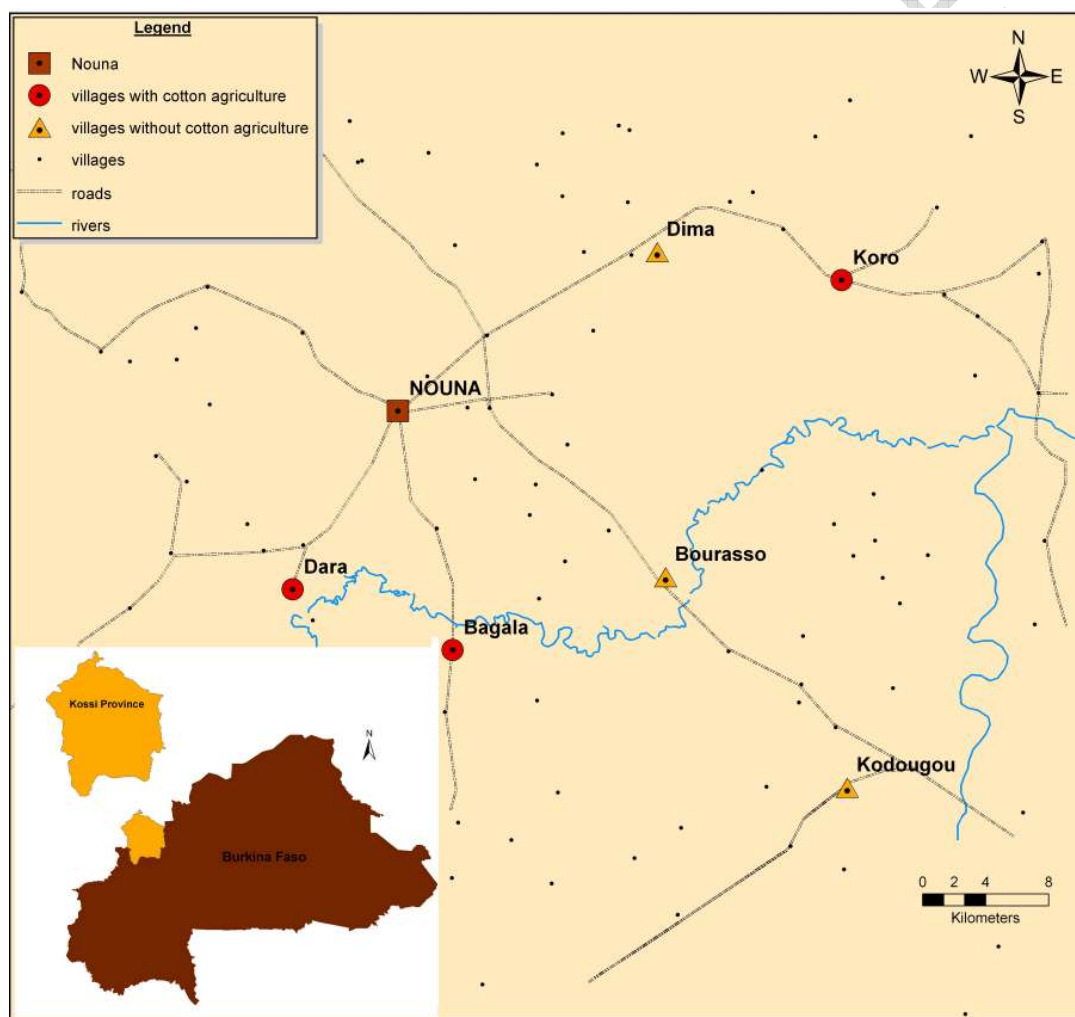


Figure. Map of study localities in Kossi Province, Burkina Faso.

The study was undertaken between September and November 2008 using a similar evaluation methodology as in 2001 (Mueller et al. 2002). A total of ninety used ITNs were collected in households selected at random within each locality (30 per sub-area). ITNs included in the study were only 'PermaNet® 2.0' (Vestergaard-Frandsen) of a maximum age of 5 years, as these were the type of nets distributed for research and program purposes in the area. A questionnaire was applied inquiring about ITN characteristics. Deltamethrin concentration on field-collected ITNs was determined with standard methods in cut outs (30 x 30 cm) sent to the Pesticides Research Department Walloon Agricultural Research Centre, Belgium (Mueller et al. 2002). ITN efficacy was measured through standard bioassays with WHO cones, using progeny *Anopheles gambiae* s.l. collected from the respective study sub-areas with the endpoint of mortality 24 hours after three minute exposure to the net.

Statistical analysis was done using SAS 9.2 (SAS Institute Inc., Cary, NC, USA). A multivariate regression analysis with a stepwise selection was performed to control for key confounding variables. The model included the following variables: sub-area, age of ITN, time since latest impregnation/age of ITN, and number of washes since latest impregnation.

Approval for the study was granted by the Ethical Committee of the Heidelberg University Medical School and the local Ethical Committee of Nouna in Burkina Faso.

3. RESULTS AND DISCUSSION

The characteristics of the field-used ITNs are shown in the table.

Table. Characteristics of field-used ITNs by sub-area in north-western Burkina Faso.

	All	Urban area	Cotton area	No cotton area
ITNs				
Number	90	30	30	30
Mean age in years (median)	2.1 (2.0)	2.6 (3.0)	1.9 (2.0)	1.9 (2.0)
[range]	[1m-5yr]	[1m-5yr]	[1m-5yr]	[1m-5yr]
Mean washes (median)	3.9 (3.0)	4.6 (3.5)	3.4 (3.0)	3.6 (3.0)
[range]	[0-20]	[0-20]	[0-10]	[0-20]
Deltamethrin content (g/kg)	0.51 ± 0.58	0.36 ± 0.54	0.59± 0.63	0.57± 0.56
± std [range]	[0-2.2]	[0-2.0]	[0-2.2]	[0-1.7]
Bioassays				
Number ITNs tested	77	24	28	25
Mosquito mortality after 24h	73%	64%	70%	85%
[range %]	[13-100%]	[13-92%]	[14-100%]	[59-100%]

* std= standard deviation; m=month; yr=year

ITNs were older in Nouna town than in villages and this was also reflected in differences in the number of washes and deltamethrin content. A total of 167 bioassays involving 5,882 adult mosquitoes were performed on positive and negative controls and field-used ITNs. The mosquito mortality rate after 24 hours was 4% (57/1,477) for the negative controls, 90% (506/558) for the positive controls, and 73% (2,821/3,847) for field-used ITNs. Differences in mosquito mortality between sub-areas disappeared after controlling for confounding variables.

This study has examined the performance of a standard LLIN under real life conditions. It was shown that nets two years and older had rather low deltamethrin content. Agricultural and domestic use of insecticides including pyrethroids appeared not to have a large influence on the susceptibility of the main malaria vector *Anopheles gambiae* to pyrethroids. These findings are reassuring for the national malaria control program in Burkina Faso which has just embarked on a major ITN distribution campaign with the aim of universal coverage (De Allegri et al.2011). However, ongoing and representative surveillance of the susceptibility of local malaria vectors to the insecticides used for public health is needed.

4. CONCLUSION

This study provides evidence for deltamethrin being still effective in the study area despite ongoing insecticide pressure. However, deltamethrin resistance has been observed in other parts of the country and thus close surveillance of ITN efficacy is needed.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

AUTHORS' CONTRIBUTIONS

VRL carried out the analysis, contributed to interpretation of the data and participated in writing the manuscript. AB, TS, WMG, JT, AJ, MY and NS contributed to the conception and the design of the study, the collection of the data and its interpretation, and drafting the manuscript. OM initiated the conception and design of the study, contributed to the interpretation of the data and wrote the manuscript. All authors read and approved the final manuscript.

ETHICAL APPROVAL

Approval for the study was granted by the Ethical Committee of the Heidelberg University Medical School and the local Ethical Committee of Nouna in Burkina Faso.

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