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## **Evaluation of Field Performance of Insecticide-Treated Mosquito Nets in North-Western Burkina Faso**

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### **Authors' contributions**

*This work was carried out in collaboration between all authors. Author VRL carried out the analysis, contributed to interpretation of the data and participated in writing the manuscript. Authors 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. Author 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.*

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### **ABSTRACT**

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

**Study design:** Cross-sectional survey.

**Place and Duration:** The study took place between September and November 2008 (end of 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. Data on age and washing

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frequency of ITNs was collected, and deltamethrin content was determined by HPLC.

**Results:** The mean age of field-collected ITNs was 2.1 years. The mosquito mortality rate (*Anopheles gambiae* sl.) 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 demonstrates that under real life conditions, deltamethrin still shows some level of effectiveness 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. More frequent replacement of ITNs is also recommended.

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

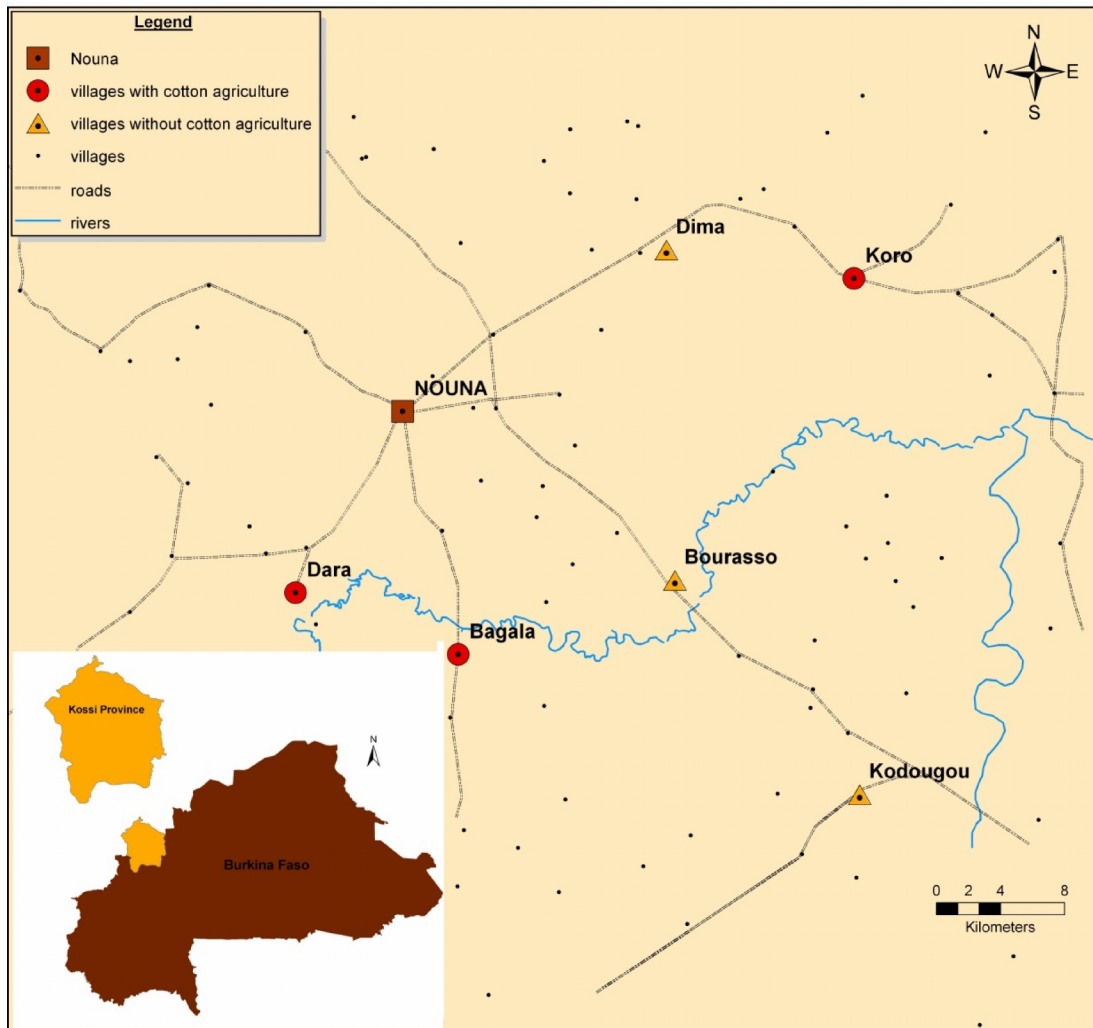
## 1. INTRODUCTION

Insecticide-treated mosquito nets (ITNs) - in particular long-lasting insecticide treated nets (LLIN) - have become the dominating vector control tool in the field of malaria in sub-Saharan Africa (SSA) [1]. 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 [2,3].

Mosquito resistance to pyrethroids has been reported from many countries of SSA [4–6]. Resistance development has been associated with pyrethroid use in agriculture, in particular cotton production, but also with indoor residual spraying (IRS) programmes [5,7–10]. However, although an impact of pyrethroid resistance on malaria control programmes was shown in Southern Africa [11], the public health impact of resistance development of malaria vectors against pyrethroids is currently not fully understood [5]. 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 [12]; ITN household coverage was 28% in 2007 [13]. Three different sub-areas were selected (Figure): a) Nouna town (longitude:-3.86179, latitude:12.72998), where insecticide use in households is known to be high [14]; b) The villages Bagala (-3.8258, 12.5956), Dara (-3.9217, 12.6264), and Koro (-3.60999, 12.80762), where cotton agriculture was intensively practiced; c) The villages Bourasso (-3.71253, 12.63369), Dina (-3.7142, 12.8167), and Kodougou (-3.60612, 12.51769), where cotton agriculture was not practiced.



**Figure 1. 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 [15]. In brief, a total of ninety used ITNs were collected in households selected at random within each locality (30 per sub-area) using the register of the Health and Demographic Surveillance System managed by the CRSN. 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 using High Performance Liquid Chromatography with UV/Visible Diode Array Detection (HPLC-DAD) in cut outs (30 x 30 cm) sent to the Pesticides Research Department Walloon Agricultural Research Centre, Belgium. 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 [16]. A multivariate regression analysis was done using SAS 9.2 (SAS Institute Inc., Cary, NC, USA). 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
<b>ITNs</b>				
Number	90	30	30	30
Mean <b>age in years</b> (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 <b>washes</b> (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]
<b>Deltamethrin content</b> (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]
<b>Bioassays</b>				
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 (ITN age, number of washes, and time since latest impregnation).

This study has examined the performance of a standard LLIN under real life conditions. If we discriminate between ITNs below and above 2 years of age, 24 hours mosquito mortality fulfils the WHO efficacy criteria (>80%) in the newer nets, but not in those above two years of age (83% vs. 66%) [16]. Overall, 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 relevant 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 [17]. On-going and representative surveillance of the susceptibility of local malaria vectors to the insecticides used for public health is needed.

### 4. CONCLUSION

This study demonstrates that under real life conditions, deltamethrin still shows some level of effectiveness 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. More frequent replacement of ITNs is also recommended.

## 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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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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