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Insecticide resistance in malaria vectors along the Thailand-Myanmar border

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Abstract

Background: There is a paucity of data about the susceptibility status of malaria vectors to Public Health insecticides along the Thailand-Myanmar border. This lack of data is a limitation to guide malaria vector-control in this region. The aim of this study was to assess the susceptibility status of malaria vectors to deltamethrin, permethrin and DDT and to validate a simple molecular assay for the detection of knock-down resistance (kdr) mutations in the study area.

Methods: *Anopheles* mosquitoes were collected in four sentinel villages during August and November 2014 and July 2015 using human landing catch and cow bait collection methods. WHO susceptibility tests were carried out to measure the mortality and knock-down rates of female mosquitoes to deltamethrin (0.05%), permethrin (0.75%) and DDT (4%). DNA sequencing of a fragment of the voltage-gated sodium channel gene was carried out to identify knock-down resistance (kdr) mutations at position 1014 in mosquitoes surviving exposure to insecticides.

Results: A total of 6295 *Anopheles* belonging to ten different species were bioassayed. Resistance or suspected resistance to pyrethroids was detected in *An. barbirostris* (*s.l.*) (72 and 84% mortality to deltamethrin ($n = 504$) and permethrin ($n = 493$) respectively), *An. hyrcanus* (*s.l.*) (33 and 48% mortality to deltamethrin ($n = 172$) and permethrin (n = 154), respectively), *An. jamesii* (87% mortality to deltamethrin, $n = 111$), *An. maculatus* (*s.l.*) (85 and 97% mortality to deltamethrin ($n = 280$) and permethrin ($n = 264$), respectively), *An. minimus* (*s.l.*) (92% mortality, $n = 370$) and *An. vagus* (75 and 95% mortality to deltamethrin ($n = 148$) and permethrin ($n = 178$), respectively). Resistance or suspected resistance to DDT was detected in *An. barbirostris* (*s.l.*) (74% mortality, $n = 435$), *An. hyrcanus* (*s.l.*) (57% mortality, $n = 91$) and *An. vagus* (97% mortality, $n = 133$). The L1014S kdr mutation at both heterozygous and homozygous state was detected only in *An. peditaeniatus* (Hyrcanus Group).

Conclusion: Resistance to pyrethroids is present along the Thailand-Myanmar border, and it represents a threat for malaria vector control. Further investigations are needed to better understand the molecular basis of insecticide resistance in malaria vectors in this area.

Keywords: Malaria, Thailand-Myanmar border, *Anopheles*, Pyrethroids, Insecticide resistance, kdr mutation, Southeast Asia

Background

Vector-borne diseases account for 17% of all infectious diseases, causing more than 1 million deaths annually [1]. Malaria causes more than 600,000 deaths every year, mostly in children under 5 years [2]. Vector-control is an essential component of malaria control, and it relies mainly on long-lasting insecticidal nets (LLINs) and indoor residual spraying (IRS) [3]. In low transmission settings, especially where residual transmission (i.e. transmission that is not prevented by LLINs and IRS) is prominent, LLINs and IRS must be supplemented by other methods to target early feeding, exophagic and zoophagic malaria vectors [4].

Pyrethroids are widely used for vector control because of their strong insecticidal effect and their low toxicity to mammals [5]. They induce a rapid "knock-down" (KD), and they have irritant and excito-repellent properties against susceptible mosquitoes [6]. Sadly, pyrethroid

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