Journal of Medical Entomology, 58(2), 2021, 756–766
doi: 10.1093/jme/tjaa213
Advance Access Publication Date: 20 October 2020
Research

Field Evaluation of a Spatial Repellent Emanation Vest for Personal Protection Against Outdoor Biting Mosquitoes

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Subject Editor: Timothy Lysyk

Received 17 August 2020; Editorial decision 3 September 2020

Abstract

Exophilic vectors are an important contributor to residual malaria transmission. Wearable spatial repellents (SR) can potentially provide personal protection in early evening hours before people retire indoors. An SR prototype for passive delivery of transfluthrin (TFT) for protecting humans against nocturnal mosquitoes in Kanchanaburi, western Thailand, is evaluated. A plastic polyethylene terephthalate (PET) sheet (676 cm^2) treated with 55-mg TFT (TFT-PET), attached to the back of short-sleeve vest worn by human collector, was evaluated under semifield and outdoor conditions. Field-caught, nonblood-fed female *Anopheles minimus* s.l. were released in a 40 m length, semifield screened enclosure. Two collectors positioned at opposite ends conducted 12-h human-landing collections (HLC). The outdoor experiment was conducted between treatments among four collectors at four equidistant positions who performed HLC. Both trials were conducted for 30 consecutive nights. TFT-PET provided 67% greater protection ($P < 0.001$) for 12 h compared with unprotected control, a threefold reduction in the attack. In outdoor trials, TFT-PET provided only 16% protection against *An. harrisoni* Harbach & Manguin (Diptera: Culicidae) compared with unprotected collector ($P = 0.0213$). The TFT-PET vest reduced nonanophelines landing by 1.4-fold compared with the PET control with a 29% protective efficacy. These findings suggest that TFT-PET had diminished protective efficacy in an open field environment. Nonetheless, the concept of a wearable TFT emanatory device has the potential for protecting against outdoor biting mosquitoes. Further development of portable SR tools is required, active ingredient selection and dose optimization, and more suitable device design and materials for advancing product feasibility.

Key words: *Anopheles harrisoni*, *Anopheles minimus* s.l., outdoor transmission, spatial repellency, transfluthrin

Control of malaria vector mosquitoes has been mainly implemented by indoor residual-spraying (IRS) of house surfaces and distribution of insecticide-treated nets (ITNs; WHO 2015, BVBD 2018, Tananchai et al. 2019a). Collectively, these tools are designed to reduce indoor mosquito population densities by targeting indoor blood-feeding (endophagy) and resting (endophily) vector species (WHO 2015). Despite full coverage of ITNs and IRS, and the occurrence of insecticide-susceptible *Anopheles* populations (WHO 2014, Sumarnrote et al. 2017), these core intervention tools are insufficient for reducing persistent malaria transmission and outdoor vector biting (Durnez and Coosemans 2013) in malaria-endemic communities and areas beyond the village (e.g., forest) (Edwards et al. 2019). Thailand's 'malaria elimination' strategic plan intends to achieve complete interruption of all autochthonous malaria transmission in the country by 2024 (WHO 2015, BVBD 2018, Manguin and Dev 2018). To do so, one paramount concern is effectively addressing outdoor vector transmission for preventing infection (Durnez and Coosemans 2013, Hii et al. 2018, Edwards et al. 2019).

In Thailand, the biting behavior of the primary vectors (e.g., *Anopheles dirus* Peyton & Harrison, *Anopheles minimus* Theobald and *Anopheles maculatus* Theobald) and closely related sibling/group species (e.g., *Anopheles baimaii* Sallum & Peyton, *Anopheles pseudowillmori* (Theobald), *Anopheles sawadwongporni* Rattanarithikul & Green, and *Anopheles aconitus* Doenitz) show a strong tendency for blood-feeding outdoors during the early evening hours (Tainchum et al. 2015, Tananchai et al. 2019a). This