EvidenceSpotlight

Spatial emanators can boost the impact of insecticide-treated nets on malaria transmission

Summary

Spatial emanators (SEs) are conditionally recommended by the World Health Organization (WHO) as a supplementary malaria prevention tool that can be used alongside core vector control interventions. Evidence supporting this recommendation comes from studies in settings with high ITN coverage (>90%), where SEs were associated with an additive reduction in malaria transmission. To date, evidence is needed on the impact of SEs as a standalone tool or in outdoor spaces.

Emanators versus repellents

SEs continuously emit volatile active ingredients into the air to disrupt key mosquito behaviours, including host-seeking and/or blood-feeding, by repelling, disorienting and/or killing the vector.[1] Although the term "spatial emanator" is often used interchangeably with "spatial repellent", including in WHO guidelines for malaria, it is increasingly used to reflect a broader mode of action as insecticide-based SEs can affect multiple aspects of mosquito behaviour and biology beyond repellency.[2]

WHO recommendation

In August 2025, WHO issued a conditional recommendation for indoor use of SEs in combination with ITNs and/or IRS.[2] Two passive, transfluthrin-based SE products – Mosquito Shield (effective for up to 1 month) and Guardian (effective for up to 12 months) – have been prequalified by WHO to date. Both are passive products evaluated for use in enclosed and semi-enclosed spaces. They rely on the natural evaporation of the active ingredient, with dispersion influenced by local environmental conditions.

The WHO recommendation considers SEs as a supplementary vector control tool for malaria, as the efficacy evidence submitted to WHO was generated from trials with high ITN coverage (>90%).[3] The recommendation is currently conditional due to variable impacts being observed across studies, and the need for additional consistent evidence.

Mode of action

Transfluthrin, the active ingredient in both WHO-prequalified SE products, is a volatile pyrethroid that is effective without requiring direct contact between mosquitoes and a treated surface. At ambient temperatures, it vaporizes and disperses the surrounding air, affecting mosquitoes. Its effects include repellency, feeding inhibition, disarming (landing but not feeding), and mortality, which vary with exposure dose and local conditions. In controlled SE-treated environments, exposure has reduced blood feeding by 70–80% and caused 20–30% mortality among mosquitoes recorded inside the treated area. These outcomes likely reflect several interacting effects and require further studies.

Pyrethroid resistance is an increasing concern in malaria control, spurring the development of dual active-ingredient ITNs: pyrethroid-chlorfenaypr ITNs capable of killing up to 90% of mosquitoes in experimental hut studies.[4] Evidence on how pyrethroid-resistant mosquitoes respond to volatile transfluthrin remains limited. Early studies indicate reduced spatial repellency in resistant populations, but effects on other behaviour endpoints such as feeding inhibition, disarming or mortality, have not been assessed.[5]

Observational and intervention studies

Studies submitted to WHO showed that when SEs were added to areas with high ITN coverage (93–98%), the additive reduction in malaria risk attributed to SEs varied widely: 41% further reduction in Indonesia (SE coverage of 93%), and 28% further reduction in Kenya (SE coverage of 89%).[6,7]

Evidence from low-ITN or humanitarian settings is sparse. One study explored camps for displaced populations in northern Nigeria, reporting a 28% reduction in malaria over 6 months among children in household units that received SEs compared with those that did not.[8] In these camps, ITN ownership was limited (64% in household units that received SEs; 37% in control units). However, substantial differences in ITN coverage between the intervention and control arms, along with insufficient data on the quality and origin of the ITNs, make it difficult to attribute effects solely to SEs or infer standalone performance.

Additional research is needed to understand the potential of SEs as a standalone tool and to assess their potential role for outdoor use.[2]

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Mathematical modelling

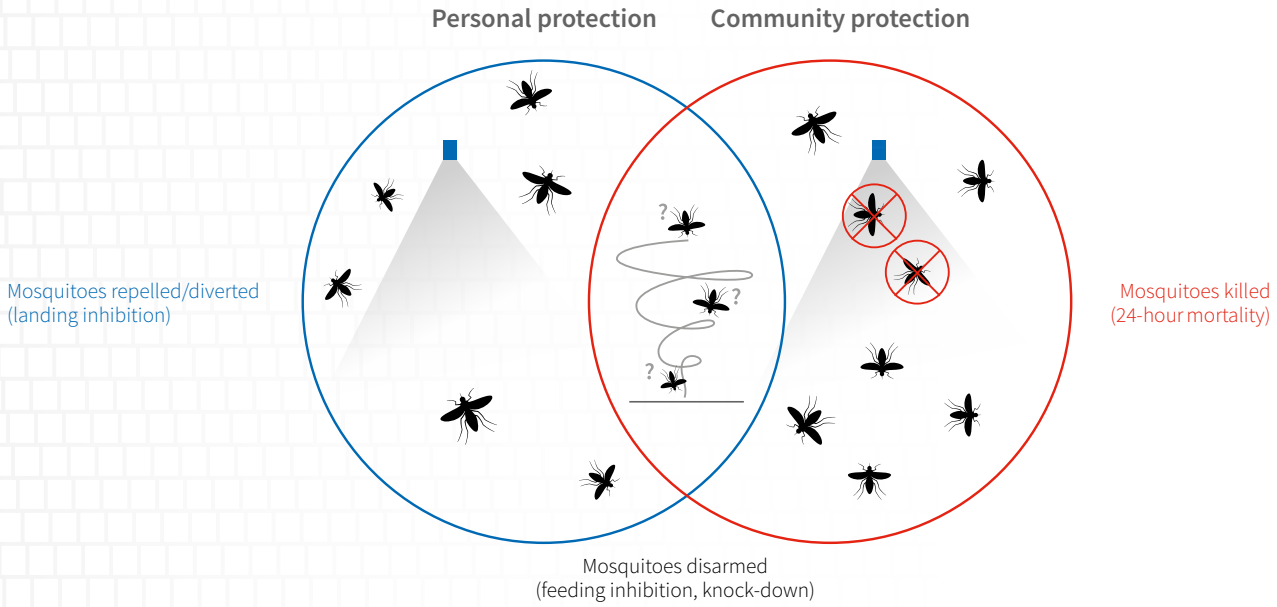
There are currently no published modelling studies examining how WHO-prequalified indoor SEs perform under different transmission conditions and/or with varying coverage of mainstay vector control interventions such as ITNs and IRS.

A modelling study on the impact of low-tech outdoor SEs on malaria cases alongside ITNs suggested that potential added benefits are highly context-specific and dependent on SE efficacy.[9] In settings where mosquitoes predominantly feed on humans rather than animals, the authors theorize that outdoor SEs could repel mosquitoes away from people and increase their likelihood of encountering indoor ITNs. However, this diversion effect remains theoretical, with no empirical evidence to presently support it.

Another modelling study used semi-field data from two passive SEs (transfluthrin-based Bite Barrier, and metofluthrin-based SumiOne) to explore the impact of repelling and disarming effects alongside killing effects on transmission potential.[10] It estimated that 25% coverage of SEs resulted in a 40-50% reduction in vectorial capacity (the potential for mosquitoes to transmit malaria), rising to a 75% reduction at 50% coverage. These findings indicate that multiple behavioural effects could contribute to overall intervention performance, although epidemiological impacts remain to be demonstrated. Neither passive SE used in these studies currently hold a WHO PQ listing.

Implications for implementation

WHO recommends that malaria programmes achieve and sustain high coverage of proven interventions, particularly ITNs, before deploying SEs. This reflects the current evidence base, which is derived almost entirely from settings where ITNs are already in place.[2] Further research is needed to understand SE performance in different environments, including their impact on mosquito behaviour, how they respond to insecticide resistance, and how to deploy them in resource-constrained settings. Clarifying where SEs add value, and how to optimize their combination with core interventions, will support evidence-informed programme decision-making.



SEs reduce mosquito bites by impacting mosquito behaviour, with a modest kill effect.

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