



A cross-sectional study assessing the residual bio-efficacy and durability of field-distributed long-lasting insecticidal nets in malaria endemic ethnic communities of Assam, Northeast India



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Summary Long-lasting insecticidal nets (LLINs) are being promoted for malaria vector control in the northeastern Indian state of Assam. A cross-sectional study was conducted to assess the current residual bio-efficacy and durability of both the Olyset[®] and PermaNet[®]2.0 LLINs that were distributed earlier in 2009, 2011 and 2013 to help formulate informed policy regarding net procurement, supplies and replacement. The study was undertaken in three different malaria endemic blocks of Assam during the period of June to October of 2014. The residual bio-efficacies were ascertained using the WHO cone-bioassay method for mosquito mortality post-exposure and corroborated with the ring-net assay for the median knockdown times of both types of LLINs in use by these communities. Cross-sectional community surveys were distributed to assess net ownership, utilization, community practices and the physical conditions of the nets in terms of being torn and the numbers of holes per position. Both the Olyset[®] and PermaNet[®]2.0 LLINs that were distributed in 2009 (i.e., nearly after five years of community usage) were completely torn, worn out and obsolete. However, the LLINs distributed in 2011 (i.e., three years of community usage) retained their residual bio-efficacies in susceptibility ranges that varied from 57% to 79%. However, for the LLINs that were distributed in 2013, the observed residual efficacy was adequate and resulted in a mosquito mortality rate >80 percent. Of the two types of LLINs inspected, the Olyset[®] nets were more durable and

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robust in terms of being torn less frequently (37.1%, 39/105) compared with the PermaNet[®]2.0 nets (51.8%, 204/394). Regarding the LLINs that were distributed in 2013, all were physically intact and in good condition. The majority of the distributed LLINs (99.2%, 639/644) were still in the possession of the householders of the surveyed populations. This study revealed that the serviceable life of the nets was slightly less than three years in terms of waning residual bio-efficacy and durability that warranted replacement. The communities were aware of the benefits of the use of mosquito net for personal protection and regularly used the nets; thus, LLIN-based interventions for sustained vector control should be scaled up.

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Introduction

Malaria is major public health concern in the north-eastern Indian state of Assam (24°44'–27°45' N lat.; 89°41'–96°2' E long.), in which the majority of districts report cases, but the disease distributions and relative risks vary [1,2]. *Plasmodium falciparum* and *P. vivax* are co-endemic, but *P. falciparum* predominantly responsible for infections (>70%) and solely responsible for the substantial increase in cases and attributable deaths. The transmission of the causative parasites is persistent with a seasonal peak from April to September that coincides with the months of heavy rainfall. *Anopheles minimus* and *An. baimaii* have been incriminated by several independent investigators and unequivocally proven to be the major vectors in the state, but a host of other mosquito species, including *An. nivipes* and *An. culicifacies*, are also believed to contribute to the overall disease burden of malaria [3]. Both the *An. minimus* and *An. baimaii* mosquito species are highly susceptible to DDT, which remains the choice insecticide in the control program specific to northeast India. However, despite decades of attempted control, malaria transmission remains uninterrupted largely due to the poor acceptance of indoor spray coverage [4]. To overcome this operational constraint, the advent of long-lasting insecticidal nets (LLINs) has proven to be an evidenced-based intervention for disease vector control and the incorporation of program implementation planning by healthcare services [5–7]. Due to the reductions in transmission that have been demonstrated in village-scale field-based studies, LLINs are now being promoted as the mainstay of vector control for prioritized high-risk population groups [8]. Among the variety of LLINs that are recommended by the WHO Pesticide Evaluation Scheme (WHOPES) for procurement and supply [9], Olyset[®] nets (polyethylene netting with incorporated permethrin) and PermaNet[®]2.0

nets (deltamethrin-coated polyester netting) have been approved by the Central Insecticide Board of the Government of India for use in public healthcare services (<http://www.cibrc.nic.in/>) in the country. Due to these specific approvals, in the period from 2009 to 2013, more than 1.5 million Olyset[®] (Sumitomo Chemical Company, Osaka, Japan) and PermaNet[®]2.0 (Vestergaard Frandsen, Lausanne, Switzerland) nets were distributed gratis in the state of Assam through primary healthcare services including nets distributed by non-governmental organizations in high-risk districts/population groups for the promotion of personal protection against mosquito bites. Given the observed declines in transmission trends and community acceptance across the state [4], the distribution of additional supplies in a phased manner is envisaged, and for this goal, the formulation of an informed policy for net procurement, supply and replacement, including campaigns for behavior-change communication to increase net usage and compliance, was mandated. Included in this report are data on the current residual bio-efficacies of the LLINs distributed in the field in 2009, 2011 and 2013 in villages/population groups of select blocks of the state in terms of malaria transmission/suspected mosquito vector species and observations regarding net durability, community practices, retention and attrition rates and any potential public perceptions of occurrences of adverse events.

Materials and methods

Topography, climate and study populations

The state of Assam is rich in biodiversity due to the extended monsoons, and the malaria receptivity is estimated to be low-to-moderate [1]. Both the Olyset[®] net (dimensions,

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