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REVIEW ARTICLE

Is declining malaria vector population in Africa a result of intervention measures or sampling tools inefficiency?

Há redução dos vetores da malária na África como resultado das medidas de intervenção ou por conta de ferramentas de amostragem ineficientes?

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Abstract

Recent entomological surveys have shown a declining trend of malaria vector population in sub-Saharan Africa and the observation have been associated with the scale-up and intensive use of malaria intervention measures such as insecticides treated nets and insecticide residual sprays. However, little is known on the contribution of the mosquito sampling tools inefficiency on the declining trends of malaria vector population. In this commentary paper, we explore the possibility of contribution of mosquito sampling tools' inefficiency to the observed declining trends of malaria vector population in Africa.

Keywords: Malaria. Mosquitoes. Anopheles. Africa.

Resumo

Pesquisas entomológicas recentes têm mostrado uma tendência de redução da população do vetor da malária na África sub-saariana e essa observação têm sido associado com o uso intensivo intensivo de medidas de intervenção, tais como mosquiteiros impregnados com inseticidas e borrifação com inseticidas residuais. Contudo, pouco se sabe sobre a eficiência de instrumentos de amostragem de mosquitos e a contribuição dessa ferramenta sobre as tendências de declínio da população do vetor da malária. Neste artigo, exploramos a contribuição ineficiente dos instrumentos de amostragem de mosquitos para observar uma redução da população de vetores da malária na África.

Palavras-chave: Malária. Mosquitos. Anopheles. África.

Malaria vector sampling against intervention tools

For many years, malaria vector density estimation has been carried out using indoor sampling methods for host seeking and resting vectors[1-3]. Little attention has been directed to the use of outdoor sampling tools especially on large scale scenarios[4-7]. Various techniques used for indoor sampling of resting mosquitoes includes: Centers for Disease Control (CDC) miniature light traps (referred as gold standard method), mechanical aspirators and pyrethrum spray catch[3,8-13]. These techniques have their own advantages and disadvantages and are described elsewhere [3,8-13].

The intensive use of malaria intervention measures is one of the important factors which in part affect the performance of the mosquito sampling tools[14-16]. Use of ITNs has been linked to the reported declining in malaria vectors population[16-18]. However, changing of mosquito feeding/ biting behaviour from feeding indoor to feeding outdoor for avoiding the knockdown effects of ITNs also affects the performance of indoor vector trapping tools. This in turn, affects estimation of vectors collected by these techniques and thus the techniques may not give a true representation of the vector abundance but rather shows the outcomes of vector interventions implemented. Thus the declining trends of indoor resting malaria vector densities might be misinterpreted due to vector feeding and resting behavioral changes or increased exophily due to use of treated ITNs.

Malaria vector decline and shift in species composition

On the other hand, IRS programmes which uses either lambdacyhalothrin or deltamethrin has been widely advocated and used for malaria control programmes[17,18]. These insecticides are sprayed on the inner wall surfaces where mosquitoes rest before and after taking a blood

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meal[3]. The insecticides have strong repellence and high knockdown effects on malaria vectors. Due to the repellence and knockdown effects, the major malaria vectors have changed their behaviours[4,19] and they remain outdoor or immediately knocked down when they gain access to houses sprayed with IRS. Under these circumstances, light traps and pyrethrum spray catch techniques are likely to collect fewer mosquitoes indoors than before the control measures were instituted. Consequently, the lower densities of indoor malaria vector which are currently collected by the indoor mosquito sampling techniques due to the effects of malaria intervention measures cannot be easily translated as the decline of malaria vectors population.

Malaria vector population decline

In an area of high coverage with ITNs and LLINs, declining trends of malaria vectors has been observed. Larvae of *An.gambiae s.s* in habitats were demonstrated to decrease with increasing bed net coverage. On the other hand, when data of two species was compared over time, it was reported that *An. arabiensis* replaced *An.gambiae s.s* as the dominant species[20,21.] One plausible reason for this incidence is, *An.gambiae s.s* prefers to feed and rest indoors, thus the population of this species may have decreased due to lack of human blood meal accessibility and mortality may have increased due to contact with insecticides treated nets. Similarly, findings from another area in western Kenya have also showed decreasing trends of *An. arabiensis* population indoors in areas with high coverage of ITN/LLINs and alternative host outdoor[22]. Previous studies in western Kenya found that *An. arabiensis* comprised 3% of the adult *An. gambiae* complex sampled indoors[23,24] while another study in the same area reported that *An .arabiensis* comprised of 10%[25]. On the other hand, larval samples from the same area reported the highest proportions (37.7%) of *An. arabiensis* ever recorded in the area[22]. The lower densities of *An. arabiensis* in indoor collections using CDC miniature light trap and PSC collections may not have suggested a reduction in vector densities as a result of the interventions tools but rather availability of alternative hosts' outdoors may have influenced outdoor abundance of the species[26,27]. This might be the source of species replacement observed by Bayoh and others in other parts of western Kenya where the coverage of the LLINs exceeded 90%[20].

Further, recent observations made in western Kenya and northern Tanzania have revealed that, traditional method of using plant repellents indoor have impacted on indoor vector densities [28-31]. Plants used include: *Ocimum* species, *Lantana camara*, Eucalyptus and *Azadirachta indica* A. Jussieu (Sapindales: Meliaceae), whether fresh, dried or smoked[32]. Smoke restricts mosquitoes' house entry and increases aggression of both fed and unfed mosquitoes[29]. Repellent plants growing around houses have been demonstrated to deter house entry of Anopheline mosquitoes hence lower indoor collection [33].

The use of Ivermectine dosages in filariasis and animal health control programmes[34-36], has been observed to reduce survivorship in mosquitoes which have fed on a blood meal taken from hosts injected with a dose of Ivermectine. In that particular study, the reduction of mosquito densities in the non-intervention areas were not clearly understood however the decline was associated with the use of Ivermectine for animals and filariasis control[14]. The decline of mosquito densities throughout the area could not be attributed only to the use of Ivermectine but rather when all animals were treated with dose of Ivermectine.

In massive interventions with IRS and LLINs, CDC light trap and bed nets failed to reliably assess the human biting rates in Bioko Island[37]. Consequently, evaluation of efficacy of other outdoor and indoor trapping systems should be of importance and priority given the scale up of intervention tools using IRS and LLINs. Currently, only a few outdoor trapping systems have been evaluated in small scale and have shown to be efficient in estimating vector abundance[4, 6, 22]. Much more focus should be given in evaluating these outdoor malaria vector trapping tools in large scale in the face of the increasing scale up of malaria intervention tools.

Conclusion

Vector density estimation in this era of massive scale up of vector control operations should be revisited with the main emphasis on the possible change in resting and feeding behaviour of mosquitoes in malaria endemic regions.

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