Acta Tropica 181 (2018) 84–94

Contents lists available at ScienceDirect

Acta Tropica

journal homepage: www.elsevier.com/locate/actatropica

Exploring the impact of house screening intervention on entomological indices and incidence of malaria in Arba Minch town, southwest Ethiopia: A randomized control trial

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ARTICLE INFO

Keywords:
An. arabiensis
House screening interventions
Entomological inoculation rate
Malaria incidence
Arba Minch town

ABSTRACT

House is the major site for malaria infection where most human-vector contact takes place. Hence, improving housing might reduce the risk of malaria infection by limiting house entry of vectors. This study aimed to explore the impact of screening doors and windows with wire meshes on density and entomological inoculation rate (EIR) of malaria vector, and malaria incidence, and assess the acceptability, durability, and cost of the intervention. The susceptibility status of malaria vector was also assessed. A two-arm randomized trial was done in Arba Minch Town, southwest Ethiopia. 92 houses were randomly included in the trial. The baseline entomological and malaria prevalence data were collected. The mosquito sampling was done twice per household per month by Centers for Diseases Control and Prevention (CDC) light traps for six months. The baseline prevalence of malaria was assessed by testing 396 (83% of the 447 study participants) household members in all the eligible houses. The 92 houses were then randomized into control and intervention groups using mosquito and malaria prevalence baseline data to make the two groups comparable except the intervention. Then, we put wire-mesh on doors and windows of 46 houses. Post-screening mosquito collection was done in each household twice per month for three months. Each household member was visited twice per month for six months to assess malaria episodes. The frequency of damage to different structure of screening was measured twice. In-depth interview was conducted with 24 purposely selected household heads from intervention group. Speciation of *Anopheles* mosquito was done by morphological key, and the circum-sporozoite proteins (CSPs) analysis was done using enzyme-linked immunosorbent assay. A generalized estimating equation with a negative binomial distribution was used to assess the impact of the intervention on the indoor density of vectors. Clinical malaria case data were analyzed using Poisson regression with generalized linear model. Screening doors and windows reduced the indoor density of *An. arabiensis* by 48% (mean ratio of intervention to control = 0.85/1.65; 0.52) (P = .001). *Plasmodium falciparum* CSP rate was 1.6% (3/190) in the intervention houses, while it was 2.7% (10/372) in the control houses. The protective efficacy of screening intervention from CSP positive *An. arabiensis* was 41% (mean ratio of intervention to control = 1.6/2.7; 0.59), but was not statistically significant (P = .6). The EIR of *An. arabiensis* was 1.91 in the intervention group, whereas it was 6.45 in the control group. 477 participants were followed for clinical malaria (50.1% from intervention and 49.9% from the control group). Of 49 RDT positive cases, 45 were confirmed to be positive with microscopy. 80% (n = 36) cases were due to P. falciparum and the rest 20% (n = 9) were due to *P. vivax*. The incidence of *P. falciparum* in the intervention group was lower (IRR: 0.39, 95% CI: 0.2–0.80; P = .01) than in the control group. Using incidence of *P. falciparum* infection, the protective efficacy of intervention was 61% (95% CI: 18–83; P = .007). 97.9% of screened windows and 63.8% of screened doors were intact after eleven months of installation. Malaria mosquito was resistance (mortality rate of 75%) to the insecticide used for bed nets treatment. Almost all participants of intervention arm were willing to continue using screened doors and windows. Screening doors and windows reduced the indoor exposure to malaria vectors. The intervention is effective, durable and well-accepted. Hence, the existing interventions can be supplemented with house screening intervention for further reduction and ultimately elimination of malaria by reducing insecticide pressure on malaria vectors. However, further research

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https://doi.org/10.1016/j.actatropica.2018.02.009
Received 23 October 2017; Received in revised form 24 January 2018; Accepted 11 February 2018
Available online 13 February 2018

could be considered in broad setting on different housing improvement and in the way how to scale-up for wider community.

1. Introduction

In the last two decades, widespread reduction in malaria prevalence and incidence have been achieved across Africa (Bhatt et al., 2015; Murray et al., 2012) due to the scale-up of long-lasting insecticide-treated nets (LLINs), indoor residual spraying (IRS), early diagnosis and prompt treatment of cases by effective anti-malaria drugs (Bhatt et al., 2015). However, these interventions failed to eliminate malaria in endemic countries partly because of the residual malaria transmission even in areas with high coverage of quality interventions (Killeen, 2014). For example, up to 36% of indoor malaria transmission was reported in Uganda before sleeping time despite high coverage of LLINs and IRS (Okello et al., 2006). Moreover, high number of host-seeking malaria vectors was found in houses regardless of high coverage of indoor based malaria control interventions (Lwetoijera et al., 2013).

Evidence indicates that poor housing is associated with increased risk of malaria incidence (Tusting et al., 2015). On the other hand, improved houses decrease contact between malaria vectors and humans (Haines et al., 2013; Lindsay et al., 2002) and provide protection to all household members (Lindsay et al., 2002) even in the rapid emergence of insecticide resistance in the vector population (Ranson and Lissenden, 2016). Moreover, the protection from good housing is not limited to malaria, but has role against other vector borne diseases by preventing house entry (Haines et al., 2013; Tusting et al., 2015). Housing intervention contributes to reduce indoor malaria transmission that occurs before sleeping time and hence fill the gaps of LLINs (Durnez and Coosemans, 2013). Therefore, the need for supplemental interventions like housing improvement is needed to strengthen the ongoing control efforts against the disease without adding insecticide pressure (Tusting et al., 2015).

On the other hand, more evidences are needed about the impact of improved housing on malaria incidence, its durability and community acceptance in different epidemiological, socio-economic and cultural settings to integrate with the existing vector control interventions. LLIN is the principal malaria control tool in most urban settings including Arba Minch town in Ethiopia. However, its effectiveness might depend on the susceptibility status and feeding behavior of malaria vectors (Ranson and Lissenden, 2016). IRS was not implemented in the study area, but malaria diagnosis and treatment is free of charge in public health centers. Regardless of all these efforts, the burden of malaria remains high and the existing malaria control strategies are not sufficient to stop transmission and, hence, there is need for supplementary interventions. Improving housing such as screening doors and windows might provide protection by keeping mosquitoes outdoor and reduce indoor human-vector contacts. A previous study in a rural village assessed the impact of doors and windows screening against indoor density of malaria vectors (Massebo and Lindtjørn, 2013). However, more sensitive entomological indicators and malaria incidence

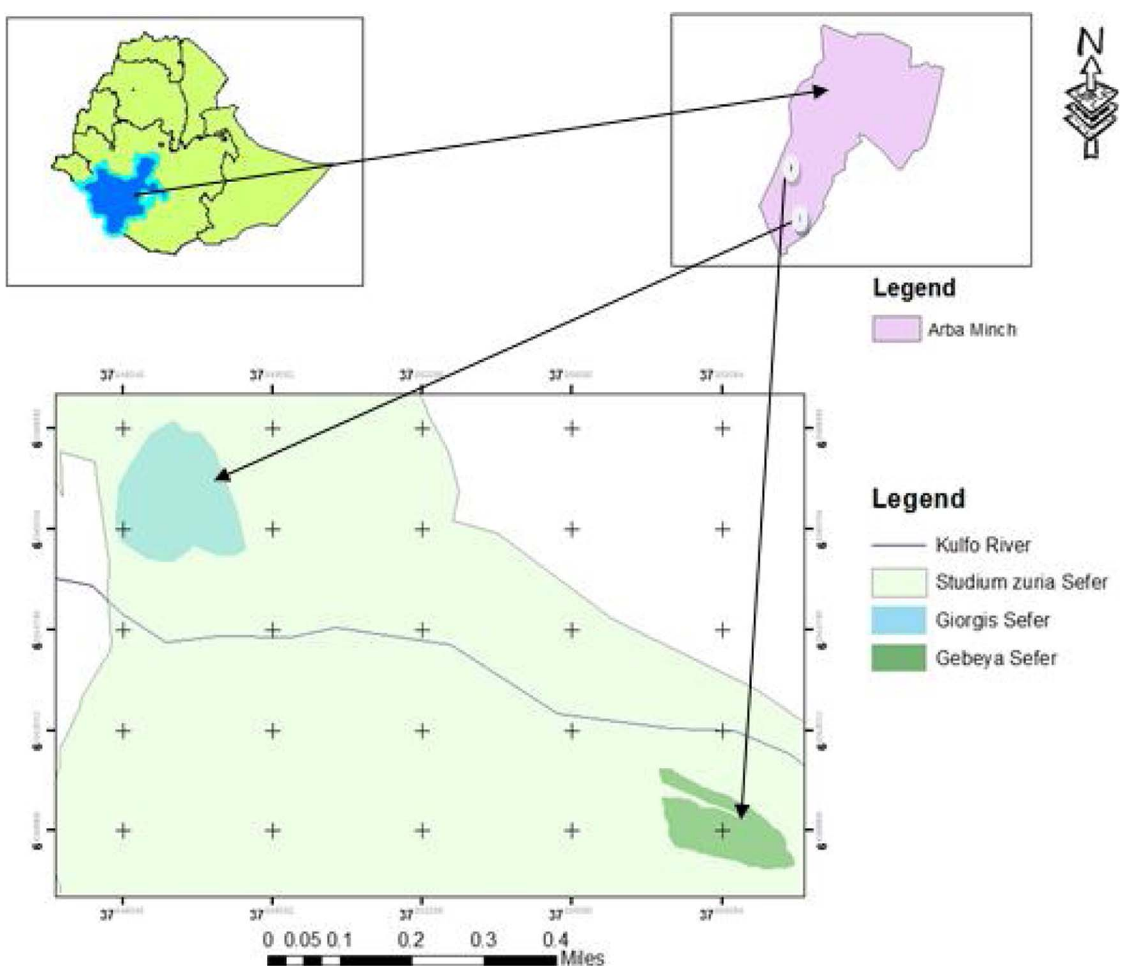

Fig. 1. Location of the study sites in Gebeya Dar and Georges sub-villages in Arba Minch town, south-western Ethiopia.