Effect of housing modification on indoor thermal comfort and malaria

Intervention title: Healthy Housing: Vector proofing and heat adaptation evaluation in malaria endemic regions

Country: Kenya

Intervention summary

Malaria transmitting mosquitoes are adapted to enter and feed indoors, sustaining disease transmission despite decades of use of insecticide treated nets (ITNs). Global warming, which has led to considerable rise in temperatures may make the home environment hostile, leading to low quality of life and increased exposure to malaria transmission due to reduced use of ITNs which are known to increase discomfort in hot environments. We propose simple incremental structural modification of existing houses in a high malaria burden area in western Kenya. The structural modification will include screening of eaves windows and doors to prevent ingress of mosquitoes into human habitations. To lower indoor temperatures and increase the comfort of occupants, a house will be randomized to receive either of the following modifications depending on the housing design. For simple single or two roomed houses without additional internal partitions, screened windows will be created on opposite walls in each room to allow free flow of wind through the home hence causing a cross-breeze. For multiple roomed houses with several internal partitions, cooling will be achieved by either painting the roof with a white reflective coat (cool roof system) to deflect much of the sun's radiations from the house or introducing a false ceiling indoor, hence lowering internal temperatures. Houses with screened eaves, windows, doors and either of the cooling options will be compared against standard house designs for differences in internal temperature, mosquito numbers, and community acceptance.

Evaluation Objectives

1. To assess the indoor cooling effect achieved in a house due to cross breeze ventilation, cool roof system and false ceiling
2. To determine the impact of full house proofing on indoor and outdoor mosquito densities as measured by UV light trap.
3. To determine the most cost-effective approach to house modification for insect proofing and thermal comfort.
4. To assess community knowledge, perception and attitude towards house modification for insect proofing and thermal comfort.

Evaluation procedures

1 **Site**. The evaluation will be conducted in Kadenge village around Yala swamp in Siaya County, western Kenya. The region is a site for high *An. funestus* densities and malaria transmission.

2 **Preliminary activities**

   a. Evaluation will be introduced to the local authorities, area chief, assistant chief, village elder and other opinion leaders within the evaluation community,
   b. Door to door mobilization will be conducted for individual members of the community. A verbal consent will be obtained from the household head to enable enumeration of structures within the village and collection data relating to housing design including wall type, roof type, number of windows, number of doors, presence of eaves and number of people within the housee,
   c. Resulting data will be used to identify 60 houses that would be used in the evaluation. Houses will be selected based on structural design and grouped into the following three categories:
      i. first - 10 single or double roomed houses for modification of windows for cross-breeze and doors and eaves for insect proofing,
      ii. second- 10 3-roomed houses that will receive painted roof for cooling plus screened doors, windows and eaves for vector proofing, and
      iii. third -10 3-roomed houses that will receive false ceiling for cooling in addition to screening of windows, door, and eaves for insect proofing.

The cooling option in each category plus insect proofing will be considered as an intervention set. In each category, half of the houses will be randomized to receive the set of intervention while the remaining half will be held as control and will not be screened throughout the evaluation.

d. After selection of the 60 houses by category, a written consent will be obtained from each household head detailing possible allocations to either control or intervention arms and the various intervention categories. Potential risks and benefits of participation in the evaluation will be explained to the household head for informed decision making

3 House modifications

Specific house characteristics including size of each house, size of the doors and windows will be collected to provide guidance for modification. Modifications will be conducted by an external housing contractor as follows,

a. ***Cross ventilation and insect proof housing*** - Cross ventilation with air cavities will be used in small houses with single or double rooms with possibility of creating windows on opposite sides of the wall. We will introduce air cavities in window spaces for insect proofing and cooling. The existing windows will be replaced with new windows with air cavities of appropriate size relative to room size, placed in opposite walls to achieve cross breeze. The eaves will be blocked with insect mesh and the door modified by introducing a screen frame opening outwards on the door of the structure,
b. ***Cool roof system and insect proof housing*** - Cool roofs will be used for houses with multiple internal rooms. Iron roofed houses will be painted with a reflective coat to reduce the amount of heat conducted into the house, hence lowering internal temperatures. Insect proofing will be achieved by blocking eaves with an insect mesh and introducing mesh in existing window and door spaces,
c. ***False ceiling and insect proof housing*** - False ceiling will also be used for houses with multiple internal rooms. Fabricated false ceiling will be introduced in the entire roof space to reduce internal temperatures. Insect proofing will be achieved by blocking the eaves with an insect mesh and introduction of mesh in the existing window and door spaces

4 **Data collection**

Daily temperature and humidity will be collected in both intervention and non-intervention (control) houses for a period of **three months** using data loggers. Data will be downloaded from the data loggers fortnightly. Temperature and humidity data will be analysed and compared between intervention and control houses to assess the level of cooling attained due to the modifications. Further comparison will be conducted between different house cooling strategies.

a. Mosquitoes will be collected indoor and outdoor using UV light traps from all the screened and unscreened houses once every two weeks. Indoor light traps will be installed in the sleeping area near an occupied bednet while the outdoor trap will be within 5 meters from the wall of each house. Collected mosquitoes will be counted per house per trap and identified to species using morphological features and by polymerase chain reaction (PCR) technique. Mean mosquito numbers per trapping night will be compared between intervention and non-intervention houses.
b. A structured questionnaire will be administered to each household head to assess knowledge, perception and attitude towards house modification for insect proofing and thermal comfort. The questionnaire will be administered before house modification and three months after modification,
c. Costs incurred in implementation of different house modification approaches will be tracked and compared between the different sets of intervention strategies.

Expected application of results.

Results from this evaluation will be useful in determining house modification approaches for thermal comfort and malaria reduction. The results will be critical in building evidence on house

modification for disease control and mitigation against effects of global warming. This is besides generating key data on the costs effectiveness and affordability of the solutions to low income households.

Evaluation Team:
Habitat for Humanity will lead this project working with a team from the Kenya Medical Research Institute and Research Word in the implementation this evaluation: Bernard Abong'o[1,2], Eric Ochomo[1,2], Daniel Kwaro[1] - [1]*Kenya Medical Research Institute, Centre for Global health Research, Kisumu, Kenya,* [2]*Research World, Kisumu, Kenya*

Duration
The intervention will be implemented between Nov 2022 - and April 2023

Budget

Budget Item	Amount ($)
Construction Practices Expert	$3,500
Travel	$1,000
Professional Services	$25,500
Sub total	***$30,000***
HFHI-Indirect Cost	$3,708
Total Budget	**$33,708**