PMI UGANDA HOUSING MODIFICATION STUDY (HMS): Lessons from a field trial in Eastern Uganda

RBM Multi-Sectoral Working Group Meeting

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Infectious Diseases Research Collaboration

Background

- After considerable investments, malaria burden remains high in Uganda and across Africa
- Evidence of the impact of house construction on malaria risk is growing, but housing modification remains underutilized in most endemic areas
  - *(Kirby 2009, Tustin 2015, Wanzirah 2015, Tustin 2016, Rek 2018)*
- **Only 2 randomized trials have evaluated the impact of housing modifications on epidemiological outcomes** (3rd one just beginning – eave tubes alone in Cote d'Ivoire):
  - **The Gambia trial (Kirby et al. 2009: Covering doors and windows with netting; screening ceilings and blocking eaves)**
    - Found that housing modifications reduced anaemia in children by 48%
  - **The Cote d'Ivoire trial (Sternberg et al. 2018 & 2021: eave tubes plus screening)**
    - Found a reduction of 38% in malaria incidence, 44% in malaria prevalence, 30% in anemia

Research question

Can housing modifications (combined with PBO LLINs) reduce the malaria burden in Uganda?

Study design, objectives & methods

Study Design

- Cluster randomized trial; 60 clusters – 20 per arm; 25 Households per cluster (1500 in total)

Primary objective

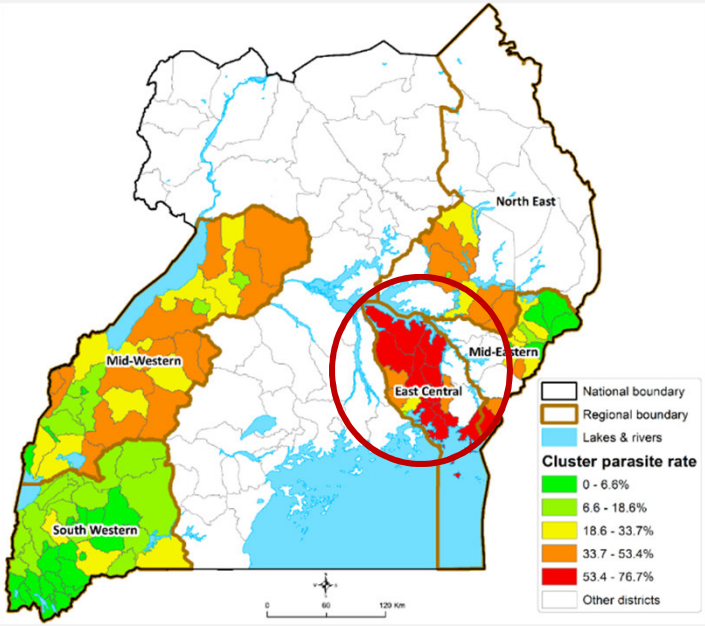
- To evaluate the effect of housing modifications plus PBO LLINs, compared to PBO LLINs alone, on the incidence of clinical malaria in Ugandan children aged <5 years
  - *Cohort study; enroll all children <5yrs from 1500 households (500 per arm) + 5 clinics for all sick visits*
  - *Data analysis ongoing*

Secondary objectives

- To assess the effect on parasite prevalence and anemia *(serial cross-sectional surveys; 1500 HHs per survey)*
- To assess the effect on vector density, EIR & other entomologic outcomes (*CDC light trap collections in cohort*)
- To assess the cost-effectiveness of housing modifications (*through cost-effectiveness analysis*)
- To evaluate the sustainability of the modifications (*feasibility, process evaluation & contextual factors*)
- To assess the acceptability of the modifications (*qualitative study; FGDs, KIIs, IDIs*)

Study site

General study area

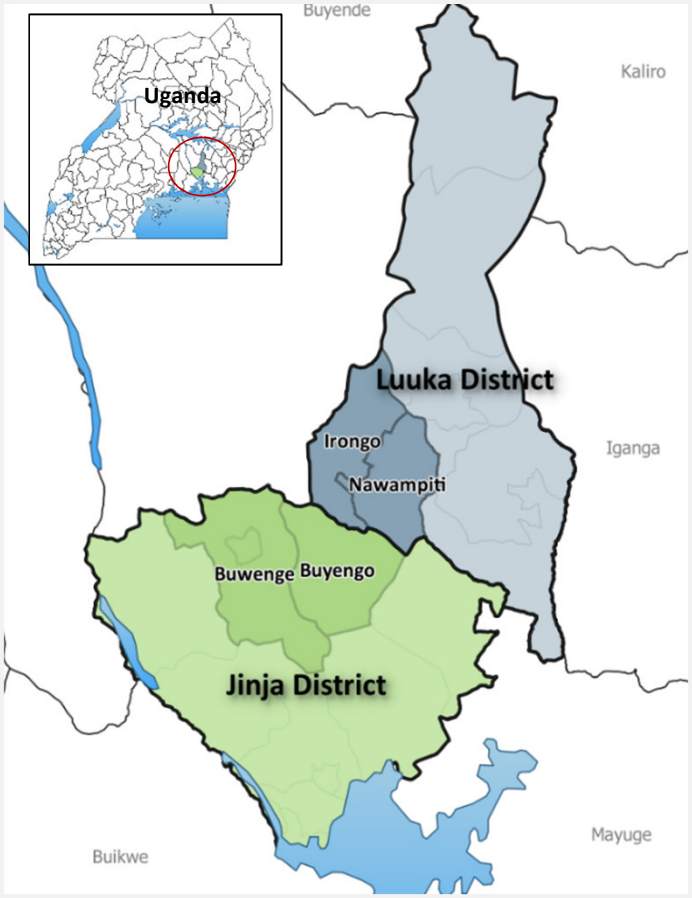


Study site: East Central Region of Uganda

Selection criteria

1. No ongoing or planned IRS
2. High parasite prevalence (> 35% in children)
3. Presence of pyrethroid resistance
4. Willingness of district health leadership to take part
5. Stable health infrastructure (well-staffed, functional Health Centres [HC] III and IV)

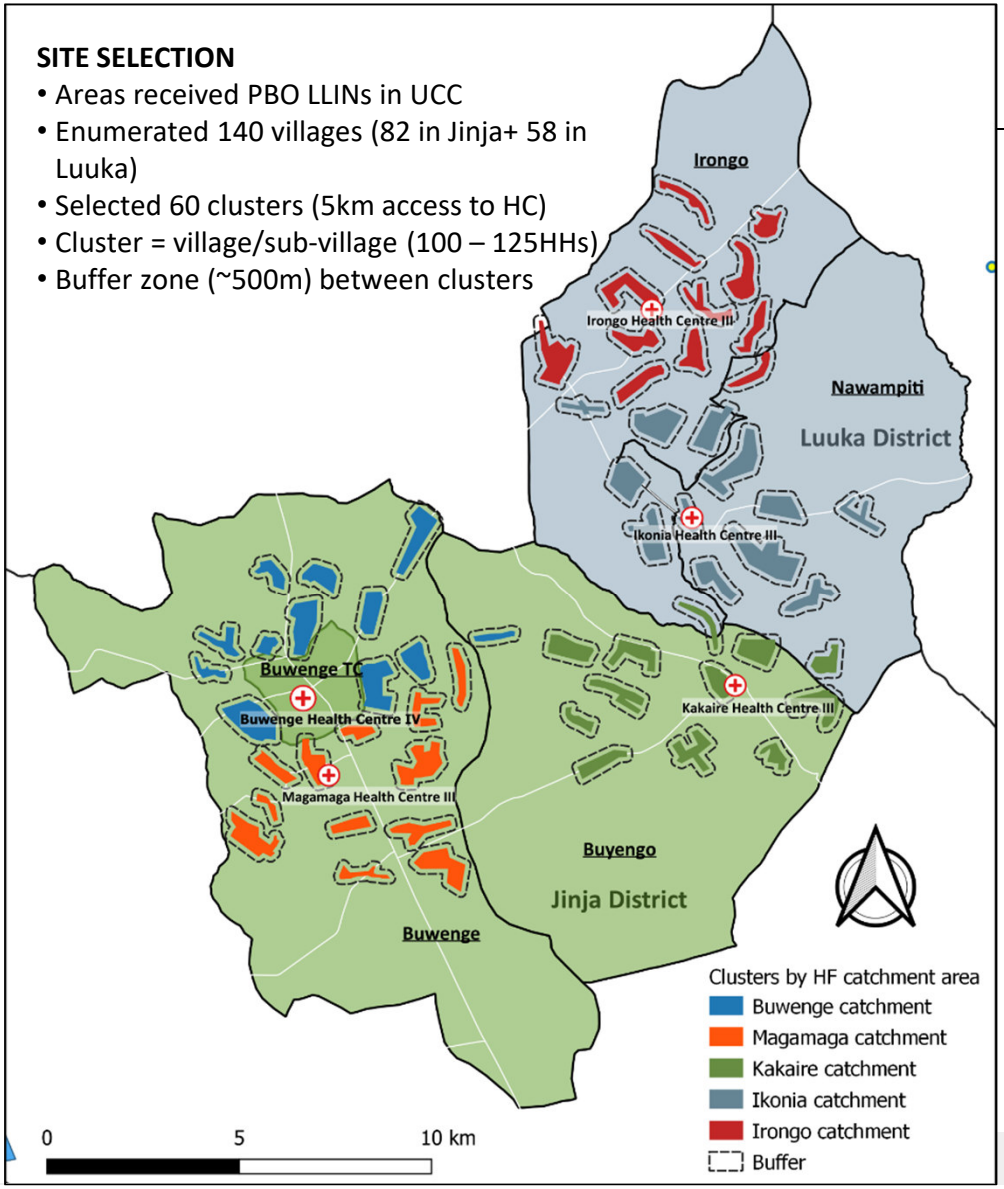
Study site–4 sub-counties in Jinja and Luuka Districts



Trial Sites: Jinja – Luuka (60 clusters)

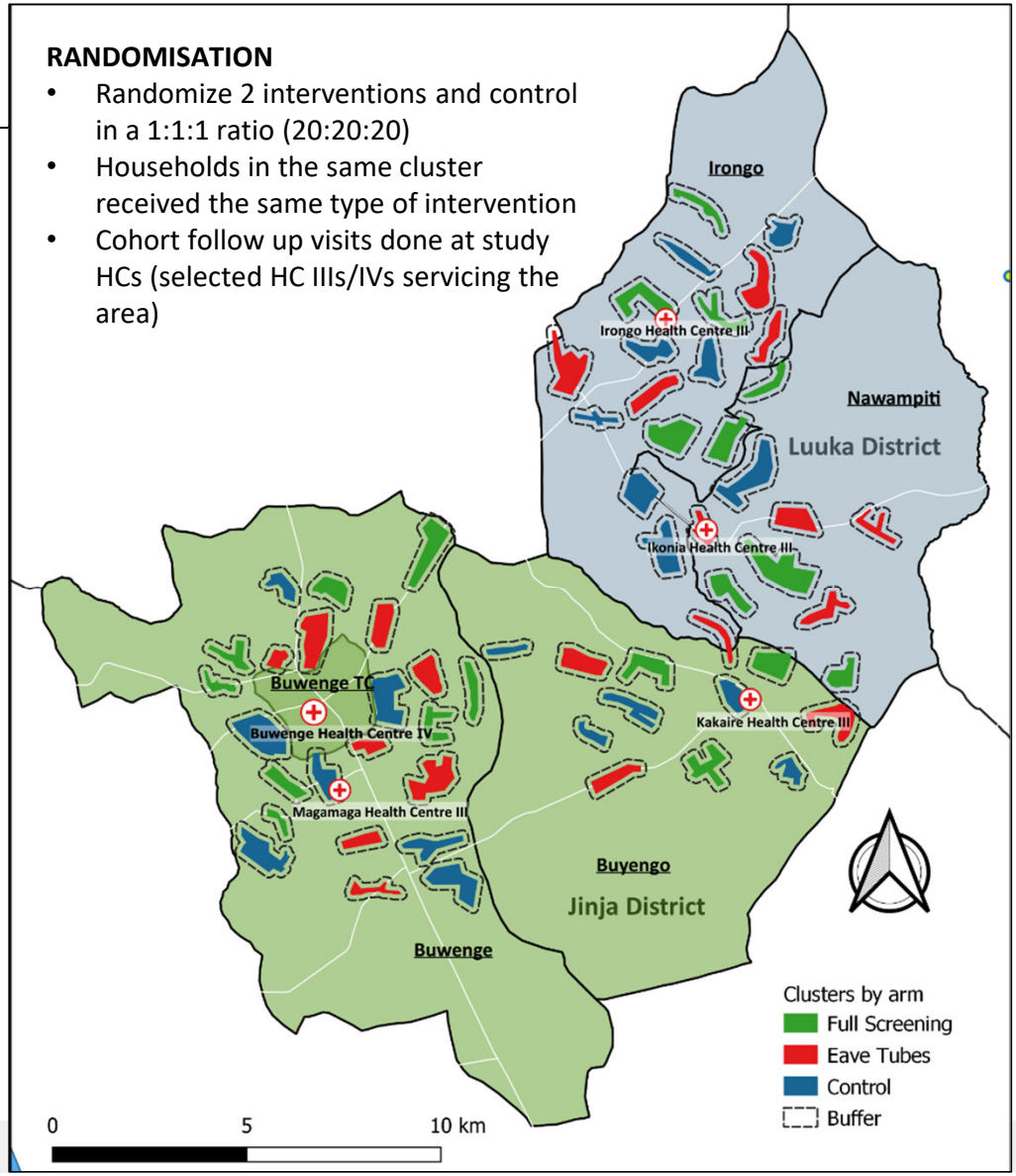
SITE SELECTION

- Areas received PBO LLINs in UCC
- Enumerated 140 villages (82 in Jinja+ 58 in Luuka)
- Selected 60 clusters (5km access to HC)
- Cluster = village/sub-village (100 – 125HHs)
- Buffer zone (~500m) between clusters



RANDOMISATION

- Randomize 2 interventions and control in a 1:1:1 ratio (20:20:20)
- Households in the same cluster received the same type of intervention
- Cohort follow up visits done at study HCs (selected HC IIIs/IVs servicing the area)



Interventions

Full house screening

- Screened eaves (if eaves are open), ventilation openings, and windows with wire mesh fixed on wooden frames
- Sealed any open gaps in the walls (e.g., around doorframes) with cement or mud depending on the individual house original material
- We did not screen the doors (literature; durability, left open)

Eave tubes

- PVC tubes installed in the rooms used by HH members either
  - in the outer wall using a specialized drill or chisel and hammer at 1.5-2 m
  - or fixed behind ventilation bricks
- Fitted with removable electrostatic mesh inserts coated with deltamethrin
- Eaves are sealed using material similar to that used to construct the house

RESULTS & LESSONS

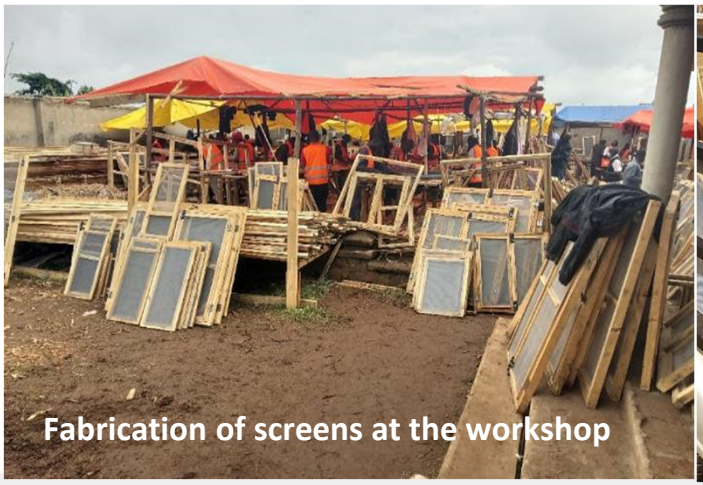
Stakeholder and community engagement

- MOH & NMCD engaged through in-person and online meetings
- District & sub-county level sensitization before the trial + field visits during the trial
- Continuous community engagement
  - LCI chairpersons, VHTs, opinion leaders, village meetings with community members
  - Meetings with health facility staffs at the five public health facilities, site support
  - Household level individual consent before any study procedures were conducted



Full Screening

- Installation of full screening started on December 6, 2021 and run for over 4 months period
- Activities included:
  - Taking and recording measurements at the household
  - Fabrication of frames and fixing mesh at the workshop
  - Sorting of screens by the household IDs
  - Sets of screens dispatched to the households for installation


Fabrication of screens at the workshop


reens sorted by HHID for delivery


Full screening modified house

Eave Tubes

- Installation of eave tubes started on March 2, 2022 and ended on April 25, 2022 (1970 houses total)
- Activities included drilling boards, cutting of pipes, drilling of walls and working around the inserted pipes


Drilling boards

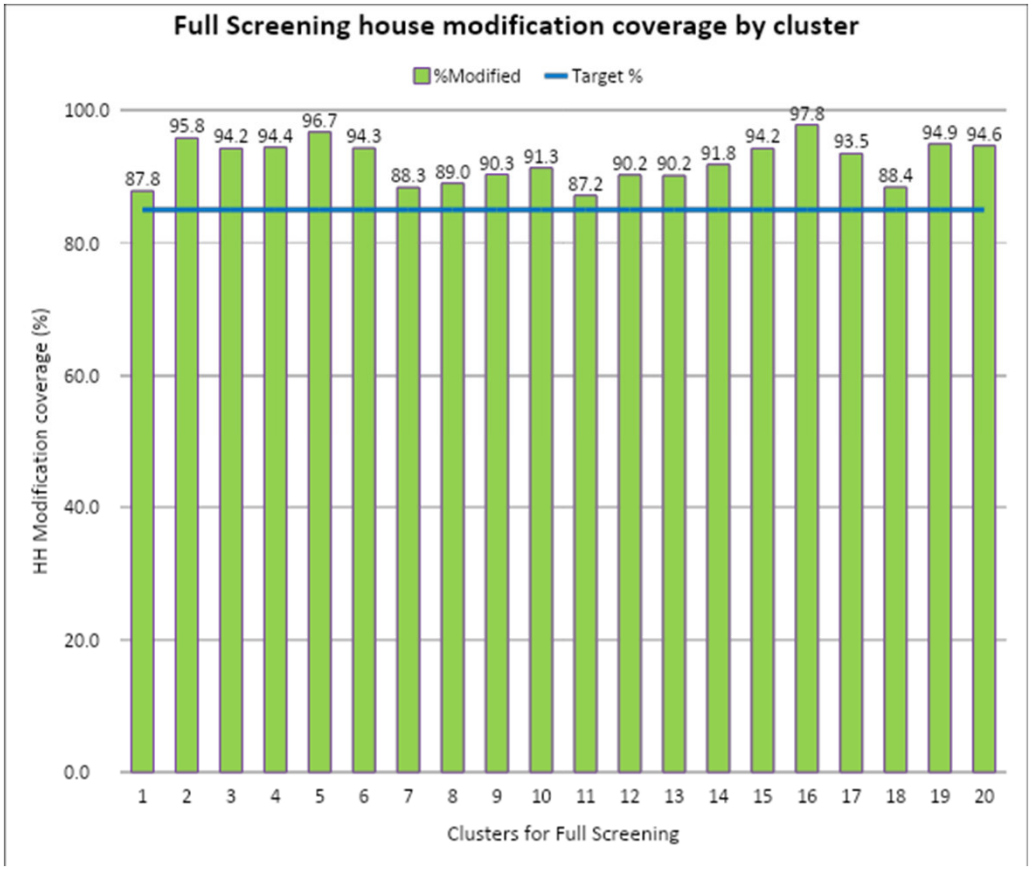

Cutting PVC pipes


Eave tubes installed with a drill

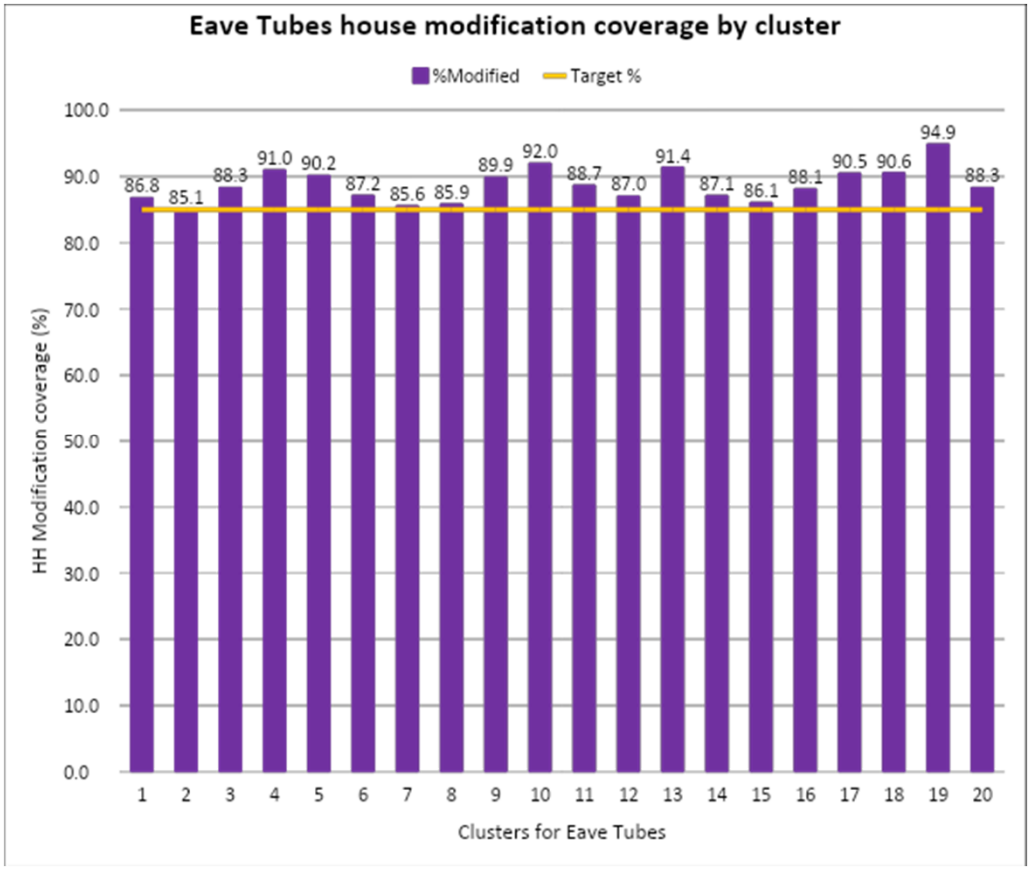

Eave tubes installed behind the vent

Intervention Coverage

Full screening overall coverage: 92.2%; refusals – 1.6%



Eave tubes overall coverage: 88.3%; refusals - 4.1%



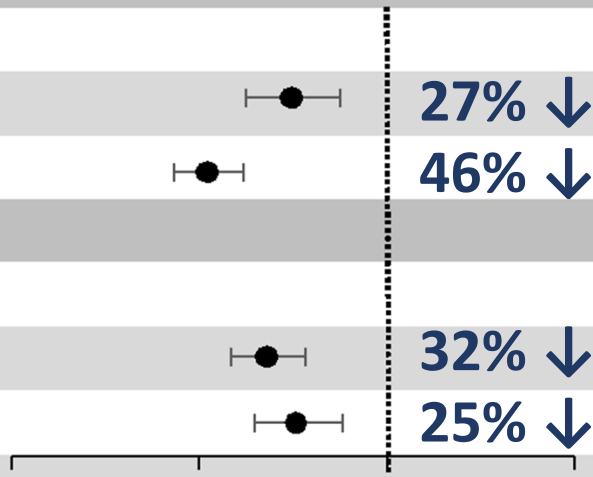
House modifications were well received with a target coverage of 85% surpassed in all 40 clusters

Entomology (light traps): Vector density ratio by arm

(negative binomial regression for repeated observations)

Model: Including baseline, time as categorical

	DR (95%CI)*	p value	
An. gambiae			
Intervention arm			
Full screening	0.73 (0.63; 0.85)	<0.001	27% ↓
Eave tubes	0.54 (0.46; 0.62)	<0.001	46% ↓
An. funestus			
Intervention arm			
Full screening	0.68 (0.59 0.78)	<0.001	32% ↓
Eave tubes	0.75 (0.65; 0.88)	<0.001	25% ↓



**Adjusted for time and clustering*

Installation Costs per Household, 2022 USD

Cost Category	Economic Costs	
	Full Screening	Eave Tubes
Labor	48.83	11.88
Workshop / Storage	1.98	0.57
Training	0.06	0.09
Community Sensitization	0.72	0.71
Local Transportation	9.58	3.41
International transport/fees	-	4.35
Supplies & materials*	9.85	14.18
Equipment	0.59	4.84
Household Contribution	0.16	0.22
TOTAL (provider perspective)	**71.61**	**40.02**
TOTAL (societal perspective)	**71.77**	**40.24**

*Note: Not including COVID PPE costs: $ 0.81 per household (FS); $0.24 per household (ET)

Cost comparisons with other vector control interventions

Malaria control strategy	Cost per person protected year 2022 USD (range)
Insecticide treated bed nets	1.39 (1.09-11.83)
Indoor residual spraying	5.70 (2.75-15.93)
Screening	3.35 (2.61-4.79)
Eave Tubes	2.42 (2.06-3.10)

Sources:
Conteh L, Shuford K, Agboraw E, Kont M, Kolaczinski J, Patouillard E. Costs and Cost-Effectiveness of Malaria Control Interventions: A Systematic Literature Review. *Value Heal* 2021; **0**. DOI:10.1016/j.jval.2021.01.013.
White MT, Conteh L, Cibulskis R, Ghani AC. Costs and cost-effectiveness of malaria control interventions - A systematic review. *Malar J* 2011; **10**: 1–14.

Summary and conclusions

- We found that both housing modification interventions (full screening and eave tubes)
  - are **feasible** to scale up,
  - are **acceptable** to the community,
  - have **significant impact** on **mosquito density**, and
  - are **comparable in cost per person protected** over the long term to other malaria prevention interventions.

- Our results suggest that prioritizing low SES houses (given their lower cost to modify) may reduce inequity in both disease and cost burden of malaria, and have vertical equity impacts.

- Engagement with PMI, MoH, NMCD, District and local leadership was crucial to the success of the project and acceptance of both the project and the housing modifications by the community.

Many thanks to:

- USAID
- US President's Malaria Initiative
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- Ugandan Ministry of Health
- Project Investigators & Institutions
- HMS & EES Field Teams
- IDRC administration
- District leaders
- Local communities
- All participants

USAID
FROM THE AMERICAN PEOPLE

U.S. PRESIDENT'S MALARIA INITIATIVE

CDC
CENTERS FOR DISEASE CONTROL AND PREVENTION

THE REPUBLIC OF UGANDA
MINISTRY OF HEALTH

IDRC
INFECTIOUS DISEASES RESEARCH COLLABORATION