Human behavior and exposure to mosquitos

Neil F. Lobo

Using data to inform optimal selection of core interventions

February, 2022

VCWG, Ghana

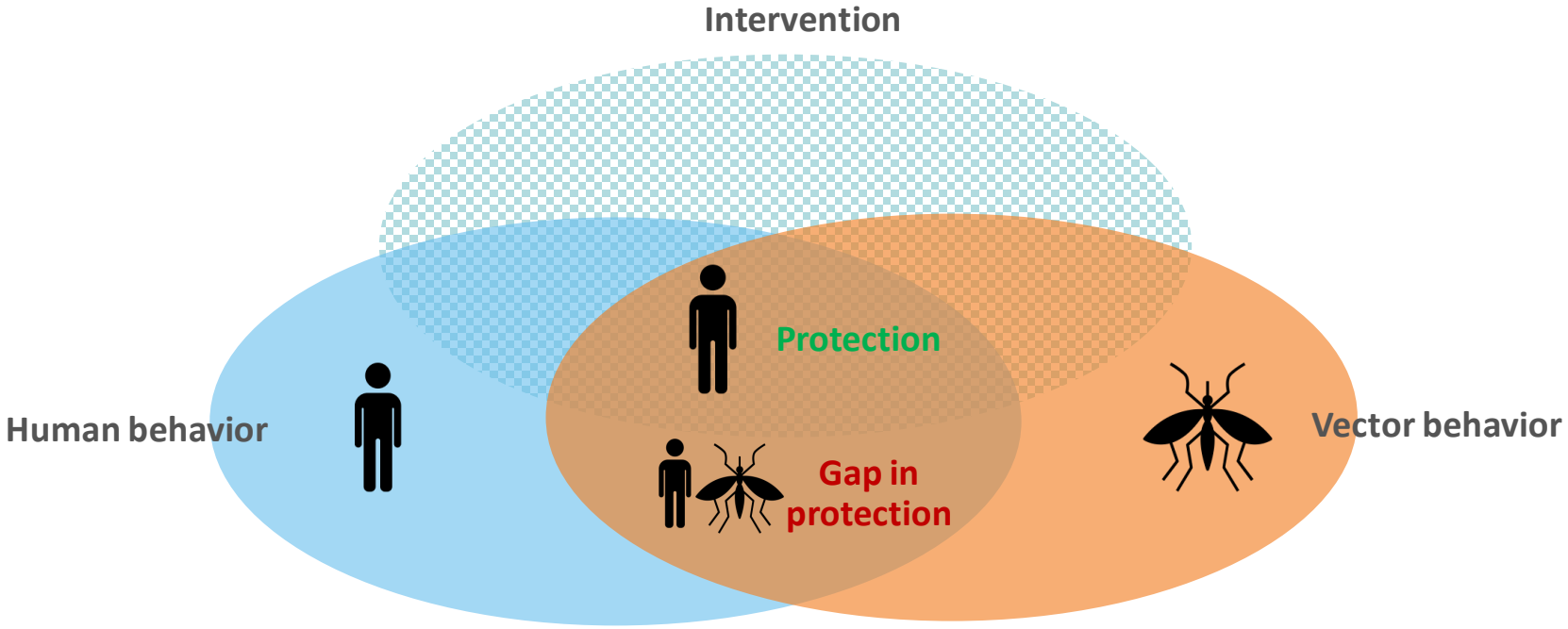
Concept

- Interventions work based on their overlap with vector behavior
- Human behavior is super important (and oft ignored) in exposure
- Key considerations are
  - When and where are humans and vectors (behaviors) overlapping –> exposure
  - What are these human activities?
  - How do these behaviors impact intervention usage / functionality?

Garrett-Jones C: A method for estimating the man-biting rate. World Health Organization; 1964.
Monroe A, et. al. Malar J. 2020 Jun 16;19(1):207. Methods and indicators for measuring patterns of human exposure to malaria vectors.

Integrating **vector** and **human behavior** data to identify **gaps in protection**

- Vector control interventions target specific vector behaviors.
- Interventions protect humans from mosquito bites when human behavior and the vector behavior targeted by the intervention overlap.



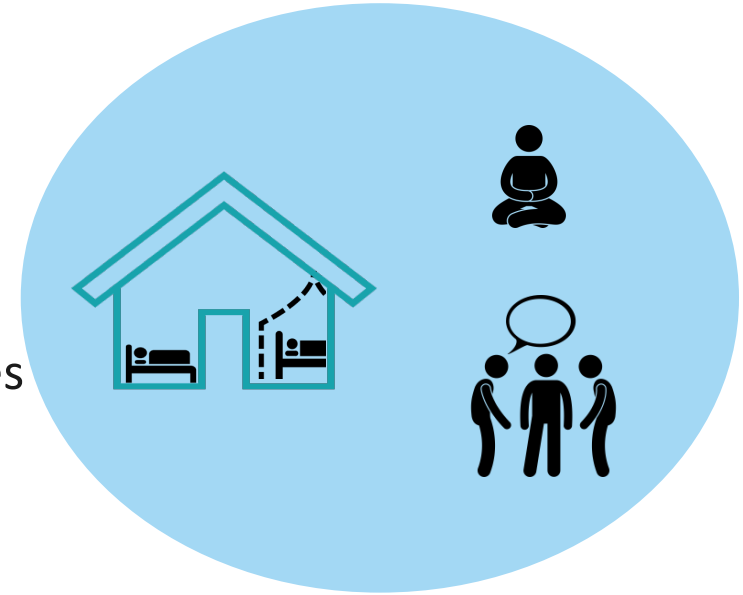
Integration of **vector** and **human behavior** data

Vector biting data analyzed *with* human behavior data, we obtain the adjusted HBR.

→ The **adjusted HBR** is the **HBR for each activity**.

→ The adjusted HBR **quantifies protection** and **gaps in protection.**

Proportions of people doing specific activities



HBR: vector biting behavior inside/outside

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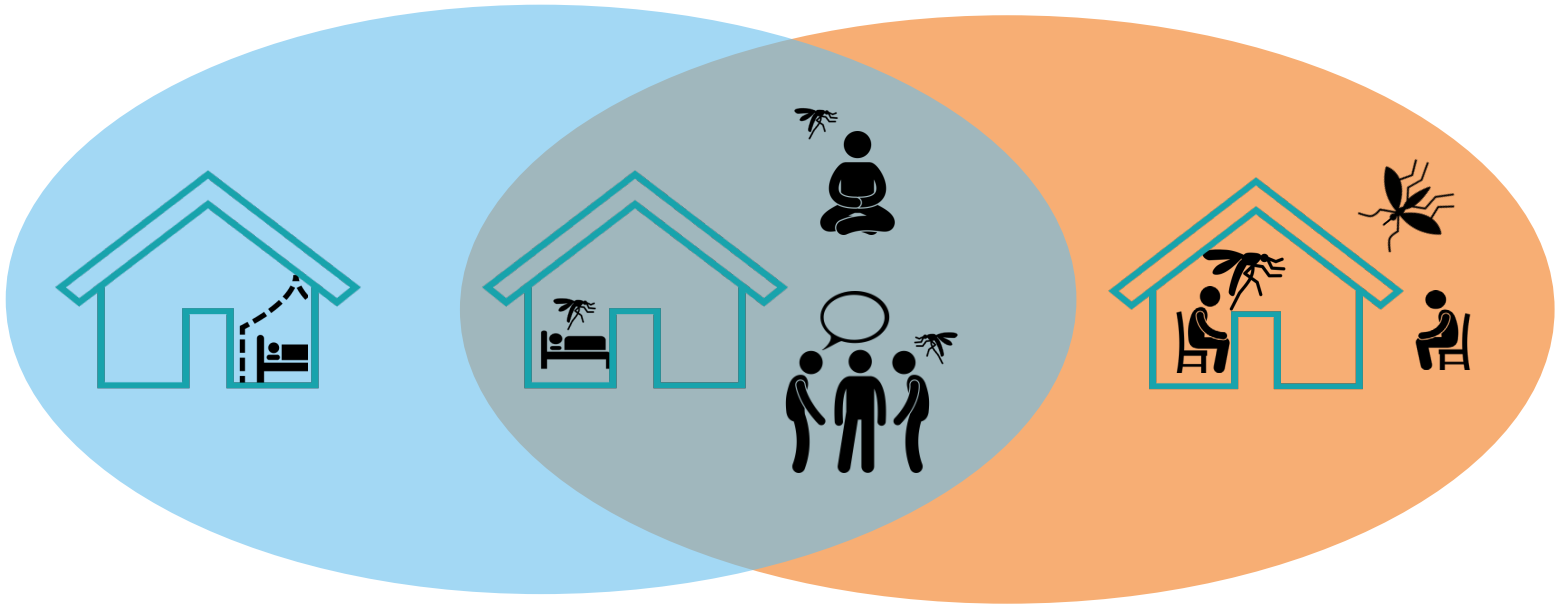
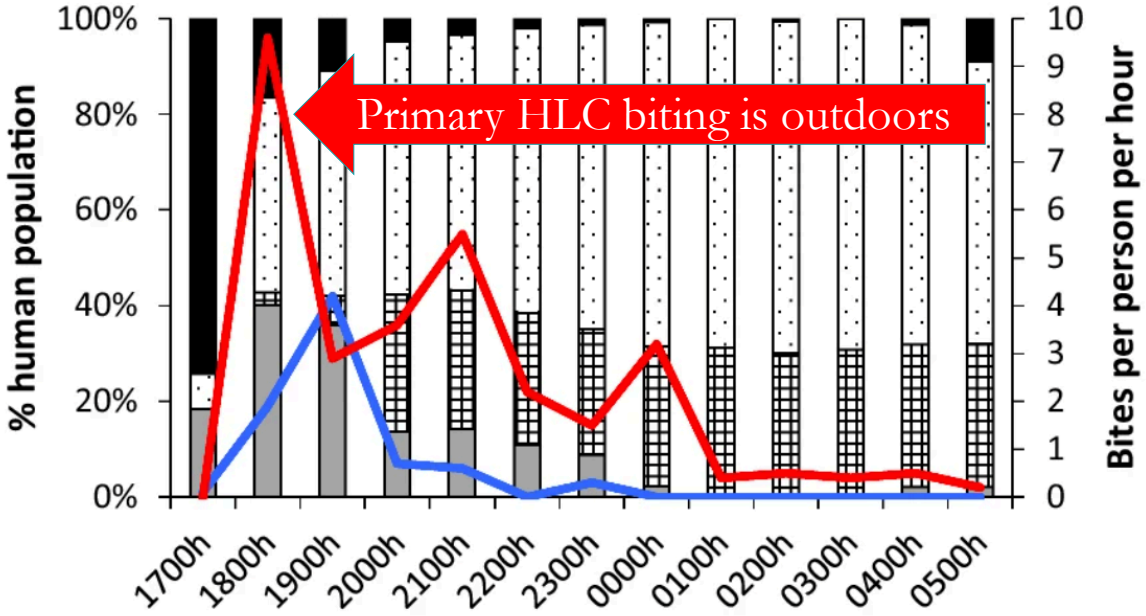


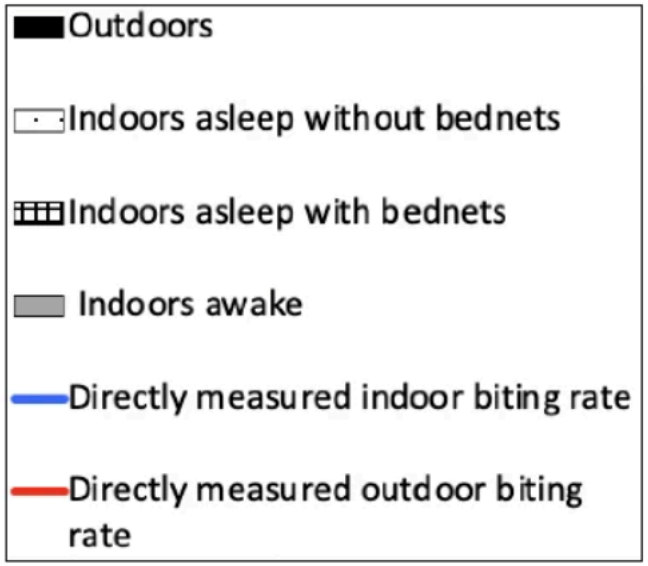
HBR: vector biting behavior inside/outside

Adjusted HBR

Panama – Quantified spatial and temporal exposure resulted in reduced exposure

Elodie Vajda





c. Proportion of human population observed sleeping or awake, inside or outside, under or not under an LLIN, superimposed with *Anopheles* hourly HBR in Permé (Aug 2019)

Ávila MI, et. al. Malar J. 2021 Nov. Entomological Surveillance Planning Tool -generated actionable evidence on human and vector behaviours optimizes present interventions and reduces exposure to Anopheles vectors in two communities of Guna Yala, Panamá. 24;20(1):443.

Panama – Quantified spatial and temporal exposure resulted in reduced exposure

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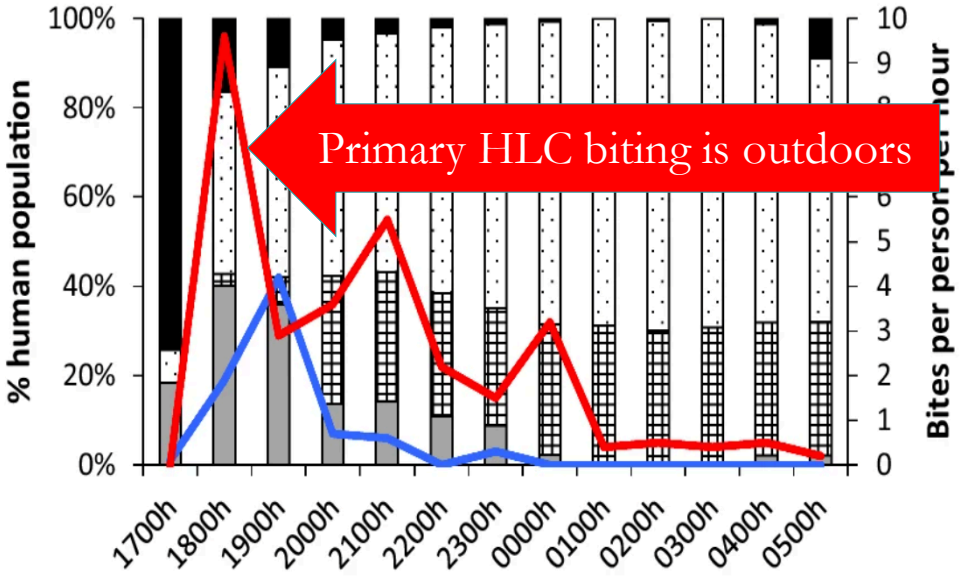

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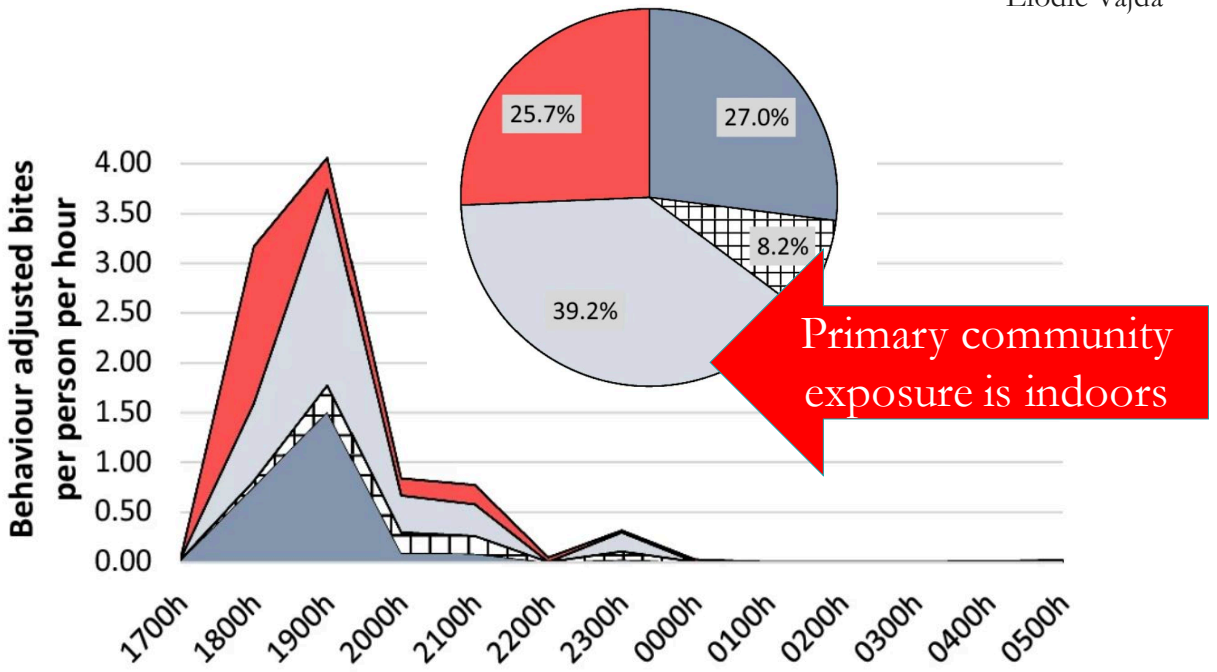

Hourly **HBO-adjusted HBR** from 1800-0600h to account for human presence and LLIN use

- Behavior adjusted bites occurring outdoors
- Behavior adjusted bites occurring Indoors while asleep
- ⊥ Bites prevented by using an LLIN
- Behavior adjusted bites occurring Indoors while awake

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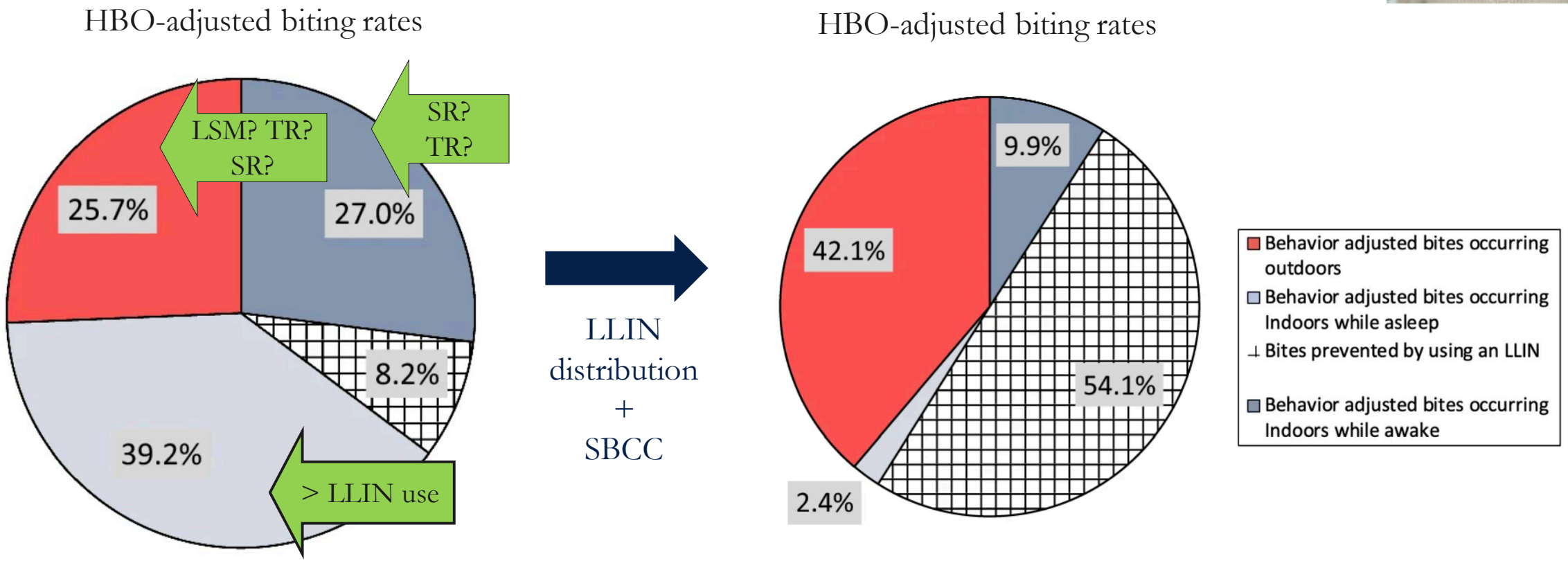
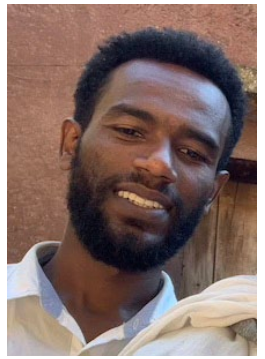
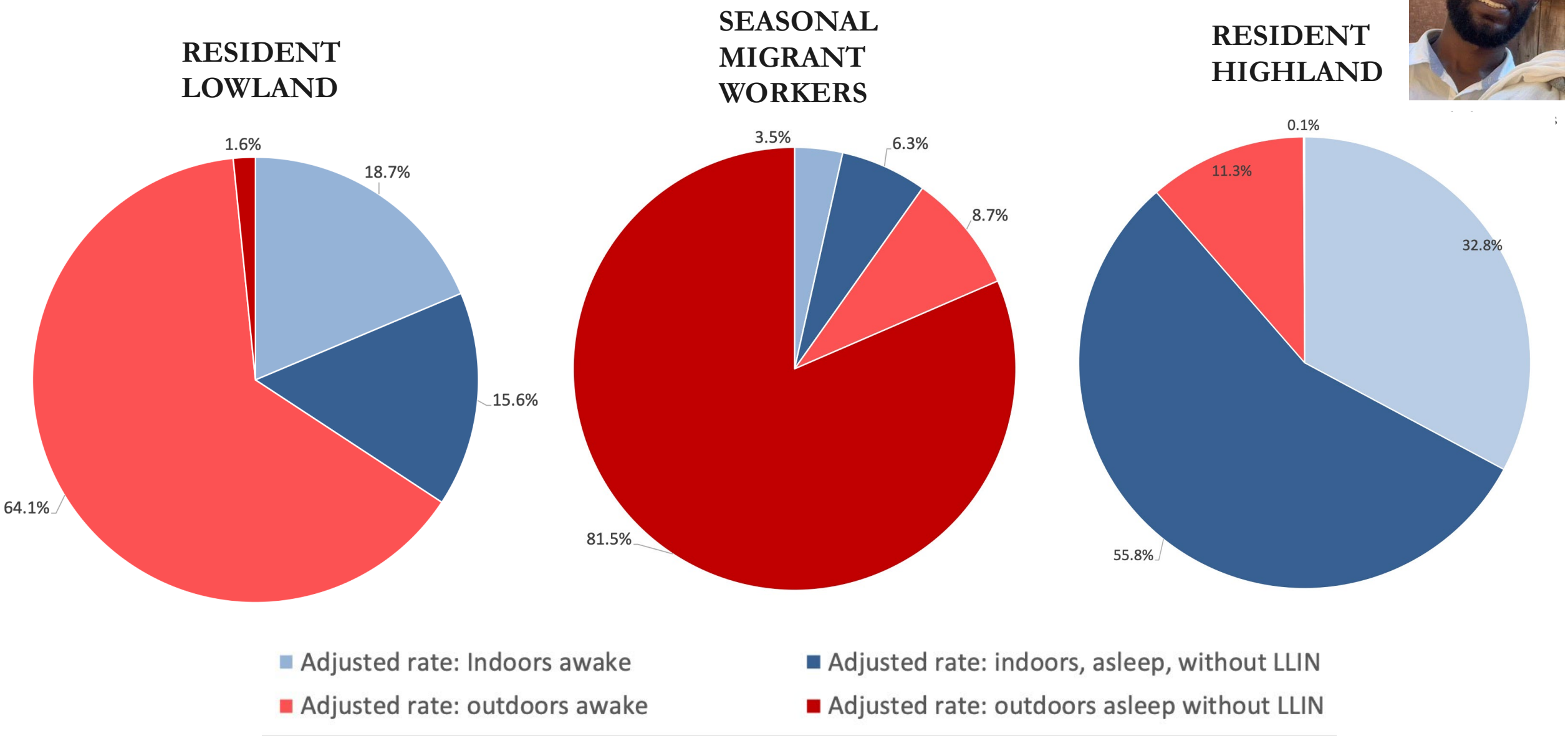


LSM: Larval Source management; SR: Spatial Repellants; TR: Topical Repellants

Ávila MI, et. al. Malar J. 2021 Nov. Entomological Surveillance Planning Tool -generated actionable evidence on human and vector behaviours optimizes present interventions and reduces exposure to Anopheles vectors in two communities of Guna Yala, Panamá. 24;20(1):443.

Ethiopia: Lowlands vs. highlands / Resident vs. Migrant exposure





Indonesia – Human behavior analysis demonstrated protections by spatial repellents

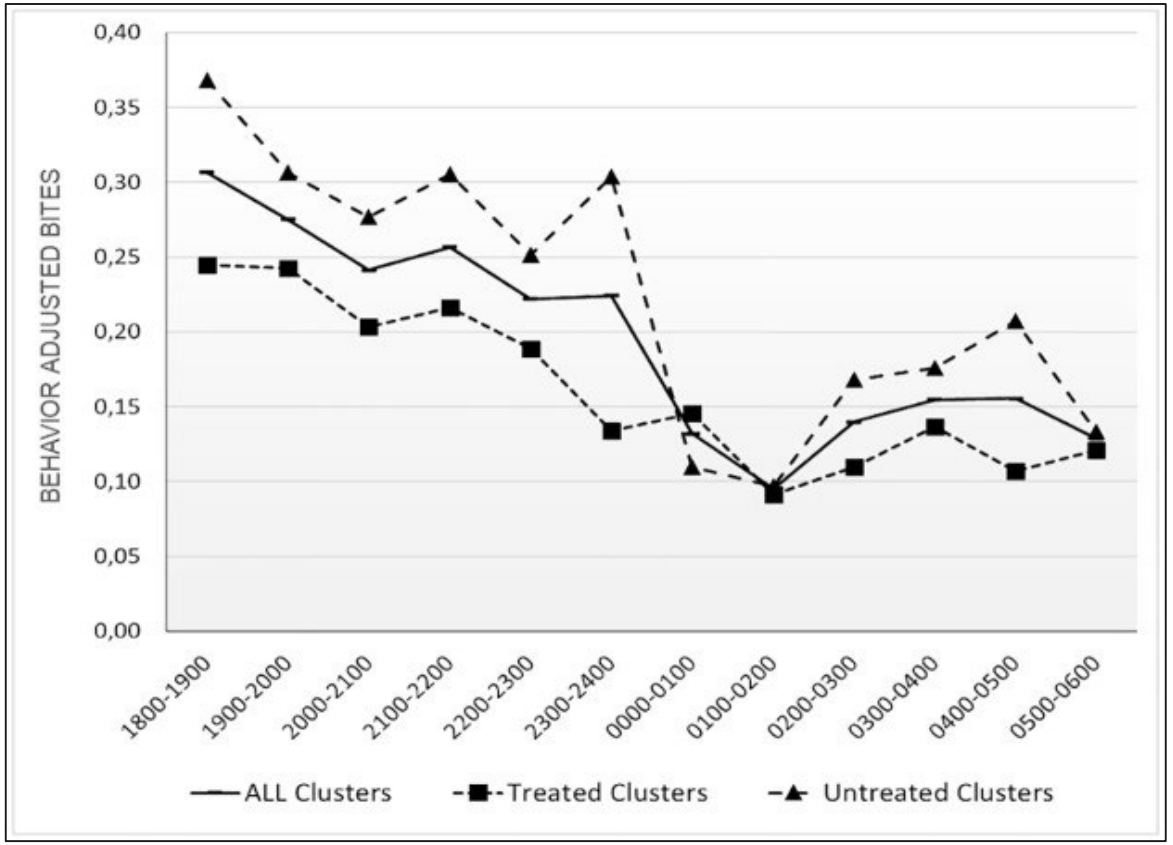
I. Ekoprayitno Rozi

Primary trial:

- **16%** reduction in vector landing resulted in a **60%** protective efficacy (in cohort of <5yo)

Secondary analysis:

- Vector landing rates were analyzed alongside HBOs (community wide)
- There was a **28% reduction in the human behavior adjusted landing rates** in intervention versus control clusters

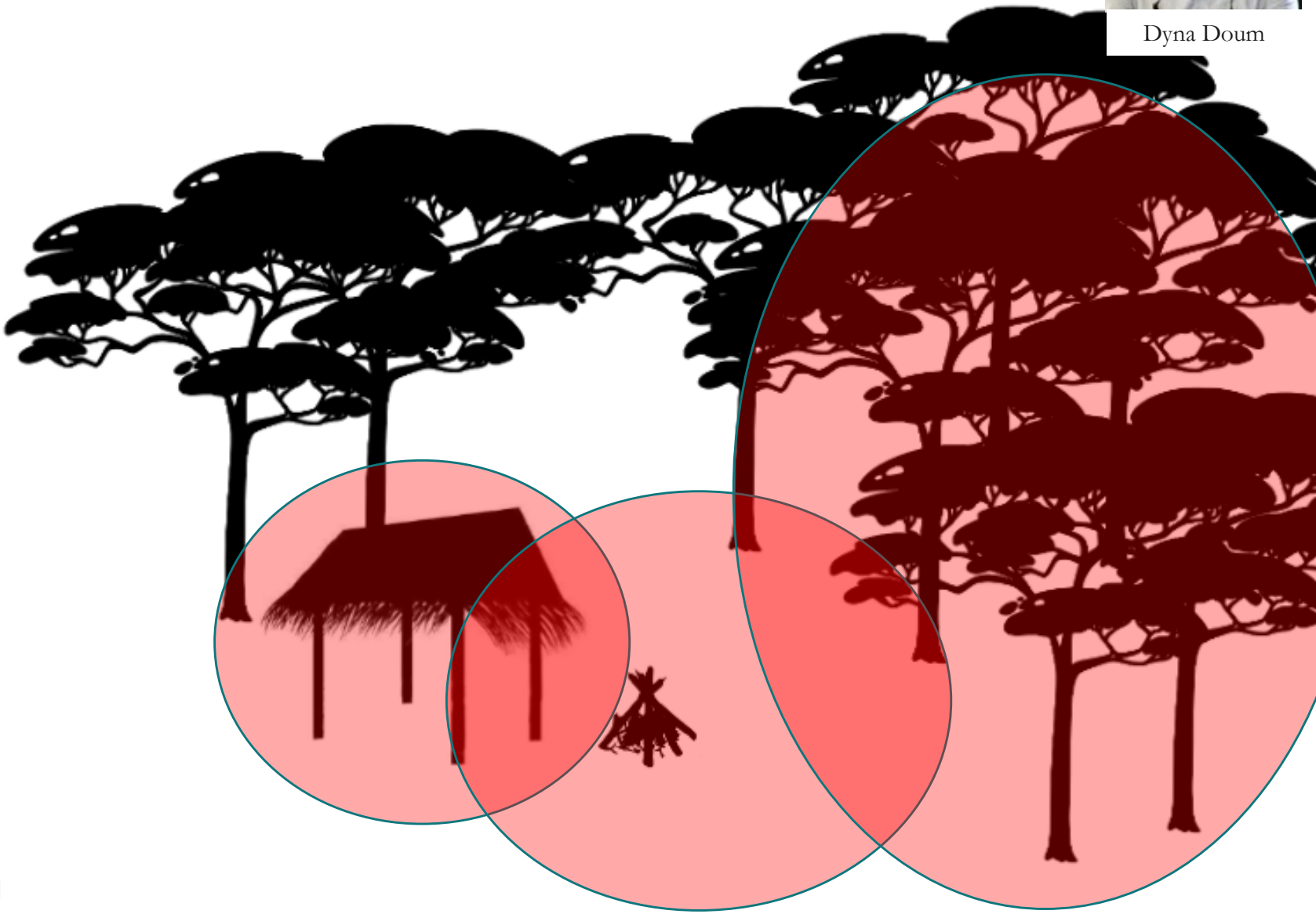


- Syafruddin D, et. al.. Am J Trop Med Hyg. 2020 Jul;103(1):344-358. Efficacy of a Spatial Repellent for Control of Malaria in Indonesia: A Cluster-Randomized Controlled Trial.
- Rozi IE, et. al. PLoS One. 2022 Nov 14;17(11). Human behavior determinants of exposure to Anopheles vectors of malaria in Sumba, Indonesia.

Cambodia – Multiple intervention paradigms - Forest packs that addresses all spatial and temporal exposure

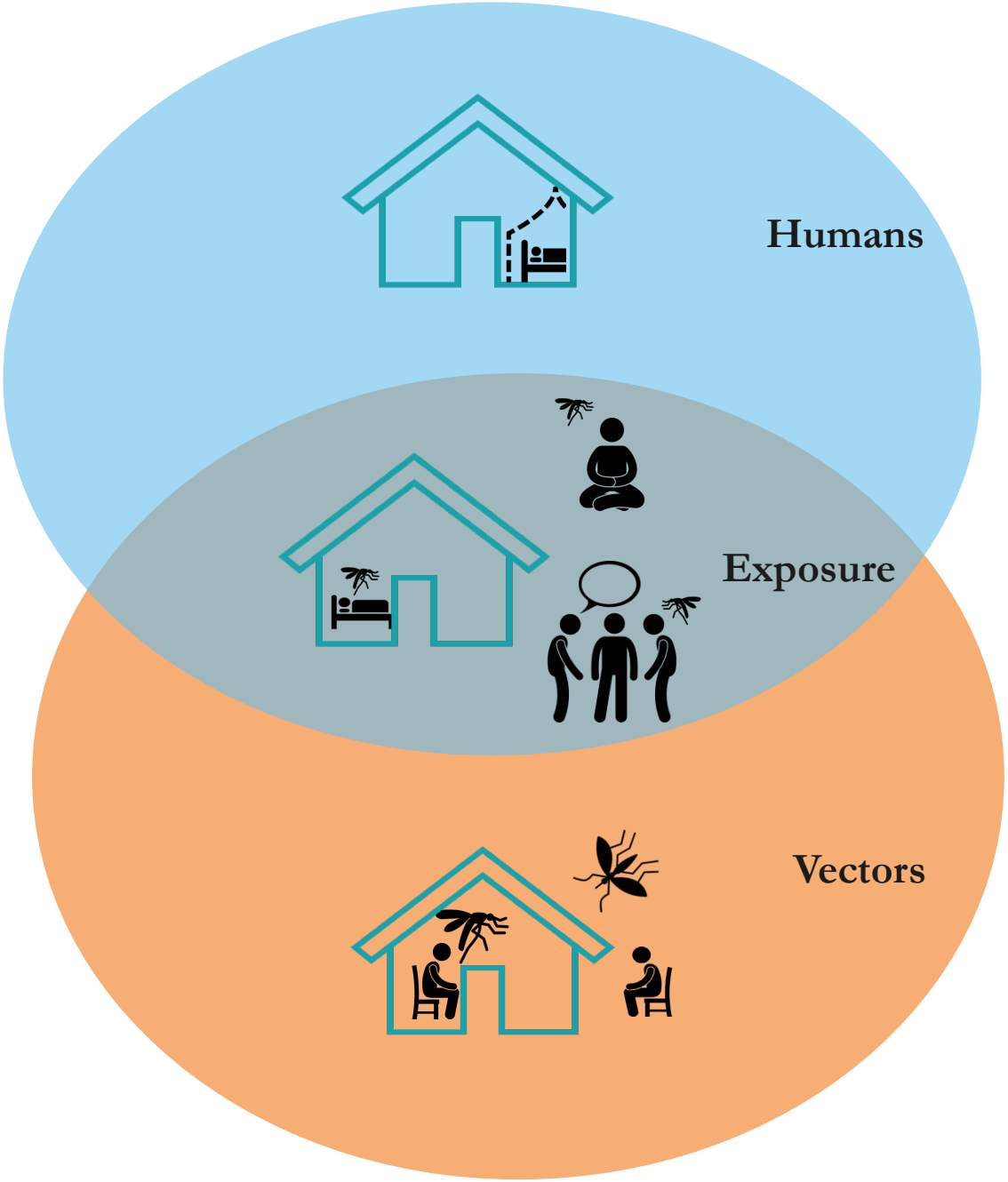
Dyna Doum

Exposure space and activity	Intervention type
Temporary structure (sleeping, resting)	- Passive Volatile Pyrethroid Spatial Repellent (VPSR) - Spatial Repellent spray - Treated clothing - Topical repellent
Outside temporary structure (eating, resting, work)	- Passive VPSR - Spatial Repellent spray - Treated clothing - Topical repellent
Forest (work, foraging)	- Treated clothing - Topical repellent



Value of HBOs

- **Understanding exposure better**
- **Evaluating an intervention - functionality**
  - Efficacy
  - Not just LLINs
    - IRS
    - SRs, ITC…
  - Species specific impacts of an intervention on exposure
- **Evaluating how an intervention is NOT functioning**
  - Optimization of core interventions
  - Gaps in protection with core interventions
  - Solutions
- **Layering of interventions**
  - Targeting and tailoring
- **Human behavioral component**
  - Value of Social and Behavior Change Communication (SBCC)



Building Partnerships
Creating Solutions
Saving Lives

Australian Government

Department of Foreign Affairs and Trade

Malaria Elimination Initiative

UCSF

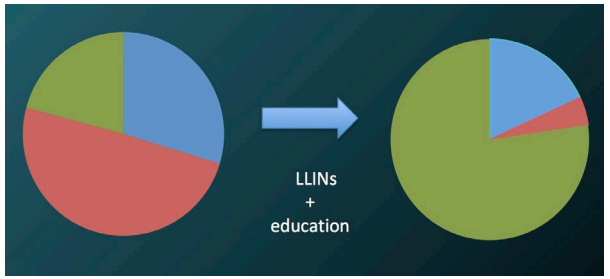
Institute for Global Health Sciences

WWF

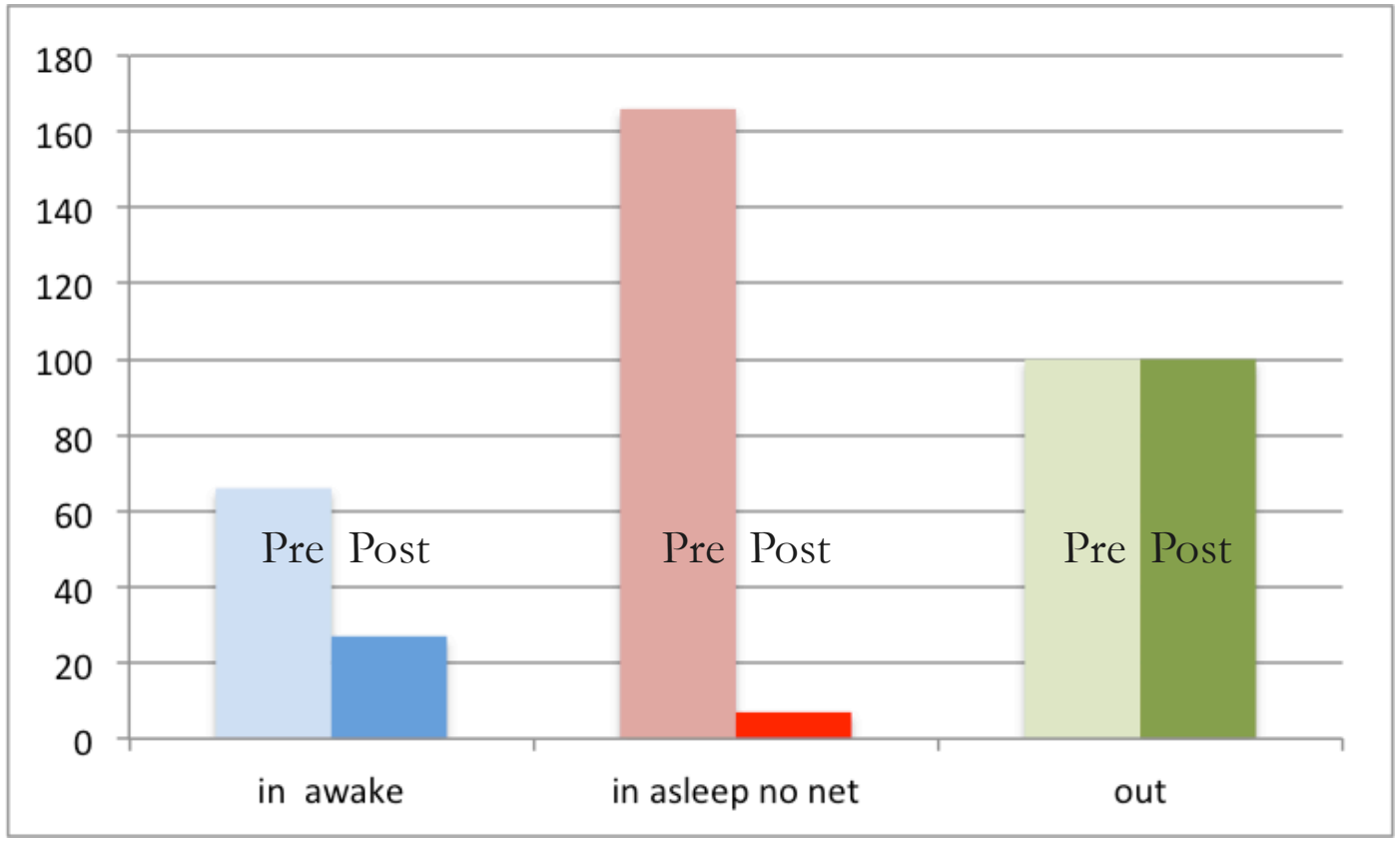
BILL & MELINDA GATES foundation

Swiss TPH

Swiss Tropical and Public Health Institute



Actual numbers



Studies…

Elodie Vajda

Tabeth Mwema

I. Ekoprayitno Rozi

Allison Hendershot

Al-Amin Hasan

Matthew Aubourg

Bangladesh [1] – Household level human behaviors can direct exposure

Ecuador [2] – Primary indoor exposure with exophagic vectors

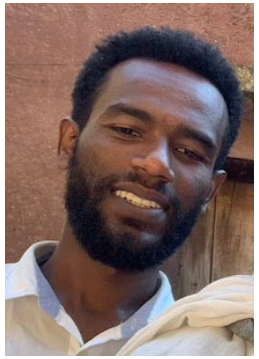
Indonesia [3] – Human behavior analysis demonstrated protections by spatial repellents

Namibia [4] – exposure based on human-vector interactions by site

Panama [5] – Quantified spatial and temporal exposure resulted in reduced exposure

Ethiopia – ongoing : Target group specific and site differences in exposure

Cambodia – ongoing: evaluation HBOs with VPSR, TRs, ITCs


Endashaw Esayas

Dyna Doum

[1] Aubourg MA, et. al.Malar J. 2022 Nov 29;21(1):355. Human behaviour directs household-level exposure to malaria vectors in Bandarban, Bangladesh. Malar J. 2021 Nov 24;20(1):443.

[2] Martin JA, et. al. Malar J. 2020 Oct 2;19(1):354. Anopheline and human drivers of malaria risk in northern coastal, Ecuador

[3]Rozi IE, et. al. PLoS One. 2022 Nov 14;17(11). Human behavior determinants of exposure to Anopheles vectors of malaria in Sumba, Indonesia.

[4]Mwema T, et. al. Parasit Vectors. 2022 Nov 17;15(1):436. Human and vector behaviors determine exposure to Anopheles in Namibia.

[5]Ávila MI, et. al. Malar J. 2021 Nov. Entomological Surveillance Planning Tool -generated actionable evidence on human and vector behaviours optimizes present interventions and reduces exposure to Anopheles vectors in two communities of Guna Yala, Panamá. 24;20(1):443.