Human behavior and exposure to mosquitoes

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Using data to inform optimal selection of core interventions
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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?

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.
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Panama – Quantified spatial and temporal exposure resulted in reduced exposure


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

**Primary HLC biting is outdoors**

**Primary community exposure is indoors**

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HBO-adjusted biting rates

LLIN distribution + SBCC

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

LLIN use

HBO-adjusted biting rates

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

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

**Resident Lowland**
- 64.1%
- 18.7%
- 15.6%
- 1.6%

**Seasonal Migrant Workers**
- Adjusted rate: Indoors awake
  - 81.5%
- Adjusted rate: outdoors awake
  - 3.5%
- Adjusted rate: outdoors asleep without LLIN
  - 8.7%

**Resident Highland**
- Adjusted rate: indoors, asleep, without LLIN
  - 55.8%
- Adjusted rate: outdoors asleep without LLIN
  - 32.8%
- Adjusted rate: outdoors awake
  - 11.3%
- Adjusted rate: outdoors asleep
  - 0.1%
Indonesia – Human behavior analysis demonstrated protections by spatial repellents

**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

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

<table>
<thead>
<tr>
<th>Exposure space and activity</th>
<th>Intervention type</th>
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| 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)
Actual numbers
Studies...

**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


