# Modeling Mosquito-Borne Disease Control: Insecticide-Treated Nets and Immunity

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# Introduction: Infectious diseases


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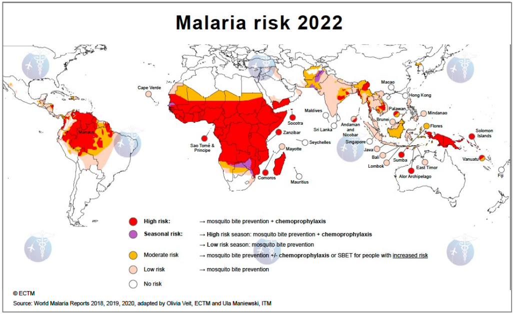
## Impact of infectious diseases

- Infectious diseases of humans have a long time history
- Infectious diseases account for over 25% of mortalities worldwide
- Infectious diseases account for $\approx$ 75% of mortalities among world poorest populations

# Introduction: Malaria health burden




- 249 million cases and 608,000 deaths in 2022
- Over 96% of mortalities in Africa

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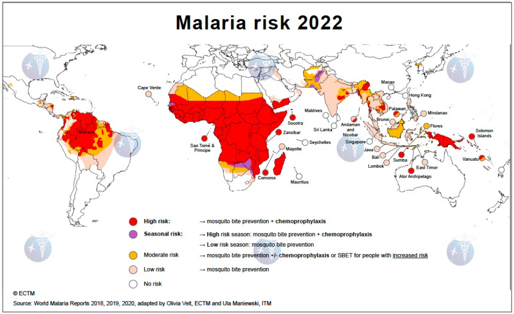
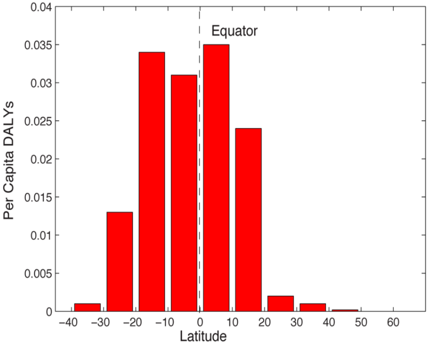
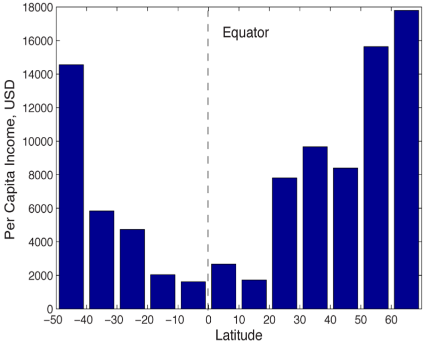



- 249 million cases and $608,000$ deaths in 2022
- Over 96% of mortalities in Africa
- Over 80% of mortalities are among African children under 5

# Introduction: Malaria economic burden




Vector-borne and parasitic disease burden




Income

- Economic loss through lost productivity and health spending

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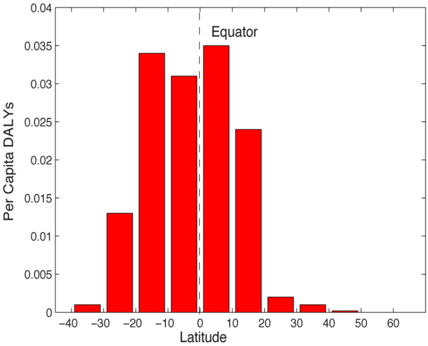


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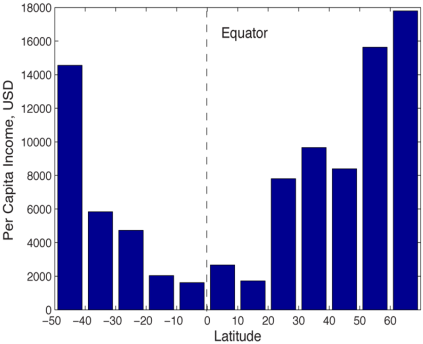


Income

- Economic loss through lost productivity and health spending
- Malaria reduced per capita income by 1.3% (Gallup and Sachs, 2001)

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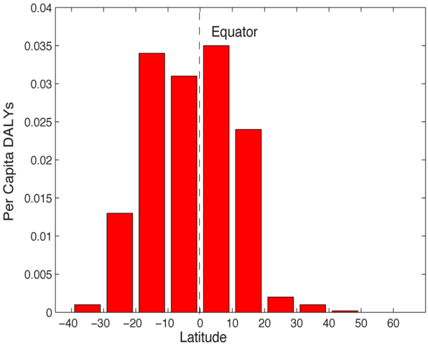


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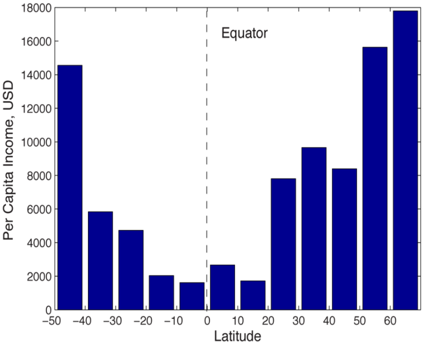
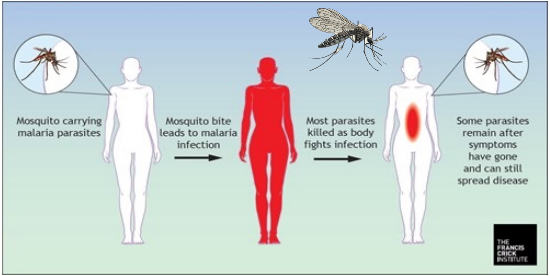



Income

- ◇ Economic loss through lost productivity and health spending
- ◇ Malaria reduced per capita income by 1.3% (Gallup and Sachs, 2001)
- ◇ Malaria costs the economy of African countries ≈ $12 million annually

# Introduction: Malaria spread




◇ Agent: *Plasmodium*

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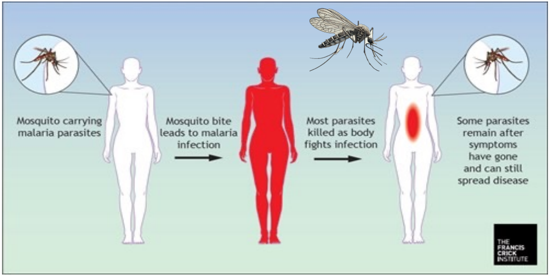


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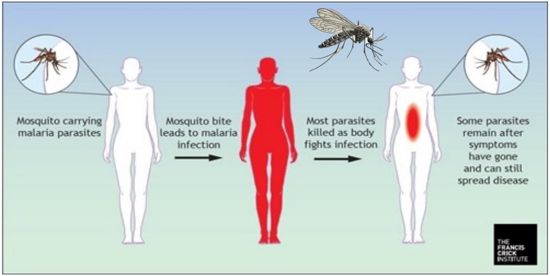


- Agent: *Plasmodium*
- Host: Humans
- Vector: Female *Anopheles* mosquitoes

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- Questing and feeding behaviors influence disease spread

# Introduction: Control and mitigation

- Insecticide-treated bed-nets (ITNs)
- Door and window screens
- Eliminating mosquito breeding grounds
- Treatment

# Introduction: Control issues

- ◇ Human behavior
- ◇ The effectiveness of ITNs is challenged by
  - resistance to insecticides,
  - Inconsistent use,
  - Mosquito adaptation.
- ◇ Funding issues
- ◇ Environmental conditions

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- Reduced exposure can leave individuals vulnerable to severe disease.
- Complementary strategies, such as vaccines, mitigate immunity trade-offs.
- Optimizing interventions enhances long-term control effectiveness.

# Problem

How do widespread ITN interventions impact long-term mosquito-borne disease transmission dynamics and immunity development, and what role can complementary interventions, such as vaccines, play in mitigating the trade-offs between reduced exposure and immunity buildup?

# Methodological approaches

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- **Environmental variability**: Stochastic models account for random factors such as weather, habitat changes, and human interventions.
- **Hybrid approaches**: Combining two or more of these approaches.