MRC Centre for Global Infectious Disease Analysis

Imperial College London

Mathematical models of MERS-CoV transmission in dromedary camel populations

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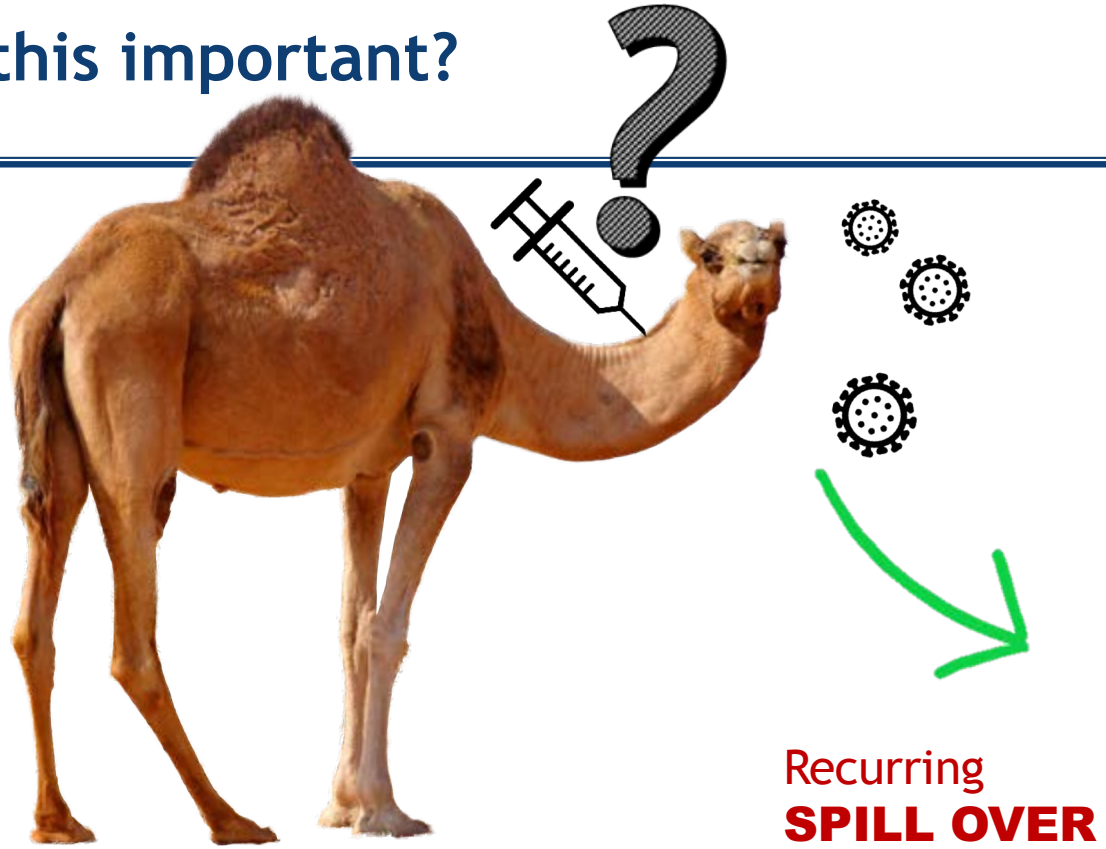
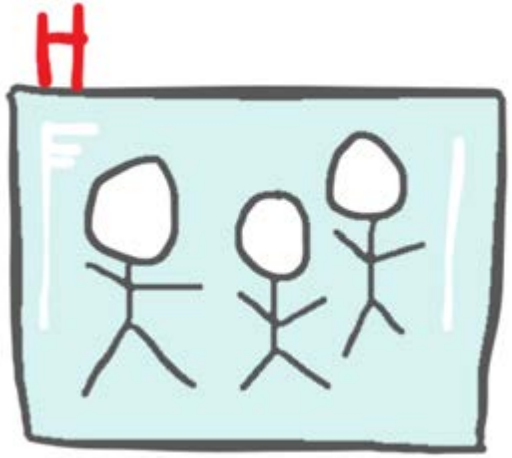
Q. What characterises the epidemiology of MERS-CoV in dromedary camel populations?

Why is this important?



Recurring
SPILL OVER

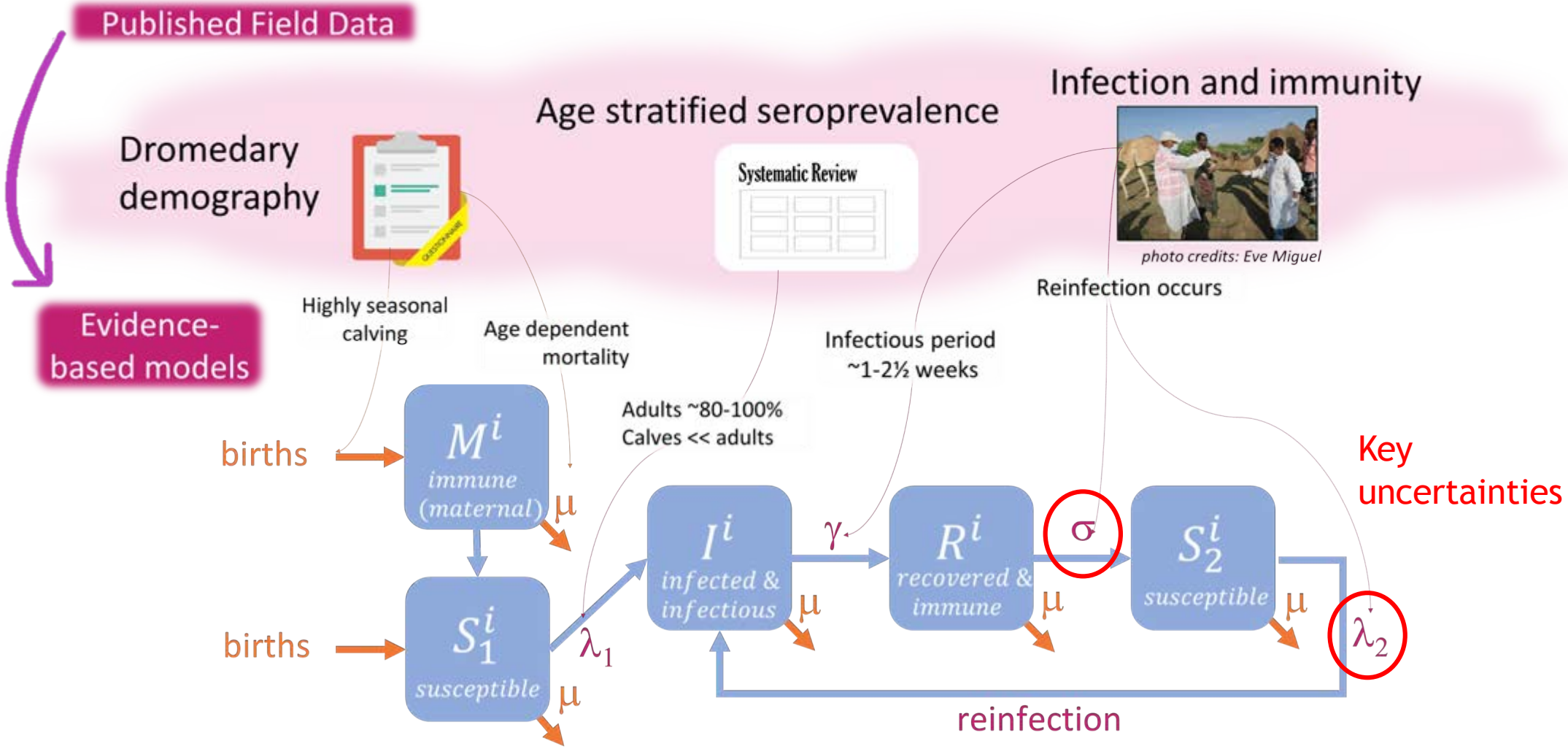


Extensive circulation of MERS-CoV in dromedary camel populations

Short human-to-human transmission chains in close contact settings

High case-fatality ratio

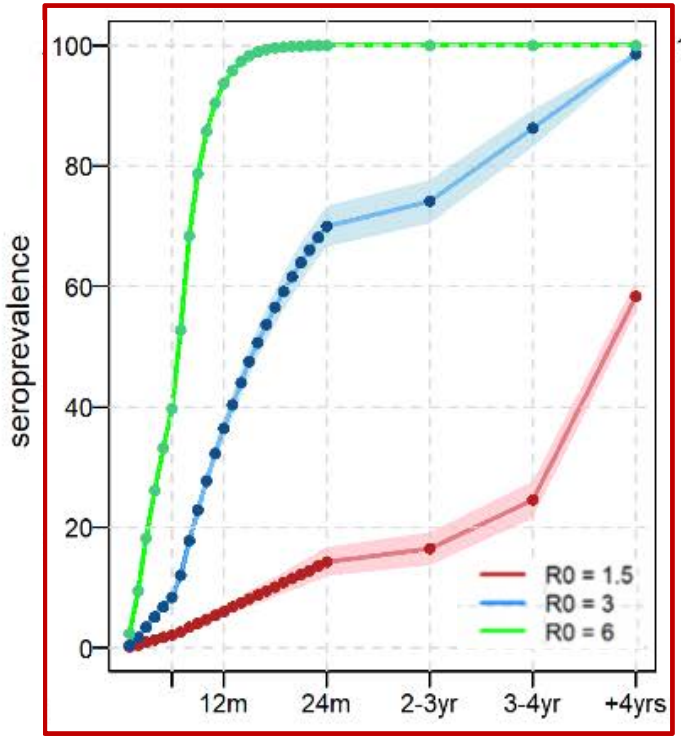
Modelling transmission dynamics:



Preliminary results

Effect of R_0 on age dependent sero-prevalence

When immunity confers partial protection…

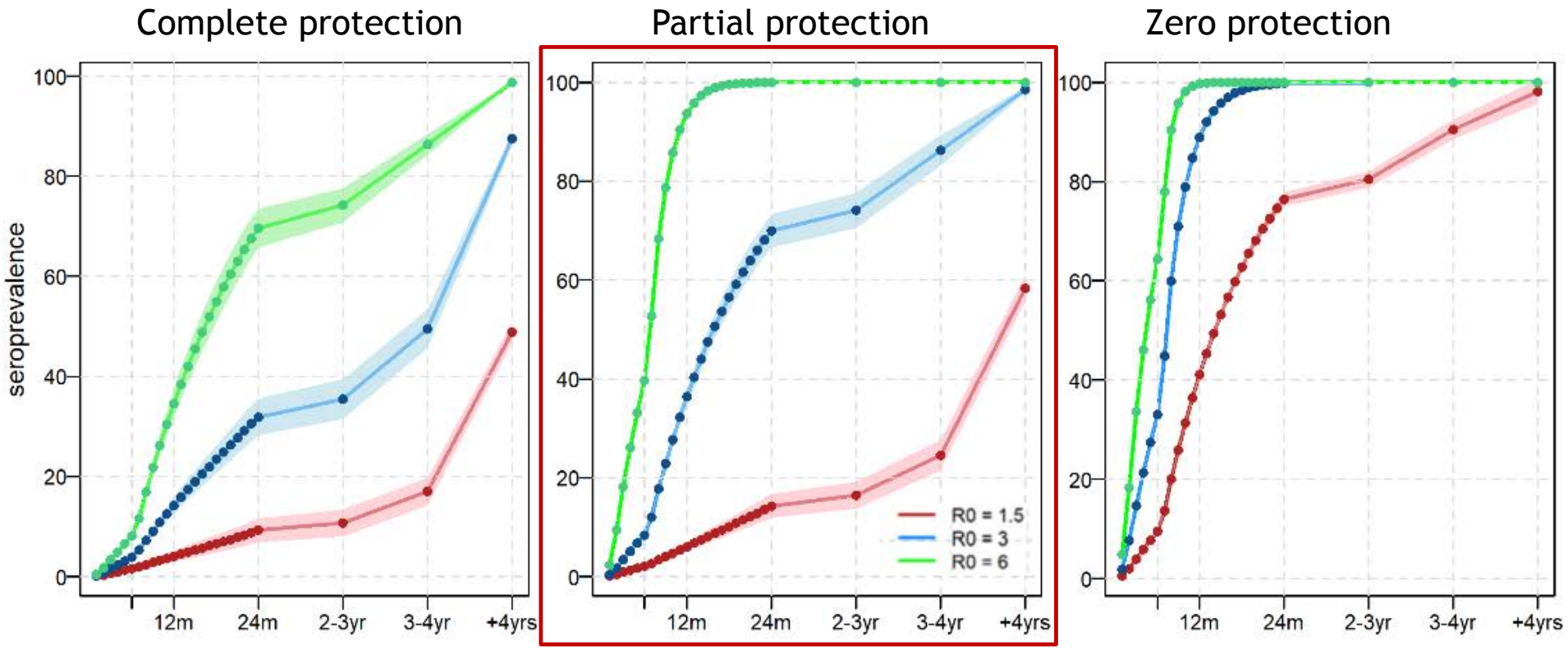


The effect of transmission intensity on age-dependent seroprevalence.

R_0 ~3 reproduces the general patterns observed in the field

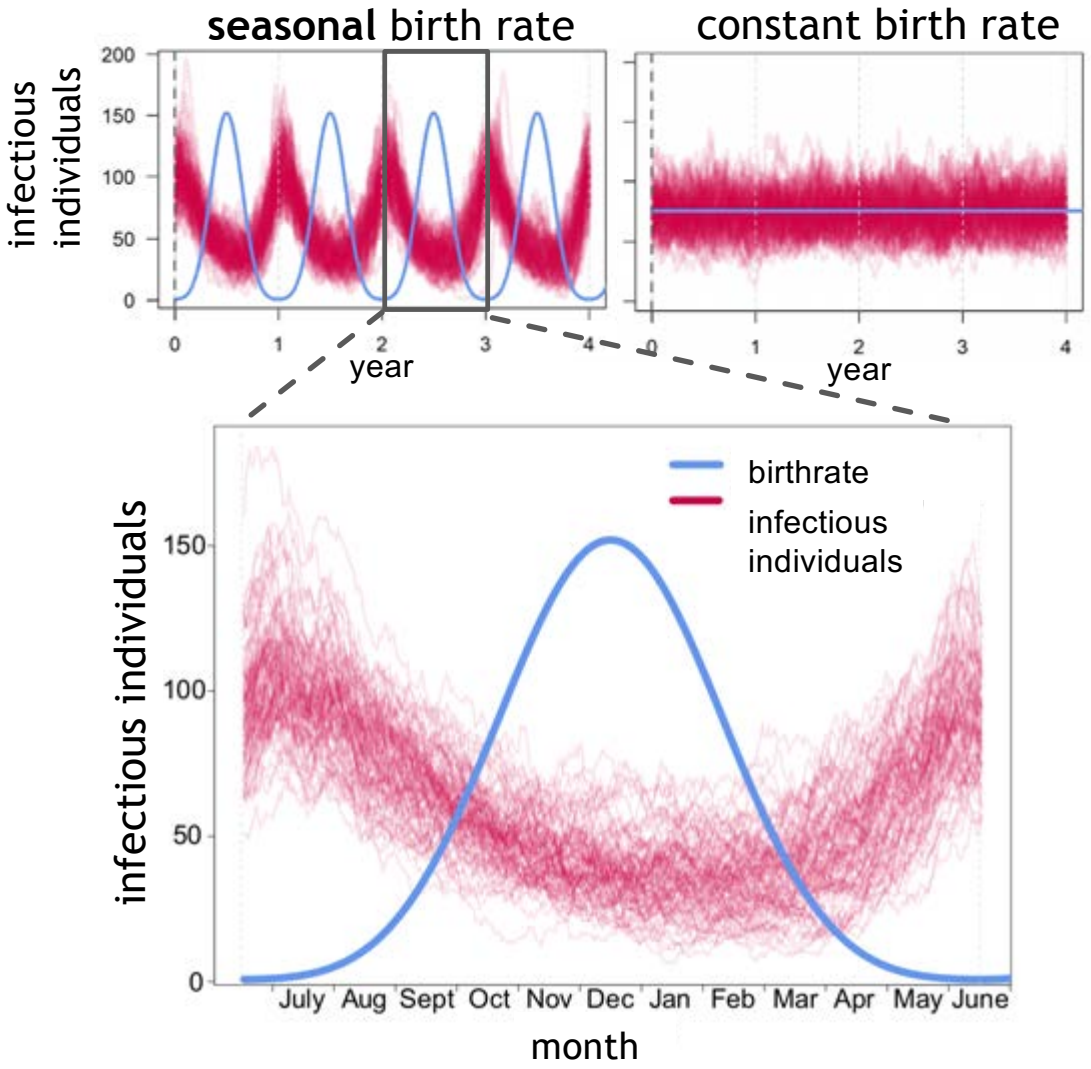
Age dependent sero-prevalence

Sensitivity analysis of the efficacy of acquired immunity…



Periodicity

- **Birth rate is driving seasonality of epidemics**
- Annual epidemics when immunity offers partial protection
- If immunity is sterilizing, epidemics are biennial – only becoming annual at very high transmission intensities



Persistence

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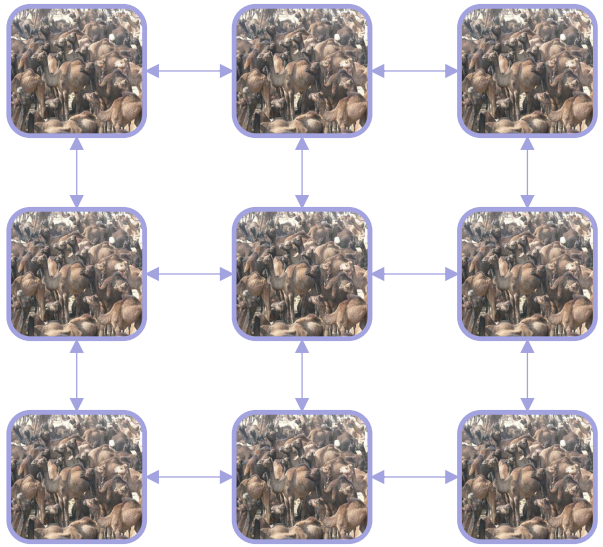
- One homogenously mixed dromedary population ("single patch model")
- Transmission **less** able to persist

- Population made up of coupled sub-populations ("meta-population model")
- Transmission **more** able to persist



Eg. In a single population of 25,000 dromedaries epidemics only persist for >10yrs 4% of the time, vs. 100% of the time in a population of 25 coupled groups of 1000 camels

Summary

1. Even allowing for uncertainty around immunity, R_0 is likely around 3-6

2. Seasonality of births is capable of driving annual epidemics

3. Large scale persistence is aided by the structure of camel populations

What is next?

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generic → context specific

Requires: Integrating husbandry system data and spatial dromedary density and movement data

Enables: Evaluation of context specific risk and vaccination strategies

Acknowledgements

- My supervisors Neil Ferguson and Thibaut Jombart,

  MRC Centre for Global Infectious Disease Analysis, Imperial College London

- Maria van Kerkhove,

  WHO Health Emergencies Programme

- Everybody who has contributed to the growing literature on MERS-CoV in dromedaries

- Wellcome Trust

Thank you for listening!

1. MERS-CoV Sero-prevalence in dromedaries

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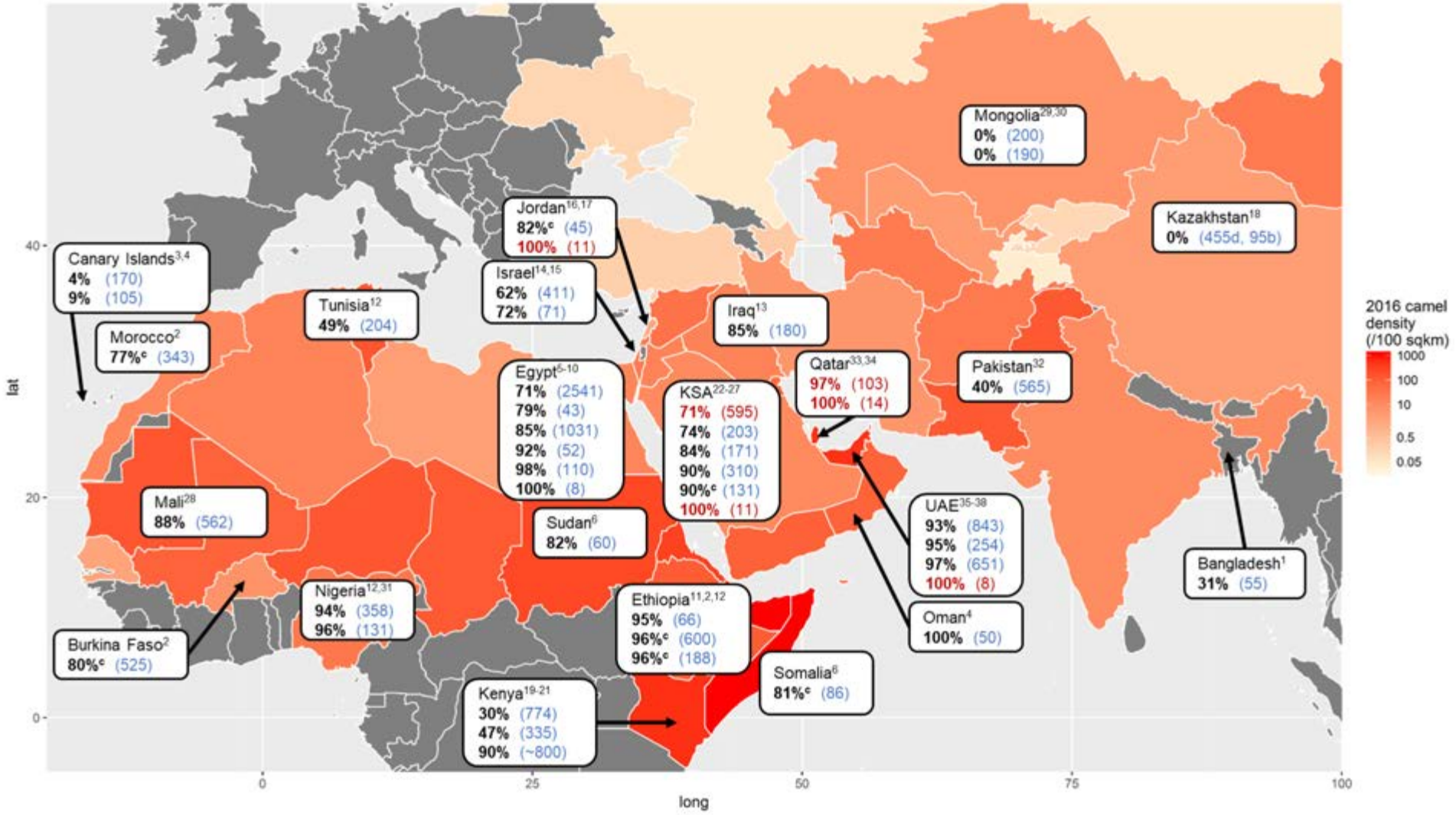

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2. MERS-CoV viro-prevalence in dromedaries

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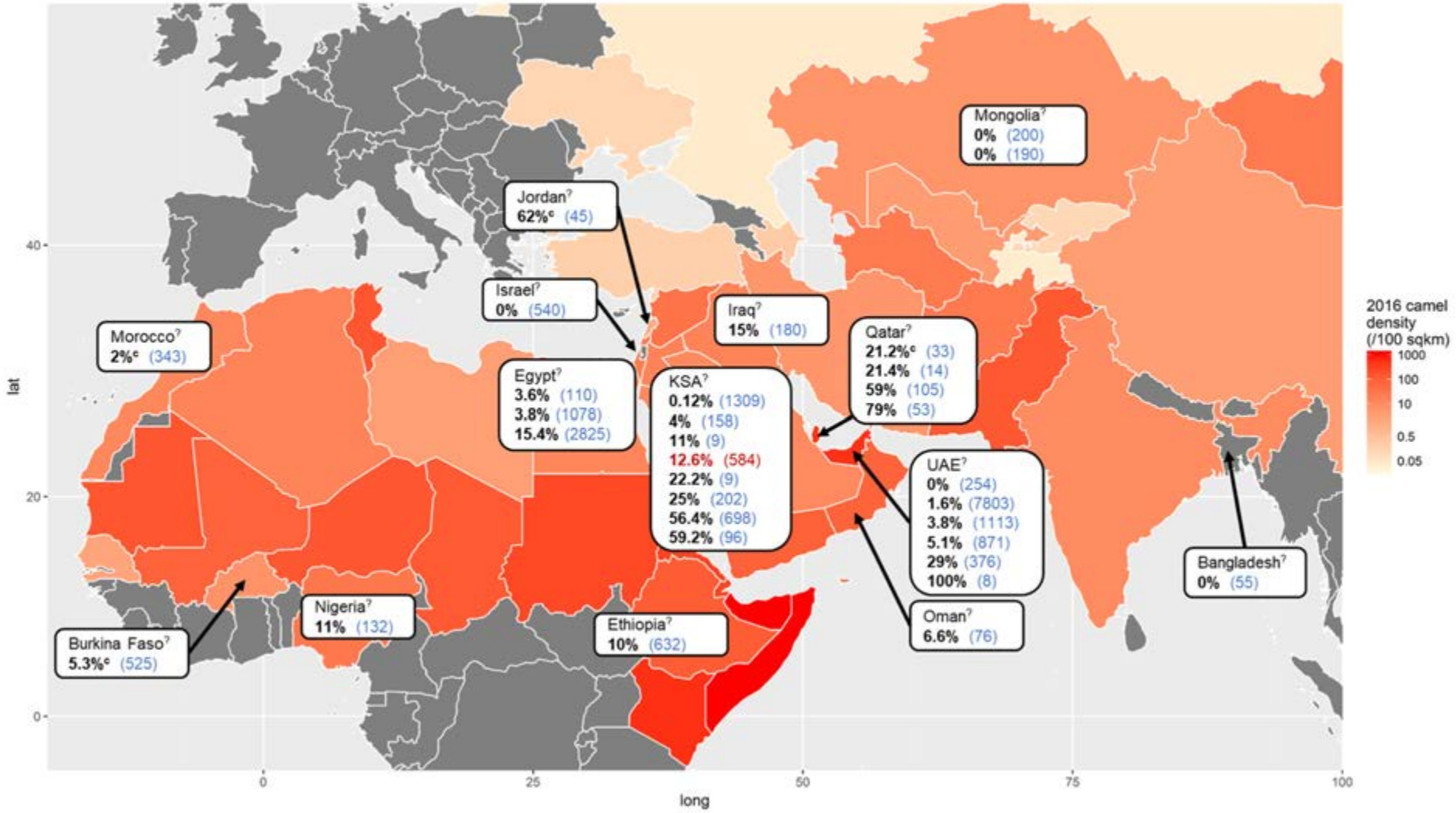

3. Sero- and viro-prevalence in dromedaries

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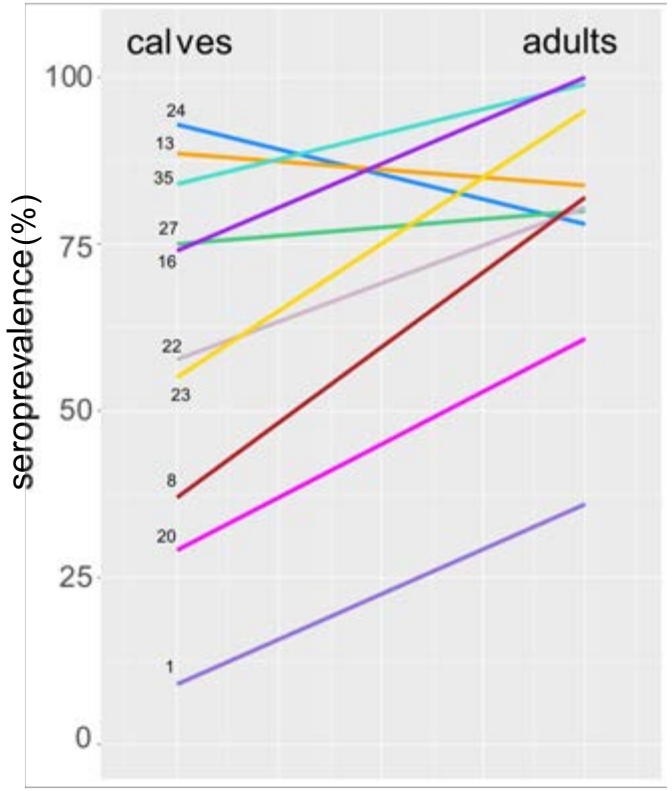
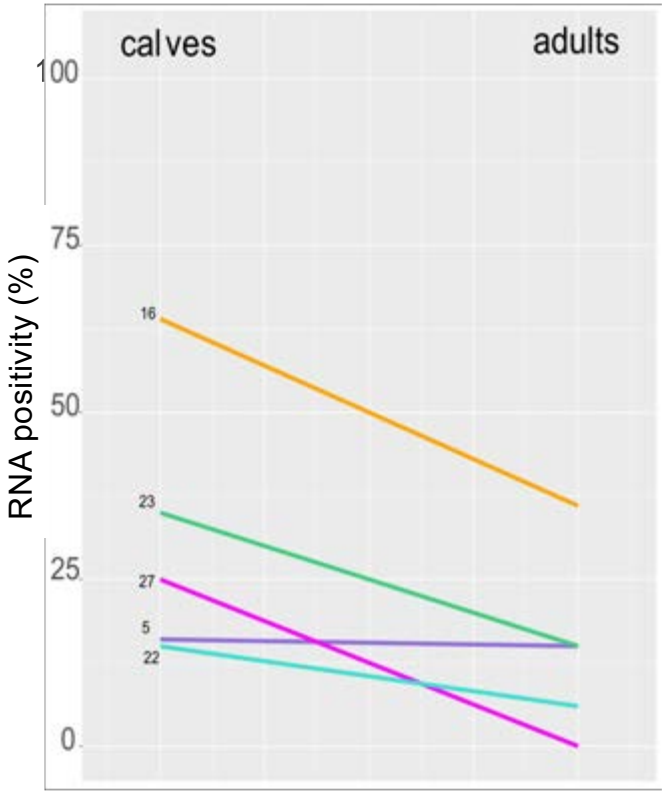
- Sero-prevalence increases with age
- Viro-prevalence decreases with age
- Extensive heterogeneity

Photo credits: Eve Miguel





How are we going to contribute?

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Develop a model for MERS-CoV transmission in dromedary camels (DCs) in order to:

1. Bring together what is known about MERS-CoV epidemiology in DCs, into one place where it can be explored mechanistically
2. Use the model to epidemiologically **evaluate potential vaccination strategy**

   At what age would vaccination be optimal?

   Is husbandry practice likely to affect this?

   How feasible is achieving herd immunity?

   Where should vaccination take place?

Age dependent sero-prevalence

Sensitivity analysis of the impact of maternally acquired antibodies…