

Battling the HIV epidemic: the role of mathematical and simulation models

- ▶ CANFAR McMaster
 - ▶ HIV/AIDS Research and Healthcare Conference 2016
-
- ▶ Jonathan Dushoff
 - ▶ Department of Biology

Outline

The HIV Epidemic

Disease modeling

- Gendered effects of intervention

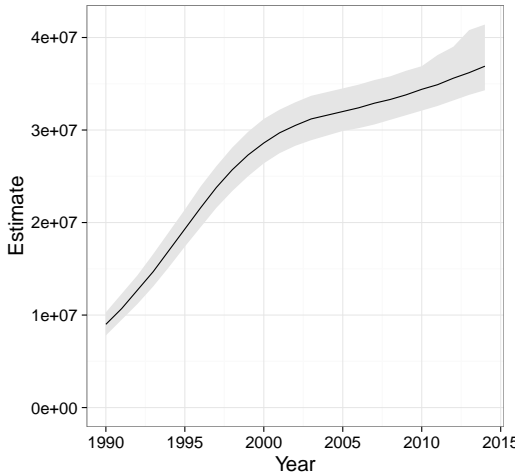
- Testing and treatment

- Routes of HIV transmission

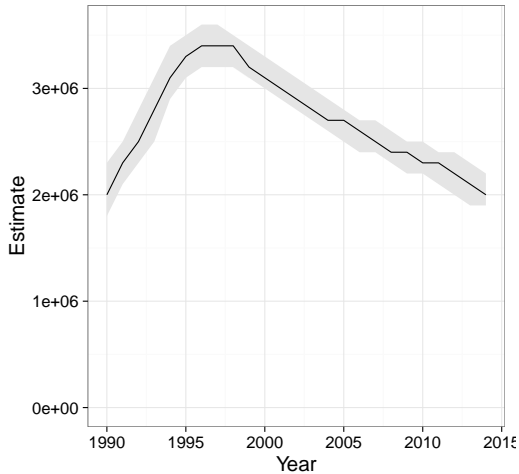
Heterogeneity

- Risk factors and targeting

People living with HIV (UNAIDS est.)



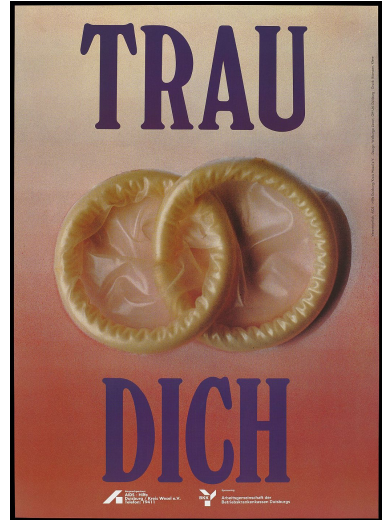
New HIV cases per year (UNAIDS est.)



Questions

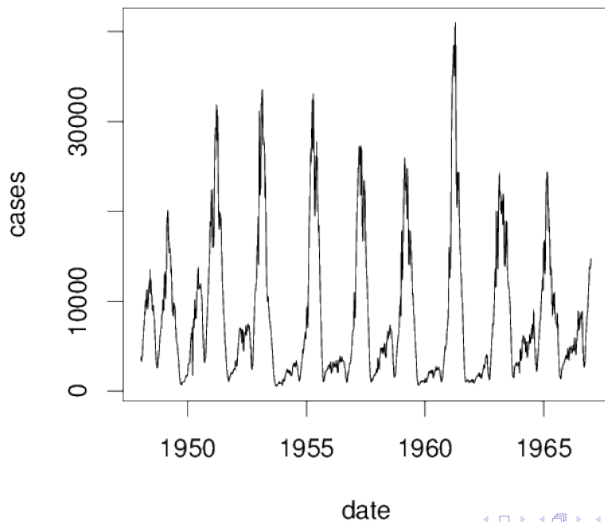
- ▶ Why is HIV declining?
- ▶ What will it take to keep it declining?
- ▶ What will it take to eliminate the disease?

Awareness and education



Dynamics of the disease

Measles reports from England and Wales



Male circumcision



Testing and care



Drugs



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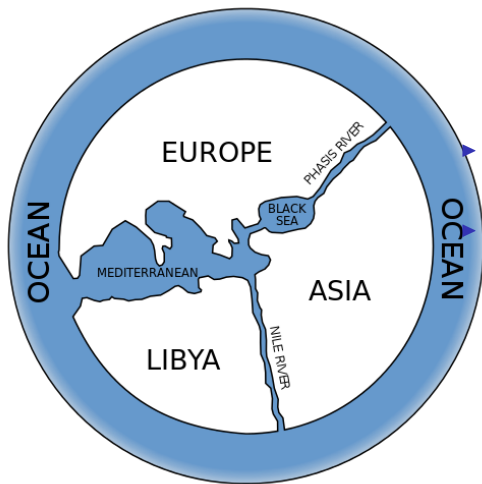
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Heterogeneity

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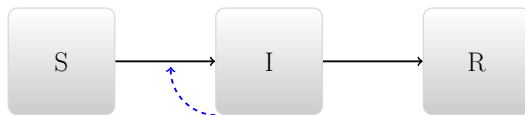
Models



A model is a simplified view of the world

Allows linking between assumptions and outcomes

Dynamic models

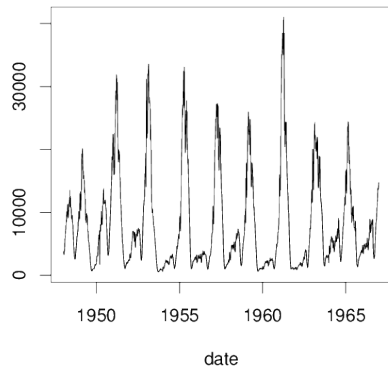


Small-scale events \Leftrightarrow Large-scale patterns and outcomes

Dynamic models



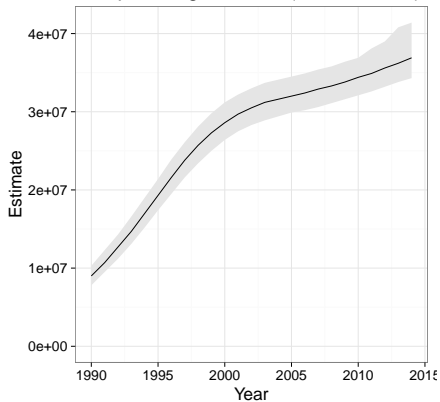
Measles reports from England and Wales



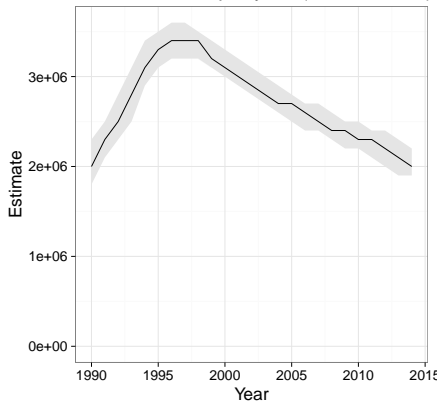
Dynamic models



People living with HIV (UNAIDS est.)



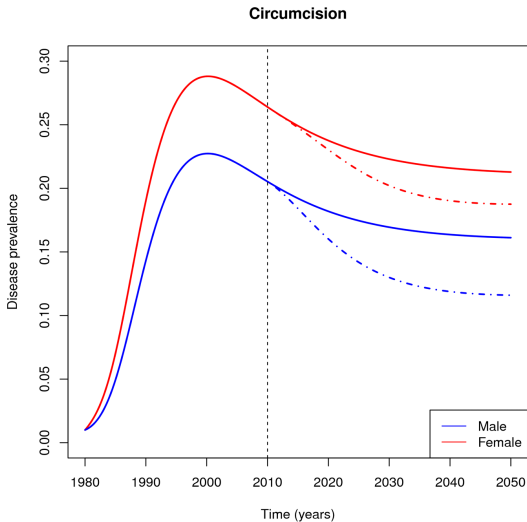
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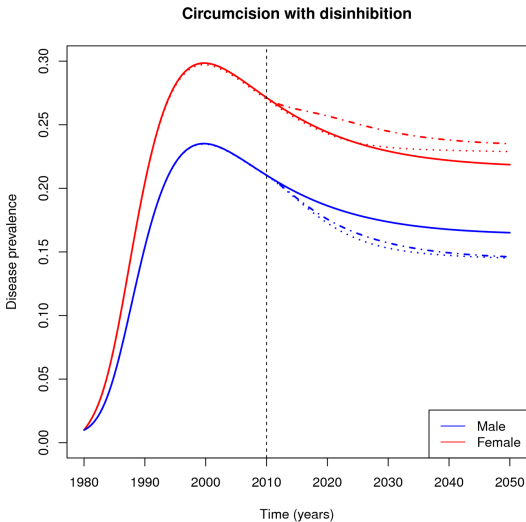
Male circumcision and HIV transmission



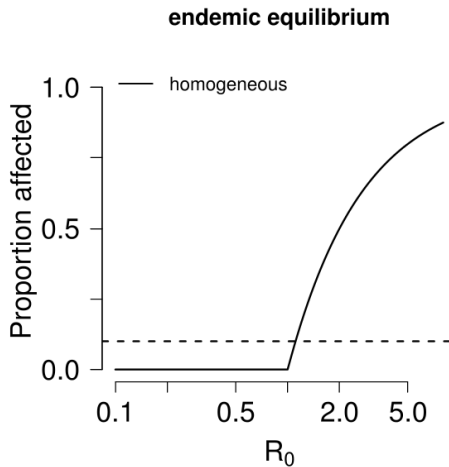
Male circumcision and HIV transmission



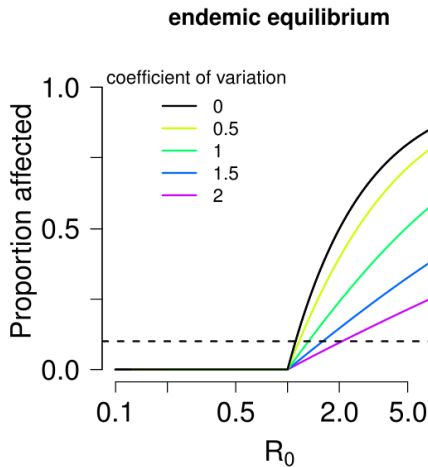
Male circumcision and HIV transmission



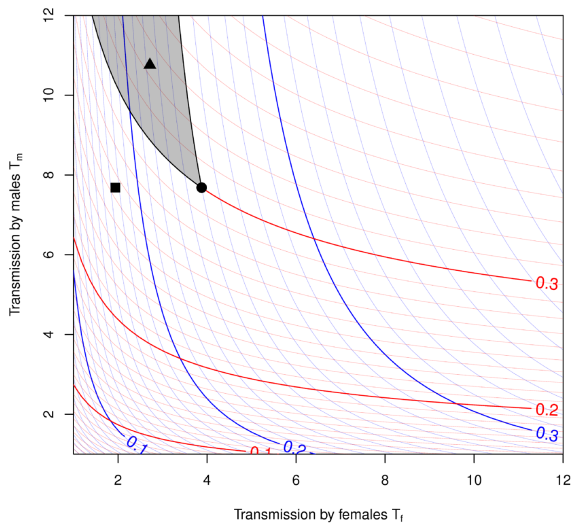
Transmission and prevalence



Transmission and prevalence



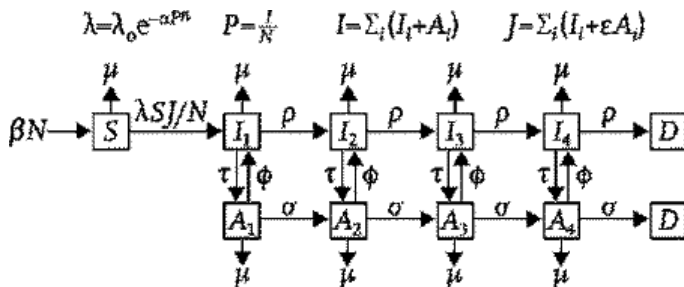
Heterosexual transmission and prevalence

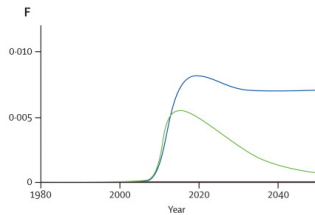
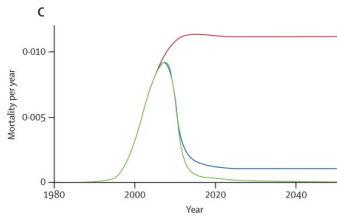
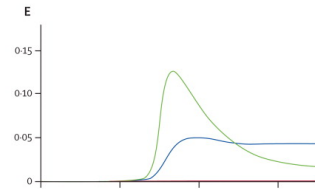
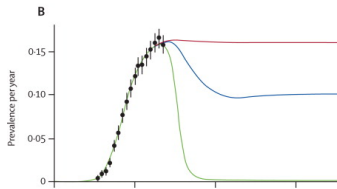
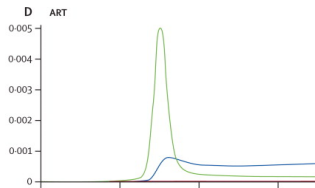
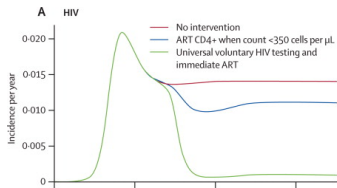


Testing and treatment



Modeling the effects of universal treatment

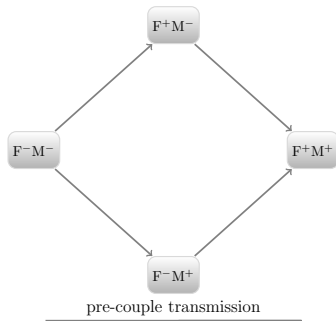




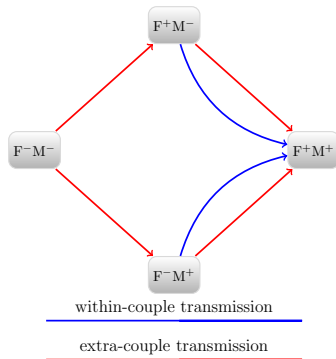
Routes of HIV transmission



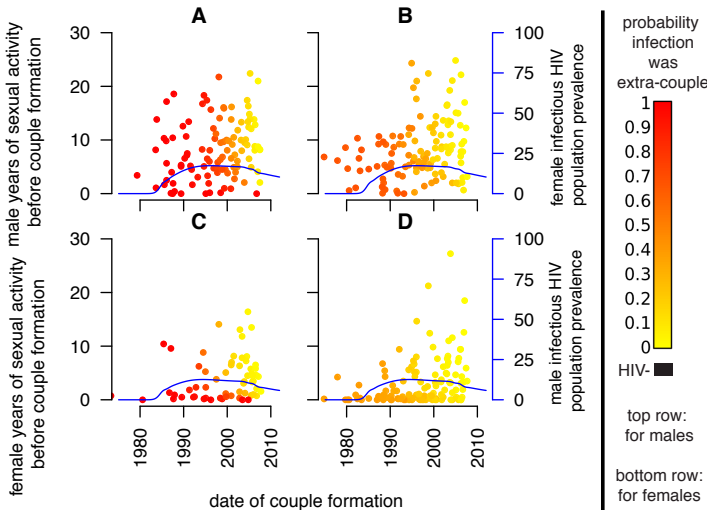
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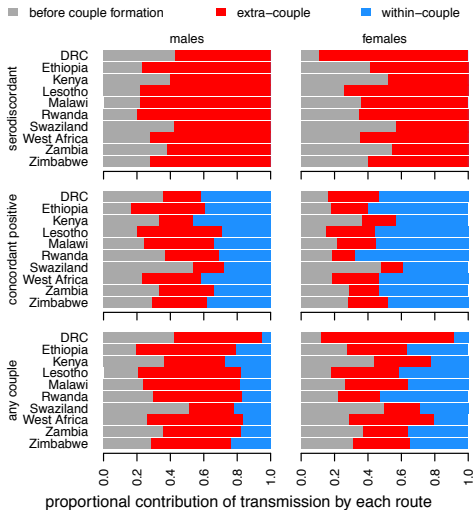
Routes of HIV transmission



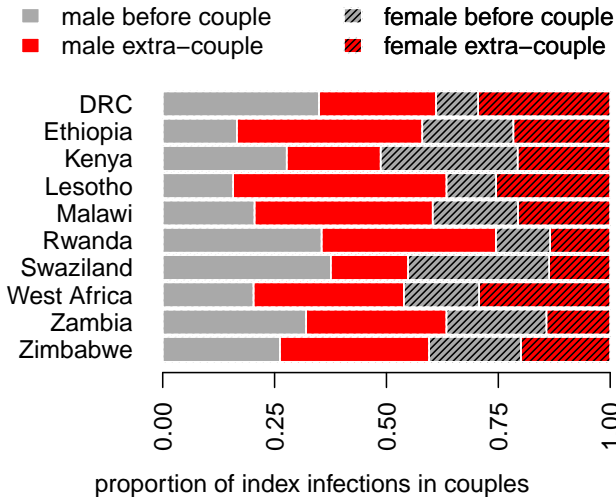
Routes of HIV transmission



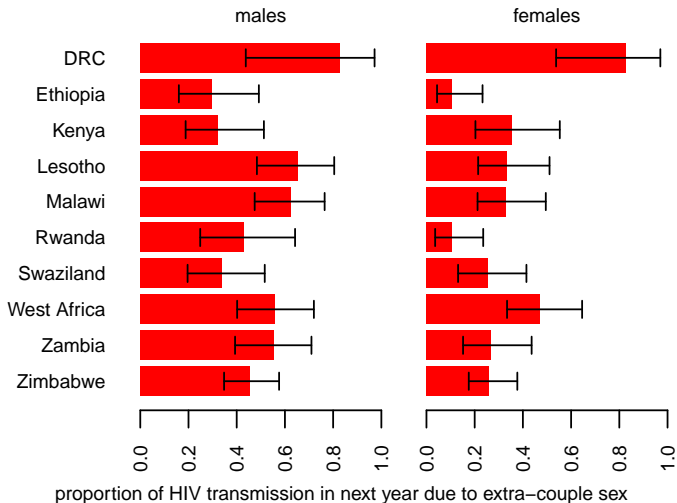
Routes of HIV transmission



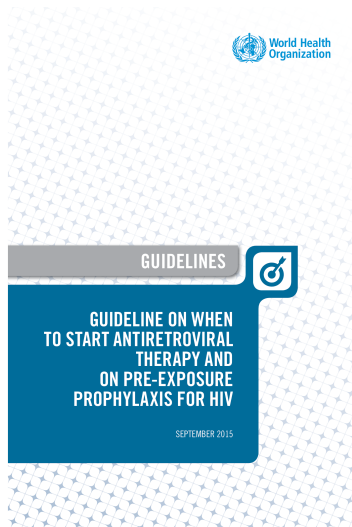
Routes of HIV transmission



Routes of HIV transmission



Success!



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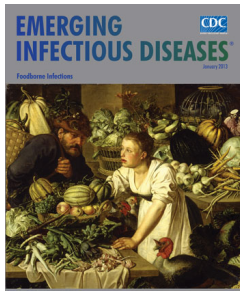
- Routes of HIV transmission

Heterogeneity

- Risk factors and targeting

The resilience of infectious disease

1967: It's time to close the book on infectious diseases



Human heterogeneity



Human heterogeneity

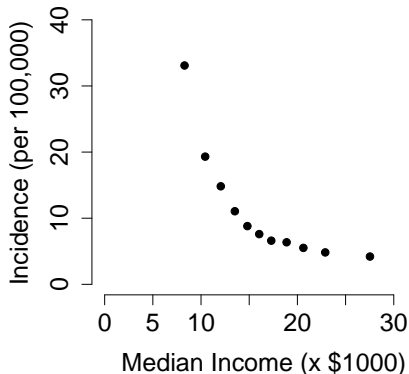


Human heterogeneity



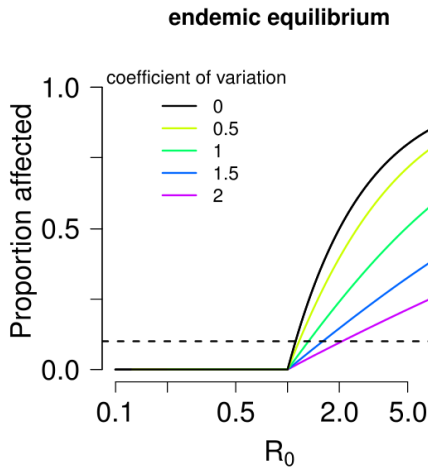
Heterogeneity in TB

Tuberculosis Notifications in USA, 1980s

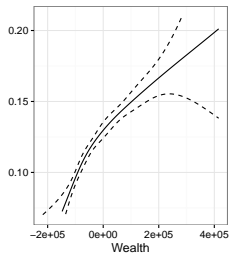
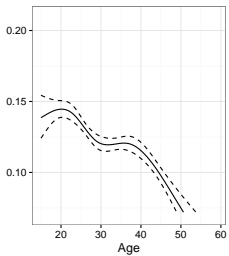
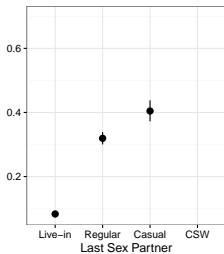
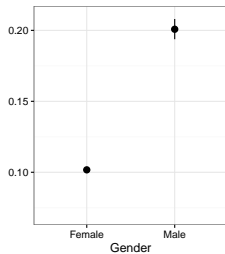
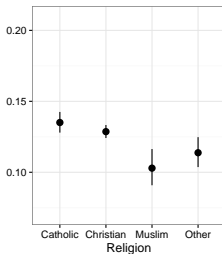
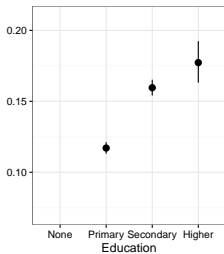


- ▶ **Progression:** Nutrition, stress
- ▶ **Contact:** Overcrowding, poor ventilation
- ▶ **Cure:** Access to medical care

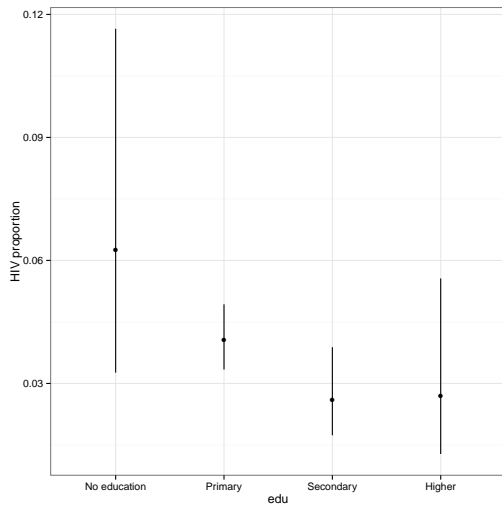
Heterogeneity and elimination



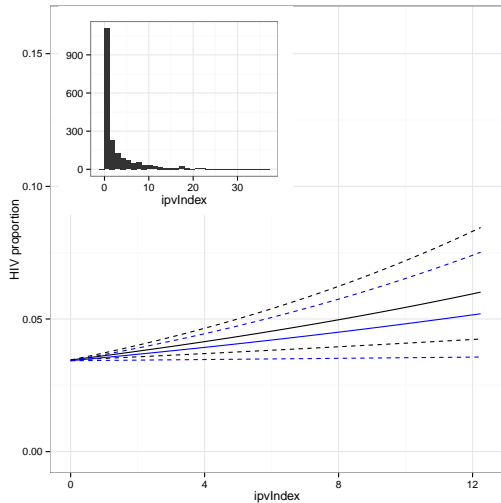
Condom use



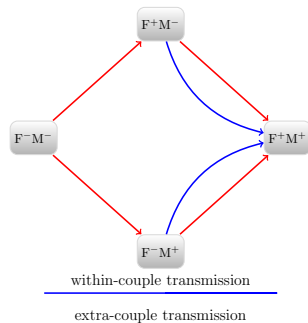
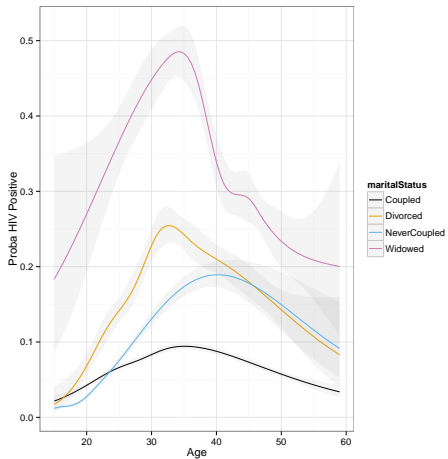
HIV risk

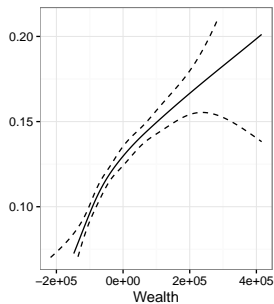
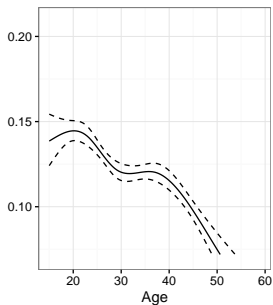
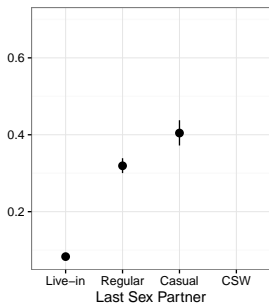
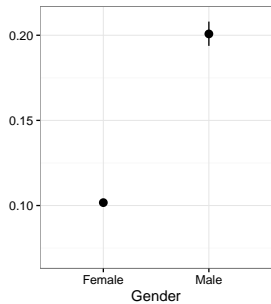
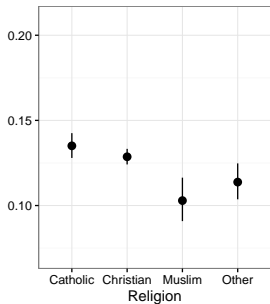
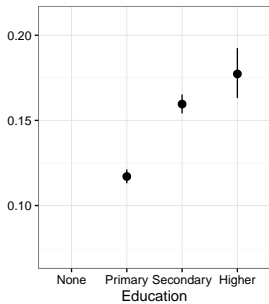


HIV risk



Future work





Thanks

- ▶ Collaborators
- ▶ Funders: CIHR, NIH, JS McDonnell Foundation
- ▶ CANFAR
- ▶ This audience