

## Network Formation as Determinant of Spatial Disparity

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September, 2015

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## Acknowledgements

Sevgi Aral  
Thomas Gift

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## Determinants of sexual infection transmission

- **Pathogen:**
  - Transmission probabilities (male to female, female to male, anatomical site)
  - Durations of infection (female, male, symptomatic, asymptomatic)
- **Behavioral:**
  - Rates of partner acquisition
    - Partners per year, time between partnerships (concurrency)
  - Rates of partnership dissolution, coital frequency
    - Is partnership long enough for effective contact (transmission) to occur
  - (Health services seeking and utilization)
    - To shorten infection duration treatment
- **System:**
  - (Mixing patterns)

## INCARCERATION AS A RUNNING EXAMPLE

## Empirical incarceration study

- **Incarceration**
  - Associated with sexual partnership **dissolution** (Khan et al. 2011)
  - Associated with **more partners per year** (Khan et al. 2008)
  - Associated with "separational concurrency" (Adimora et al. 2005)
  - Alters sex ratios and thereby power dynamics (Thomas et al. 2006, Pouget et al. 2010, Green et al. 2012)
- **Ecologically** associated with higher STI Prevalence (Thomas et al. 2005, Thomas et al. 2008, Thomas et al. 2010, Stoley et al. 2015)

## Young black men are disproportionately incarcerated

**Table 1. Number of Sentenced Prisoners Under State or Federal Jurisdiction per 100,000 Residents, By Sex, Race, Hispanic Origin, and Age, 1996**

| Age          | Male       |              |              |              | Female    |            |           |            |
|--------------|------------|--------------|--------------|--------------|-----------|------------|-----------|------------|
|              | White      | Black        | Hispanic     | Total        | White     | Black      | Hispanic  | Total      |
| 18-19        | 263        | 2,615        | 1,303        | 771          | 17        | 74         | 32        | 27         |
| 20-24        | 762        | 6,740        | 2,774        | <b>1,886</b> | 35        | 203        | 115       | 71         |
| 25-29        | 829        | 8,319        | 2,609        | <b>2,024</b> | 54        | 415        | 186       | <b>123</b> |
| 30-34        | 862        | 7,052        | 2,547        | <b>1,845</b> | 73        | 597        | 200       | <b>160</b> |
| 35-39        | 759        | 6,601        | 2,278        | <b>1,615</b> | 61        | 518        | 193       | <b>134</b> |
| 40-44        | 606        | 4,824        | 2,308        | <b>1,244</b> | 38        | 326        | 126       | 82         |
| 45-54        | 380        | 2,768        | 1,313        | <b>692</b>   | 20        | 161        | 93        | <b>42</b>  |
| 55 or older  | 96         | 505          | 413          | <b>151</b>   | 3         | 18         | 9         | 5          |
| <b>Total</b> | <b>370</b> | <b>3,098</b> | <b>1,278</b> | <b>809</b>   | <b>23</b> | <b>188</b> | <b>78</b> | <b>51</b>  |

Source of data: Bureau of Justice Statistics

## Objective

- Explore how prison incarceration affects
  - known STI risk factors
    - Partners per year
    - Gap length
  - community STI levels
  - (STI network features)
- Stochastic individual based model of heterosexual *Chlamydia trachomatis* transmission

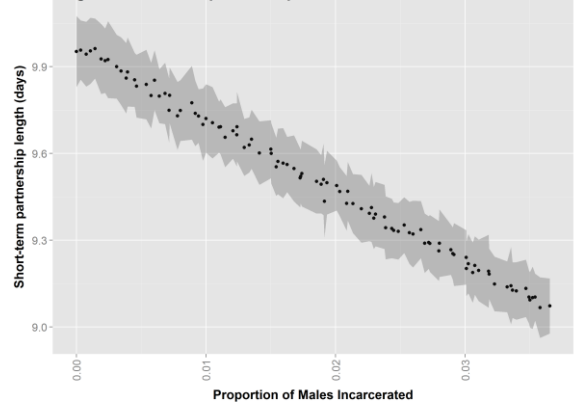
## A simple model of incarceration

- Men are incarcerated at a constant rate (varied)
  - Men remain incarcerated for 3-4 years
- Their sexual partnerships are dissolved
- Women may form new sexual partnerships with remaining men who are not incarcerated
- No additional forced concurrency
- No altering of other behaviors (tolerance of concurrency, condom use, etc).

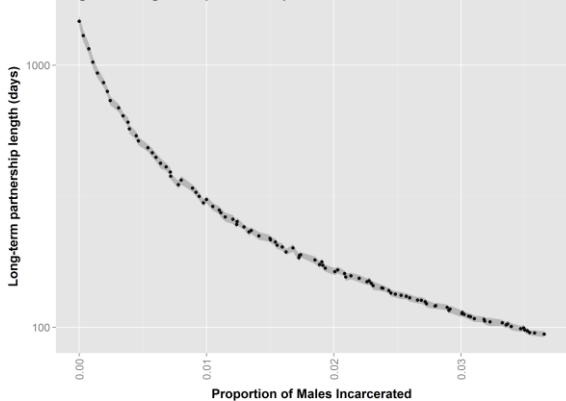
## Incarceration's effects on determinants of sexual infection transmission

- Pathogen
- Behavioral
  - Shorter partnerships
  - More partners per year
  - Gap length
- System
  - Unbalanced sex ratios
  - Altered mixing patterns (measured by resulting network shape)
  - Lower effective population size

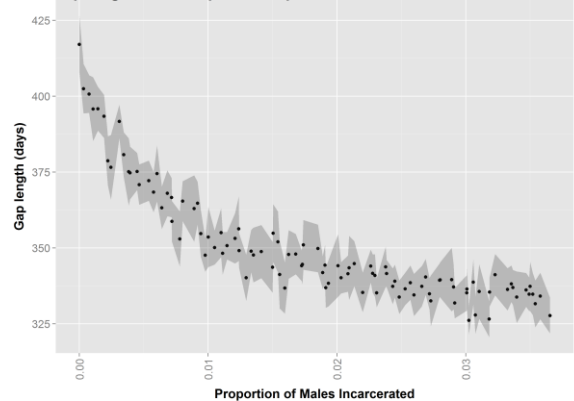
Length of short-term partnerships with variable levels of incarceration



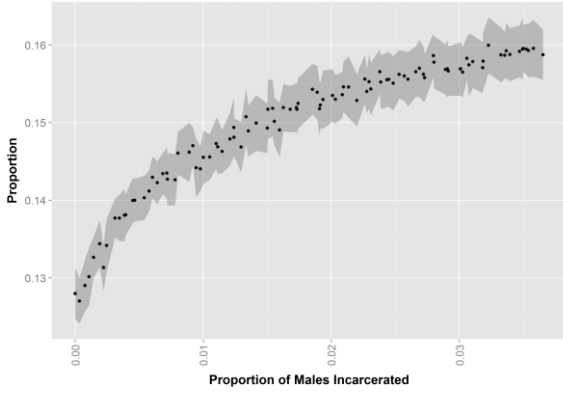
Length of long-term partnerships with variable levels of incarceration



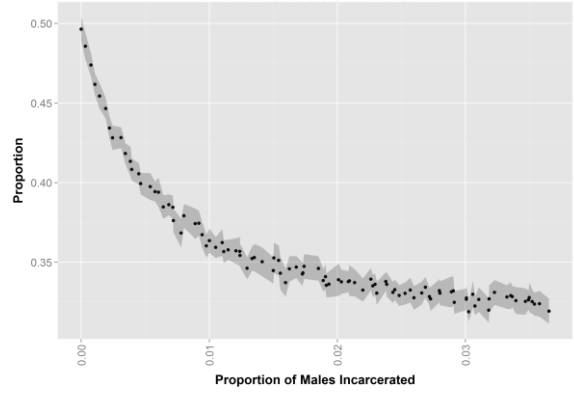
Gap length between partnerships with variable levels of incarceration



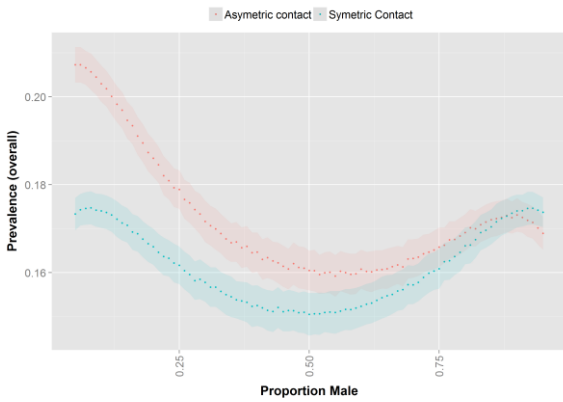
Proportion of women with 3 or more partners in the past year with variable levels of incarceration



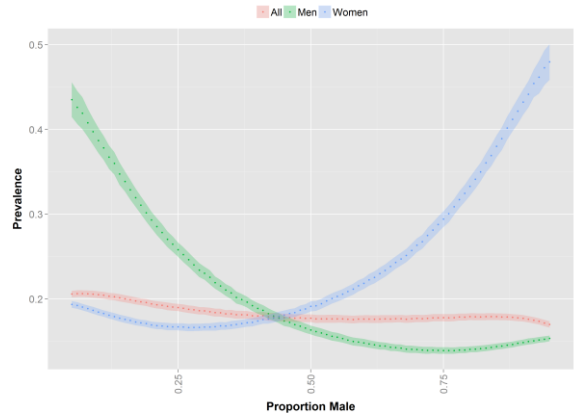
Proportion of women with zero partners in the past year with variable levels of incarceration



Equilibrium prevalence of infection among all as sex ratio is varied

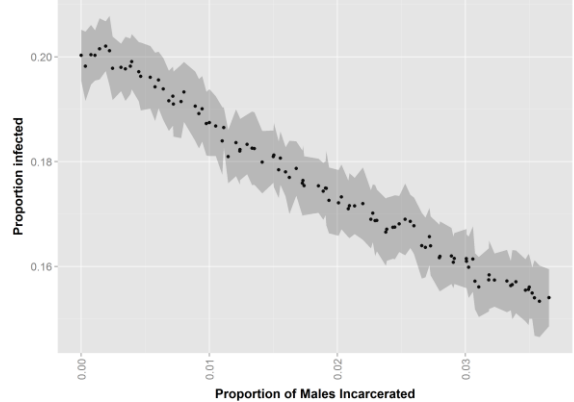


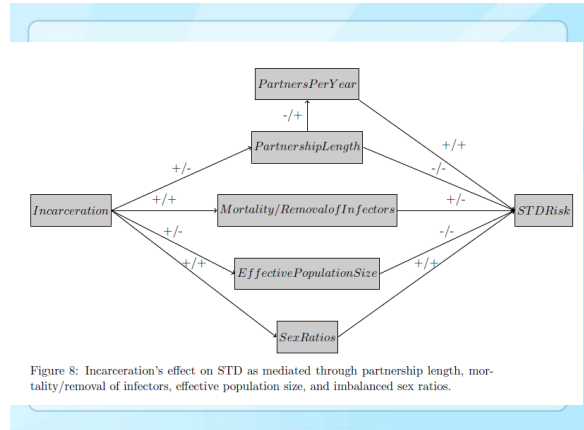
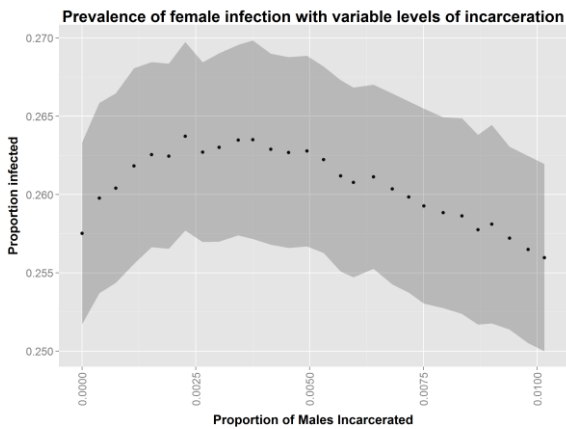
Prevalence of infection as sex ratio is varied



**SO WILL GREATER INCARCERATION  
RESULT IN GREATER STD INFECTION  
RATES?**

Prevalence of female infection with variable levels of incarceration





### Why does incarceration not result in greater STD infection rates?

- ❑ What are we not accounting for?
- ❑ Sexual assault and transmission while in prison
- ❑ Altered power dynamics based on slight imbalance in sex ratios (concurrency tolerance, condoms, etc)
- ❑ Changes in behavior
- ❑ Greater age at long term relationship establishment (i.e. cessation of new partner acquisition)

### Incarceration disrupts sexual networks

- ❑ Increases the total number of partnerships formed between people
- ❑ Unbalances sex ratios
- ❑ Removes of a disproportionate number of men:
  - Remaining network more tightly connected (more contacts are made with the remaining subset of non-incarcerated men)
- ❑ Premature partnership dissolution can make partnerships too short to allow for sufficient time (number of coital acts) to transmit infection
- ❑ However, these factors alone, do not cause an increase in community STD burden.

### Next steps:

- ❑ If incarceration increases STD burden in communities, it does so because factors not considered today
  - Providing a venue for sexual assault which can thereby amplify STDs back to the community
  - Altering power dynamics between the sexes potentially resulting in greater tolerance and thus prevalence of concurrency, lack of condom use, etc.

Thank you

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