# Egocentric ERGM: Application to Persistent Racial Disparities in HIV Incidence

Pavel N. Krivitsky  Martina Morris

Sunbelt Workshop

# Outline

Motivation

Methods

Analysis

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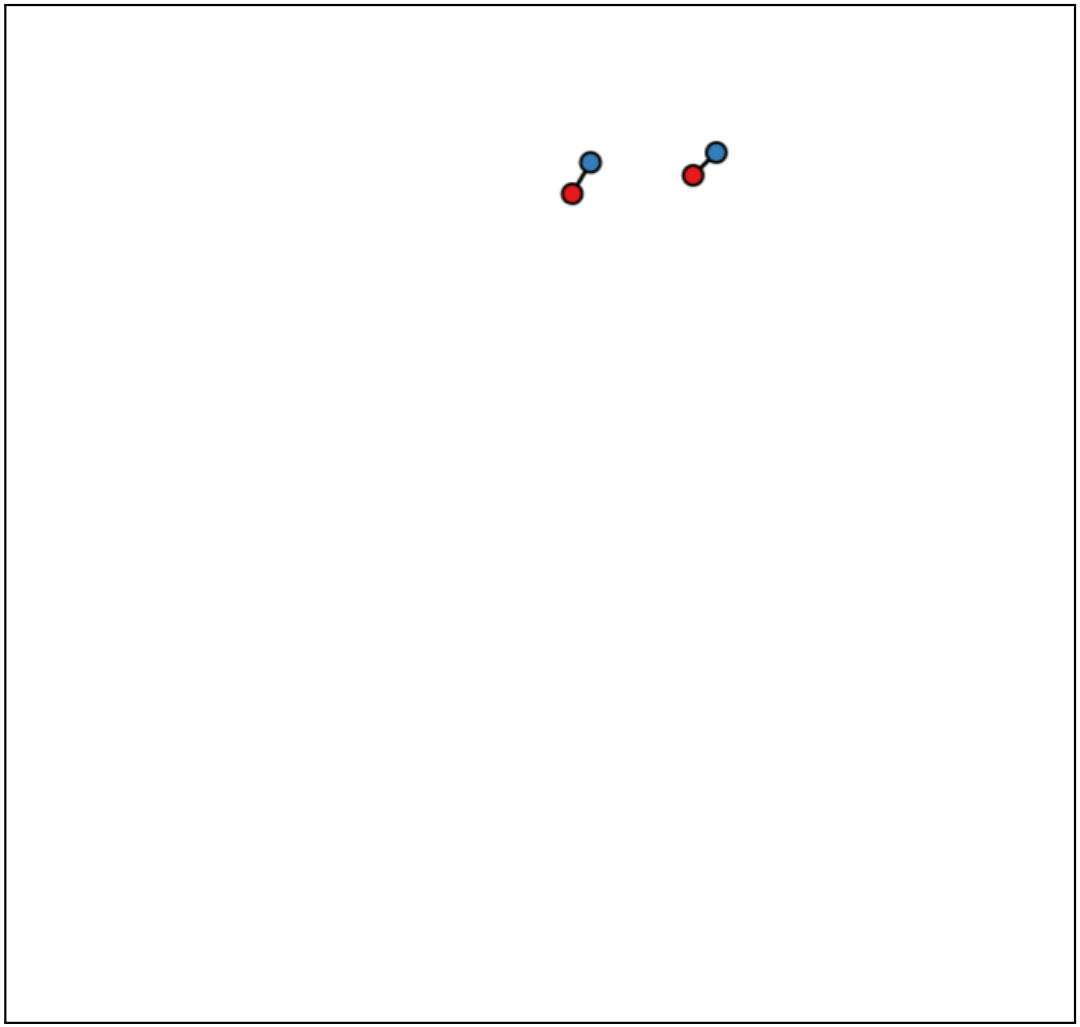
# Network exposure

## Whose behavior matters?



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(Illustration courtesy of Martina Morris (University of Washington). Used with permission.)

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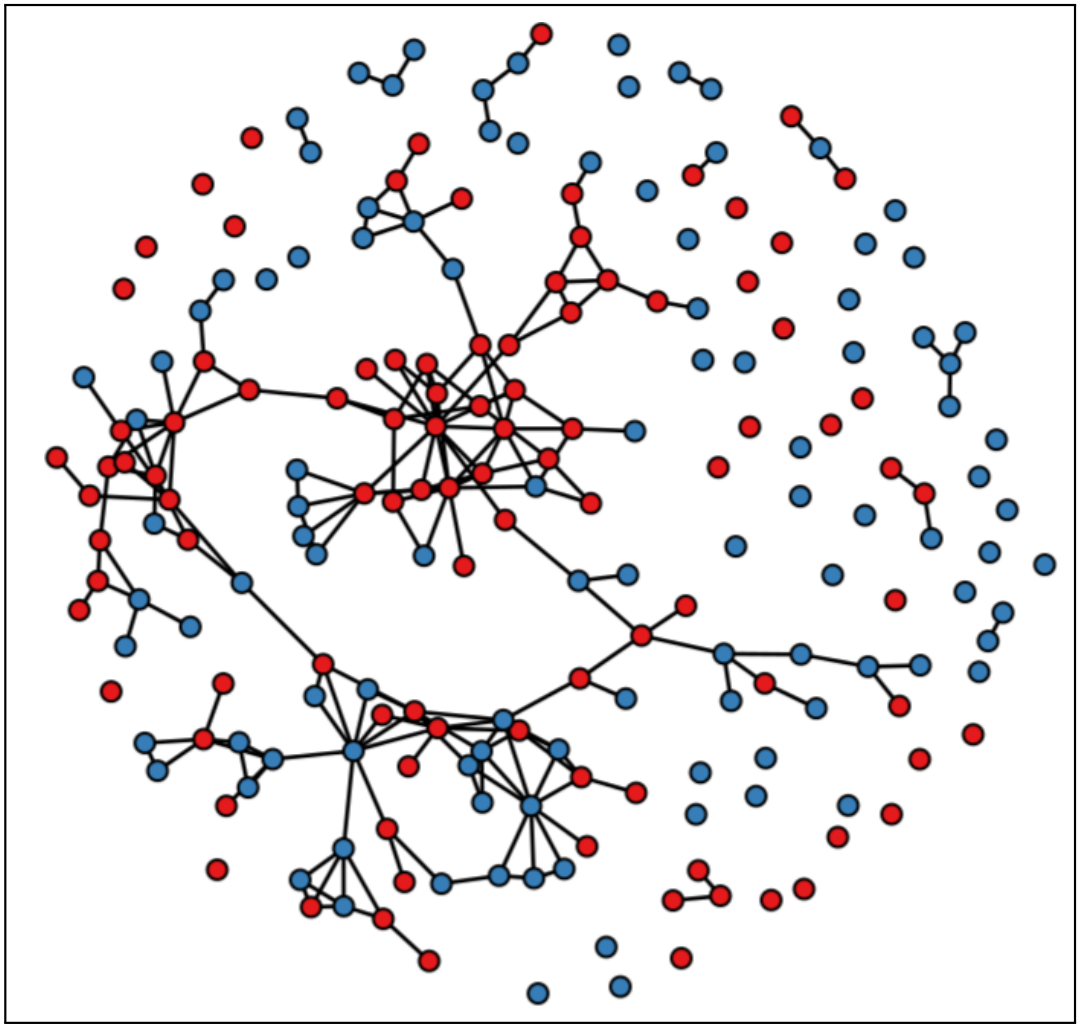

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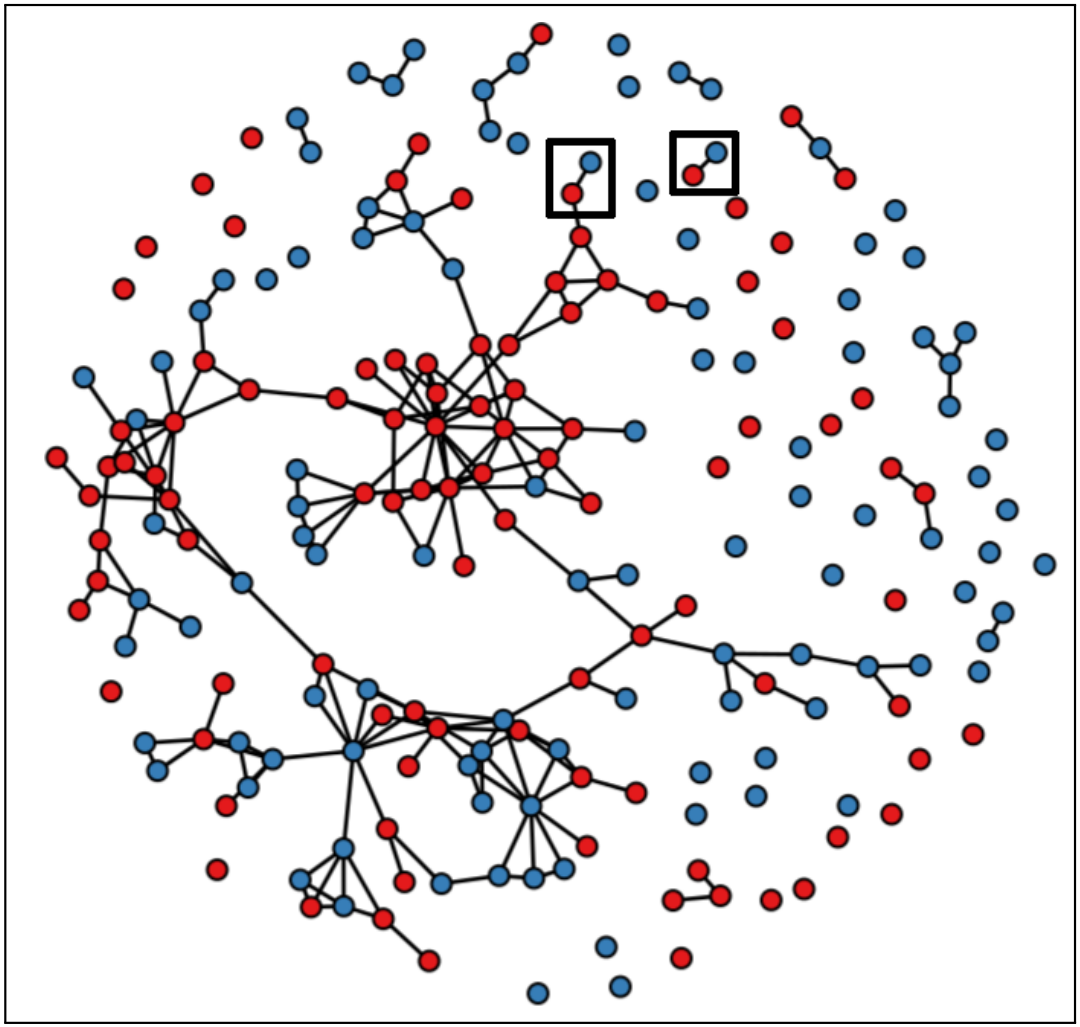

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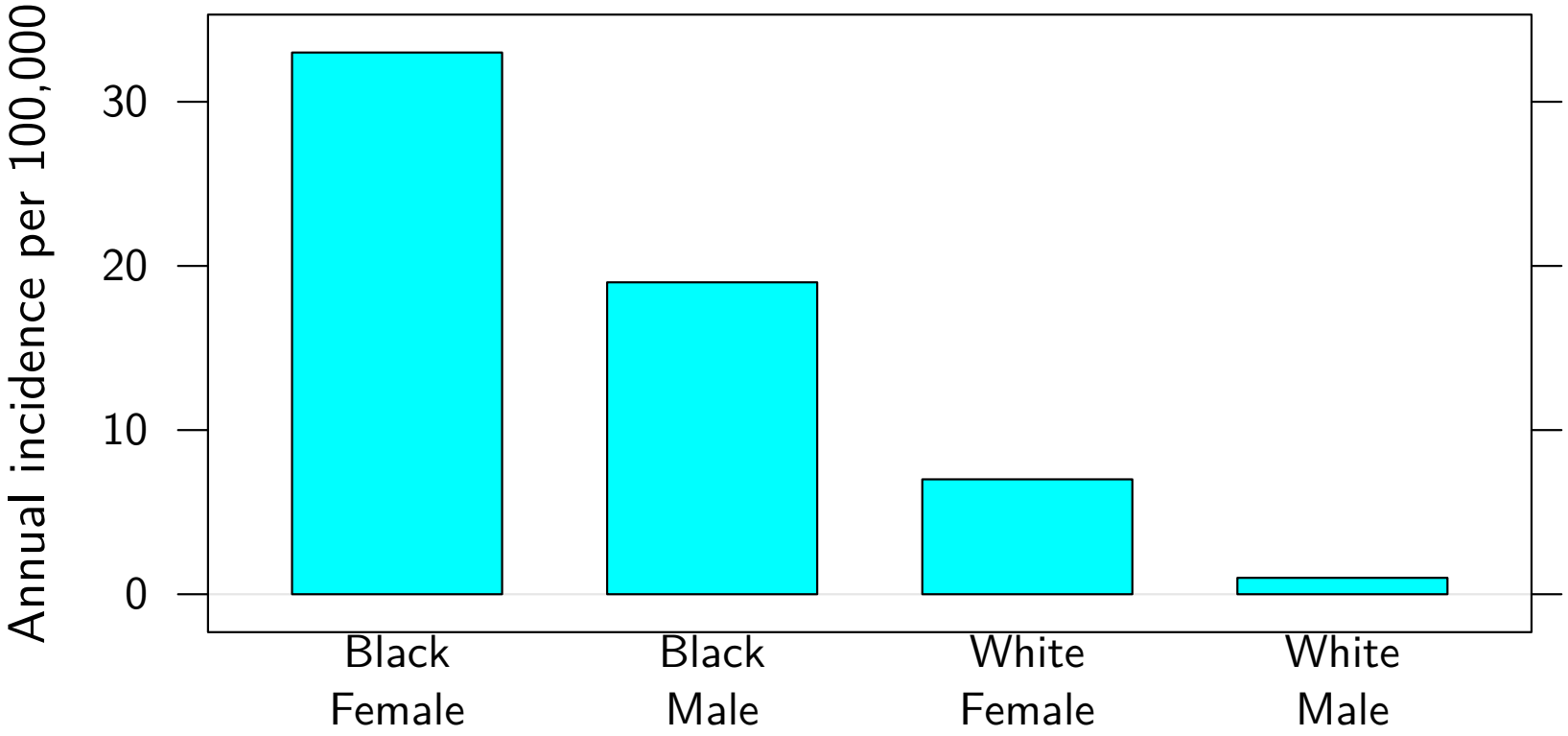
# Racial disparities in HIV prevalence in the US

Morris et al. (2006), Hallfors et al. (2007), and others

- An African-American is 10 times more likely than a white American to be living with HIV.
- This has been the case for a long time.
- Disparity holds across all age and risk groups: heterosexuals, MSM, and drug users.
- Disparity for African-American women is particularly severe.

# Heterosexually acquired HIV infections in 2010

(National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention (NCHHSTP), 2012)



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- Other STIs show similar patterns.

- *Individual* behaviors have not been able to fully account for this.
- No race-linked biological differences have been identified.

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Sexual partnership networks are...

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# Egocentrically sampled data

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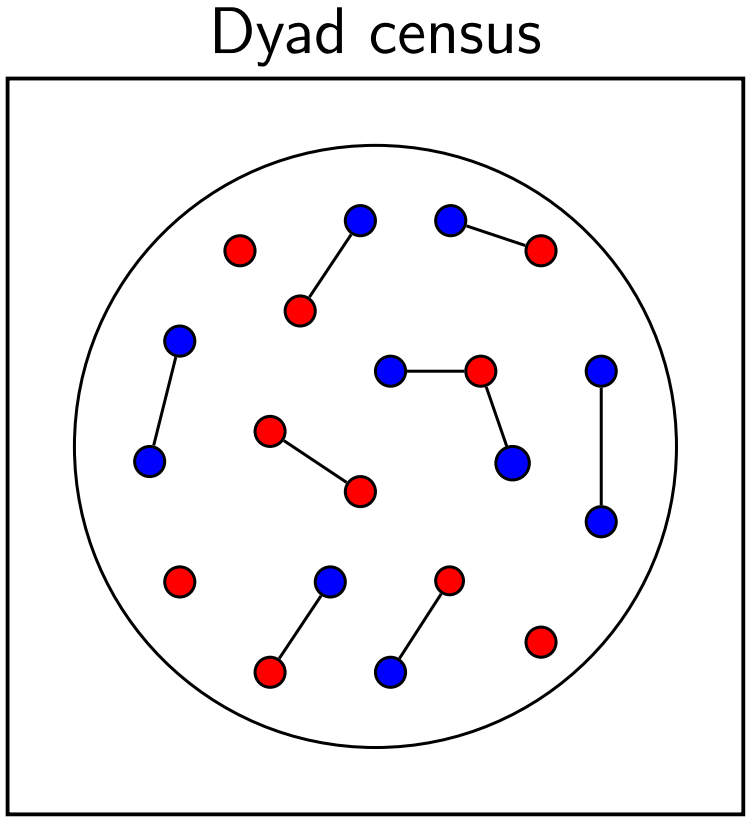

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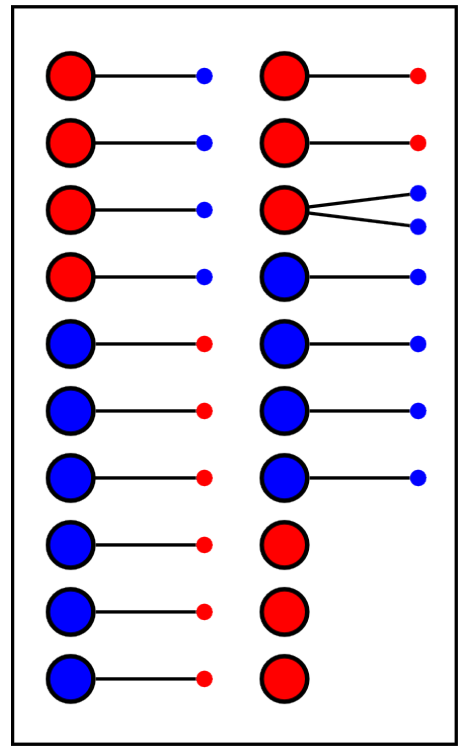

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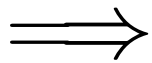

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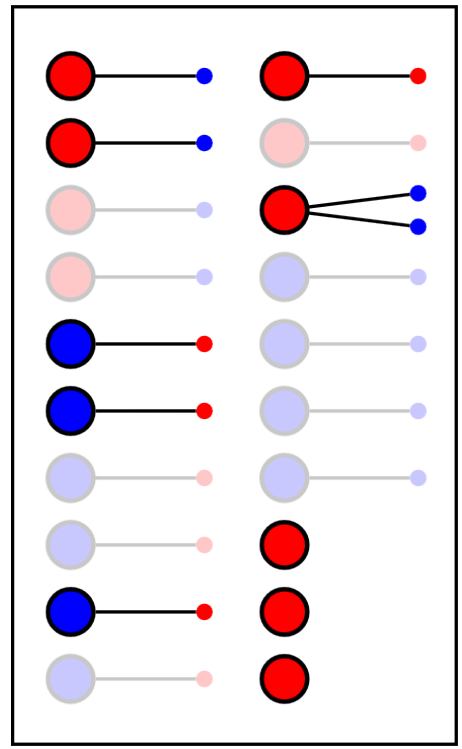

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$$\Pr(\boldsymbol{Y} = \boldsymbol{y}; \boldsymbol{\theta}, \boldsymbol{x}) = \frac{\exp\{\boldsymbol{\theta}^\top \boldsymbol{g}(\boldsymbol{y}, \boldsymbol{x})\}}{\kappa(\boldsymbol{\theta}; \boldsymbol{x})},$$

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- $\boldsymbol{g}(\cdot, \cdot)$ a vector of network features (incorporating actor attributes $\boldsymbol{x}$)
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# Recovering $\boldsymbol{g}(\boldsymbol{y}, \boldsymbol{x})$ from egocentric data

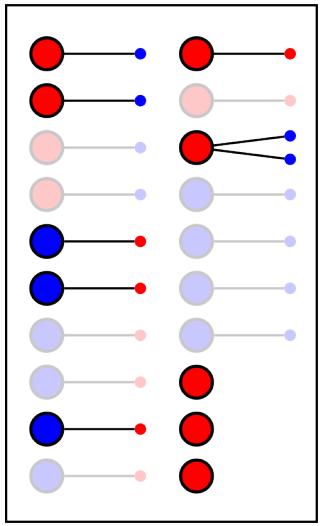
Or, "Sufficiency to the rescue!"

Dyad census



$\Rightarrow$

Egocentric sample



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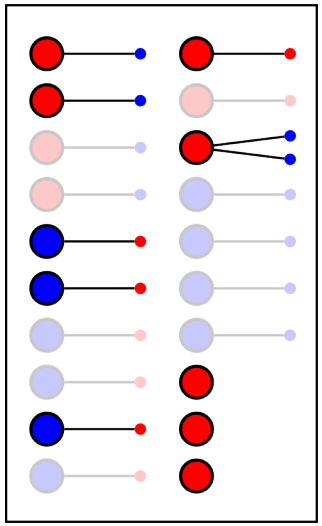

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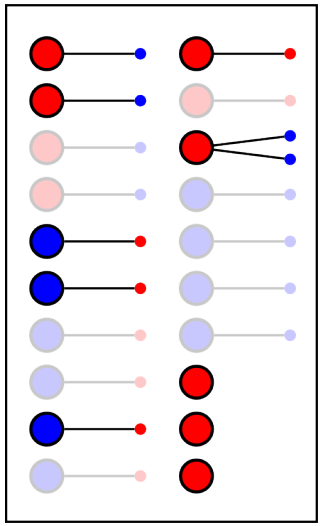

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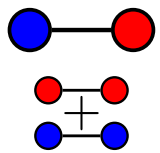

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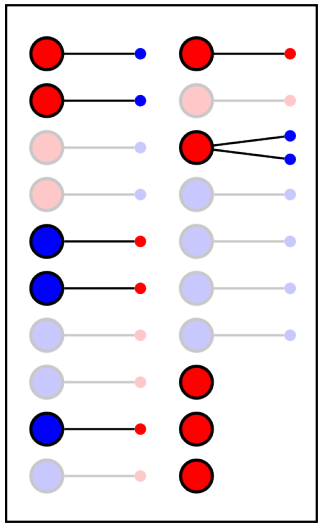

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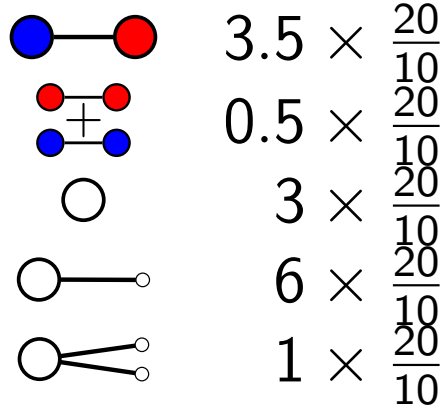

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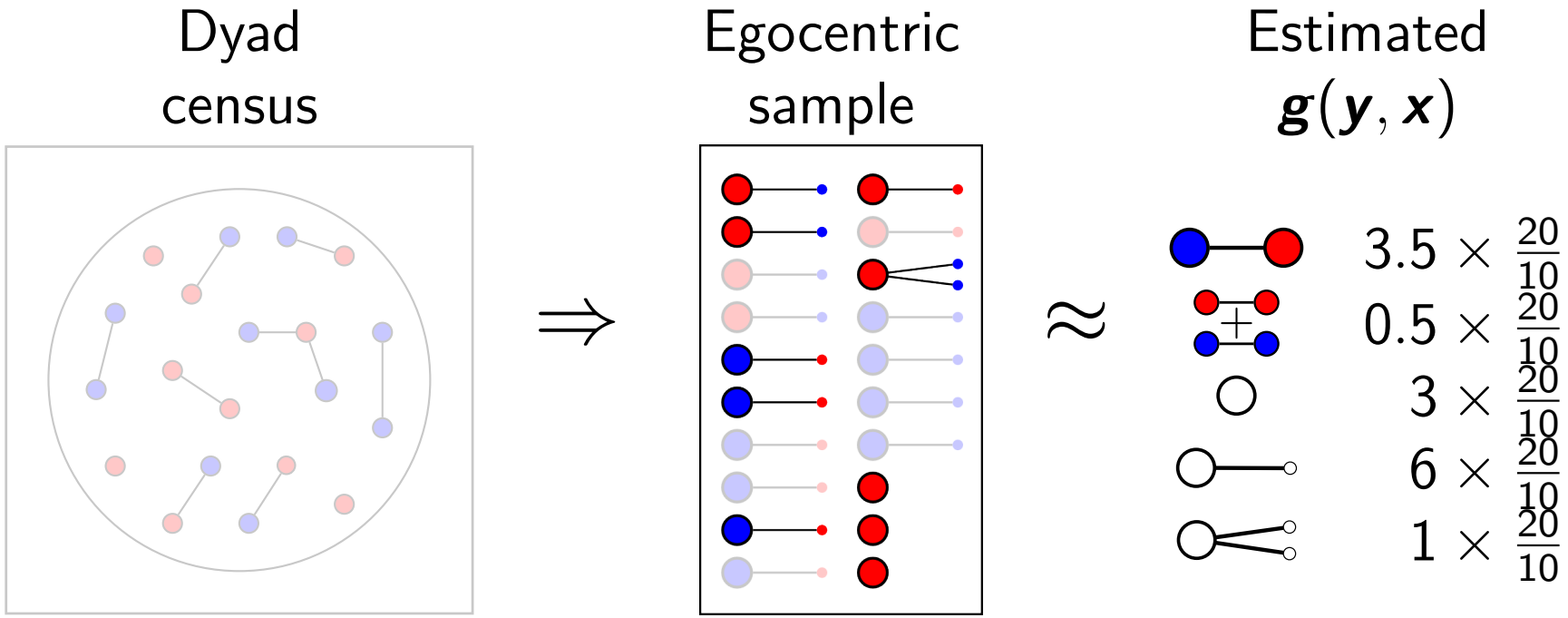


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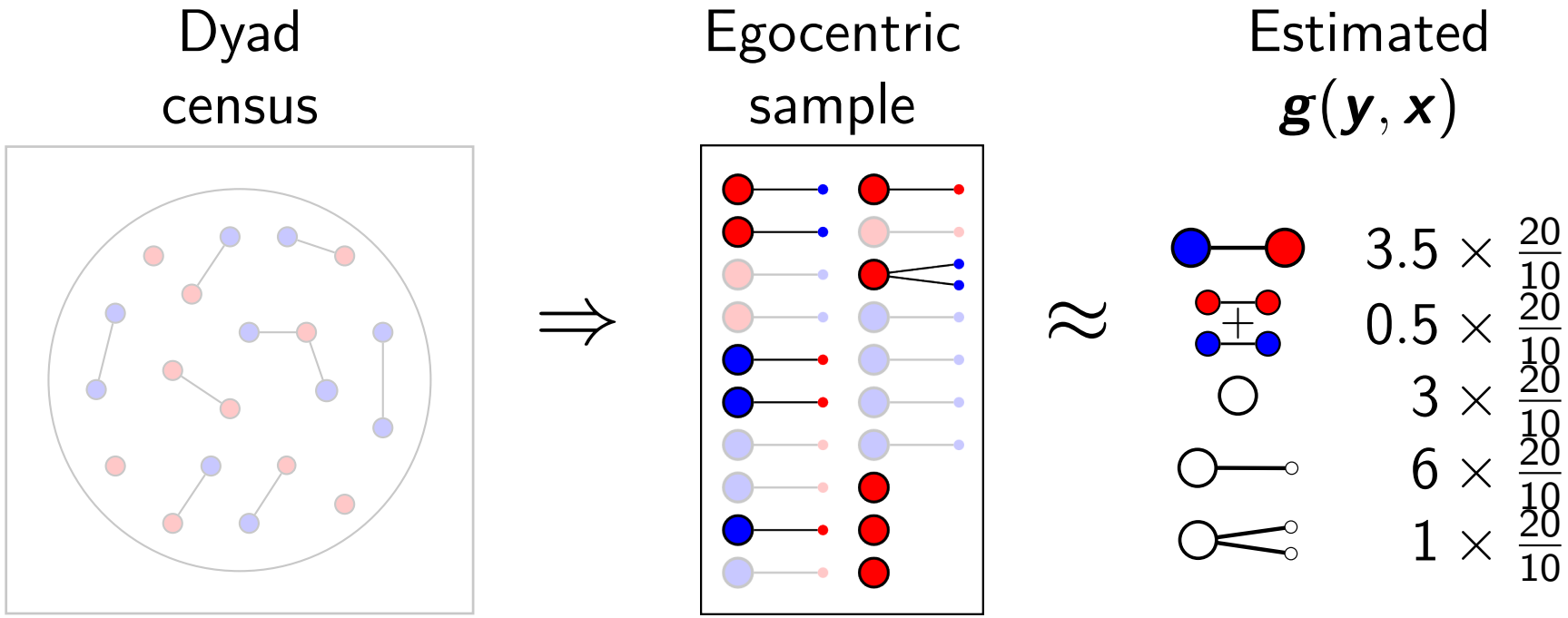


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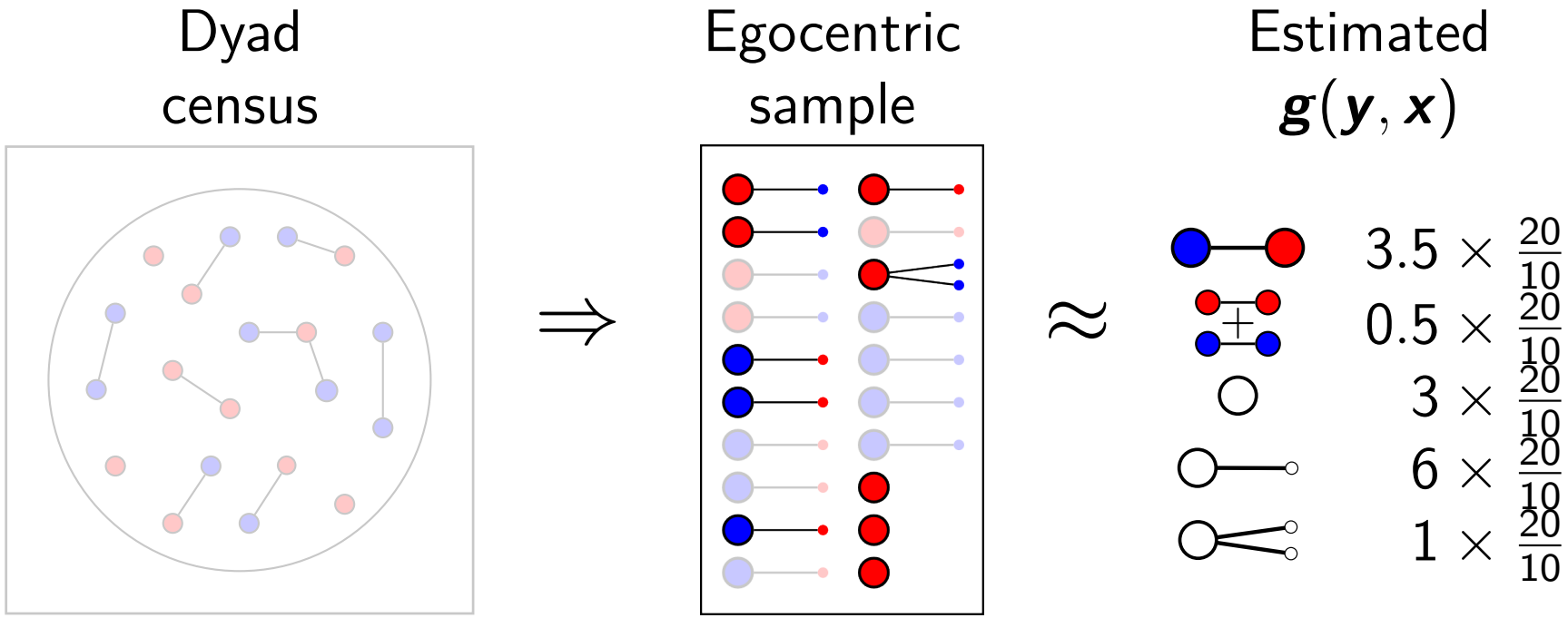


- Given $g(y, x)$, we can estimate $\theta$, simulate, etc..
- Estimates $g(y, x)$ for are noisy.
  - $\Rightarrow$ Use design-based statistical inference techniques to quantify uncertainty.

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1. How strong is the race homophily in the the population?
2. Are there differences in the propensity towards monogamy and concurrency for the races and the sexes?
3. What impact do these network features have on overall network connectivity and differentials in network exposure by race and sex?

# 1992 National Health and Social Life Survey (NHSLS) (Laumann et al., 1992, 1994)

- 3,432 American men and women between 18 and 60 years old
- Surveyed age, sex, and race/ethnicity of each respondent and current and some past sexual partner(s)

$\Rightarrow$ The data are representative but egocentric.

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We will

- fit these models answer Questions 1 and 2.
- simulate complete networks from fitted models to answer Question 3.

# Results

## After adjusting for network size

| *Model* | *1* (Main) | *2* (+ Mix.) | *3* (+ Monog.) |
|---|---|---|---|
| Actor activity by sex | | | |
| Female | 0.02 (0.10) | $-0.99\ (0.19)^{***}$ | $-1.88\ (0.31)^{***}$ |
| Male | $0.46\ (0.10)^{***}$ | $-0.55\ (0.20)^{**}$ | $-1.18\ (0.25)^{***}$ |
| Same-sex | $-4.49\ (0.21)^{***}$ | $-4.50\ (0.20)^{***}$ | $-4.52\ (0.21)^{***}$ |
| Actor activity by race | | | |
| White | | 0 (baseline) | |
| Black | $-0.09\ (0.07)$ | $-0.58\ (0.29)^{*}$ | $-0.30\ (0.38)$ |
| Other | $-0.03\ (0.07)$ | $0.83\ (0.33)^{*}$ | $0.93\ (0.42)^{*}$ |
| Race homophily by race | | | |
| Black | | $5.13\ (0.35)^{***}$ | $5.15\ (0.38)^{***}$ |
| Other | | $2.06\ (0.35)^{***}$ | $2.04\ (0.35)^{***}$ |
| White | | $2.25\ (0.34)^{***}$ | $2.32\ (0.36)^{***}$ |
| Monogamy by sex and race | | | |
| Black Female | | | $1.80\ (0.47)^{***}$ |
| Other Female | | | $2.51\ (0.67)^{***}$ |
| White Female | | | $2.25\ (0.31)^{***}$ |
| Black Male | | | $0.99\ (0.24)^{***}$ |
| Other Male | | | $1.40\ (0.31)^{***}$ |
| White Male | | | $2.16\ (0.25)^{***}$ |

Significance levels: $0.05 \geq {}^{*} > 0.01 \geq {}^{**} > 0.001 \geq {}^{***}$

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Significance levels: $0.05 \geq {}^{*} > 0.01 \geq {}^{**} > 0.001 \geq {}^{***}$

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## After adjusting for network size

| *Model* | *1* (Main) | *2* (+ Mix.) | *3* (+ Monog.) |
|---|---|---|---|
| Actor activity by sex | | | |
| Female | 0.02 (0.10) | $-0.99\ (0.19)^{***}$ | $-1.88\ (0.31)^{***}$ |
| Male | $0.46\ (0.10)^{***}$ | $-0.55\ (0.20)^{**}$ | $-1.18\ (0.25)^{***}$ |
| Same-sex | $-4.49\ (0.21)^{***}$ | $-4.50\ (0.20)^{***}$ | $-4.52\ (0.21)^{***}$ |
| Actor activity by race | | | |
| White | | 0 (baseline) | |
| Black | −0.09 (0.07) | $-0.58\ (0.29)^{*}$ | −0.30 (0.38) |
| Other | −0.03 (0.07) | $0.83\ (0.33)^{*}$ | $0.93\ (0.42)^{*}$ |
| Race homophily by race | | | |
| Black | | $5.13\ (0.35)^{***}$ | $5.15\ (0.38)^{***}$ |
| Other | | $2.06\ (0.35)^{***}$ | $2.04\ (0.35)^{***}$ |
| White | | $2.25\ (0.34)^{***}$ | $2.32\ (0.36)^{***}$ |
| Monogamy by sex and race | | | |
| Black Female | | | $1.80\ (0.47)^{***}$ |
| Other Female | | | $2.51\ (0.67)^{***}$ |
| White Female | | | $2.25\ (0.31)^{***}$ |
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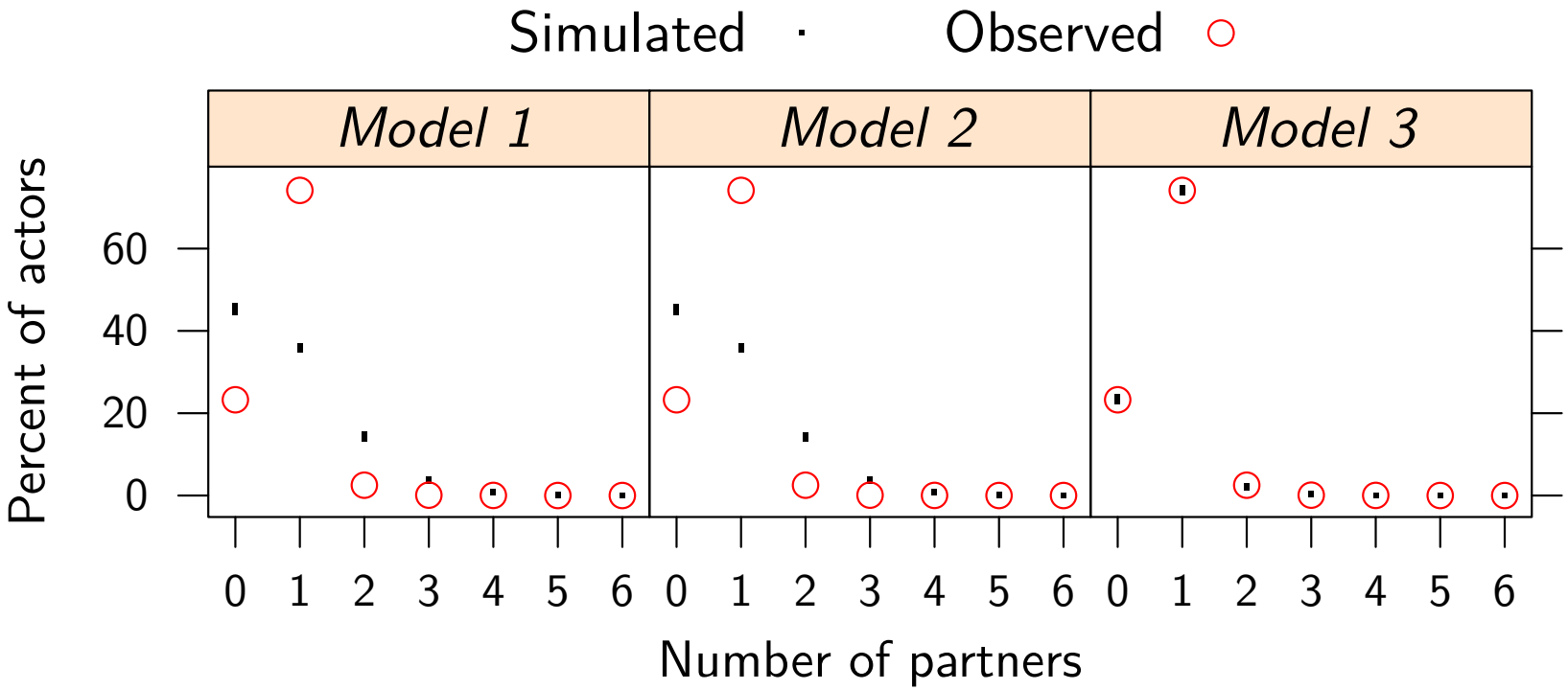
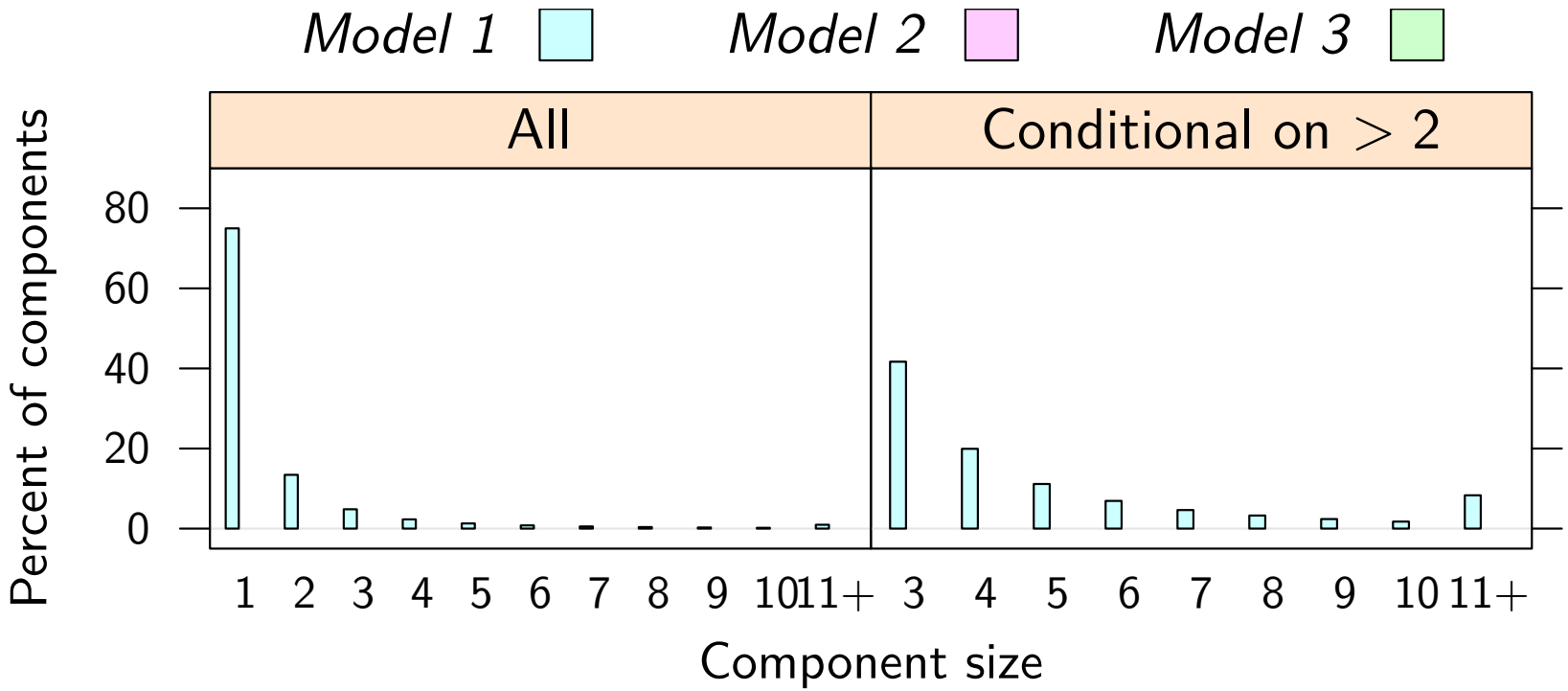
# Goodness-of-fit of degree distributions



# Simulated distribution of connected component sizes



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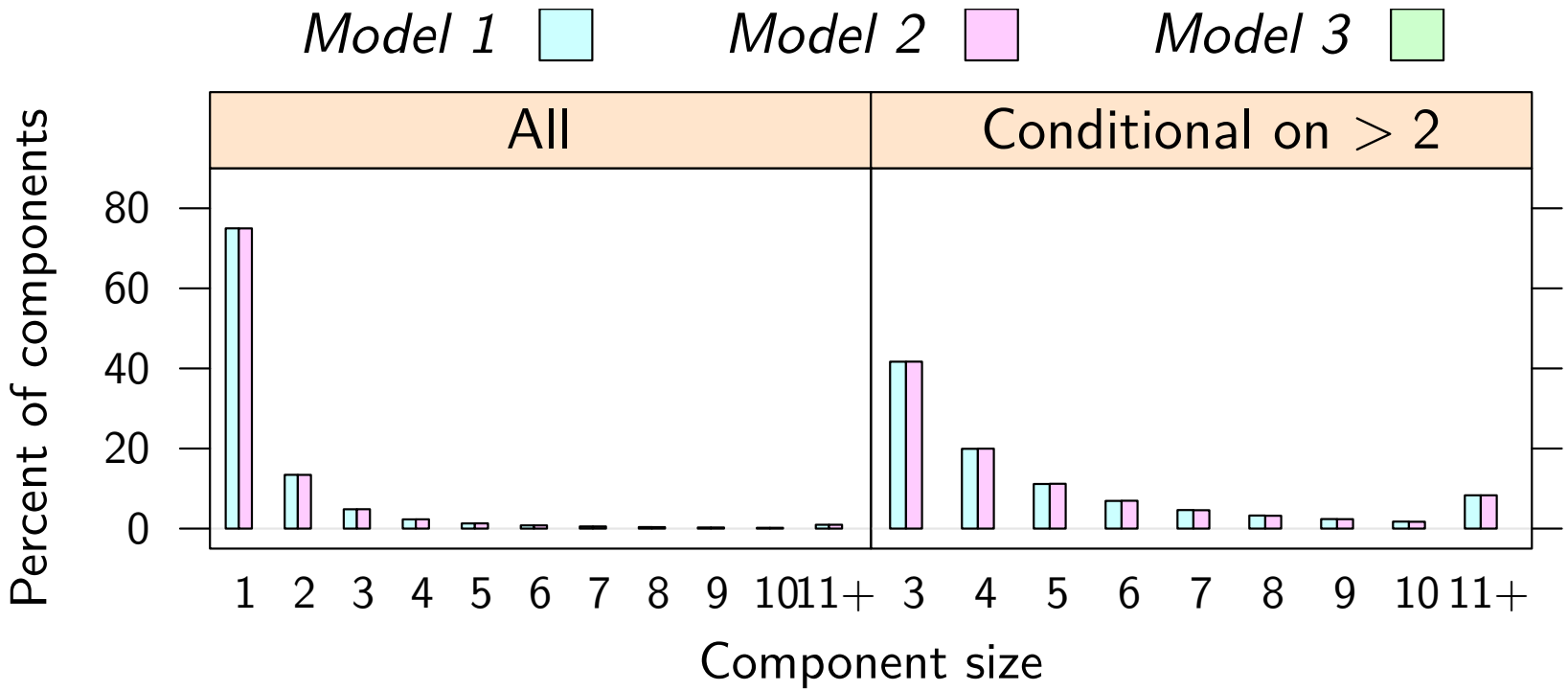

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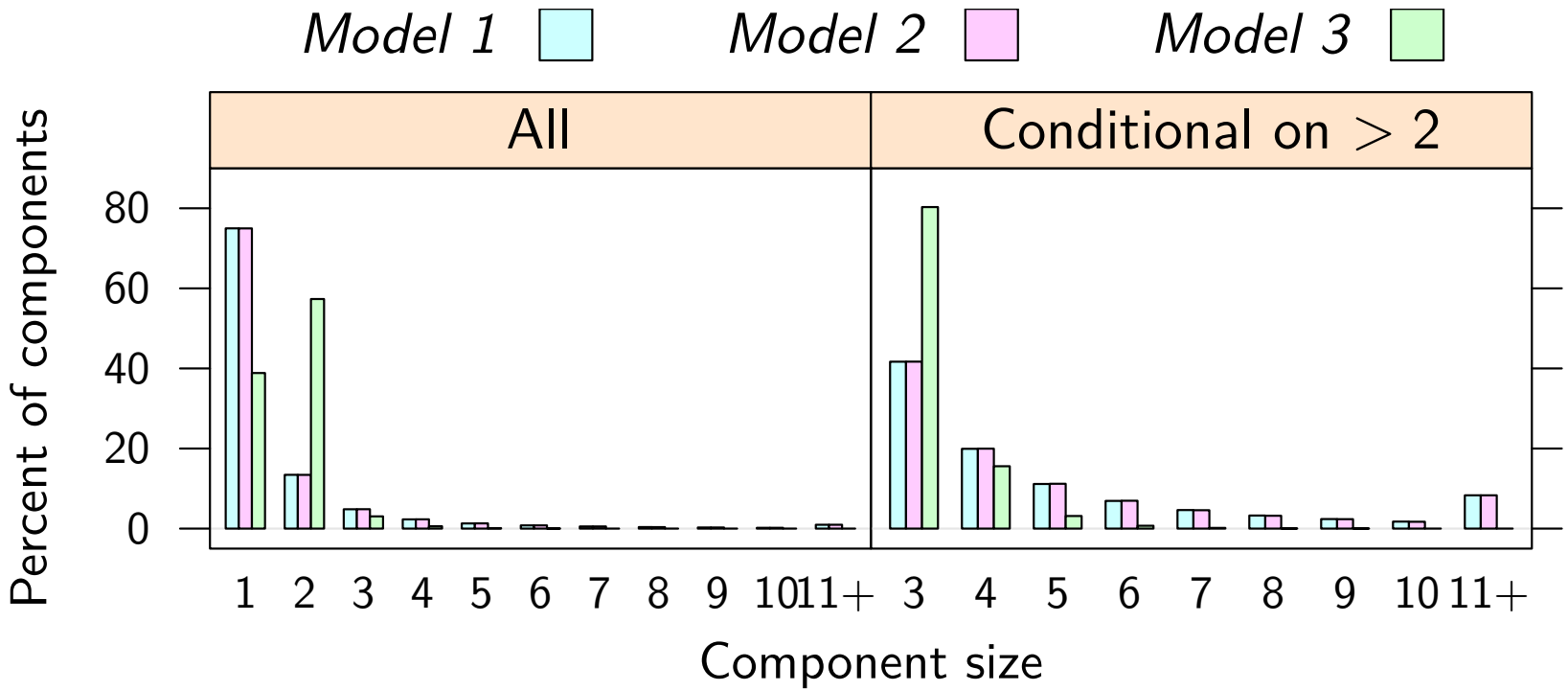

# Contrasts of interest

Differences in monogamy:

White Female and Black Female: $2.25 - 1.80 = +0.45$,
s.e. $= 0.51$, $P$-value $> 0.3$

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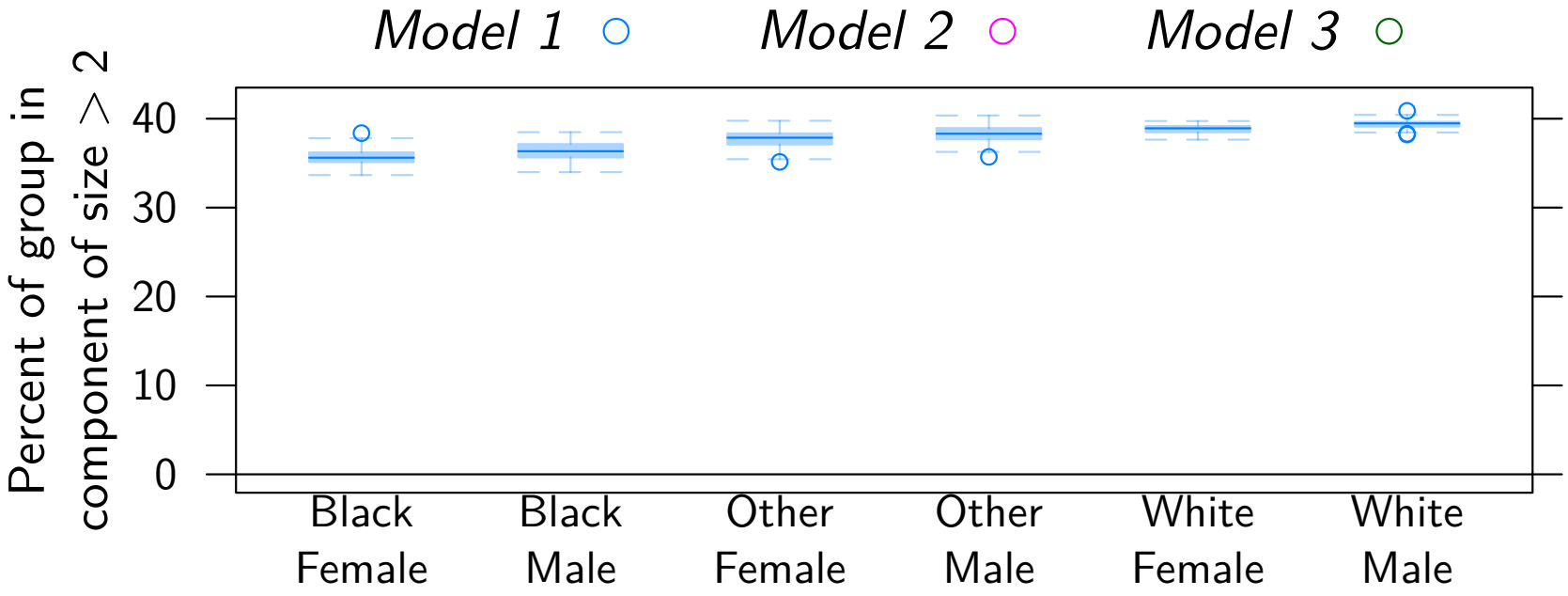
Female and Male: Women have higher monogamy coefficients in all groups, but not statistically significant.

# Simulated network exposure by race and sex



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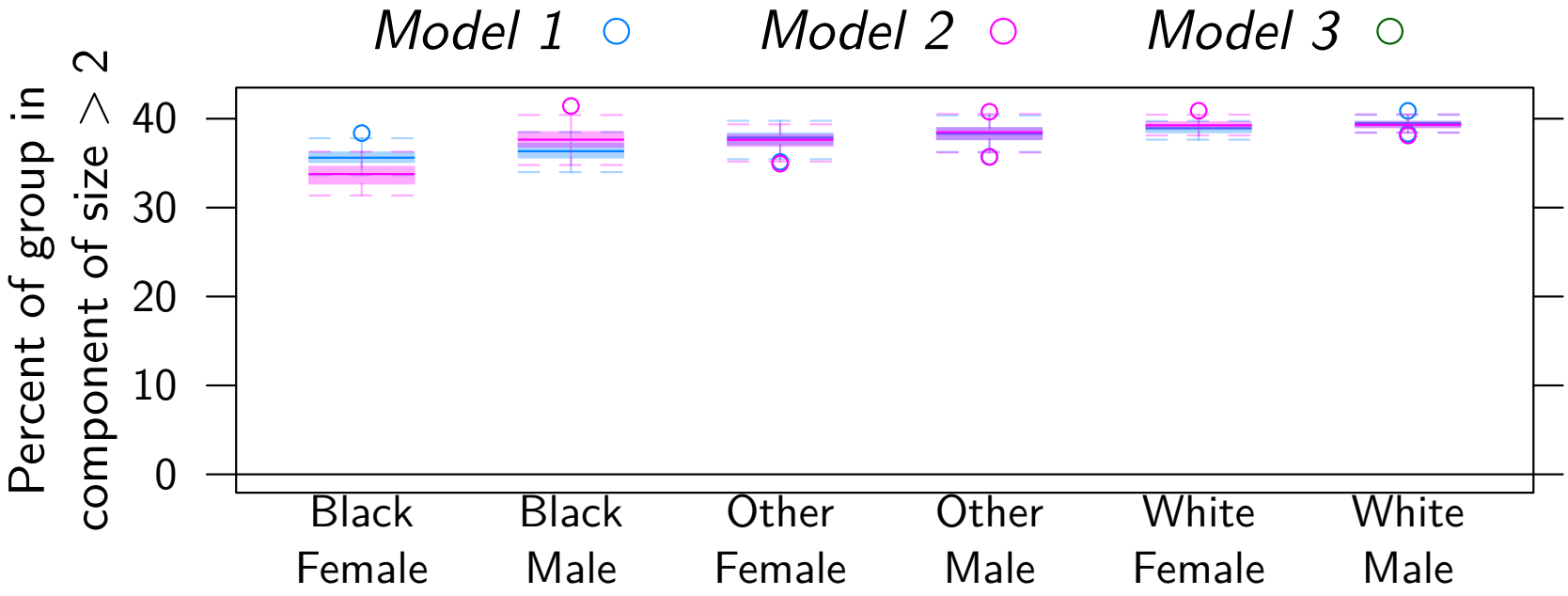

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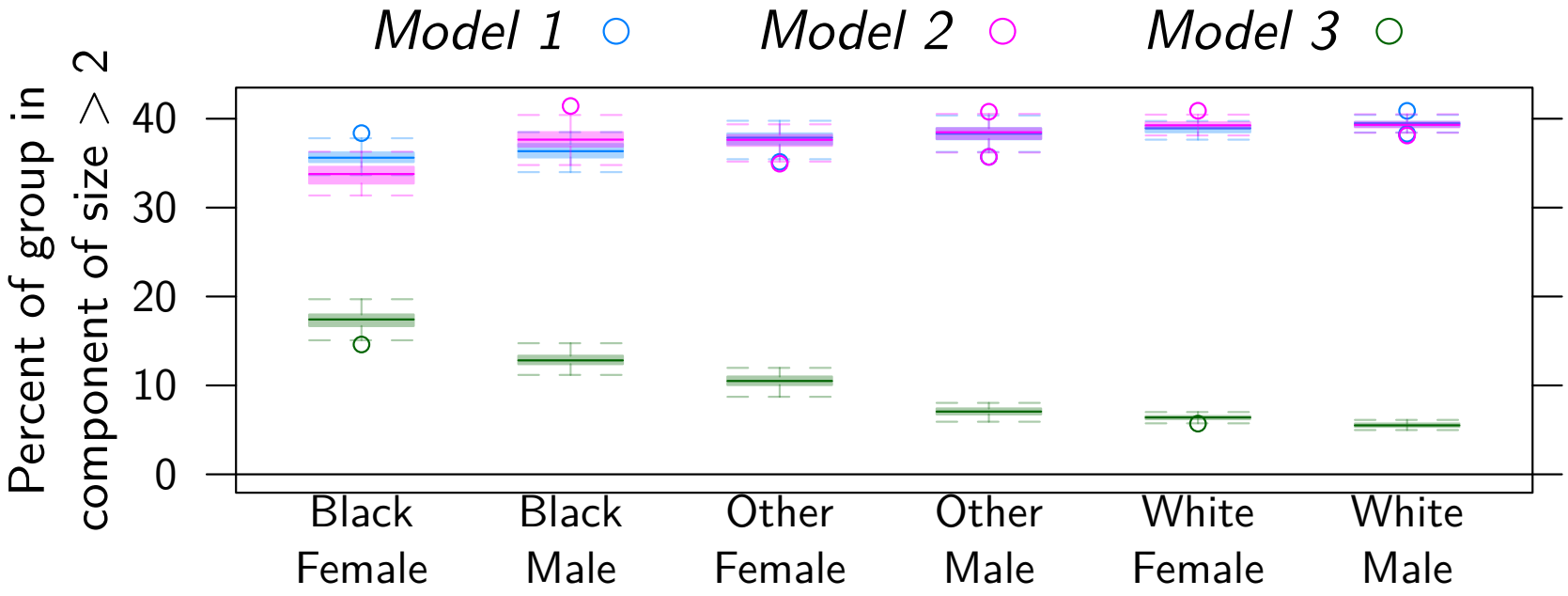
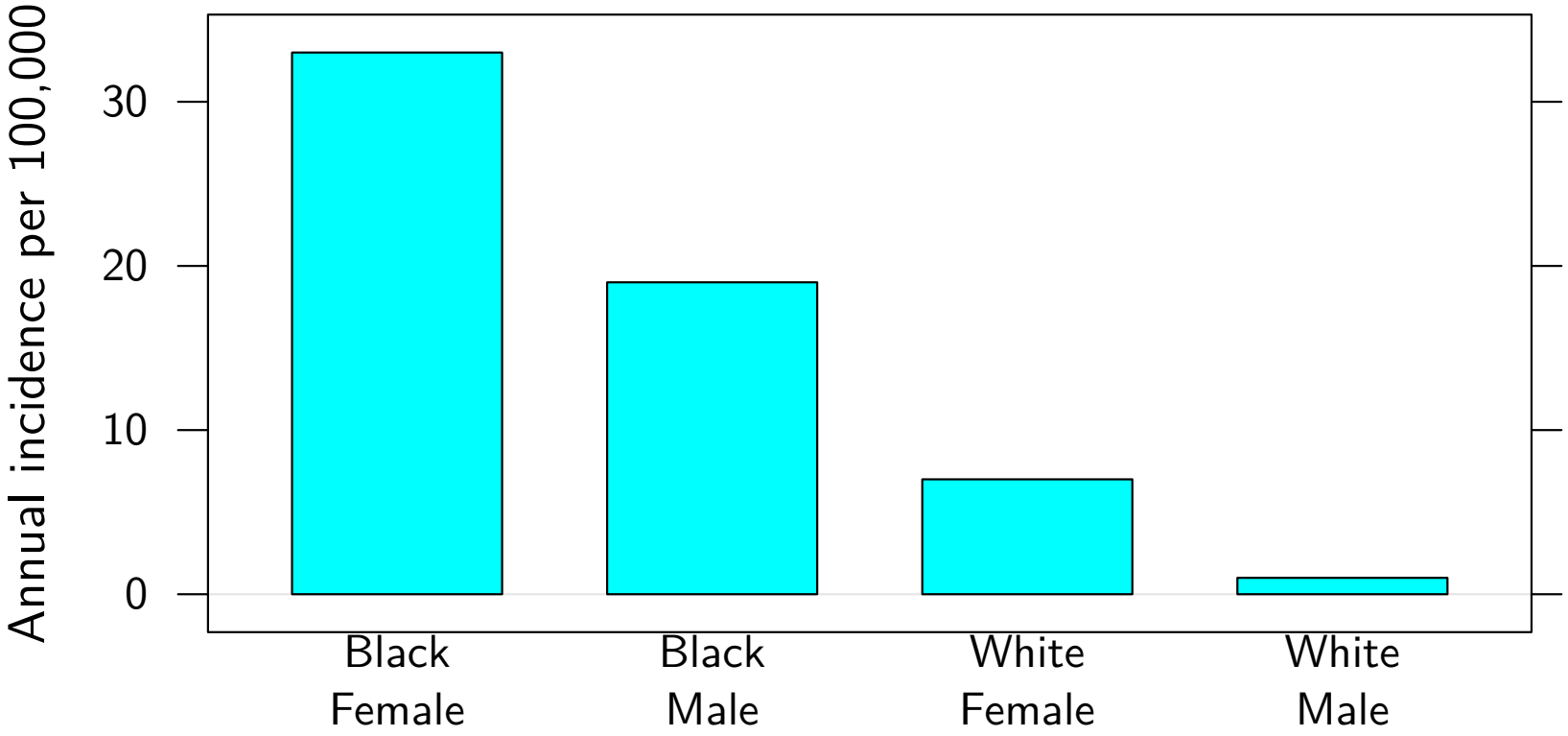


# Heterosexually acquired HIV infections in 2010

(National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention (NCHHSTP), 2012)



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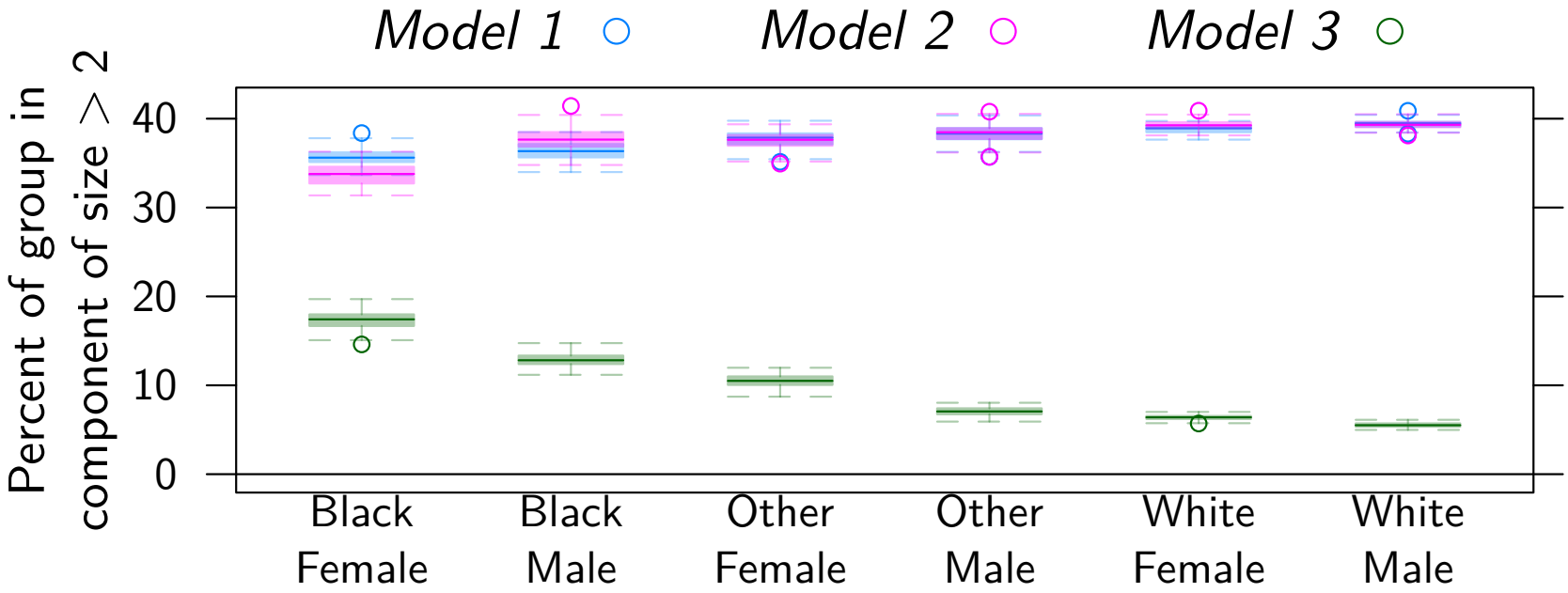


- Model 3 exposure consistent with observed prevalence of HIV.

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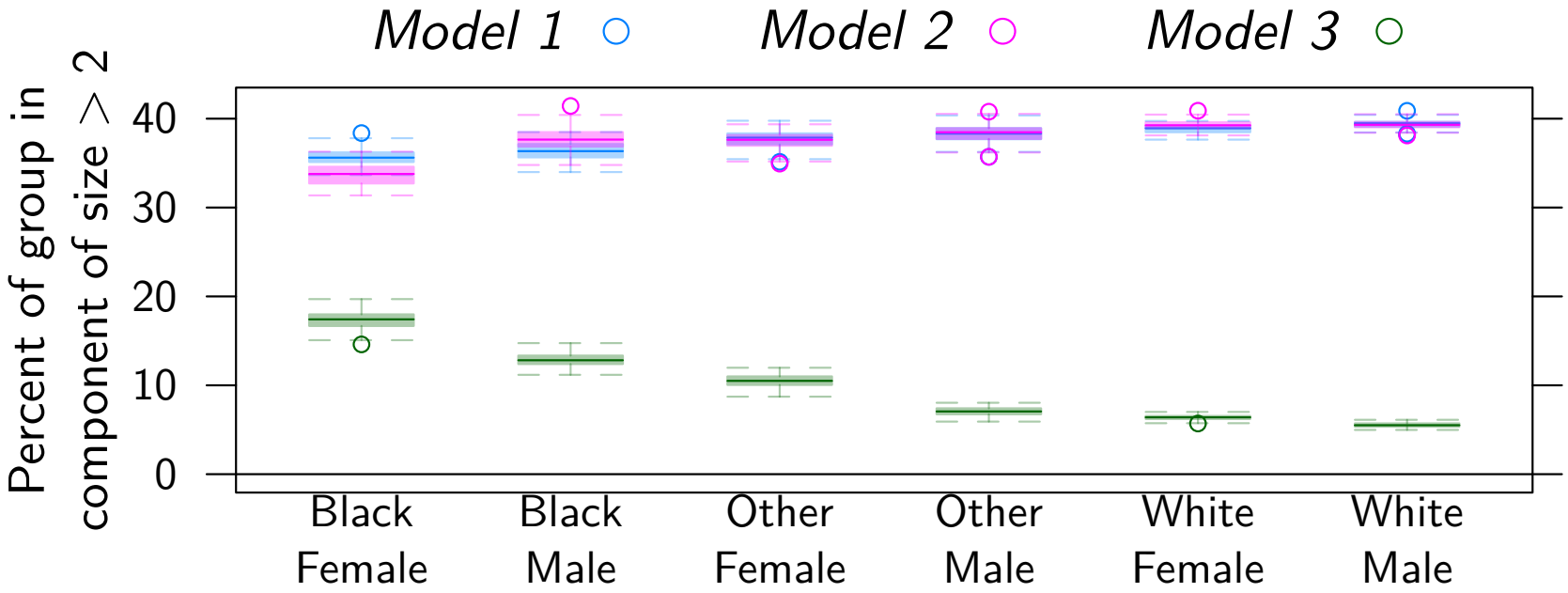


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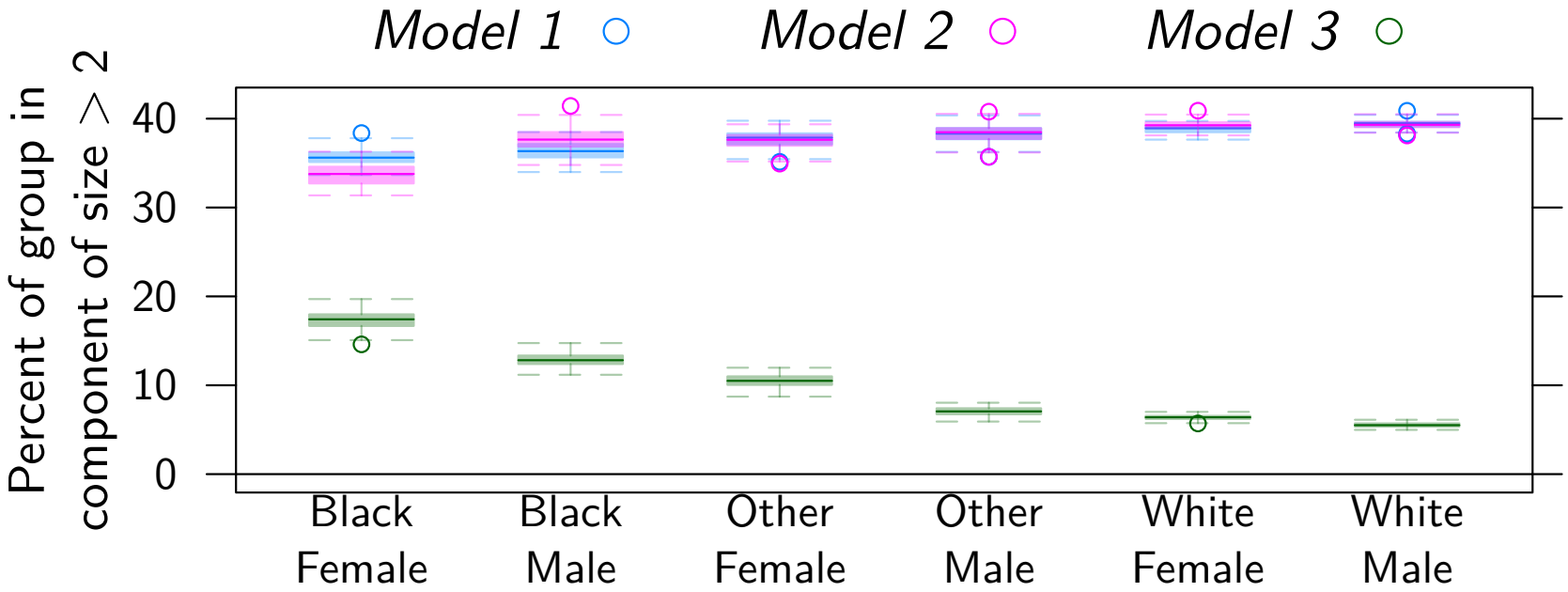


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$\Rightarrow$ In a network, what you do might be less important than what those you are connected to do.

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Tech report available at `https://niasra.uow.edu.au/workingpapers/UOW190187.html`.

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Edward O. Laumann, John H. Gagnon, Robert T. Michael, and Stuart Michaels. *The social organization of sexuality*. University of Chicago Press, Chicago, 1994. ISBN 0226469573.

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