Uncovering the (lack of) social science behind mathematical models of behaviour change for HIV prevention

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Mathematical models in HIV epidemiology

Compartmental models

\[
\begin{align*}
B &= \text{Birth rate} \\
C &= \text{Sexual contact rate} \\
P &= \text{Probability of HIV transmission per sexual contact} \\
I/(S+I) &= \text{HIV prevalence} = \text{Probability that a random contact is with an HIV positive partner} \\
M &= \text{Mortality rate among HIV positive people}
\end{align*}
\]
Mathematical models in HIV epidemiology

Individual-based models

- Blue circle = HIV negative
- Red circle = HIV positive
- Black circle = Dead
- Black line = Sexual relationship
Health behavioural theories and models in HIV prevention

- HIV mortality rate
- Mass media
- Peer pressure
- Age gap with (prospective) partner
- ART status of (prospective) partner
- Exposure to “some” behavioural change campaign

Society

Network

Couple

Individual
Frailty selection bias, but no behaviour change

\[ C' = C \times \exp\left(-a \times \frac{I}{(S+I)}\right) \]

Average sexual contact rate among HIV negative people decreases with increasing HIV prevalence

But no-one changes their behaviour
Frailty selection bias, AND behaviour change

\[ C'(t) = \frac{PSI}{S+I} \]
\[ C0' = C \exp(-a\frac{I}{S+I}) \]
\[ C'(t) = C0' \frac{(1-b)\exp(d(t-f))}{1+\exp(d(t-f))} + b \]

People change behaviour, in response to "some" intervention.
Assortative mixing, by ART status

- Changes in sexual mixing pattern?

![Diagram](attachment:image.png)

- HIV+ on ART
- HIV+ not on ART
- HIV-
How could ART assortativity emerge?

- People on ART prefer partners also on ART
- ART concordant couples are more stable
- People not on ART are more likely to start ART if their partner is on ART
Assortative mixing, by ART status

- **ART Assortativity index (m)**
- **PopIRR_m**
- **ART coverage (a)**
  - 0.3
  - 0.9
- **IRR of ART (r)**
  - 0.04
  - 0.19
  - 0.34
Assortative mixing, by age