Volatile contact rates and the transmission of HIV

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Public health significance

1:1000
The homogeneous model

\[
\begin{align*}
\dot{S} & \propto -S \frac{I}{N} \beta \chi \\
\dot{I} & \propto S - I \delta
\end{align*}
\]
Stages of infection

Acute

Chronic
Transmission potential homogeneous model

acute chronic
Transmission potential, alternative hypothesis

acute  chronic
Homogeneous contact
Heterogeneous contact
Heterogeneous volatile contact
Evidence for heterogeneous contacts
Hazard is proportional to contact rate

$\chi$ susceptible

$\langle \chi \rangle$

risk $\propto \chi$

$\chi^*$ infected

$\langle \chi^* \rangle = \langle \chi \rangle + \frac{\langle \chi \rangle}{\langle \chi \rangle}$
Evidence for contact rate volatility
The simulation model

\[ S^* = \sum_{i \in S} \chi_{i,t} \]

\[ \dot{S} \propto -S^* \left( \frac{A^*}{N^*} \beta_a + \frac{C^*}{N^*} \beta_c \right) \]

\[ \dot{A} \propto S - A \delta_a \]

\[ \dot{C} \propto A \]

\[ \chi \sim \log N(\mu, \sigma^2) \]
Endemic prevalence, no volatility
Endemic prevalence, increasing volatility
Acute and chronic incidence rates

![Graph showing acute and chronic incidence rates]
The 3 mechanisms of volatility, an illustration

mean value unsampled

mean value time from sampling
Volatility sustains high contact rates among susceptible
Volatility increases the contact rate of acute infecteds

- **Frequency**
  - Heatmap showing the distribution of frequency contact rate variance.
  - The x-axis represents frequency, and the y-axis represents the contact rate variance.
  - The color scale ranges from blue (low variance) to red (high variance).

- **Contact rate variance**
  - Another heatmap showing the relationship between frequency and contact rate variance.
  - The x-axis represents frequency, and the y-axis represents contact rate variance.
  - The color scale ranges from blue (low variance) to red (high variance).
Volatility decreases the contact rate of chronic infecteds
Volatility ‘compresses’ risk