HIV/AIDS and rape: Modeling predictions of the increase in individual risk of HIV infection from forced sex in conflict & post-conflict settings

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Presentation Outline

- Project Aims
- Research Context
- Methodology
- Background
  1. Factors that may increase HIV transmission
  2. Modelling approach
  3. Key assumptions
- Results: Model Scenarios
  1. Violence & coercion
  2. Anal rape
  3. Population movement
- Summary & Conclusions
Project Aims

Use mathematical modelling to:

- Estimate how forced sex may increase an individual’s risk of HIV acquisition for different conflict scenarios
- Explore scenarios when rape may lead to a > 5% increase in population HIV incidence
RESEARCH CONTEXT
Non-conflict settings: Increasing biological evidence of linkages between IPV and HIV & STIs

- South Africa:
  - Women with violent partners more than 50% more likely to be HIV infected than other women

- Tanzania:
  - The odds of reporting violence are 10 times higher for young, HIV-positive women compared to young, HIV-negative women

- Goa, India:
  - Among married women with violent partners, the risk of incident STI is 3 times higher than married women without violent partners

- Rakai, Uganda:
  - Girls who report forced/coerced sex had higher risk of HIV infection
Conflict settings: High proportion girls, women and some boys experience forced sex

- Rape, coerced sex & transactional sex common
- Debate about extent to which this may contribute to HIV epidemic
  - Ecological analysis has found no associations between community levels of rape and community prevalence of HIV
  - Modelling concludes that rape unlikely to lead to large increases in population HIV prevalence
- Population prevalence is a broad measure of HIV which reflects the cumulative effects of behaviours over many years
Methodology

- Literature review on factors which may increase HIV transmission during forced sex: (1) genital injury; (2) higher HIV/STI prevalence among perpetrators
- Development of scenarios for forced sex
- Adaptation of an existing mathematical model of individual risk of HIV acquisition
- Development of an analytical equation to describe relative probability of acquiring HIV infection in conflict scenarios vs. comparable non-conflict scenarios
- Development of a model to estimate impact of rape on population HIV incidence
- Modelling analysis of scenarios
Many factors influence risk of HIV acquisition following rape:

- Likelihood rapist HIV infected
- HIV susceptibility of younger vs. older women & children
- Extent of coercion and genital trauma & extent that this trauma may facilitate HIV transmission
- Number of assailants & number of times rape occurs
- Likelihood assailant has an STI & extent to which this facilitates HIV transmission (cofactor)
- Extent of condom use
- Whether rape anal or vaginal
- Availability of PEP
Evidence on effect of rape & genital injury on probability of HIV transmission

- Genital injury disrupts the multi-layered stratified epithelium that lines a woman’s reproductive tract and acts as a natural barrier to infection.
- Studies in trauma centres record 36% to 53% of women suffering genital injuries.
- Colposcopy can detect genital injury in 87% of sexual assaults.
- Extensive damage can occur from rape of a child.
- No estimates of how this may affect per sex act probability of HIV transmission.
Modelling approach to conceptualise comparison of individual risk

Compare risk in conflict vs. non-conflict scenarios:
- Forced sex occurs vs. no forced sex
- Forced sex + consensual sex
- Transactional/commercial sex vs. primary relationship sex

Factoring in:
- Level of trauma
- Likelihood that partner is HIV infected
- Likelihood partner has a STI
- High viraemia
Background

MODELLING APPROACH & KEY ASSUMPTIONS
Probability of HIV acquisition ($p$) over fixed period of time:

$$1 - [1 - p + p(1 - b)^n]^m$$

- $p$ is probability that selected sexual partner is HIV infected
- $b$ is probability of HIV transmission per sex act
- $m$ is average number of sexual partnerships the person has over the fixed period of time
- $n$ is average number of sexual acts per partnership during the fixed period of time

Extrapolate to include:
- Generic STI facilitating HIV transmission
- Initial period of high infectivity
- Increased risk of HIV transmission with genital injury
Key assumptions

- HIV and STI prevalence is twice as high among higher risk / violent males compared to other males.
- Probability M->F HIV infection per vaginal sex act 0.002.
- Probability M->F HIV infection anal sex act 0.01.
- Assume genital trauma increases ‘per-sex-act’ risk by multiplicative factor of:
  - 1.5 for single sites of trauma
  - 3 for multiple sites of trauma (gang rape)
  - 6 for anal rape
- STIs increase probability of HIV transmission 3-fold.
Results

MODEL SCENARIOS
Could rape impact on population HIV incidence?

- Consider range of assumptions about:
  - Percentage experienced rape (5% - 15%)
  - HIV prevalence among women (5%)
  - HIV prevalence among rapists (10%, 25%)
  - Transmission probability due to rape (0.001, 0.08, 0.16)
  - Underlying HIV incidence (1%, 2%, 3%, 4%)

- NB: in this analysis consider solely single rape by single perpetrator
# Model Scenario: Violence & coercion against adult women

<table>
<thead>
<tr>
<th>Conflict scenario</th>
<th>Comparison</th>
<th>Risk ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult female, forced to have sex by unknown assailants (multiple site trauma)</td>
<td>Same number of consensual sex acts with one partner from own community</td>
<td>4.3</td>
</tr>
<tr>
<td>Adult female raped by 3 men at refugee camp (multiple site trauma) and also has low risk male partner that she has 3 consensual sex acts with</td>
<td>Only has 3 consensual sex acts with low risk male partner</td>
<td>5.3</td>
</tr>
<tr>
<td>Adult female trades sex with several male members of peacekeeping force (single site trauma once in every 8 sex acts)</td>
<td>Same number of consensual sex acts with one man from own community</td>
<td>1.5</td>
</tr>
</tbody>
</table>
## Model Scenario: Anal rape

<table>
<thead>
<tr>
<th>Conflict scenario</th>
<th>Comparison</th>
<th>Risk ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anal rape of adult male or female by 3 men at refugee camp, and also has low risk partner of opposite sex that he/she has 3 consensual penile-vaginal sex acts with</td>
<td>Only has 3 consensual penile-vaginal sex acts with low risk partner</td>
<td>86</td>
</tr>
</tbody>
</table>

* Probability HIV transmission per anal sex act = 0.02
* Assume trauma increases ‘per sex act’ risk by multiplicative factor of 6
## Model Scenario: Effect of population movement

<table>
<thead>
<tr>
<th>Conflict scenario</th>
<th>Comparison</th>
<th>Risk ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Influx of higher exposed population to an area of lower exposure</td>
<td>No population movement, otherwise same behavioural patterns</td>
<td>1.4</td>
</tr>
<tr>
<td>Influx of lower exposed population to an area of higher exposure</td>
<td>No population movement, otherwise same behavioural patterns</td>
<td>0.6</td>
</tr>
<tr>
<td>Adult woman, quarter of sex acts are forced by her highly exposed male partner (single site trauma)</td>
<td>Comparison is same number of sex acts with a male partner who has not been to higher risk situation</td>
<td>1.6</td>
</tr>
</tbody>
</table>
Illustrative scenarios where rape increases community HIV incidence by > 5%

<table>
<thead>
<tr>
<th>Percentage women experienced rape (r)</th>
<th>Transmission probability due to rape (t)</th>
<th>Population HIV incidence if no rape (i)</th>
<th>Percentage increase in HIV incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>10%</td>
<td>0.16</td>
<td>3%</td>
<td>5.2%</td>
</tr>
<tr>
<td>15%</td>
<td>0.16</td>
<td>4%</td>
<td>5.8%</td>
</tr>
<tr>
<td>15%</td>
<td>0.08</td>
<td>2%</td>
<td>5.9%</td>
</tr>
<tr>
<td>15%</td>
<td>0.16</td>
<td>3%</td>
<td>7.8%</td>
</tr>
<tr>
<td>10%</td>
<td>0.16</td>
<td>2%</td>
<td>7.8%</td>
</tr>
<tr>
<td>10%</td>
<td>0.08</td>
<td>1%</td>
<td>7.9%</td>
</tr>
<tr>
<td>5%</td>
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<td>7.9%</td>
</tr>
<tr>
<td>15%</td>
<td>0.16</td>
<td>2%</td>
<td>11.8%</td>
</tr>
<tr>
<td>10%</td>
<td>0.16</td>
<td>1%</td>
<td>15.8%</td>
</tr>
<tr>
<td>15%</td>
<td>0.16</td>
<td>1%</td>
<td>23.8%</td>
</tr>
</tbody>
</table>

* Assuming 5% women HIV infected, 10% rapists HIV infected
SUMMARY & CONCLUSIONS
Summary of findings (1)

- Findings illustrate extent to which rape may increase individual HIV risk
- In general, relative increase in risk dependent upon STI prevalence in non-conflict comparison and RELATIVE:
  - HIV & STI prevalence and STI cofactor
  - Extent of coercion and genital trauma, and degree to which this facilitates HIV transmission
  - Number of male partners/assailants and number of sex acts
Summary of findings (2)

- The likelihood that rape may increase population HIV incidence by > 5% dependent on:
  - Prevalence of HIV among victims & assailants
  - Extent of rape in community
  - Anal or vaginal sex & impact of trauma on the likelihood of HIV transmission if assailant HIV infected
  - Underlying HIV incidence
Conclusions

- For scenarios considered, modelling suggests that conflict may result in large individual increases in HIV risk.
- Debate about HIV and rape in high and low conflict should not confuse population & individual affects.
- As with other factors shown to increase individual HIV risk, rape and coercion should be considered in HIV programming.
- Rape could impact on population HIV incidence if high HIV prevalence among assailants, high levels of rape have occurred, and rape associated with increased HIV risk,
- Data gaps make accurate modelling difficult
Implications for programming

- Rape is a fundamental abuse that requires a serious response in its own right
- Rape is also a barrier to effective HIV programming
- Responses to rape, violence & coercion should be integrated into HIV programming, like other factors known to increase individual HIV risk
- Prevention of HIV and prevention of sexual violence are integrally linked
- Responses to rape include:
  - Post-rape services (PEP, EC, ....)
  - Referral to HIV services if needed
  - Broader counseling and support
Acknowledgments

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