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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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

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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

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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

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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

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EXISTING EVIDENCE

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

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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

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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

Static HIV model

- 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

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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

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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

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Model Scenario:
Violence & coercion against adult women

Conflict scenario	Comparison	Risk ratio
Adult female, forced to have sex by unknown assailants (multiple site trauma)	Same number of consensual sex acts with one partner from own community	**4.3**
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	Only has 3 consensual sex acts with low risk male partner	**5.3**
Adult female trades sex with several male members of peacekeeping force (single site trauma once in every 8 sex acts)	Same number of consensual sex acts with one man from own community	**1.5**

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Model Scenario: Anal rape

Conflict scenario	Comparison	Risk ratio
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	Only has 3 consensual penile-vaginal sex acts with low risk partner	**86**

* 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

Conflict scenario	Comparison	Risk ratio
Influx of higher exposed population to an area of lower exposure	No population movement, otherwise same behavioural patterns	**1.4**
Influx of lower exposed population to an area of higher exposure	No population movement, otherwise same behavioural patterns	**0.6**
Adult woman, quarter of sex acts are forced by her highly exposed male partner (single site trauma)	Comparison is same number of sex acts with a male partner who has not been to higher risk situation	**1.6**

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Illustrative scenarios where rape increases community HIV incidence by > 5%

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

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* 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

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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

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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

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