Transmission dynamics of HIV among men who have sex with men in Southern India: insights from mathematical modelling

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Background

- In India the HIV epidemic remains concentrated in high-risk groups including men who have sex with men (MSM).
- Indian MSM show considerable behavioural heterogeneity in anal sex roles.
- Different MSM behavioural subgroups are likely to have different risks of infection and some may contribute disproportionately to the epidemic.
- Detailed data have been collected in an Integrated Behavioural & Biological Assessment (IBBA) in Bangalore.
Aims

Within a Southern Indian setting:

- simulate the transmission of HIV among MSM
- estimate the contribution from each MSM subgroup to the HIV epidemic among MSM
- compare the potential impact of different prevention interventions
- determine which are the most important MSM subgroups to reach with a prevention strategy
- establish the extent to which behavioural heterogeneity influences the HIV epidemic among MSM
Methods: model building, parameterisation and fitting

- A deterministic compartmental model has been developed
- The model:
  - simulates joint transmission dynamics of HIV, herpes and syphilis
  - incorporates 3 behavioural subgroups of MSM in a Southern Indian setting
  - is parameterised and fitted to setting-specific behavioural and epidemiological data with non-setting-specific biological parameters being derived from the literature
Methods: sexual interactions between MSM identity subgroups

Key:
- ■: predominantly insertive
- ●: predominantly receptive
- ▲: either insertive or receptive
Bangalore preliminary data analysis for model parameterisation: prevalence

The Bangalore data were collected as part of the monitoring and evaluation of Avahan, the multisite HIV prevention intervention funded by the Bill & Melinda Gates Foundation

<table>
<thead>
<tr>
<th></th>
<th>Panthi / Bisexual</th>
<th>Kothi / Hijra</th>
<th>Double Decker</th>
<th>All MSM</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIV seroprevalence in IBBA (2005)</td>
<td>13%</td>
<td>23%</td>
<td>13%</td>
<td>18%</td>
</tr>
<tr>
<td>Syphilis seroprevalence in IBBA (2005)</td>
<td>8%</td>
<td>13%</td>
<td>9%</td>
<td>12%</td>
</tr>
<tr>
<td>HSV-2 seroprevalence in IBBA (2005)</td>
<td>30%</td>
<td>39%</td>
<td>27%</td>
<td>36%</td>
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</tbody>
</table>
Bangalore preliminary data analysis for model parameterisation: reported behaviour

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Average no. of partners per month (IBBA)</td>
<td>9</td>
<td>57</td>
<td>19</td>
<td>36</td>
</tr>
<tr>
<td>Proportion of sex acts that are insertive (IBBA)</td>
<td>73%</td>
<td>8%</td>
<td>12%</td>
<td>23%</td>
</tr>
<tr>
<td>Proportion of sex acts protected by condom (IBBA)</td>
<td>59%</td>
<td>76%</td>
<td>65%</td>
<td>69%</td>
</tr>
<tr>
<td>Proportion of MSM ever having had sex with female (IBBA)</td>
<td>89%</td>
<td>34%</td>
<td>69%</td>
<td>56%</td>
</tr>
</tbody>
</table>

The Bangalore data were collected as part of the monitoring and evaluation of Avahan, the multisite HIV prevention intervention funded by the Bill & Melinda Gates Foundation.
Initial insights into the MSM population in Bangalore came from IBBA.

Need to estimate size of ‘hidden MSM’ population, by identity subgroup.

IBBA over-representative of high-risk, predominantly receptive, MSM.
Estimated number of Kothi, Hijra and Double Decker from Sangama MSM programme

- Used IBBA ratio of Kothi / Hijra to Double Decker

- Calculated ratio of number of partners per month, assuming Panthi / Bisexual are mostly clients of Kothi / Hijra

Bangalore preliminary data analysis for model parameterisation: population sizes

- Estimated total number of MSM of each subgroup in Bangalore Urban

<table>
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<tr>
<th>Subgroup</th>
<th>Estimated Number</th>
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<tbody>
<tr>
<td>Panthi / Bisexual</td>
<td>52,575</td>
</tr>
<tr>
<td>Kothi / Hijra</td>
<td>4,670</td>
</tr>
<tr>
<td>Double Decker</td>
<td>1,557</td>
</tr>
</tbody>
</table>

89% Panthi / Bisexual, 3% Kothi / Hijra, 8% Double Decker
Sampling, behaviour and reporting issues

- Estimating number and behaviour of ‘hidden MSM’, and HIV prevalence among those not included in the high-risk MSM IBBA sample
- Fluidity of identity groupings according to situation / specific partner
- Movement between identity subgroups over time
- Possibly some disparities between reported identity and behaviour
- Reporting bias
Conceptual framework for types of parameters and forms of parameter uncertainty

Parameters specific to intervention
- HIV- and STI- efficacy of new intervention
- Coverage & use of new intervention
- Sexual behaviour & use of pre-existing methods (after)

Biological parameters from literature
- Condom efficacy
- Duration of initial HIV high viraemia
- HIV high viraemia cofactor
- HIV/STI transmission probabilities
- STI cofactor(s)

Setting-specific parameters
- HIV/STI prevalence
- When/how HIV/STI entered
- Sexual behaviour (before)
- Size of population groups, and mobility and mortality
- Levels of access/use of pre-existing methods (before)
Modelling issues

- 3 sexual behavioural subgroups and 2 roles in anal sex
  - Lack of data on who has sex with whom
- Handling uncertainty:
  - Identify several model fits to evaluate the uncertainty in the projections
  - Model validation
  - Scenarios analysis for intervention parameters
  - Conduct multivariate sensitivity analysis to explore robustness of findings
Next steps

- Estimate the contribution from each subgroup to the HIV epidemic among MSM
- Model potential impact of interventions reaching different subgroups of MSM
  - Impact among MSM
  - Impact among female partners of MSM
- Parallel analysis using data from Peru
- Further explore importance of MSM behavioural heterogeneity for HIV epidemic in Bangalore, and implications for future research and prevention priorities
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