Causal interactions among structural, behavioural and biological drivers of STD/HIV epidemics

What does the "mega model" look like?

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"Mega" Model?

What is a "model"*?

- Representation or simplified version of a concept or system to:
  – Facilitate understanding by eliminating unnecessary components and connections.
  – Aid in decision making by simulating "what if" scenarios.
  – To explain and/or predict events based on past observations.

* http://www.businessdictionary.com/definition/model.html

Why do we need a model for STI / HIV programming?

- To understand heterogeneity epidemic trajectories
  – Why do populations that look similar often have very different HIV epidemics?
  – Which epidemics are likely to grow fastest?

- To design effective prevention strategies, especially in mixed epidemics
  – Which interventions – structural, behavioural, biomedical?
  – Which populations?
  – When?
  – How much (coverage, intensity?)
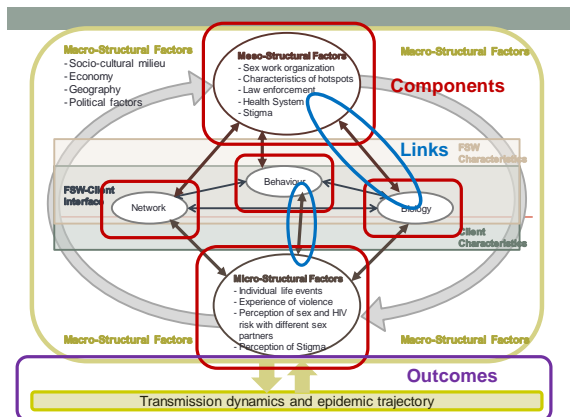

Some historical echoes….

SYMPOSIUM

Populations, pathogens, and epidemic phases: closing the gap between theory and practice in the prevention of sexually transmitted diseases

J F Blanchard

Sex Transm Infect 2002;78(Suppl I):i183–i188

- Limited appreciation for complex interactions and network properties
- Focused more on pathogen characteristics, rather than individual biological and "host-pathogen" interactions
- Ignored the concept of individual trajectories over time
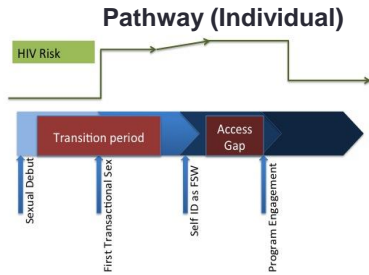

The Transition Period and the Access Gap

Pathway (Individual)

HIV Risk

Transition period

Access Gap

Sexual Debut

First Transactional Sex

Self ID as FSW

Program Engagement

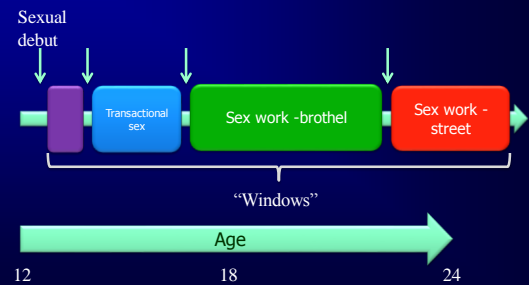**Figure 1: Schematic of the central hypothesis**

Approach to model development – a program perspective

- Start with a conceptual model, not a mathematical model
- Focus on programmatic considerations, not necessarily robust in explanatory power
- Consider:
  - Key elements that directly influence individual risk and population transmission dynamics – biology, behaviour, networks
  - Opportunities for programs to influence these
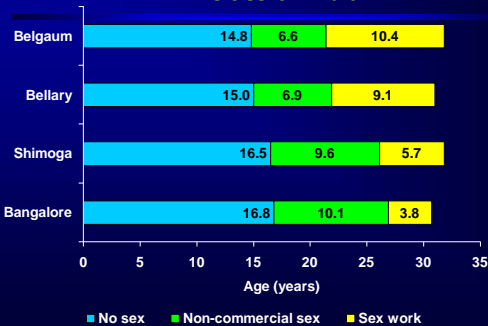 - Pathways through the elements

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A simple start – "pathways" and "windows"

- "Pathways"
  - Trajectories that individuals and groups follow **through time**.
  - Sometimes they are unidirectional, but they are often bidirectional and/or recursive
- "Windows"
  - Important frames along the pathway that have dimensions of time, space and interactions.
  - Have variable characteristics and influences on risk.
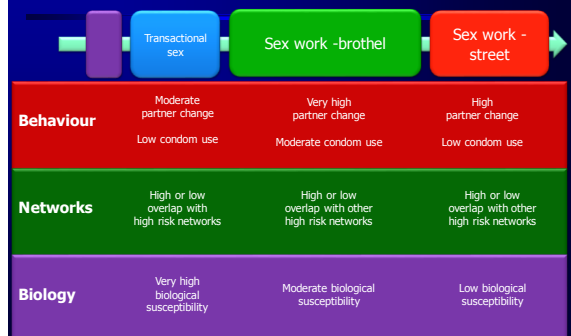 - Provide "windows" of opportunity for programs
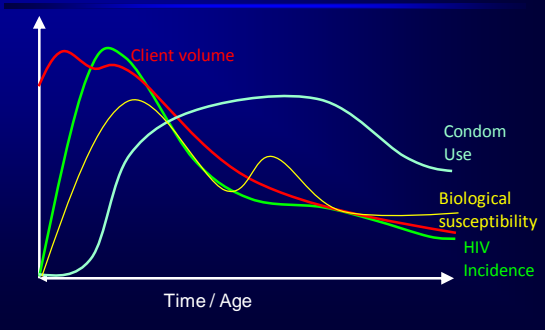

A simple pathway example – from "Transitions"

Sexual debut

Transactional sex

Sex work -brothel

Sex work - street

"Windows"

Age

12   18   24

Average Sexual "Life Course" for FSWs in 4 Cities of India

City	No sex	Non-commercial sex	Sex work
Belgaum	14.8	6.6	10.4
Bellary	15.0	6.9	9.1
Shimoga	16.5	9.6	5.7
Bangalore	16.8	10.1	3.8

Age (years): 0, 5, 10, 15, 20, 25, 30, 35

■ No sex ■ Non-commercial sex ■ Sex work

What's happening in the "windows" along this pathway?

Transactional sex

Sex work -brothel

Sex work - street

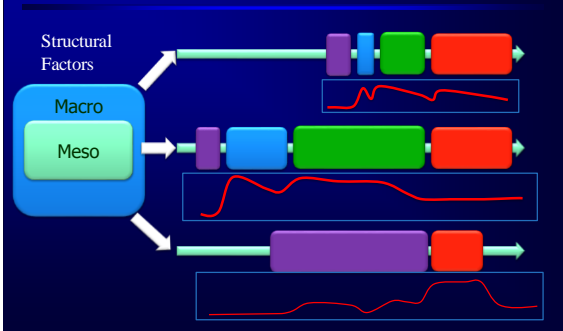|	Transactional sex	Sex work -brothel	Sex work - street
Behaviour	Moderate partner change / Low condom use	Very high partner change / Moderate condom use	High partner change / Low condom use
Networks	High or low overlap with high risk networks	High or low overlap with other high risk networks	High or low overlap with other high risk networks
Biology	Very high biological susceptibility	Moderate biological susceptibility	Low biological susceptibility

Schematic representation of temporal asymmetry in FSW behaviour and risk

The patterns of risk vary by context, modified by behavioural, biological and network properties

Different contexts, different pathways at the individual and population levels
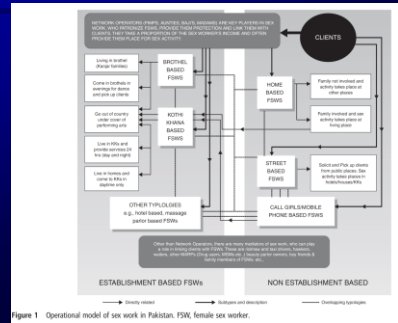

Social organization of sex work in Pakistan
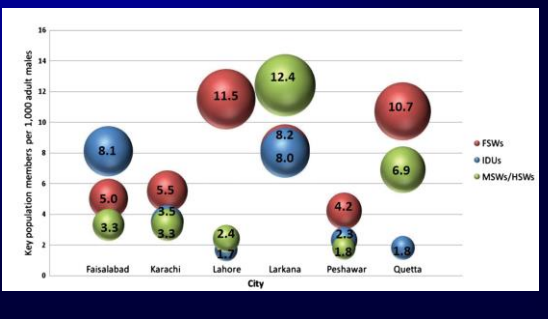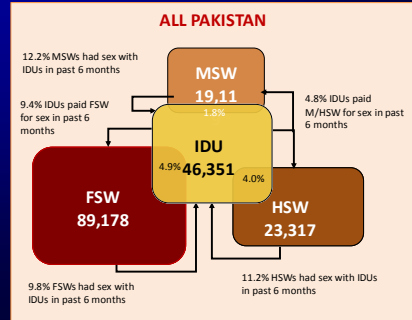

Figure 1 Operational model of sex work in Pakistan. FSW, female sex worker.
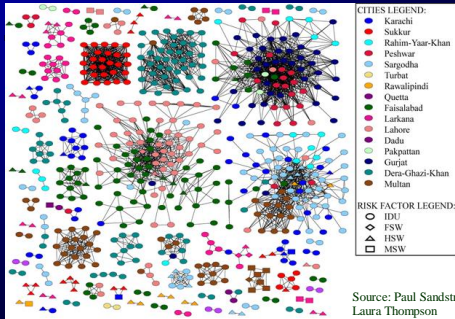
Relative size (per 1000 men) of key populations in cities of Pakistan

Sexual interactions between key populations in Pakistan

Networks – vary by context (example for HIV transmission among key populations in Pakistan)

CITIES LEGEND:
- Karachi
- Sukkur
- Rahim-Yaar-Khan
- Peshwar
- Sargodha
- Turbat
- Rawalpindi
- Quetta
- Faisalabad
- Larkana
- Lahore
- Dadu
- Pakpattan
- Gurjat
- Dera-Ghazi-Khan
- Multan

RISK FACTOR LEGEND:
- IDU
- FSW
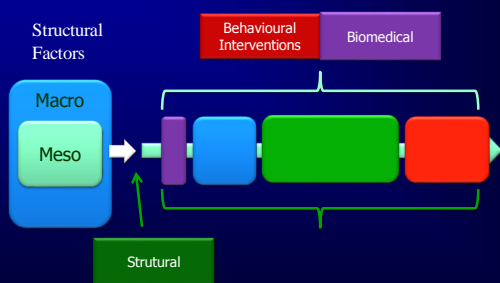- HSW
- MSW

Source: Paul Sandstrom and Laura Thompson

Transmission network for HIV-1 *env* sequences from Pakistan. Edges represented divergence less than or equal to 1.0% Tamura-Nei genetic distance. Nodes are colored by geography and shape indicates risk factor. The network contains 87 clusters, comprising 652 nodes and 2829 edges.

Programs – key elements

- Structural interventions
  - Alter the meso-structural factors that influences the social organization and distribution of pathways and windows.
  - Influences the pathways and vulnerability of individuals and groups – "power within", "power with others", "power over resources".
- Behavioural interventions
  - Addresses the behavioural risks within specific windows along the pathway, with either short-term or long-term effects
- Biomedical interventions
  - Reduce the susceptibility or transmission risk, either in the short term or long term

Different contexts, different pathways at the individual and population levels

Structural Factors

Behavioural Interventions

Biomedical

Macro

Meso

Strutural

Some issues for further development…

- How can we improve our description and understanding of the temporal "pathways"?
  - What methods can we develop to systematically describe them?
  - What are the factors that influence these pathways at the individual and population levels?
- How does risk vary in the different windows along the pathways?
  - Biological
  - Behavioural / network
- How can we better understand how to prioritize the focus of our interventions along the pathway?
  - Optimize interventions for the specific pathways and windows

Thank you