

## The role of sexual networks in the Chinese HIV epidemic<sup>1</sup>

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### Introduction

With an estimated 740,000 HIV cases at the end of 2009 [range: 560 000–920 000] (Wang et al. 2010), corresponding to 0.05 percent of the adult population, China is a low HIV prevalence country, with infections mostly concentrated in subpopulations such as female sex workers (FSWs), their clients and injecting drug users (China MOH 2010) and now rising among men who have sex with men (MSMs), many of whom marry women and have concurrent sex with men (Ma et al. 2007).

The gains of the epidemic in China have been attributed to recent, profound changes in sexual attitudes and behaviors that have accompanied the rapid pace of social and economic change (Farrer 2002; Sigley and Jeffreys 1999) and to the growth of the sex industry in the past several decades (Kong et al. 2008; Lu et al. 2008), with the re-emergence of syphilis and other sexually transmitted diseases providing evidence for this change (Parish et al. 2003; Chen et al. 2007; Tucker, Chen and Peeling 2010; Zhang et al. 2009). The proportion of cases due to homosexual and heterosexual transmission has grown gradually over the years. While at the onset of the epidemic, infections were mainly concentrated among injecting drug users and blood plasma donors, among the 48,000 new infections estimated for 2009, heterosexual transmission accounted for 42.2% (mainly female sex workers, their clients and the partners of clients of FSWs) and homosexual transmission 32.5% of cases (China MOH 2010; Wang et al. 2010).

Recommended approaches to preventing further spread of HIV to the general population in China include targeting population groups most affected by the epidemic such as female sex workers and their clients, MSMs, and the organizations able to assist them (Zhang et al. 2008). At the same time differences in the characteristics of sexual networks, especially low levels of partner concurrency in Asia relative to sub-Saharan Africa (Halperin and Epstein 2004) have been singled out as the main explanatory factor for differences between the Asian and Sub-Saharan African epidemics, a point which has fueled much debate over whether concerns about the future growth of HIV cases in the world's largest population are misplaced (Chin 2007; Whiteside 2007).

Progression of HIV infection in a population depends not only on individual behaviors and attributes, but also on characteristics of groups, social, demographic and geographic contexts which put these groups in contact with each other and the characteristics of sexual networks: the location of individuals within a network, the level of partner concurrency, patterns of sexual mixing between groups and sexual bridges which provide a linkage between otherwise unrelated groups.

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In this paper, we provide empirical grounding to an evaluation of China's regime of sexual relations, the structure of sexual networks, and the attributes of key population groups, e.g. female sex workers, in contributing to the spread of infection in China, including the possibility that China's present regime of sexual relations is such that an HIV/AIDS epidemic cannot be sustained.

Two main points about the Chinese regime of sexual relations are relevant for our evaluation. The first is that social constraints on choice of marital partners in China are strong. Homogamy in age, education and geographic place of origin (urban versus rural) have consistently influenced the selection of marital partners over time (Han 2010), but these rigid social boundaries are less likely to hold for non marital relations, which have risen over the past two decades in China (Parish, Laumann and Moyola 2007) due to greater opportunities for contact with new sexual partners and increase in availability of commercial sex. Yet, despite these changes, most people in China still report low rates of partner change with the overwhelming majority of Chinese men and women reporting monogamous relationships in the previous year, and close to ten per cent of men and two per cent of women reporting two or more partners (Merli et al. 2007). The second is that, for HIV to spread, a susceptible individual must come in contact with an infected partner. Because of very low HIV prevalence in the Chinese population, there are observable characteristics of partners that condition the probability of HIV infection to the point that having monogamous sex with an infected partner drawn from a sub-group with certain characteristics is far more dangerous than having sex with multiple partners randomly drawn from the population.

We use data from the first survey of sexual behavior and egocentric sexual networks ever conducted in China to (1) identify key attributes of the social organization of sexual partnering, in particular the sexual mixing of population groups identified by their age and education; (2) evaluate observed patterns of sexual mixing, the structure of sexual networks (e.g. network connectivity) and how these contribute to differences in network connectivity across population groups.

## Data

Data come from the Shanghai Sexual Networks Survey (SSNS), a local sexual networks survey conducted between October 2007 and January 2008 in Shanghai, China. The design of the study yielded a citywide representative sample of Shanghai 18-49 year old residents with a Shanghai household registration (*hukou*) and migrants (residents without a Shanghai *hukou*). Participation rates in the survey of 56% for registered residents and 61% for migrants are now common in urban China where rapid social changes increasingly constrain access to the urban population and their willingness to participate in social surveys ([de Leeuw and Heer 2002](#); [Treiman, Lu, and Qi 2009](#)). The total sample size was adjusted for non-response. It yielded 1,192 Shanghai registered residents and 496 migrants. Sampling weights were calculated to compensate for unequal selection probabilities and non-coverage and involved calibration of the sample age-sex distribution to match the values of the Shanghai 2005 3% intercensal sample survey. The adjusted sample was thus representative of the Shanghai adult population of registered residents and migrants ages 18-49.

The survey contains rich information on demographic and socioeconomic information on respondents and their current marital and cohabiting partners. Information was also solicited from respondents about up to three most recent non-marital/non-cohabiting partners, including demographic and socioeconomic characteristics of partners, relationship characteristics (start and end dates of partnership, concurrency, type, etc), and behavioral repertoire (frequency of sexual intercourse, type of sexual act, condom use). The sections of the questionnaire which covered sexual behaviors, marital and non marital sexual histories were self-administered to improve item response rates on potentially sensitive topics. All interviewees were administered an informed consent during which they were ensured confidentiality of responses and were given a small compensation for successful participation.

To assess the validity of the responses, at the end of each interview, respondents were asked whether they would participate in a repeat interview. Among respondents who agreed to this request (89%), we selected a random sample of 100 to whom we administered a repeat interview after a gap of between one and two months. When comparing two responses on the same respondent, objective items (e.g. age, household registration, education, occupation, income) had a mean kappa statistics of 0.93. Less objective items (e.g. age at first sex, number of entertainment establishments in neighborhood, travel away from Shanghai) and sensitive items (e.g. marital relationship quality, coital frequency with spouse, and responses on non-marital partners) both had mean kappas of 0.92. While this is not the best indicator of accurate reporting, those who reported on these items did so consistently.

Our sample of 1,655 partnerships (respondent-alter dyads who report sexual partnership) is constructed from the marital and nonmarital sexual histories of 1,389 sexually active males and females. Of these, 86.1% report one partnership, 10% report two partnerships and the remaining 4% report 3 or more partnerships. Of the 1,665 partnerships, 9.5% overlap other partnerships, 77.1% are first marital, 19.3% are premarital (dating) and 3.7% are extramarital partnerships. Partnerships involving a female sex worker characterize 41% of extramarital partnerships and 20.6% of premarital partnerships.

## Methods

The analyses will proceed as follows:

1. Generate sexual mixing matrices by cross-classifying all partnerships according to gender, birth cohort, and educational attainment (elementary, junior high school middle high school, college and up) of respondents and their marital and non marital partners.
2. Summarize mixing matrices by estimating coefficients measuring deviation from random mixing.
3. Fit log-linear models to the mixing matrices, to evaluate the rules or patterns governing the selection process of sexual partner across different types of partners (marital, extramarital and non marital partnerships).

4. Generate random networks (Newman and Girvan 2003) consistent with the observed sexual contacts data (conditional on mixing by age and education, degree distribution and assortativity by degree). All the parameters, except for mixing by degree are empirically informed.
5. Use these simulated networks to estimate the effect of observed patterns of mixing by age, education and degree on epidemic potential and identify the role that high risk population groups (e.g. female sex workers and their clients) are playing in fueling the spread of infection.