IMBALANCED SEX RATIOS, MEN'S SEXUAL BEHAVIOR, AND STI RISK IN CHINA*

Scott J. South
Department of Sociology
Center for Social and Demographic Analysis
University at Albany
State University of New York
Albany, NY 12222
Phone: 518-442-4691
E-mail: s.south@albany.edu
Fax: 518-442-4936

Katherine Trent
Department of Sociology
Center for Social and Demographic Analysis
University at Albany
State University of New York
Albany, NY 12222
Phone: 518-442-4681
E-mail: k.trent@albany.edu
Fax: 518-442-4936

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*Direct correspondence to Scott J. South, Department of Sociology, University at Albany, SUNY, Albany, NY 12222. E-mail: s.south@albany.edu. We thank Yong Cai, Baochang Gu, Lin Guo, Elizabeth Kozakiewicz, Zai Liang, Jeremy Pais, William Parish for assistance and several anonymous reviewers for helpful comments. This research was supported by a grant to the authors from the National Institute of Child Health and Human Development (R21 HD057289). The Center for Social and Demographic Analysis of the University at Albany provided technical and administrative support for this research through a grant from NICHD (R24 HD044943).

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Abstract

China has been experiencing pronounced changes in its sex ratio, but little research has explored the consequences of these changes for sexual behavior and health. We merge data from the 1999-2000 Chinese Health and Family Life Survey with community-level data from the 1982, 1990, and 2000 Chinese censuses to examine the relationship between the local sex ratio and several dimensions of men's sexual behavior and sexual health. Multilevel logistic regression models show that, when faced with a relative abundance of age-matched women in their community, Chinese men are less likely to have intercourse with commercial sex workers, but are more likely to engage in premarital noncommercial intercourse and to test positive for a sexually-transmitted infection (STI). These findings are generally consistent with hypotheses derived from demographic-opportunity theory, which suggests that an abundance of opposite-sex partners will increase the risk of early, frequent, and multi-partner sex and, through this, STI risk.

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Research into the causes of HIV/AIDS and other sexually-transmitted diseases and infections has generally emphasized the role of individual-level risk factors. Particular emphasis has been given to the impact of demographic characteristics (e.g., age, race, and sex), socioeconomic status, and risky sexual and non-sexual (e.g., drug use) behaviors (e.g., Fleming et al. 1997; Friedman et al. 1997; Laumann and Youm 1999; McQuillan et al. 2006; Radcliffe et al. 2001; Xu et al. 2006). Less attention has been given to characteristics of the broader social environment that might influence opportunities to form different types of sexual relationships. One of these distal factors is the sex ratio, that is, the relative numbers of women and men in the local marriage market. The relative availability of women and men in the population is likely to shape opportunities for engaging in different types of sexual encounters, which in turn are likely to influence the risk of contracting a sexually-transmitted infection. However, few studies have explored the impact of imbalanced sex ratios on individual sexual risk behavior.

In this paper we examine the impact of imbalanced sex ratios on several aspects of Chinese men's sexual behavior and their health outcomes. Given pronounced changes in its sex ratio at birth over recent decades, China presents a timely case for examining the effect of imbalanced sex ratios on sexual behavior and sexually-transmitted infections (STIs). We explore this issue by merging individual data from the Chinese Health and Family Life Survey (CHFLS) with community-level data taken from three Chinese censuses. From the Chinese censuses we create simultaneously cohort-specific and community-specific sex ratios describing the number of women available to men in their local marriage market, and we attach these sex ratios to the individual records of the male respondents to the CHFLS. We then estimate a series of logistic regression models linking three dimensions of men's sexual behavior and sexual health—whether they have engaged in premarital sex, whether they have ever had sex with a commercial sex worker, and whether they test positive for an STI—to the sex ratio in their local marriage market. In contrast to pessimistic speculations about how China's growing deficit of females will affect men's sexual risk behavior (Poston and Glover 2005; Tucker et al. 2005), our findings suggest a more guarded but generally more benign view of how China's looming sex ratio imbalance is likely to influence the spread of HIV/AIDS. Although we find that a deficit of women is positively associated with men's likelihood of having commercial sexual intercourse, we also find that a deficit of women is inversely associated with men's risk of having noncommercial premarital sex and of testing positive for a sexually-transmitted disease.

Imbalanced sex ratios in China

Dramatic changes have been occurring in the relative numbers of young women and men in the People's Republic of China. China's longstanding cultural preference for sons over daughters has combined with sharp reductions in fertility—partly a consequence of China's one-child policy—and the availability of sex-selective abortion technology to create a severe deficit of females over recent decades (Banister 2004; Goodkind 2004). Many observers have described abnormally masculine sex ratios at birth in China (e.g., Cai and Lavely 2003; Coale and Banister 1994; Gu and Roy 1995; Hull 1990; Johansson and Nygren 1991; Lavely 2001; Murphy 2003; Peng and Huang 1999; Secondi 2002; Yi et al. 1993; Yuan and Tu 2004). While a normal range of the sex ratio at birth (number of boys per 100 girls) is between 103 and 107, China has been reporting quite high and increasing sex ratios over recent decades. In 1982 the Chinese sex ratio at birth was 107.6, only slightly outside the typical range (Yuan and Tu 2004). However, by 1990 the sex ratio at birth had risen to 111.3, and by 2001 it had risen to 118 (Poston and Glover

2005). At higher birth orders (three and above), the sex ratio at birth reached a remarkable 159.4 in 2000 (Yuan and Tu 2004). Although some other Asian societies, including India and South Korea (Das Gupta et al. 2003), also exhibit a numerical preponderance of males, few if any contemporary societies match China's degree of imbalance in the relative numbers of boys and girls (National Research Council 2005).

As these birth cohorts age, China will experience a dramatic overabundance of adult males relative to adult females (Tuljapurkar, Li, and Feldman 1995). The consequences of this impending imbalance in the numbers of adult males and females are thought to be profound and far-reaching (Poston and Morrison 2005). Some scholars go so far as to suggest that this surplus of males in China and other Asian societies will foster militaristic and authoritarian regimes that threaten U.S. national security and global political stability (Hudson and Den Boer 2004). Other observers suggest that this growing population of "surplus males" will contribute substantially to the spread of HIV and other sexually transmitted infections (STIs) and diseases (STDs). For example, Poston and Glover (2005) predict a dramatic increase in commercial sex in so-called "bachelor ghettos," along with a marked spread of HIV/AIDS that will reach epidemic proportions. And, Tucker et al. (2005) speculate that the ostensibly high sexual risk behaviors among surplus men will serve as bridging mechanisms transmitting HIV/AIDS and other STIs and STDs from high-risk populations to low-risk populations.

However, despite these speculations, no study has yet examined how imbalances in the population sex ratio influence men's sexual behavior and STI risk in China. Of course, the effects of the most recent imbalances in the sex ratio at birth will not be felt fully at the national level for another decade or two. However, there is currently substantial age-graded and sub-national geographic variation in China's adult sex ratios (Yi et al. 1993; Yuan and Tu 2004), and this variation can be exploited to examine how existing imbalances in the relative numbers of women and men influence men's sexual risk behavior. Exploring how contemporary imbalances in the sex ratio across age groups and communities are associated with men's sexual risk behavior and STI risk may provide clues as to how the looming imbalance in adult sex ratios will affect men's sexual health in the future.

THEORETICAL BACKGROUND AND HYPOTHESES

The dominant theoretical framework for examining the association between the sex ratio and men's marital, family, and sexual behavior is best called "demographic-opportunity theory."[1] A main premise of demographic-opportunity theory is that the likelihood of forming cross-sex relationships such as marriage and other romantic associations is determined largely by the number of available opposite-sex members with whom such associations can be formed (South, Trent, and Shen 2001; Uecker and Regnerus 2009). When applied to men's sexual behavior, demographic-opportunity theory's overarching empirical claim is that the probability of engaging in early and frequent sexual intercourse with multiple partners is enhanced by the sheer number of women available to those men. Conversely, men's opportunities to engage in sexual intercourse are diminished when there is a numerical shortage of women.

Prior applications and tests of demographic-opportunity theory have focused primarily on how the availability of men affects U.S. women's marital and family behavior.[2] Research shows that female marriage rates are higher in geographic areas containing more eligible men (e.g., Fossett and Kiecolt 1993; Lichter et al. 1992), although only a small proportion of the pronounced racial (black-white) difference in female marriage rates is attributable to racial differences in the sex ratio or marriage opportunities more generally (Lichter, LeClere, and McLaughlin 1991; Schoen and Kluegel 1988). Fewer studies have explored the impact of imbalanced sex ratios on men's marriage propensities, but Lloyd and South (1996) find that men's marriage rates are reduced as the relative number of available women in the local geographic area decreases. Sex ratios also affect patterns of assortative mating. In favorable marriage markets (i.e., with relatively more men than women), young women are more likely to "marry up" educationally (Lichter, Anderson, and Hayward 1995).

High male-to-female sex ratios also elevate women's risk of premarital childbearing, ostensibly because an abundance of available men increases women's likelihood of engaging in premarital intercourse and thus becoming premaritally pregnant (Billy and Moore 1992; South 1996; South and Lloyd 1992). Imbalanced sex ratios have also been linked to marital dissolution and relationship quality. South and Lloyd (1995) and South, Trent, and Shen (2001) find that the risk of divorce is greater in geographic areas with either abnormally high or abnormally low sex ratios. These researchers interpret this association as indicating that exposure to an abundance of romantic alternatives to one's current spouse increases the risks of marital infidelity and of finding a more attractive partner. A shortage of men in the local community impairs relationship quality among unmarried parents (Harknett 2008) but not among married persons more generally (Trent and South 2003).

Other studies focus on the impact of imbalanced sex ratios on demographic and family behaviors in cross-national context. For example, South and Trent (1988) find that, in a sample of 117 countries *circa* 1980, the sex ratio is positively related to the percentage of women who are married and inversely related to the nonmarital fertility ratio. Divorce is less common in countries with high adult sex ratios (Barber 2003; Trent and South 1989), and countries with a scarcity of men have comparatively high rates of teen pregnancy (Barber 2000; 2001) and single parenthood (Barber 2004). Violence against women is more frequent in areas characterized by low sex ratios, both cross-nationally (South and Messner 1987) and across sub-areas of the U.S. (Avakame 1999; O'Brien 1991).

The literature is less consistent regarding the influence of mate availability on the timing of first sexual intercourse and other dimensions of sexual activity. Consistent with the predictions of demographic-opportunity theory, Billy, Brewster, and Grady (1994) find that in the U. S. the county-level sex ratio is positively associated with young women's risk of engaging in premarital intercourse and the frequency with which they engage in intercourse. However, Brewster (1994) does not observe a significant association between the neighborhood-level sex ratio and the timing of young black women's transition to first sexual activity. Moreover, contrary to expectations, Uecker and Regnerus (2009) find that young women are more likely to engage in sexual intercourse when they attend college with comparatively few men. Similarly, Browning and Olinger-Wilbon (2003) find that men engage in more short-term sexual partnerships in neighborhoods that contain comparatively few women. They also find that women's likelihood of engaging in short-term sexual partnerships is unrelated to the neighborhood sex ratio.

Hypotheses

One hypothesis that can be derived from demographic-opportunity theory is that, when faced with a relative deficit of women, men will be less likely to engage in noncommercial premarital sexual intercourse. Simply put, a numerical shortage of women reduces the chances that, prior to marriage, young men will be able to meet and attract a romantic sexual partner. By the same logic, a numerical surfeit of women will increase young men's chances of having noncommercial premarital sex because exposure to an abundance of women increases men's chances of finding an attractive and willing sexual partner. Admittedly, there may be countervailing forces at work, inasmuch as an abundance of women may also increase the odds that young men will encounter an attractive potential spouse, and marrying at a young age limits the amount of time that young men are exposed to the risk of having premarital sexual intercourse. But most Chinese men marry rather late in life (Sheng 2005), so it is likely that this offsetting influence will be minimal.

Our second hypothesis extends demographic-opportunity theory to consider the influence of the sex ratio on the likelihood that men will engage in intercourse with a commercial sex worker. It seems reasonable to hypothesize that the fewer the number of women available to men, the more likely men will be to visit a commercial sex worker or, more generally, to pay money for sexual services. Absent a sufficient supply of women with whom to form a romantic (i.e., noncommercial) sexual relationship, men will be more likely to turn to commercial sex workers for sexual gratification. Such a relationship between the sex ratio and men's engagement in commercial sex would be consistent with the concerns expressed by Poston and Glover (2005) and Tucker et al. (2005) over the possibly detrimental impacts of China's growing deficit of women for men's sexual health. In contrast, when women are in ample supply, opportunities for romantic sexual relationships will be plentiful, and fewer men will opt to turn to commercial sex workers. To our knowledge, no study has yet examined the relationship between the sex ratio and men's utilization of commercial sex services.

Third, we hypothesize that a numerical shortage of women will diminish the risk that men will contract an STI. A numerical deficit of women is likely to reduce men's chances of contracting an STI through several pathways. As argued above, a shortage of women is likely to decrease men's risk of having sexual intercourse prior to marriage. In addition, a shortage of women may also reduce men's risk of having extramarital sexual intercourse and frequent sexual intercourse with multiple partners, all risk factors for sexually-transmitted infections (Sambisa and Stokes 2006). In short, when few women are available to men, men's opportunities to engage in most forms of sexual intercourse are diminished, and thus so is their risk of contracting an STI. In contrast, when women are in relative abundance, men will face greater opportunities to engage in intercourse more frequently and with more different women, thereby increasing men's risk of contracting an STI.

Granted, there may be countervailing influences of the effect of the sex ratio on men's risks of contracting an STI. For example, as argued above, men's ostensibly heightened likelihood of having sex with a commercial sex worker when faced with a shortage of women would tend to increase their chances of contracting an STI (Parish et al. 2003). But the negative influence of a numerical shortage of females on other sexual risk factors for STIs, including early, premarital, extramarital and multiple-partner sex, is likely to overwhelm the offsetting positive influence that runs through an increased probability of having commercial sex.

These hypotheses derived from demographic-opportunity theory both converge and diverge with speculations that the growing deficit of Chinese females will facilitate the spread of risky sexual behaviors and HIV/AIDS risk among men (Poston and Glover 2005; Tucker et al. 2005). They converge with these speculations by positing that a numerical deficit of women will increase the likelihood that men will have intercourse with commercial sex workers. But they generally diverge from these speculations by also positing that a deficit of women will diminish men's likelihood of having premarital intercourse and of contracting an STI—both potential risk factors for HIV/AIDS.

Historical changes in men's sexual behavior

Studies of sexual behavior in China need to attend to the dramatic ideological and cultural changes that have occurred in recent decades. China has experienced not only rapid economic changes, but also rapid ideological and cultural shifts that allow for more individual freedom and personal choice than in the past. As China has moved toward becoming a less ideologically controlled society, family and related values have become increasingly diverse (Sheng 2005). These secular changes in values associated with sexuality have likely influenced behaviors. In the recent more liberal environment, individuals are freer to choose their sexual partners and they have greater latitude in their sexual behaviors. Indeed, both premarital and commercial sexual activity appears to have increased in China over recent decades (Feng and Quanhe 1996; Parish, Laumann, and Mojola 2007). Thus, the risks of engaging in premarital sex, of engaging in commercial sex, and of contracting an STI are likely to have changed over time.

Importantly, these trends in the historical and cultural forces shaping sexual behavior in China may have implications for how the sex ratio affects the outcomes examined here. Among older cohorts, for whom nonmarital sexual activity was more controlled, premarital, commercial, and other sexual behaviors affecting STI risk may be comparatively unresponsive to sex ratio imbalances. Given limited freedom to engage in nonmarital sexual intercourse, older men may have been unlikely to engage in these behaviors even when afforded the opportunity to do so by a relative surfeit of women in their local marriage market. In contrast, younger men ostensibly enjoy greater choice in matters related to sexual behavior, and thus their behaviors may be more likely to be influenced by the number of women available to them. We test this idea by examining whether the impact of the sex ratio on men's sexual behavior and STI risk varies across birth cohorts.

DATA AND METHODS

To test these hypotheses, we use data from the Chinese Health and Family Life Survey (CHFLS) in conjunction with data from three Chinese censuses. The CHFLS is a nationally-representative (with the exception of Hong Kong and Tibet) survey of 3,821 Chinese adults ages 20 to 64 (Chinese Health and Family Life Survey 2006). The CHFLS data were collected between August 1999 and August 2000. The main focus of the CHFLS survey questionnaire is on family-related and sexual behaviors and attitudes (Parish et al. 2003; 2004; 2007). The design of the CHFLS questionnaire is based in large measure on the 1992 U.S. National Health and Social Life Survey (Laumann et al. 1994).

For this analysis we select male CHFLS respondents between the ages of 20 and 44. We focus on this age range partly because of the need to estimate the number of females available to men when these men were age 20. Because the earliest available China census containing the requisite information is for 1982, it is not possible to estimate with confidence the relevant sex ratio for men who are older than 44 at the time that the CHFLS was administered. We further limit the sample to respondents who were born in the same geographic area (county, city, prefecture, or municipality) that they are observed in at the time of the CHFLS administration. The CHFLS does not include complete residential histories of the respondents that would allow us to determine migrants' community of residence—and thus the sex ratio these men were exposed to—at age 20. However, by selecting only non-migrants, we increase the likelihood that the respondent's community as ascertained at the time of the CHFLS is the same as the community that they resided in at age 20. Imposing these selection criteria results in a maximum sample size of 1,023 men. The number of respondents within communities ranges from 5 to 142 with a mean of 28.

Dependent Variables: We examine the impact of the relative number of women available to the male CHFLS respondents on two dimensions of men's sexual behavior and one dimension of their sexual health. All three outcomes are dichotomous variables. Premarital sex is a dichotomous variable scored 1 if the respondent reports having had noncommercial sexual intercourse (i.e., intercourse with a partner other than a sex worker) prior to marrying. Whether the respondent engaged in commercial sex is a dichotomous variable scored 1 for respondents who reported ever providing money or gifts in return for sexual intercourse. Our third dependent variable is a dichotomous variable scored 1 for respondents who tested positive for gonorrheal, chlamydial, or trichomoniasis infection.[3] CHFLS respondents were asked to provide a urine sample to be tested for the presence of these infections. Over 90% of the respondents provided a urine sample.

Independent Variables: Our focal independent variable is the sex ratio, expressed here as the number of women per 100 men.[4] The relevant pool of women available to serve as marital and/or sexual partners for men is of course circumscribed both by geography and by age. To circumscribe marriage markets geographically, we have coded the county or county-equivalent (e.g., urban district, county-level city) for each of the CHFLS respondents. For county-level cities that are under prefecture-level cities and *shixiaqu*, we use data for the entire prefecture-level city (essentially a large city or metropolitan area). For county-level cities that are under the province and for non-city counties, we use data at the county level. These geographic approximations of "community" correspond fairly closely to the approximations of marriage markets (e.g., metropolitan areas, labor market areas, or nonmetropolitan counties) used in much

U.S.-based research on the impact of imbalanced sex ratios (e.g., Lichter et al. 1992; South and Lloyd 1992). The CHFLS respondents in our sample are distributed across 37 such communities.

To circumscribe the relevant pool of eligible women by age, and to take into account the fact that the sexual behaviors that serve as dependent variables or that lead to an STI could have occurred many years before the administration of the CHFLS, we assign to each male respondent a seven-year sex ratio with a two-year staggering of the numerator (number of females) and denominator (number of males) when the respondent was age 20. This two-year staggering corresponds to the age difference between spouses in China (Porter 2006). More specifically, the sex ratio is defined as the number of women ages 15 to 21 divided by the number of men ages 17 to 23. We use data from the full-count 2000 China census (China Data Center 2004) and the one-percent samples from the 1982 and 1990 censuses (China Population and Information Research Center 2008), along with standard techniques of interpolation and extrapolation, to estimate the value of this community-specific sex ratio for each male CHFLS respondent when he was age 20.[5]

We acknowledge that these population sex ratios are not likely to be measured completely without error. For example, high levels of migration—especially rural-to-urban migration of unregistered migrants (without local *hukou*)—may lead to census underenumeration. Seasonal migrants may also be missed. Yet, for several reasons we believe that measurement error in these sex ratios will not be severe. First, according to official Chinese policy for the 2000 census, even unregistered inhabitants of a given area will be counted as residents of that area if they have lived there for at least six months. Thus, only very short-term residents will be intentionally excluded from the census counts. Second, given our concern with the relative numbers of women and men, rather than the size of the total population, the observed sex ratios will be inaccurate only to the extent that there exists a sex differential in the undercount that also varies across the communities represented in the CHFLS. At the national level, the sex difference in census under-enumeration appears minimal (Goodkind 2004).

The relative numbers of women and men can vary across these marriage markets for several reasons. Inter-community differences in son preference (Poston and Glover 2005) and the prevalence of Hepatitis B (Oster 2005) could produce spatial variation in the sex ratio at birth, and this variation will manifest itself in variation in adult sex ratios decades later. Some studies suggest that sex ratios at birth are associated with levels of economic development and maternal education (Banister 2004; Gu and Roy 1995; Yi et al. 1993). Even among communities with the same level of son preference, variation in fertility levels will produce variation in the sex ratio at birth because a preference for sons will have little effect on the sex ratio at birth when fertility is unregulated. Place-to-place variation in the sex difference in mortality, perhaps particularly female infanticide, will also generate inter-community variation in the sex ratio. Sex differences in migration during the young adult years will contribute to inter-community variation in the adult sex ratio. And, given that our sex ratios involve an average two-year difference between the number of available women and the number of men "competing" for them, fluctuations in fertility will create disparities across birth cohorts (and, to the extent such fertility fluctuations vary from place to place, variation across communities as well) in the sex ratio (Porter 2006). For example, when a given birth cohort is followed by a larger birth cohort, men from the initial cohort will encounter a relative surfeit of women because men tend to marry women who are younger than themselves. In contrast, when a birth cohort is followed by a smaller cohort, men from the initial cohort will face a relative shortage of women in their marriage market.

We include several other explanatory variables in our models. Educational attainment is measured as a 6-point continuous variable ranging from never attending school (= 1) to attending university or graduate school (= 6). To capture age-related and/or historical trends in sexual behavior, our models include dummy variables for decadal birth cohort (1950s, 1960s, and 1970s, with the 1950s serving as the reference category). We include a dummy variable for whether respondents report residing in an urban area (county-level city or larger) when they were age 14.

We also control for three community-level characteristics that could potentially confound an association between the sex ratio and the outcome variables. Each of these variables is computed by aggregating responses from all CHFLS respondents to the community level. Community percent urban is the percentage of the community members who reside in an urban locale, defined as a village or neighborhood in which fewer than 15% of the workers are farmers.[6] Community mean education is the mean level of education (measured using the scale described above) of the CHFLS respondents, and community mean age is the average age of the CHFLS respondents. Table 1 presents descriptions for all the variables used in our analyses.

Table 1 about here

Analytical strategy: To examine the effect of the numerical availability of females on men's sexual behavior and STI status, we estimate multilevel logistic regression models. These models include random intercepts that take into account the nesting or clustering of respondents within the 37 communities (Raudenbush and Bryk 2002). Allowing the model intercepts to vary randomly across communities allows for a correlation between respondents in the same communities. In addition, multilevel models generate significance tests for the community-level variables that are based on the correct degrees of freedom. Models are estimated using STATA's xtlogit procedure (StataCorp 2005).

RESULTS

Table 1 presents weighted descriptive statistics for all variables used in the analysis. Slightly over one-quarter of the male CHFLS respondents in our sample report having engaged in noncommercial sexual intercourse prior to marriage. About nine percent of the respondents report having engaged in commercial sexual intercourse. Of the respondents who agreed to provide a urine sample, slightly fewer than four percent tested positive for a gonorrheal, chlamydial, or trichomoniasis infection.

Descriptive statistics for the focal explanatory variable indicate that, on average, there were about 90 women aged 15 to 21 per 100 men aged 17 to 23 in the respondents' communities when these respondents were twenty years old. Thus, these men tended to face a deficit of women in their local community during early adulthood.[7] At the individual level, the standard deviation (10.98) indicates that there is a reasonable amount of variation in the number of women available to these men. Taking the average of the sex ratio across single year of age groups for each community, the (mean) sex ratio varies across communities from a low of 82.74 to a high of 104.8, with a mean of 94.2 and a standard deviation of 6.22.

Average educational attainment (3.14) falls between junior and senior high school. Fourteen percent of the respondents were born in the 1950s (and were thus ages 40 to 44 at the time of the CHFLS administration), 38% were born during in the 1960s (and were thus ages 30 to 39 at the time of the survey), and 48% were born during the 1970s (and were thus ages 20 to 29 at the time of the survey). Slightly less than 20% of the respondents resided in an urban community when they were age 14.

At the community level, slightly less than half of respondents reside in a village or neighborhood that the CHFLS defines as urban. The mean educational attainment in the typical community is at the junior high school level. The average age of community members (of those aged 20 to 64) is 38 years.

Table 2 presents three multilevel logistic regression models relating the dimensions of men's sexual behavior and STI status to the community- and cohort-specific sex ratio and the other explanatory variables. Model 1 shows the results for noncommercial premarital sex. Consistent with the hypothesis derived from demographic-opportunity theory, the coefficient for the sex ratio is positive and statistically significant. A one-unit change in the sex ratio (i.e., an increase of one woman per 100 men) increases the odds that men will have engaged in noncommercial premarital sexual intercourse by 1.5% (= $[(e^{[.015]}) - 1] * 100$). Perhaps a more intuitive metric for assessing the magnitude of this effect is to use recent changes in the sex ratio at birth. As noted above, between 1982 and 2001 the sex ratio at birth in China increased by about 10 males per 100 females (from 108 to 118). This change corresponds to a decrease in the female-to-male sex ratio of 7.9 females per 100 males (from 92.6 to 84.7). A change of this magnitude in the young adult sex ratio would increase the odds that men will engage in noncommercial premarital sexual intercourse by about 13% (= $[(e^{[.015][7.9]}) - 1] * 100$).

Other explanatory variables are also significantly associated with the odds of having engaged in noncommercial premarital sexual intercourse. The coefficients for the dummy variables for birth cohort indicate a significant upward trend in the likelihood of experiencing premarital sex. The odds of having had premarital sex among respondents who were born in the 1960s and 1970s are, respectively, 2.5 and 2.8 times the corresponding odds among respondents who were born in the 1950s. Respondents who grew up in an urban area are significantly more likely than respondents who grew up in a rural area to have had premarital sexual intercourse. At borderline significance levels, the percent of the community population that is urban is positively associated with the risk of having premarital intercourse, while the mean level of education in the community is inversely associated with this risk. Neither individual educational attainment nor community age structure is significantly associated with the odds of having had noncommercial premarital sex.

Table 2 about here

Model 2 of Table 2 presents the results for the second dependent variable—whether the respondent reports having ever engaged in commercial sexual intercourse. The coefficient for the focal explanatory variable—the sex ratio—is negative and statistically significant at a borderline level (p = .053, two-tailed test). As predicted by our extension of demographic-opportunity theory, the greater the number of women available to men, the lower the likelihood that those men will have engaged in commercial sexual intercourse. Or, equivalently stated, men are more likely to visit a commercial sex worker when these men are faced with a numerical *deficit* of women in their local community and age group. This finding is consistent with concerns that the growing deficit of women in China may spur risky sexual behavior among men (e.g., Tucker et al. 2005). The magnitude of the effect of the sex ratio is neither trivial nor overwhelming. A one-unit difference in the female-to-male sex ratio decreases the odds that men have paid for sexual intercourse by about 2% [= $(1 – e^{[-.020]}) * 100$]. Applying the simulation described above, a drop in the sex ratio of 7.9 females per 100 males would decrease the odds that men will experience commercial sex by about 15% [= $(1 – e^{[-.020][7.9]}) * 100$].

Several of the other covariates in this model also take on statistically significant coefficients. The dummy variables for birth cohort indicate a significant upward trend in the likelihood that men have ever had commercial sex. Community percent urban is significantly and positively associated with the likelihood that men have paid for sexual services.

The third model in Table 2 presents the results for whether the respondent tests positive for a sexually-transmitted infection (STI). Only two independent variables in this model take on a statistically significant coefficient. Most importantly, the positive coefficient for the sex ratio indicates that, when faced with a relative abundance of women in their local marriage market, men are more likely to contract a sexually-transmitted infection. Put another away, a numerical deficit of females *reduces* the likelihood that men will contract an STI. This finding contrasts sharply with speculations over the impact of China's growing undersupply of women (and attendant oversupply of men) for the transmission of STDs, including HIV/AIDS (e.g., Tucker et al. 2005). Rather than increasing the likelihood that men will contract an STI, a deficit of women appears to reduce this probability. Although a deficit of women may increase STI rates by increasing the likelihood that men will have sex with commercial sex workers (Model 2), this effect is apparently overwhelmed by other pathways, perhaps including but not limited to the reduced likelihood that men will have sex early in life, outside of marriage, and with multiple partners.

The effect of the female-to-male sex ratio on the odds that men test positive for an STI is at least moderate in strength. A one-unit change in the sex ratio increases the odds that men will contract an STI by 3.1% ($= [(e^{[.031]}) - 1] * 100$). Again applying the simulation described above, a reduction in the sex ratio of 7.9 females per 100 males would increase the odds that men will contract an STI by about 28% ($= [(e^{[.031][7.9]}) - 1] * 100$). This model also shows that, at a borderline significance level, community mean age is positively associated with the risk that men will test positive for an STI.

The findings presented thus far indicate that a numerical shortage of women increases the likelihood that men will engage in commercial sex, but that such a shortage also reduces the overall likelihood that men will contract an STI. It is known, however, that commercial sex is a key risk factor for STIs (Parish and Pan 2006; Parish et al. 2003; Yang et al. 2005). Given this, we would expect that the effect of the sex ratio on the risk of contracting an STI is partially suppressed by commercial sex. In other words, the positive effect of the sex ratio on the risk of contracting an STI would be even stronger if a female surplus did not also reduce the likelihood that men will engage in commercial sex.

Table 3 about here

The model presented in Table 3 tests this idea. In this model, testing positive for an STI is regressed on the sex ratio, separate dummy variables for having engaged in noncommercial premarital sex and in commercial sex, and the other covariates. Not surprisingly, respondents who report having paid for sex are significantly more likely than other men to test positive for an STI (odds ratio = 3.31). In contrast, the coefficient for having engaged in noncommercial premarital sex, while as expected positive, is not statistically significant. Perhaps more importantly, controlling for the occurrence of commercial sex increases—albeit modestly—the observed effect of the sex ratio on the odds of contracting an STI relative to Model 3 of Table 2. When having engaged in commercial sex is controlled, a one unit increase in the female-to-male sex ratio increases the odds of contracting an STI by almost 4% (= $[(e^{[.035]}) - 1] * 100$), and an increase in the sex ratio of 7.9 females per 100 males increases the odds of contracting an STI by 32% (= $[(e^{[.035][7.9]}) - 1] * 100$).

Additional analyses

As suggested earlier, it is possible that the effect of the sex ratio on men's sexual behavior and STI risk varies across birth cohorts. Members of the older cohorts grew up at a time in which men may have been unlikely to engage in premarital or commercial intercourse regardless of the demographic opportunities (or lack thereof) available to them. Thus, the sexual behaviors of members of the older cohorts may be less responsive than the behaviors of members of the younger cohorts to the availability of women. We tested this idea by adding to the models in Table 2 product terms representing the interaction between the sex ratio and the dummy variables for birth cohort (results not shown). However, we found no evidence that the effect of the sex ratio on the outcomes varies across birth cohorts. In none of the models were the coefficients for these product terms statistically significant, nor as a group did they improve the models' fit.

Sensitivity checks

We explored several sensitivity analyses as checks on the robustness of our findings. First, we performed diagnostic checks on the regression models, focusing particularly on the influence of possible outliers. First, we aggregated the data to the community level and constructed scatterplots of the relationship between the mean sex ratio, on the one hand, and the proportion of males who had premarital sex, commercial sex, and who tested positive for an STI. We then re-estimated the regression models deleting respondents who resided in communities that might be having a disproportionate influence on the results. We found no evidence that particular communities were inordinately contributing to the parameter estimates. Second, following the suggestions of Menard (1995), we also re-estimated the models deleting observations with large standardized and Studentized residuals. Here, too, we failed to observe any clear evidence that our results are being driven by a small number of influential observations.

We also estimated models in which the sex ratio is measured by the age-specific numbers of men and women (using seven-year age groups with the two-year staggering described above) at the time of the CHFLS interview. Measuring the sex ratio this way assumes negligible influences of sex differences in mortality and migration throughout a cohort's life course; that is, this measurement strategy assumes that the number of women that men are exposed to in the year 2000 adequately represents the number of women that these men were exposed to throughout their lives when they were at risk of experiencing the outcomes. This is perhaps a reasonable assumption for the younger respondents but arguably less so for the older respondents. However, this measurement strategy has the advantage of drawing entirely on the full-count (or complete coverage) 2000 census data, thus eliminating the influence of errors in the measurement of the sex ratio incurred by using the 1982 and 1990 1% samples. Moreover, the sex ratio encountered at the time of the CHFLS survey may be closer in time to the risk period for experiencing some of the (unmeasured) events, such as extramarital sexual intercourse, that ostensibly increase the likelihood of contracting an STI. Results from these supplementary analyses were generally similar to, albeit slightly weaker than, those we report above. Re-estimating the model of noncommercial premarital sex (Model 1 of Table 2) substituting the sex ratio encountered at the time of the survey for the estimated sex ratio at age 20 yields a coefficient for the sex ratio of .011 ($p < .05$, two-tailed test). Re-estimating the models of commercial sex (Model 2 of Table 2) and STI status (Model 3 of Table 2) employing the same substitution yields coefficients for the sex ratio of -.012 ($p < .10$, two-tailed test), and .019 ($p < .10$, two-tailed test), respectively.

DISCUSSION AND CONCLUSION

The relative numbers of women and men in a population are likely to shape opportunities to engage in various forms of sexual behavior, but studies of the sexual risk behaviors that contribute to sexually-transmitted infections tend to overlook the sex ratio as a possible causal factor. We examine this connection using data on Chinese men. The case of China is well-suited to such an investigation, both because China has been experiencing a growing imbalance between the numbers of women and men in its population and because the increasing deficit of females is thought to have profound implications for the spread of HIV/AIDS and other sexual-transmitted diseases.

We merge individual-level data from the CHFLS with census-derived measures of the numerical availability of women in men's age group and local community. Consistent with hypotheses drawn from demographic-opportunity theory, we find statistically significant (at least at a borderline level) effects of the sex ratio on men's likelihood of engaging in premarital sex, of engaging in commercial sex, and of contracting an STI. In contrast to pessimistic and often dire speculations regarding the possible impact of China's burgeoning deficit of women, our findings suggest a more guarded—and perhaps more optimistic—scenario. Consistent with these speculations, we find that, when faced with an undersupply of women, men are more likely to engage in intercourse with commercial sex workers. But contrary to these pessimistic predictions, we also find that men who encounter comparatively few women in their local marriage market are less likely to have noncommercial premarital sex and, more importantly, are less likely to test positive for a sexually-transmitted infection. Presumably, the positive effect of a surfeit of females on men's risk of contracting an STI runs through mechanisms that we do not incorporate into our analysis, including but not limited to the age at first intercourse, the frequency of sex outside of marriage, and the number of different sexual partners. At the very least, then, it does not appear from this analysis that the growing numerical deficit of females in

China will result in sharp increases in men's rate of contracting sexually-transmitted diseases (cf. Poston and Glover 2005; Tucker et al. 2005).

At a broad level, our analysis highlights the importance of macrolevel social-structural characteristics such as population distributions for shaping sexual behaviors and their outcomes. The vast bulk of prior research on sexual risk behaviors and sexually-transmitted diseases focuses on their proximate, individual-level determinants. Our analysis directs attention to salient factors farther up the causal chain, underscoring how more distal characteristics of the social environment also influence these behaviors. In this way, our findings thus help to inform the macro-micro linkage in the study of individual health behavior and health status.

Of course, our analysis provides only indirect clues to how China's deficit of females will affect the future spread of HIV/AIDS. HIV/AIDS and other STDs have been spreading rapidly in China (Grusky, Liu, and Johnston 2002; Hong and Li 2009), but the extent to which a numerical deficit of females underlies these trends is not well understood. Much depends on the strength of the association between the various dimensions of men's sexual activity and the risk of contracting HIV/AIDS. On the one hand, if intercourse with commercial sex workers is the overriding risk factor for the transmission of HIV/AIDS in the heterosexual population (Qu et al. 2002; van den Hoek et al. 2001), then there is ample cause for concern given our finding that a female deficit is positively associated with men's utilization of commercial sex services. On the other hand, our results regarding the impact of the sex ratio on the probability that men have contracted an STI—which we are able to measure here with a biomarker—may be particularly instructive both because STIs are a risk factor for HIV/AIDS and because of likely similarity in their determinants and modes of transmission (Galvin and Cohen 2004; Yang et al. 2005). And on this score the findings suggest a considerably more optimistic view since we find that men are less likely to test positive for at least some STIs when there are relatively few women in their local marriage market.

We acknowledge several limitations to our analysis. First, we are unable to precisely date the life-course timing of the sexual behaviors that serve as dependent variables in the analysis. That is, we do not know exactly when during their lives men had premarital sex or commercial sex or when they contracted an STI. We also lack complete residential histories that would allow us to determine the sex ratio to which men are exposed at each point during their at-risk years. Because of these limitations, it is not possible to perform fine-grained event-history analyses of these outcomes, or to estimate unambiguous structural equation models (e.g., path models) of how these sexual risk behaviors and health states relate to each other. For example, while the analysis in Table 3 shows a positive association between engaging in commercial sex and testing positive for an STI, we cannot be certain that respondents engaged in commercial sex prior to contracting the STI. Moreover, because our measure of STI status is a point-in-time rather than a lifetime prevalence measure, our analysis may underestimate the effect of the sex ratio on men's risk of contracting an STI. In addition, because of data limitations we have not attempted to circumscribe the pool of eligible females by marital status or by social class. Our analysis is also limited by the relatively small samples of both individuals and communities.

We also acknowledge that our analysis does not take into account most of the potential pathways through which sex ratio imbalances might influence Chinese men's risk of contracting an STI. For example, we have not attempted here to examine the effect of the sex ratio on men's sexual frequency or their likelihood having sexual intercourse outside of marriage or with multiple partners. Our analysis is also not well-suited for determining whether a deficit of females spurs male migration from predominantly rural communities into large metropolitan areas, and through this fosters higher rates of sexual risk behaviors or HIV/AIDS transmission (Tucker et al. 2005). High rates of geographic mobility and China's large floating population may contribute to the spread of HIV/AIDS in ways that our analysis cannot capture (He et al. 2006; Hong et al. 2006; Zhang and Ma 2002).

Of course, using these findings to project the future of Chinese men's sexual behavior and STI risk in the face of a growing numerical deficit of females is a risky endeavor. If there are nonlinear, or threshold, effects of the sex ratio on men's sexual behavior, then our findings may not be able to capture the future impact of imbalanced sex ratios on men's behavior. In the future, the adult sex ratio is likely to reach values that are uncommonly observed in our cross-sectional analysis of the contemporary sex ratio. Moreover, increasing rates of internal geographic mobility may help to alleviate gender imbalances in local areas, as would the emigration of males and the immigration of females. At the same time, one key difference between the current cross-sectional inter-community variation in the adult sex ratio exploited here and the looming imbalance in adult sex ratios in China's future is that, currently, men can move from a community with few women to a community with more women; in the future, however, there are likely to exist few if any communities with an abundance of women to serve as destinations for internal migrants.

Our analysis leads to several recommendations for future research. Certainly, no analysis of how China's sex ratio imbalance will affect sexual health would be complete without also considering how the growing oversupply of males affects women's behavior. It is possible that a relative abundance of men increases Chinese women's chances of having premarital, extramarital, and multi-partner sexual intercourse and of contracting an STI. Consequently, any effects of a female deficit on men's sexual behavior and STI risk may be counterbalanced by a parallel but opposite effect of a male surplus on women's sexual behavior and STI risk.

Finally, our analysis might be extended profitably to other countries and contexts. India, for example, has also been experiencing a pronounced and growing deficit in the number of girls (Das Gupta et al. 2003; Griffiths, Matthews, and Hinde 2000), as well as a pronounced increase in the seroprevalence of HIV/AIDS (Chandrasekaran et al. 2006). But, as in China, the degree to which these trends might be interconnected is unknown. Future research might profit from exploring the consequences of imbalanced sex ratios for men's and women's sexual health behavior in India as well as other countries that are experiencing a numerical deficit of women.

NOTES

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[1] South, Trent, and Shen (2001) refer to this perspective as "macrostructural-opportunity theory;" Uecker and Regnerus (2009) refer to it as "opportunity theory."

[2] Some of these studies are also informed by Guttentag and Secord's (1983) sociocultural theory, but because this theory generally makes predictions similar to demographic-opportunity theory regarding the effect of the sex ratio on men's behavior, we do not discuss it here.

[3] The majority of the positive test results are for chlamydial infection.

[4] Although the sex ratio is conventionally measured as the number of men per 100 women (Hobbs 2004), given our interest in how the availability of women affects men's behavior, interpretation of the results is greatly facilitated by measuring it here as the number of women per men. See Lloyd and South (1996) for a similar approach.

[5] A few communities could not be identified in the 1982 or 1990 censuses. For men in these communities, we substitute the age-specific sex ratio observed in the 2000 census. Substantive findings are unaffected by this substitution. We also observed some extreme values of the sex ratio, likely a consequence of sampling variability in the smaller communities. To limit the influence of these extreme values, we bottom-code and top-code the values of the sex ratio at 80 and 120, respectively.

[6] Because of data constraints, it is not possible to measure respondents' urbanicity at age 14 and the community's level of urbanization at the time of the CHFLS in a strictly comparable manner.

[7] We acknowledge that the mean sex ratio observed for this sample is lower than that for all adults in China as a whole. Some of this difference results from our use of sample data from the 1982 and 1990 censuses for different cohorts of adults. The 2000 China census indicates there

were about 95 women per 100 men for the age group 20-44 (Anderson 2004). The mean sex ratio for our sample computed using only the full-count 2000 census data is 93.3, which is closer to the national figure.

REFERENCES

Anderson, Barbara. 2004. "Undercount in China's 2000 Census in Comparative Perspective." PSC Research Report No. 04-565, Population Studies Center, University of Michigan, Ann Arbor, MI.

Avakame, Edem F. 1999. "Sex Ratios, Female Labor Force Participation, and Lethal Violence Against Women: Extending Guttentag and Secord's Thesis." *Violence Against Women* 5:1321-41.

Banister, Judith. 2004. "Shortage of Girls in China Today." *Journal of Population Research* 21:19-45.

Barber, Nigel. 2000. "On the Relationship between Country Sex Ratios and Teen Pregnancy Rates: A Replication." *Cross-Cultural Research* 34:26-37.

Barber, Nigel. 2001. "On the Relationship between Marital Opportunity and Teen Pregnancy: The Sex Ratio Question." *Journal of Cross-Cultural Psychology* 32:259-67.

Barber, Nigel. 2003. "Divorce and Reduced Economic and Emotional Interdependence: A Cross-National Study." *Journal of Divorce and Remarriage* 39:113-24.

Barber, Nigel. 2004. "Reduced Female Marriage Opportunity and History of Single Parenthood (England, Scotland, U.S.)." *Journal of Cross-Cultural Psychology* 35: 648-51.

Billy, John O. G, Karin L. Brewster, and William R. Grady. 1994. "Contextual Effects on the Sexual Behavior of Adolescent Women." *Journal of Marriage and the Family* 56:387-404.

Billy, John O. G., and David E. Moore. 1992. "A Multilevel Analysis of Marital and Nonmarital Fertility in the U.S." *Social Forces* 70:977-1011.

Brewster, Karin L. 1994. "Neighborhood Context and the Transition to Sexual Activity among Young Black Women." *Demography* 31:977-1011.

Browning, Christopher, and Matisa Olinger-Wilborn. 2003. "Neighborhood Structure, Social Organization, and Number of Short-Term Sexual Partnerships." *Journal of Marriage and Family* 65:730-45.

Cai, Yong, and William Lavely. 2003. "China's Missing Girls: Numerical Estimates and Effects on Population Growth." *The China Review* 3:13-29.

Chandrasekaran, Padma, Gina Dallabetta, Virginia Loo, Sujata Rao, Helene Gayle, and Ashok Alexander. 2006. "Containing HIV/AIDS in India: The Unfinished Agenda." *The Lancet Infectious Diseases* 6:508-21.

China Data Center. 2004. *The Complete Collection of 2000 China County/District Population Census Data Assemblies* [MRDF]. China Data Center: University of Michigan.

China Population and Information Research Center. 2008. *1% Sample of the 1990 China Population Census Data* [MRDF]. Accessed from the Texas A&M University China Archive, July 21, 2008.

Chinese Health and Family Life Survey. 2006. http://www.src.uchicago.edu/prc/chfls.php. Accessed March 30, 2006.

Coale, Ansley J., and Judith Banister. 1994. "Five Decades of Missing Females in China." *Demography* 31:459-79.

Das Gupta, Monica, Jiang Zhenghua, Bohua Li, Zhenming Xie, Woojin Chung, and Hwa-Ok Bae. 2003. "Why is Son Preference So Persistent in East and South Asia? A Cross-Country Study of China, India, and the Republic of Korea." *Journal of Development Studies* 40:153-87.

Feng, Wang, and Yang Quanhe. 1996. "Age at Marriage and the First Birth Interval: The Emerging Change in Sexual Behavior among Young Couples in China." *Population and Development Review* 22: 229-320.

Fleming, Douglas T., Geraldine M. McQuillan, Robert E. Johnson, Andre J. Nahmias, Servi O. Aral, Francis K. Lee, and Michael E. St. Louis. 1997. “Herpes Simplex Virus Type 2 in the United States, 1976-1994.” *New England Journal of Medicine* 337:1105-1111.

Fossett, Mark A. and K. Jill Kiecolt. 1993. “Mate Availability and Family Structure among African Americans in U.S. Metropolitan Areas.” *Journal of Marriage and the Family* 55:288-301.

Friedman, Samuel R., Alan Neaigus, Benny Jose, Richard Curtis, Marjorie Goldstein, Gilbert Ildefonso, Richard B. Rothenberg, and Don C. Des Jarlais. 1997. “Sociometric Risk Networks and Risk of HIV Infection.” *American Journal of Public Health* 87:1289-1296.

Galvin, Shannon R., and Myron S. Cohen. 2004. “The Role of Sexually Transmitted Diseases in HIV Transmission.” *Nature Reviews Microbiology* 2:33-42.

Goodkind, Daniel M. 2004. “China’s Missing Children: The 2000 Census Underreporting Surprise.” *Population Studies* 58:281-295.

Griffiths, Paula, Zoe Matthews, and Andrew Hinde. 2000. “Understanding the Sex Ratio in India: A Simulation Approach.” *Demography* 37:477-88.

Grusky, Oscar, Hongjie Liu, and Michael Johnston. 2002. “HIV/AIDS in China: 1990-2001.” *AIDS and Behavior* 6:381-93.

Gu, Baochang, and Krishna Roy. 1995. “Sex Ratio at Birth in China, with Reference to Other Areas in East Asia: What We Know.” *Asia-Pacific Population Journal* 10:17-42.

Guttentag, Marcia, and Paul F. Secord. 1983. *Too Many Women? The Sex Ratio Question.* Beverly Hills, CA: Sage.

Harknett, Kristen. 2008. “Mate Availability and Unmarried Parent Relationships.” *Demography* 45:555-71.

He, Na, Roger Detels, Zheng Chen, Qingwu Jiang, Jinde Zhu, Yiqun Dai, Min Wu, Xing Zhong, Chaowei Fu, and Dexin Gui. 2006. “Sexual Behavior among Employed Male Rural Migrants in Shanghai, China.” *AIDS Education and Prevention* 18:176-86.

Hobbs, Frank. 2004. “Age and Sex Composition.” Pp. 125-173 in Jacob S. Siegel and David A Swanson (eds.), *The Methods and Materials of Demography*. San Diego, CA: Elsevier Academic Press.

Hong, Yan, and Xiaoming Li. 2009. “HIV/AIDS Behavioral Interventions in China: A Literature Review and Recommendation for Future Research.” *AIDS and Behavior* 13:603-13.

Hong, Yan, Bonita Stanton, Xiaoming Li, Hongmei Yang, Danhua Lin, Xiaoyi Fang, Jing Wang, and Rong Mao. 2006. “Rural-to-Urban Migrants and the HIV Epidemic in China.” *AIDS and Behavior* 10:421-30.

Hudson, Valerie M., and Andrea Den Boer. 2004. *Bare Branches: Security Implications of Asia’s Surplus Male Population*. Cambridge, MA: MIT Press.

Hull, Terence H. 1990. “Recent Trends in Sex Ratios at Birth in China.” *Population and Development Review* 16:63-83.

Johansson, Sten, and Ola Nygren. 1991. “The Missing Girls of China: A New Demographic Account.” *Population and Development Review* 17:35-51.

Laumann, Edward O., John H. Gagnon, Robert T. Michael, and Stuart Michaels. 1994. *The Social Organization of Sexuality: Sexual Practices in the United States*. Chicago: University of Chicago Press.

Laumann, Edward O., and Yoosik Ma Youm. 1999. “Racial/Ethnic Group Differences in the Prevalence of Sexually Transmitted Disease in the United States: A Network Explanation.” *Sexually Transmitted Diseases* 26:250-261.

Lavely, William. 2001. “First Impressions from the 2000 Census of China.” *Population and Development Review* 27:755-69.

Lichter, Daniel T. Robert N. Anderson, and Mark D. Hayward. 1995. “Marriage Markets and Marital Choice.” *Journal of Family Issues* 16:412-31.

Lichter, Daniel T., Felicia B. LeClere, and Diane K. McLaughlin. 1991. “Local Marriage Market Conditions and the Marital Behavior of Black and White Women.” *American Journal of Sociology* 96:843-67.

Lichter, Daniel T., Diane K. McLaughlin, George Kephart, and David J. Landry. 1992. "Race and the Retreat from Marriage: A Shortage of Marriageable Men?" *American Sociological Review* 57:781-99.

Lloyd, Kim M., and Scott J. South. 1996. “Contextual Influences on Young Men’s Transition to First Marriage.” *Social Forces* 74:1097-1119.

McQuillan, Geraldine M., Deanna Kruszon-Moran, Benny J. Kottiri, Laurie A. Kamimoto, Lee Lam, Faye Cowart, Marjorie Hubbard, and Thomas J. Spira. 2006. “Prevalence of HIV in the U.S. Household Population, The National Health and Nutrition Examination Surveys, 1988 to 2002.” *Journal of Acquired Immune Deficiency Syndrome* 41:651-656.

Menard, Scott. 1995. *Applied Logistic Regression Analysis*. Thousand Oaks, CA: Sage.

Merli, M. Giovanna, Sara Hertog, Bo Wang, and Jing Li. 2006. "Modelling the Spread of HIV/AIDS in China: The Role of Sexual Transmission." *Population Studies* 60:1-22.

Murphy, Rachel. 2003. "Fertility and Distorted Sex Ratios in a Rural Chinese County: Culture, State, and Policy." *Population and Development Review* 29:595-626.

National Research Council, Panel on Transitions to Adulthood in Developing Countries. 2005. *Growing Up Global: The Changing Transitions to Adulthood in Developing Countries*. Washington, DC: National Academies Press.

O'Brien, Robert M. 1991. "Sex Ratios and Rape Rates: A Power-Control Theory." *Criminology* 29:99-114.

Oster, Emily. 2005. "Hepatitis B and the Case of the Missing Women." *Journal of Political Economy* 113:1163-1216.

Parish, William L., Edward O. Laumann, Myron S. Cohen, Suiming Pan, Heyi Zheng, Irving Hoffman, Tianfu Wang, and Kwai Hang Ng. 2003. "Population-Based Study of Chlamydial Infection in China: A Hidden Epidemic." *JAMA* 289:1265-73.

Parish, William L., Edward O. Laumann, and Sanyu A. Mojola. 2007. "Sexual Behavior in China: Trends and Comparisons." *Population and Development Review* 33: 729-756.

Parish, William L., and Suiming Pan. 2006. "Sexual Partners in China, Risk Patterns for Infection by HIV and Possible Interventions." Pp. 190-213 in Joan Kaufman, Arthur Kleinman, and Tony Saich (eds.), *AIDS and Social Policy in China*. Cambridge, MA: Harvard University Asia Center.

Parish, William L., Tianfu Wang, Edward O. Laumann, Suiming Pan, and Ye Luo. 2004. "Intimate Partner Violence in China: National Prevalence, Risk Factors and Associated Health Problems." *International Family Planning Perspectives* 30:174-81.

Peng, Xizhe, and Juan Huang. 1999. "Chinese Traditional Medicine and Abnormal Sex Ratio at Birth in China." *Journal of Biosocial Science* 31:487-503.

Porter, Maria. 2006. "Imbalance in China's Marriage Market and Its Effect on Bargaining within the Household." Unpublished paper. Department of Economics, University of Chicago.

Poston, Dudley L., Jr., and Karen S. Glover. 2005. "Too Many Males: Marriage Market Implications of Gender Imbalances in China." *Genus* 61:119-40.

Poston, Dudley L., Jr., and Peter Morrison. 2005. "China: Bachelor Bomb." *International Herald Tribune*, September 14.

Qu, Shuquan, Wei Liu, Kyung-Hee Choi, Rongjian Li, Deyuan Jiang, Yuejiao Zhou, Fang Tian, Priscilla Lee Chu, Huang Shi, Xiwen Zheng, and Jeffrey Mandel. 2002. "The Potential for Rapid Sexual Transmission of HIV in China: Sexually Transmitted Diseases and Condom Failure Highly Prevalent among Female Sex Workers." *AIDS and Behavior* 6:267-75.

Radcliffe, K. W., S. Ahmad, G. Gilleran, and J. D. C. Ross. 2001. "Demographic and Behavioural Profile of Adults Infected with Chlamydia: A Case Control Study." *Sexually Transmitted Diseases* 77:265-270.

Raudenbush, Stephen W. and Anthony S. Bryk. 2002. *Hierarchical Linear Models* (second edition). Thousand Oaks, CA: Sage.

Sambisa, William and C. Shannon Stokes. 2006. "Rural/Urban Residence, Migration, HIV/AIDS, and Safe Sex Practices among Men in Zimbabwe." *Rural Sociology* 71:183-211.

Schoen, Robert, and James R. Kluegel. 1988. "The Widening Gap in Black and White Marriage Rates: The Impact of Population Composition and Differential Marriage Propensities." *American Sociological Review* 53:895-907.

Secondi, Giorgio S. 2002. "Biased Childhood Sex Ratios and the Economic Status of the Family in Rural China." *Journal of Comparative Family Studies* 2002:215-34.

Sheng, Xuewen. 2005. "Chinese Families." Pp. 99-128 in Bert Adams and Jan Trost (eds.) *Handbook of World Families*. Thousand Oaks, CA: Sage.

South, Scott J. 1996. "Mate Availability and the Transition to Unmarried Motherhood: A Paradox of Population Structure." *Journal of Marriage and Family* 58:265-79.

South, Scott J., and Kim M. Lloyd. 1992. "Marriage Markets and Nonmarital Fertility in the United States." *Demography* 29:247-64.

South, Scott J., and Steven F. Messner. 1987. "The Sex Ratio and Women's Involvement in Crime: A Cross-National Analysis." *Sociological Quarterly* 28:171-88.

South, Scott J., and Katherine Trent. 1988. "Sex Ratios and Women's Roles: A Cross-National Analysis." *American Journal of Sociology* 93:1096-1115.

South, Scott J., Katherine Trent, and Yang Shen. 2001. "Changing Partners: Toward a Macrostructural-Opportunity Theory of Marital Dissolution." *Journal of Marriage and Family* 63:743-54.

StataCorp. (2005). *Stata Statistical Software: Release 9*.0. College Station, TX: Stata Corporation.

Trent, Katherine, and Scott J. South. 1989. "Structural Determinants of the Divorce Rate: A Cross-Societal Analysis." *Journal of Marriage and the Family* 51:391-404.

Trent, Katherine, and Scott J. South. 2003. "Spousal Alternatives and Marital Relations." *Journal of Family Issues* 24:787-810.

Tucker, Joseph D., Gail E. Henderson, Tian F. Wang, Ying Y. Huang, William Parish, Sui M. Pan, Xiang S. Chen, and Myron S. Cohen. 2005. "Surplus Men, Sex Work, and the Spread of HIV in China." *AIDS* 19:539-47.

Tuljapurkar, Shripad, Nan Li, and Marcus W. Feldman. 1995. "High Sex Ratios in China's Future." *Science* 267:874-76.

Uecker, Jeremy E. and Mark D. Regnerus. 2009. "Campus Sex Ratios, Romantic Relationships, and Sexual Behavior." Paper presented at the annual meeting of the Population Association of America, Detroit, MI.

van den Hoek, Anneke, Fu Yulian, Nicole H.T.M. Dukers, Chen Zhiheng, Feng Jiangting, Zhang Lina, and Zhang Xiuxing. 2001. "High Prevalence of Syphilis and Other Sexually Transmitted Diseases among Sex Workers in China: Potential for Fast Spread of HIV." *AIDS* 15:753-59.

Xu, Fujie, Maya R. Sternberg, Benny J. Kottiri, Geraldine M. McQuillan, Francis K. Lee, Andre J. Nahmias, Stuart M. Berman, and Lauri E. Markowitz. 2006. "Trends in Herpes Simplex Virus Type 1 and Type 2 Seroprevalence in the United States." *JAMA* 296:964-973.

Yang, Hongmei, Xiaoming Li, Bonita Stanton, Hongjie Liu, Hui Liu, Ning Wang, Xiaoyi Fang, Danhua Lin, and Xinguang Chen. 2005. "Heterosexual Transmission of HIV in China: A Systematic Review of Behavioral Studies in the Past Two Decades." *Sexually Transmitted Diseases* 32:270-80.

Yi, Zeng, Ping Tu, Baochung Gu, Xu Yi, Li Bohua, and Li Yongping. 1993. “Causes and Implications of the Recent Increase in the Reported Sex Ratio at Birth in China.” *Population and Development Review* 19:283-302.

Yuan, Xin, and Edward Jow-Ching Tu. 2004. “Analysis of High Sex Ratio at Birth in Mainland China.” *Journal of Population Studies* 29:147-81.

Zhang, Kong-lai and Shao-Jun Ma. 2002. “Epidemiology of HIV in China.” *BMJ* 324:803-04.

Table 1. Descriptive Statistics for Variables Used in Analysis of Sexual Behavior and STI Risk: Men Ages 20-44, Chinese Health and Family Life Survey

Dependent Variables	Description	Percent	N
Premarital sex	R reports engaging in non-commercial sexual intercourse prior to marrying	25.25	1023
Commercial sex	R reports ever providing money or gifts for sexual intercourse	9.14	1007
Has STI	R's urine test is positive for gonorrhea, chlamydia, or trichomonas	3.82	905
Independent Variables		**Mean**	**SD**
Sex ratio	Estimated number of women ages 15-21 per 100 men ages 17-23 in R's community when R was age 20	90.35	10.98
Education	R's level of education (1=never attended school; 2=elementary school; 3=junior high school; 4=senior high school; 5=junior college; 6=university/graduate school)	3.14	.89
Birth cohort 1950	R was born 1950 to 1959 (1=yes)	.14	
Birth cohort 1960	R was born 1960 to 1969 (1=yes)	.38	
Birth cohort 1970	R was born 1970 to 1979 (1=yes)	.48	
Urban residence at age 14	R resided in urban area at age 14 (1=yes)	.19	

Table 1. (continued)

Community percent urban	Percent of community population residing in urban locale	48.72	34.38
Community mean education	Mean educational attainment of community population	3.01	.37
Community mean age	Mean age of the community adult population	38.04	1.56

Notes: Descriptive statistics for independent variables taken from largest sample (N = 1,023).
Standard deviations for dummy variables not shown.

Table 2. Multilevel Logistic Regression Analyses of Sexual Behavior and STI Risk: Men Ages 20-44, Chinese Health and Family Life Survey

	Model 1 Premarital Sex			Model 2 Commercial Sex			Model 3 Has STI		
Independent Variables	b	se	e^x	b	se	e^x	b	se	e^x
Sex ratio	.015*	.007	1.015	-.020+	.010	.980	.031*	.015	1.032
Education	.045	.078	1.046	.035	.116	1.035	-.167	.188	.846
Birth cohort									
1950	Reference			Reference			Reference		
1960	.912**	.217	2.490	.602+	.350	1.826	-.053	.427	.948
1970	1.020**	.228	2.774	.797*	.358	2.220	-.169	.484	.845
Urban residence at age 14	.410*	.172	1.506	.219	.243	1.245	.073	.397	1.076
Community percent urban	.008+	.004	1.008	.011*	.006	1.011	-.001	.008	.999
Community mean education	-.558+	.337	.572	-.289	.463	.749	.246	.673	1.279
Community mean age	-.013	.037	.987	-.030	.050	.970	.155+	.082	1.168
Constant	-1.574	1.679		.114	2.368		-12.207**	3.352	
N of persons	1023			1007			905		

Table 2. (continued)

N of communities	37	37	37
Log-likelihood	-617.194	-329.545	-152.014

Note: See Table 1 for variable measurements.
$^{+}$ $p < .10$ * $p < .05$ ** $p < .01$ (two-tailed tests)

Table 3. Multilevel Logistic Regression Analysis of Having a Sexually-Transmitted Infection: Men Ages 20-44, Chinese Health and Family Life Survey

	Has STI		
Independent Variables	b	se	e^x
Sex ratio	.035*	.015	1.035
Premarital sex	.425	.350	1.529
Commercial sex	1.197**	.416	3.311
Education	-.175	.190	.840
Birth cohort			
1950		Reference	
1960	-.151	.438	.860
1970	-.334	.495	.716
Urban residence at age 14	-.001	.399	.999
Community percent urban	-.004	.008	.996
Community mean education	.398	.685	1.489
Community mean age	.163*	.082	1.177
Constant	-13.316**	3.396	
N of persons		905	
N of communities		37	
Log-likelihood		-147.631	

Note: See Table 1 for variable measurements.
$^{+}$ $p < .10$ * $p < .05$ ** $p < .01$ (two-tailed tests)