Population-Based Study of Chlamydial Infection in China: A Hidden Epidemic

William L. Parish; Edward O. Laumann; Myron S. Cohen; et al.

JAMA. 2003;289(10):1265-1273 (doi:10.1001/jama.289.10.1265)

http://jama.ama-assn.org/cgi/content/full/289/10/1265

Population-Based Study of Chlamydial Infection in China

A Hidden Epidemic

William L. Parish, PhD
Edward O. Laumann, PhD
Myron S. Cohen, MD
Suiming Pan, MA
Heyi Zheng, MD
Irving Hoffman, MPH
Tianfu Wang, MS
Kwai Hang Ng, MA

Context Sexually transmitted diseases are increasing rapidly in China. Surveillance data imperfectly indicate current prevalence and risk factors.

Objectives To estimate the prevalence of genital chlamydial and gonococcal infections and to describe patterns of infection by subgroup and behavioral patterns.

Design, Setting, and Participants A national stratified probability sample of 3426 Chinese individuals (1738 women and 1688 men) aged 20 to 64 years, who were interviewed between August 1999 and August 2000, completed a computer-administered survey, and provided a urine specimen (69% total participation rate).

Main Outcome Measure Positive test result for chlamydial or gonococcal infections.

Results The overall prevalence per 100 population of chlamydial infection was 2.6 (95% confidence interval [CI], 1.6-4.1) for women and 2.1 (95% CI, 1.3-3.3) for men. For gonococcal infection, the overall prevalence per 100 population was 0.08 (95% CI, 0.02-0.4) for women and 0.02 (95% CI, 0.005-0.1) for men. Risk factors for chlamydial infection among men aged 20 to 44 years were unprotected sex with a commercial sex worker (odds ratio [OR], 8.24; 95% CI, 3.51-19.35), less education (OR, 7.20; 95% CI, 2.31-22.37), and recent sex with their spouse or other steady partner (OR, 7.73; 95% CI, 2.70-22.10). Among women aged 20 to 44 years, risk factors for chlamydial infection were having less education (OR, 2.82; 95% CI, 1.01-7.91) and living in a city (OR, 3.46; 95% CI, 1.67-7.18) or along the southern coast (OR, 2.16; 95% CI, 1.29-3.63) and having a spouse or other steady sexual partner who earned a high income (OR, 2.85; 95% CI, 1.11-7.29), who socialized often (OR, 2.79; 95% CI, 1.08-7.19), or who traveled less than 1 week per year (OR, 5.40; 95% CI, 1.44-20.3).

Conclusions The prevalence of chlamydial infection in China is substantial. The patterns of infection suggest potential avenues for intervention.

JAMA. 2003;289:1265-1273 www.jama.com

After record high levels of sexually transmitted diseases (STDs) in the late 1940s, China's socialist regime was remarkably successful in suppressing commercial sex and STDs from the 1950s through the 1970s.[1-3] However, in the last 2 decades, commercial sex has returned, and STD prevalence in China has increased. Human immunodeficiency virus (HIV) infection has begun to spread beyond the initial transmission pockets of injection drug users (IDUs) and blood transfusions.[4-6] If current infection trends persist, absolute numbers of individuals with HIV infection are projected to surpass current numbers in the United States within 2 years and those in South Africa (currently the highest) within a decade.[6,7] Reports from public health clinics and special studies of high-risk clinic patients, IDUs, and commercial sex workers reveal several dimensions of the problem.[8-10]

China's public health reporting system tracks 8 STDs, including HIV and acquired immunodeficiency syndrome (AIDS), gonorrhea, syphilis, genital warts, nongonococcal urethritis/cervicitis, genital herpes, lymphogranuloma venereum, and chancroid. The system does not track chlamydial infections. The reported annual incidence of all 8 infections combined was only 0.07 per 100 total population for the year 2000.[4,11] Asymptomatic infections, incomplete coverage, and other issues could lead to underreporting.[4] *Chlamydia trachomatis* and, to a lesser extent, *Neisseria gonorrhoeae* can remain asymptomatic, leading to a hidden epidemic.[12-15] In this study, we surveyed a probability sample from the Chinese adult population aged 20 to 64 years to determine the prevalence of in-

For editorial comment see p 1303.

Author Affiliations: Population Research Center, National Opinion Research Center (NORC)/University of Chicago, Chicago, Ill (Drs Parish and Laumann and Messrs Wang and Ng); Division of Infectious Diseases, University of North Carolina, Chapel Hill (Dr Cohen and Mr Hoffman); Sociology of Sexuality Institute, Renmin University, Beijing, China (Mr Pan); and Dermatology/Venerology Division, Peking Union Medical College, Beijing, China (Dr Zheng).
Corresponding Author and Reprints: William L. Parish, PhD, 1126 E 59th St, Chicago, IL 60637 (e-mail: w-parish@uchicago.edu).

fection with *C trachomatis* and *N gonorrhoeae* and to identify social and behavioral characteristics associated with infection.

METHODS

Sample

With the exclusion of Tibet and Hong Kong, the sample is nationally representative of the adult population of China aged 20 to 64 years. This population sample was drawn probabilistically in 4 steps following standard procedures for complex samples.[16] First, using the 1990 national population census and public health reports of STD infection rates in different provinces and cities, China was divided into 14 strata based on size of urban population and location on the southern and eastern coasts (where STD infection rates have been reported to be high). To capture higher STDs in some regions, coastal regions and large cities were oversampled using known population weights. Second, 2 to 6 administrative units (urban districts, smaller cities, and counties) were selected from each stratum, with the probability of the unit being selected being proportional to the population of that unit. These provided 48 primary sampling units. Third, on arriving at a sampling unit, each survey team arrayed the subunits in the county or city by population size and again picked 1 to 2 subunits (neighborhoods in cities, villages or towns in counties) probabilistically, with more highly populated subunits having a greater probability of being selected. This produced a total of 60 sample communities. Fourth, using the official community registers of households and temporary migrants, the adult population aged 20 to 64 years was arrayed in order. Starting with a randomly chosen person from this list, individuals were picked at fixed intervals to produce approximately 83 individuals per community (5000/60 communities=83).

The 60 interview sites (villages and urban neighborhoods) were distributed as shown in the FIGURE. Except for Tibet, all of the 31 provincial-level municipalities (Beijing, Shanghai, Tianjin, and Chongqing) and provinces had a chance of being included in the sample. Each of the provincial-level units can be ranked by 1996-2000 average prevalence in the national STD reporting system for the 8 STDs mentioned earlier.[1,2] With the exception of Chongqing, the sample included 2 or more sample sites in each of the 8 provinces with the highest prevalence levels for 8 reportable STDs. Thirteen provinces were not represented in the sample. Tibet was intentionally omitted because of the sparse population and travel difficulties, and 12 happened not to be selected by chance. Of the 13 not included, 10 ranked below the median STD prevalence for all provinces. These include Yunnan (southwest) and Xinjiang (far west) provinces, which had many IDU-related HIV cases but only modest levels of STDs. The 3 unrepresented provinces with above-median STD prevalence were Chongqing Municipality and Jiangxi and Guangxi provinces, with Guangxi having a high rate of IDUs and cases of HIV.

Figure. Interview Sites in China

Interview

A computerized interview, based in part on the 1992 US National Health and Life Survey,[17] was pretested in China in 3 field trials. Also, 50 husband-wife pairs were given shortened versions of the questionnaire. Statistics on their agreements about shared sexual behavior produced κ values that averaged 0.35, modest but in the same range as agreement about other aspects of family life such as spousal violence and relative social status of parents (average κ=0.27). Another 50 respondents had repeat interviews after a gap of 2 months. The 21 items about sexual behavior had average κ agreement values of 0.75 when the same items were compared across the 2 separate interviews. The final questionnaire for the

study (Chinese Health and Family Life Survey) can be downloaded at http://www.src.uchicago.edu/DATALIB/DLproj/chfls.html.[18]

Mostly mid- to late-career social workers and researchers in their 40s and 50s (a total of 39 interviewers) had 1 week's training, and then continued with the project for most of a year from August 1999 to August 2000. In the field, interviewers were of the same sex as the respondent.

For the sake of privacy, interviews took place away from the respondent's home. In large cities, these facilities were typically private rooms in a neighborhood hotel. In villages and smaller towns, these facilities were rooms in a larger home or in a village meeting place. Interview team members approached individuals who had been drawn in the sample, explained the purpose of the interviews, and read them an informed consent statement approved by the institutional review boards. Oral and computer-entered consent were obtained prior to the hour-long interview, which began with the interviewer in control of the computerized interview and continued with the computer controlled entirely by the respondent. Only 13% (often older women in the countryside) needed continued interviewer assistance in this last portion of the interview. Respondents were also asked to provide a urine sample. The methods were approved by institutional review boards at the University of Chicago, Chicago, Ill; Renmin University, Beijing, China; and Peking Union Medical College, Beijing, China.

Weighting and Statistical Analysis

When weighted according to sampling fractions, the data set of successful interviews had too few individuals in their 20s and too few in their 50s and 60s, as judged by national census figures and annual population surveys conducted by the government. Accordingly, analysis weights were further adjusted to make the age distribution approximate what is found in these other data sources. Since those who failed to provide a urine sample were only marginally different from those who did, judged by tests of significance, we made no further adjustments among those who provided urine. After adjusting weights for both sampling fractions and age distributions, percentage distributions for urban residence, age, and education closely paralleled data available in the national census and other national-level statistics, thereby implying that the adjusted sample is representative of the total adult working-age population.[19,20]

Using *svy* methods in the STATA 7.0 statistical package (STATA Corp, College Station, Tex), the analysis was adjusted for sample strata, primary sampling units, and population weights.[21-23] Confidence intervals (CIs) for prevalences used a logit transform so that the end points lie between 0 and 1. Risk factors that commonly emerge in the literature on STDs in developing countries were included. A stepwise procedure to report the most parsimonious logistic equation models was not used because of the danger of overemphasizing chance features in the data. Instead, relatively full models that engage the existing literature and the assumptions within China on major risk factors were used. Other risk factors found in other societies, but found not to be applicable in China, were also considered in the baseline models. Standard logistic equation methods were used,[24] and condition indexes and other indicators of possible multicollinearity among risk factors were examined.[25] Standard demographic characteristics (age, education, income, urban residence), standard risk factors (sexual partner history), and migration status were forced into the models.

Laboratory Methods

Urine specimens were frozen and taken to a central laboratory where assays were performed within 30 days. *Neisseria gonorrhoeae* and *C trachomatis* were measured with ligase chain reaction (Abbott Laboratories, North Chicago, Ill), according to the manufacturer's instructions. The testing was done without further confirmation. Cleaning and maintenance of instruments were performed as instructed by the manufacturer. Notification of results was sent by mail. However, confidentiality in the mail system was a concern. To reduce the number of individuals who would have access to the names of participants in the survey, only participants with positive results were notified if they had requested notification at the time of interview. In the notification, participants were referred to their local public health clinic with a description of their infection and the appropriate treatment.

RESULTS

Of the 5000 individuals initially sampled, 3813 study participants completed the interview and 3426 also provided a urine sample, yielding a final participation rate of 69%. Participant and data losses were of 3 types: (1) those who refused to be interviewed (n=897); (2) those who failed to provide a urine sample (n=340), including those who refused (n=299) and those for whom a urine sample or data were mishandled during processing (n=41); and (3) those who did not actively refuse to be interviewed but for whom data were not obtained (n=337), including those who had migrated or were never at home after repeated visits, were outside the designated age range, were deceased, had mental or physical illness, or were not Chinese, as well as loss of data due to computer failure or data mishandling after the interview. Those who provided urine samples were only marginally different from the total sample of 3813 individuals who provided demographic interview data. In comparisons of age, education, income, region, and the risk factors used in our analysis, only urban residence influenced whether respondents provided urine ($P<.001$). Urine was given more readily when individuals were rural (97%) rather than urban (90%). This differential response only increased the urban estimates from 28% to 29%. Accordingly, we did not adjust for differential urine response in subsequent analysis.

In the weighted sample of respondents of all ages, prevalence of chlamydial infection per 100 population for women was 2.6 (95% CI, 1.6-4.1) and was 2.1 (95% CI, 1.3-3.3) for men. Gonorrheal infection prevalence for women was 0.08 (95% CI, 0.02-0.4) and 0.02 (95% CI, 0.005-0.1) for men. Given the paucity of gonorrheal infection in the sample, the subsequent analysis focuses on chlamydial infections. Also, because only those younger than 45 years have many chlamydial infections, the analysis below concentrates on this younger half of the sample (n=2373).

Demographic and behavioral characteristics of study participants aged 20 to 44 years are reported in TABLE 1. The coastal south includes counties close to the coast in the 2 provinces of Fujian and Guangdong, both near Hong Kong. The urban sites in our sample had figures for farm labor force of less than 15%. In this study, migrants were defined as individuals from other locales who have been in their current locale less than 5 years and who remain without an official household registration at their current locale. Of these, 95% were rural-to-urban migrants. They were younger (mean age of 26 vs 32 for residents; $P<.001$) and more likely to be single (35% vs 18%; $P=.02$). A higher proportion of male migrants worked in manual labor and sales and service jobs than their urban male counterparts (71% vs 46%; $P=.03$). A higher proportion of female migrants were self-employed or worked in sales and service jobs than their urban counterparts (74% vs 38%; $P<.001$). When weighted, the sample percentage distributions for urban residence, migration, age, and education shown in Table 1 are all within 5% of percentages in the 2000 census for China.[26]

Table 1. Unweighted Observations and Weighted Distributions of Sample of Chinese Men and Women Aged 20 to 44 Years

Characteristic	Unweighted Observations, No.		Weighted Distributions, %	
	Men (n = 1138)	Women (n = 1235)	Men	Women
Age, y				
20-24	160	184	15	16
25-34	467	469	50	45
35-44	511	582	35	39
Education				
≤Elementary school	118	227	18	41
≥Junior high school	1020	1008	82	59
Region				
Coastal south	246	317	5	5
Other	892	918	95	95
Location of residence				
Urban	892	944	29	25
Rural	246	291	71	75
Residential status				
Migrant*	194	152	5	3
Resident	944	1083	95	97
No. and type of sexual partners in the last year				
None	111	121	9	8
1	765	1041	72	87
≥2	142	69	10	4
Always used condom with commercial sex worker	22	1	0.3	0
Sometimes or never used condom with commercial sex worker	98	3	8.7	0.8
Relationship status				
Steady sex partner	581†	1076‡	52	91
Other	557§	159‖	48	9
Male's income¶				
High	889	811#	57	43
Low	249	265#	43	57
Frequency of male's socializing per week				
>Once	288	304#	25	27
≤Once	850	772#	75	73
No. of weeks male traveled in the last year				
>1	318	230#	30	21
≤1 or never	820	846#	70	79

*Indicates resident in locale for less than 5 years and lack of household registration.
†Indicates sex with steady sex partner during previous week.
‡Indicates sex with spouse for 1032 and not spouse for 44.
§Indicates no sex with steady sex partner during previous week.
‖Indicates no sexual partner or only partnerships lasting less than 1 month.
¶High income indicates top half; low income, bottom half.
#Based on responses from an unweighted total of 1076 women who had a spouse or steady male sex partner.

Ten percent of men and 4% of women reported having sex with 2 or more noncommercial sexual partners in the last year. Less than 1% of women reported receiving money for sex either from repeat customers or from a boyfriend. Nine percent of men reported paying for sex. When having sex with a commercial sex worker, they typically failed to use a condom. About half the men reported they had sex with their wife or other steady partner during the last week. Eighty-seven percent of the women were married (n=1032) or had some other steady sexual partner (n=44). The last 3 categories of Table 1 report characteristics reported either by a man or his wife or steady partner. Split at the midpoint of all men and male incomes, women had partners who were somewhat older and thus more likely to be retired and receiving a lower income. Possibly as part of business or official entertaining, 25% of men socialized in the evening more than once a week. Thirty percent of men were out of town on business or official travel for more than a week during the year.

Chlamydial infections varied with risk factors (TABLE 2). Among men aged

20 to 44 years, chlamydial infection was associated with less education, living away from the southern coast, having had unprotected sex with a commercial sex worker during the previous year, and having had recent sex with their spouse or other steady partner. Men were more likely to have had unprotected sex with a commercial sex

Table 2. Prevalence of *Chlamydia trachomatis* and Unprotected Sex With Commercial Sex Workers Among Chinese Adults Aged 20 to 44 Years*

	Cases of Chlamydia						Men Who Had Unprotected Sex With Commercial Sex Worker		
	Women			Men					
Characteristic	Sample Size (n = 1235)	No. of Cases (n = 41)	Prevalence (95% CI)	Sample Size (n = 1138)	No. of Cases (n = 37)	Prevalence (95% CI)	Sample Size (n = 1138)	No. of Men (n = 100)	Prevalence (95% CI)
Age, y									
20-24	194	1	0.6 (0.2-2.1)	169	2	1.1 (0.2-5.5)	169	19	11.1 (2.9-34.3)
25-34	554	19	3.4 (1.5-7.0)	566	22	3.9 (1.8-8.2)	566	56	9.9 (5.2-17.9)
35-44	487	21	4.2 (2.7-6.7)†	403	13	3.1 (1.0-9.1)	403	25	6.3 (2.4-15.6)
Education									
≤Elementary school	510	19	3.7 (1.5-8.7)	210	19	8.9 (3.3-22.0)†	210	18	8.5 (1.3-38.9)
≥Junior high school	725	22	3.0 (1.9-4.9)	928	18	1.9 (1.0-3.6)	928	82	8.9 (4.0-18.7)
Region									
Coastal south	65	7	9.9 (7.5-13.0)†	53	1	1.0 (0.3-3.1)†	53	8	16.0 (13.9-18.2)
Other	1170	34	2.9 (1.7-5.1)	1085	36	3.3 (2.2-5.0)	1085	92	8.4 (4.0-17.0)
Location of residence									
Urban	312	21	6.7 (5.3-8.4)†	327	9	2.8 (2.0-3.8)	327	34	10.3 (8.5-12.5)
Rural	923	20	2.1 (0.9-5.2)	811	28	3.4 (2.0-5.8)	811	66	8.2 (2.9-21.0)
Residential status									
Migrant‡	41	2	5.5 (2.6-11.1)	53	1	2.1 (0.7-6.2)	53	5	10.1 (7.3-13.9)
Resident	1194	39	3.2 (1.9-5.3)	1085	36	3.3 (2.1-5.0)	1085	95	8.7 (4.3-17.1)
No. and type of sexual partners in the last year									
None	97	2	2.5 (0.5-12.1)	104	2	2.3 (0.5-10.9)		. . .	
1	1083	38	3.5 (2.1-5.7)	818	23	2.8 (1.2-6.8)		. . .	
≥2	45	1	1.0 (0.3-3.1)	110	1	0.2 (0.001-1.2)		. . .	
Always used condom with commercial sex worker	0	0	0	6	1	12.1 (1.8-51.5)†		. . .	
Sometimes or never used condom with commercial sex worker	10	0	0	100	10	10.1 (4.4-21.6)†		. . .	
Relationship status								. . .	
Steady sex partner	1126	38	3.4 (2.0-5.6)	597	32	5.3 (3.2-8.6)†		. . .	
Other	109§	3	2.3 (0.5-10.5)	541‖	5	1.0 (0.4-2.2)		. . .	
Male's income									
High	461¶	25¶	5.6 (4.2-7.4)†		. . .		651	95	14.6 (8.6-23.5)†
Low	615¶	11¶	1.8 (0.7-4.7)		. . .		487	5	1.1 (0.4-2.9)
Frequency of male's socializing per week									
>Once	291¶	16¶	5.4 (2.6-10.9)		. . .		281	56	19.9 (9.6-37.0)†
≤Once	785¶	20¶	2.6 (1.4-4.7)		. . .		857	44	5.2 (3.0-8.9)
No. of weeks male traveled in the last year									
>1	231¶	2¶	0.8 (0.2-2.8)		. . .		341	60	17.7 (7.0-37.9)†
≤1 or never	845¶	34¶	3.9 (2.3-6.4)†		. . .		797	40	5.0 (3.0-8.3)
Total	1235	41	3.3 (2.0-5.3)	1138	37	3.2 (2.1-4.8)	1138	100	8.8 (4.4-16.7)

Abbreviation: CI, confidence interval.
*All results are adjusted by sample weights. The number of cases of chlamydia among men and the number of men who had sex with commercial sex workers are identical in weighted and unweighted figures. The number of cases of chlamydia among women is 62 unweighted and 41 weighted. For the columns under "Men Who Had Unprotected Sex With Commercial Sex Worker," ellipses indicate data intentionally omitted because unprotected commercial sex is the dependent variable. For the columns under "Cases of Chlamydia" and "Men," ellipses indicate data intentionally omitted because statistically insignificant.
†Indicates values are statistically greater than lowest reference category at $P<.05$.
‡Indicates resident in locale for less than 5 years and lack of household registration.
§Indicates no sexual partner or only partnerships lasting less than 1 month.
‖Indicates no sex with steady sex partner during previous week.
¶Based on responses from an unweighted total of 1076 women who had a spouse or steady male partner.

worker when they earned a high income and socialized or traveled often. Among women aged 20 to 44 years, chlamydial infection was associated with older age, living near the southern coast or in cities, and being in a steady relationship with a man who earned a high income or who traveled less than 1 week per year or never traveled. Only 45 women had 2 or more sexual partners last year, and these women had a modest infection prevalence of 1.0 (95% CI, 0.3-3.1). Separate tabulations show that among those aged 45 years or older, diagnosis of chlamydial infections tapered off to 0.8 per 100 (95% CI, 0.3-2.0) for women and to 0.3 (95% CI, 0.1-1.3) for men.

Table 3. Logistic Analysis of Chlamydial Infection and Unprotected Sex With Commercial Sex Workers*

Characteristic	Odds Ratio (95% Confidence Interval)		
	Cases of Chlamydia		Men Who Had Unprotected Sex With Commercial Sex Worker
	Women	Men	
Age, y			
20-24	1.00	1.00	1.00
25-34	9.32 (0.81-107.4)	1.04 (0.11-9.70)	0.59 (0.18-1.93)
35-44	9.24 (0.64-132.5)	1.02 (0.10-10.18)	0.54 (0.23-1.26)
Education			
≤Elementary school	2.82 (1.01-7.91)†	7.20 (2.31-22.37)†	3.21 (0.34-30.8)
≥Junior high school	1.00	1.00	1.00
Region			
Coastal south	2.16 (1.29-3.63)†	0.29 (0.07-1.26)	1.72 (1.18-2.50)†
Other	1.00	1.00	1.00
Location of residence			
Urban	3.46 (1.67-7.18)†	1.40 (0.57-3.43)	0.82 (0.28-2.42)
Rural	1.00	1.00	1.00
Residential status			
Migrant‡	1.05 (0.33-3.38)	0.76 (0.18-3.28)	0.77 (0.38-1.56)
Resident	1.00	1.00	1.00
No. and type of sexual partners in the last year			
None	1.00	1.00	. . .
1	1.00	1.00	. . .
≥2	0.32 (0.10-1.06)	0.87 (0.10-7.30)	. . .
Always used condom with commercial sex worker	1.00	1.00	. . .
Sometimes or never used condom with commercial sex worker	1.00	8.24 (3.51-19.35)†	. . .
Relationship status			
Steady sex partner	0.03 (0.0011-0.55)†	7.73 (2.70-22.10)†	. . .
Other	1.00§	1.00‖	. . .
Male's income			
High	2.85 (1.11-7.29)†	. . .	15.43 (3.80-62.7)†
Low	1.00¶	. . .	1.00
Frequency of male's socializing per week			
>Once	2.79 (1.08-7.19)†	. . .	3.08 (1.90-5.00)†
≤Once	1.00¶	. . .	1.00
No. of weeks male traveled in the last year			
>1	1.00¶	. . .	3.17 (1.79-5.61)†
≤1 or never	5.40 (1.44-20.3)†	. . .	1.00

*For the column under "Men Who Had Unprotected Sex With Commercial Sex Worker," ellipses indicate data intentionally omitted because unprotected commercial sex is the dependent variable. For the column under "Cases of Chlamydia" and "Men," ellipses indicate data intentionally omitted because statistically insignificant.
†Indicates values are statistically greater than lowest reference category at $P<.05$.
‡Indicates resident in locale for less than 5 years and lack of household registration.
§Indicates no sexual partner or only partnerships lasting less than 1 month.
‖Indicates no sex with steady sex partner during previous week.
¶The 159 women with no steady sex partner are included in this category.

In multivariate analysis (TABLE 3), risk factors for chlamydial infection among men were unprotected commercial sex (OR, 8.24; 95% CI, 3.51-19.35), less education (OR = 7.20; 95% CI, = 2.31-22.37), and recent sex with their spouse or other steady partner (OR, = 7.73; 95% CI, 2.70- 22.10). The activity of unprotected commercial sex was more common when the men earned a high income (OR, 15.43; 95% CI, 3.80-62.7), socialized often (OR, 3.08; 95% CI, 1.90-5.00), and traveled frequently (OR, 3.17; 95% CI, 1.79-5.61). Risk factors for chlamydial infection among women were having less education (OR, 2.82; 95% CI, 1.01-7.91), living in a city (OR, 3.46; 95% CI, 1.67-7.18) or along the southern coast (OR, 2.16; 95% CI, 1.29-3.63) and having a spouse or other steady sexual partner who earned a high income (OR, 2.85; 95% CI, 1.11-7.29), socialized often (OR, 2.79; 95% CI, 1.08-7.19), or who traveled less than 1 week per year (OR, 5.40; 95% CI, 1.44-20.3). The steady partner coefficient merely adjusts for the inclusion women with no steady sex partner in the lowest reference category of the male characteristics at the bottom of the table.

Other possible risk conditions and factors were not significantly associated with chlamydial infection. When included singly or in combination with other risk conditions, current symptoms (burning urination, genital ulceration, genital discharge) and symptoms in the previous year (vaginal bleeding, genital pain) were not associated with positive laboratory test results. Many other plausible risk conditions were not associated with chlamydial infection, including ever having an STD, having an STD last year, recently having taken antibiotics, being unemployed or self-employed (*geti hu*),

working in a sales or clerical job, being hit by partner ever or during last year, having sexual contact as a child, early puberty, and heavy alcohol consumption.

COMMENT

The results from this population-based national study suggest that there is a hidden STD epidemic in China. Consistent with a study of Chinese commercial sex workers, which found 38% had chlamydial infections and 8% gonorrheal infections,[9] we found chlamydial infections much more common than gonorrheal infections in the general population. Given the infrequency of symptoms with chlamydia, few individuals with chlamydial infection will seek treatment. The Chinese national reporting system, which does not monitor chlamydial infections, reports an annual incidence for 8 STDs of only 0.07 per 100 total population for 2000.[4-11] The low reported figure is consistent with the prevalence being reported for total rather than adult population, the acknowledged underreporting of all STDs,[4] and the absence of systematic data gathering for chlamydial infection.[4] This silent chlamydial epidemic may cause many women to become infertile, to have ectopic pregnancies, and possibly to be at greater risk for HIV infection.[27] A failure to confront the epidemic could have serious consequences.

In addition, this study shows that the prevalence of chlamydial infection in urban China is as high as or higher than among urban groups in developed western societies. Three comparable studies in developed western settings used population-based probability samples and urine ligase chain reaction tests of infections. We compared the results of these studies to the results found for China in our study, using comparable residence, sexual experience, and age group data. Fenton et al[12] conducted a study of the sexual behavior of sexually experienced individuals aged 18 to 44 years in England, Scotland, and Northern Ireland and the prevalence of STDs, including chlamydial infection. Among women aged 20 to 44 years, prevalence of chlamydial infection per 100 was 1.5 (95% CI, 1.1-2.1) in Britain compared with 7.4 (95% CI, 5.9-9.3) in China. Among men, the prevalence was 2.2 (95% CI, 1.5-3.2) in Britain compared with 3.0 (95% CI, 2.1-4.1) in China. In another study, Turner et al[15] examined a probability sample of individuals aged 18 to 35 years with rates of untreated chlamydial and gonococcal infection, regardless of sexual activity, who were living in Baltimore, Md. For women, prevalence was 4.3 (95% CI, 1.3-7.3) in Baltimore and 7.6 (95% CI, 5.5-10.4) in China. For men, prevalence was 1.6 (95% CI, –1.1 to 4.3) in Baltimore and 2.2 (95% CI, 1.0-4.8) in China. A third study, conducted by Morré et al in the Netherlands,[14,28] used both ligase chain reaction and COBAS Amplicor laboratory tests on probability samples of individuals aged 15 to 40 years in 20 general medical practices in Amsterdam who reported having had sex in the previous year. Among women, prevalence was 2.8 (95% CI, 2.2-3.4) in Amsterdam and 9.0 (95% CI, 7.3-11.0) in China. For men, prevalence was 2.4 (95% CI, 1.7-3.0) in Amsterdam and 2.6 (95% CI, 1.6-4.4) in China. Thus, prevalence among urban Chinese women was 3% to 6% higher than among comparable women in the West.

Chlamydial infection rates among rural Chinese seem comparable with those in rural Africa, a region typically reported to have extremely high infection rates.[29] Ignoring large regional differences, Chinese rural chlamydial infection prevalences for those aged 20 to 59 years were 1.7 (95% CI, 0.1-3.3) for women and 2.2 (95% CI, 0.8-3.6) for men. In a region of Uganda among individuals aged 15 to 59 years, rural prevalences were 2.1 (95% CI, 1.7-2.5) for women and 2.4 (95% CI, 2.0-2.8) for men.[29]

The results of this study also suggest that infection transmission remains concentrated in paths that lead from commercial sex worker to husband/steady partner to wife/steady partner. Even in the developed countries of the West, infection often results not from a woman's own risky sexual behavior, but instead from that of her husband or steady sexual partner.[30-32] This risk pattern may be even stronger in developing countries. With a dual-standard about sexual behavior for men and women, many of these societies find women most often infected by their husbands.[33-40] A typical infection path is that of commercial sex worker to husband to spouse.[34,41]

The results of this study of chlamydial infection in China fit a similar pattern. In our weighted sample, only 110 men and 45 women had sex with 2 or more (noncommercial) sexual partners during the previous year (Table 2). And these individuals had low rates of chlamydial infection. These results are consistent with a low rate of transmission of chlamydial infections through lateral, casual sex networks. Chlamydial infections are more often passed through commercial sex networks, with men who earn a high income, travel, and socialize often having the most opportunities for commercial sex. Women married to men and women with male steady partners with these same characteristics are more often infected, giving circumstantial evidence of the infection path.

The good news of this finding is that concentrated public health campaigns to educate commercial sex workers and their clients and to encourage condom use could have a major impact, much as it did in Thailand.[42] The bad news is that open publicity about condoms use by commercial sex workers (who remain technically illegal in China) is politically difficult—as much or more with the public as with government officials.[43,44]

Finally, these data suggest that it is possible to identify significant risk groups, even if not always the risk groups one would expect from the experience of other societies.[45] Chlamydial infection is typically seen as a disease of youth in developed countries in the West, and screening concentrates on those younger than 25 or 30 years old.[46,47] More recent popula-

tion-based studies complicate this picture with findings that individuals may also carry asymptomatic *C trachomatis* into their middle 30s.[12,28,48] Moreover, in China and other Asian societies, with sexual activity typically beginning after adolescence, earliest first sexual intercourse with one's spouse or fiancé, and the slow acquisition of income for use in commercial sex, the onset of STDs could be particularly late.[8,49] The results of this study show that chlamydial infection is concentrated among those aged 25 to 44 years in China, rather than among those younger than 25 years.

In much of the world, individuals who are more educated and who earn higher incomes are more sexually active.[49,50] However, the educated can also learn to use condoms, avoid the riskiest sexual partners, and take other protective measures in ways that help weaken socioeconomic status as a risk factor for STDs.[12,49,51] In this study, successful Chinese men who earned a high income were more likely to engage in unprotected commercial sex. Likewise, women linked to men who earn a high income were more likely to be infected. However, more educated Chinese men and women were less likely to be infected (Table 2 and Table 3). Education, then, may confer unspecified advantages that public health campaigns could build on.

Other risk factors were not useful in predicting infection. As measured in this study, being a rural-to-urban migrant posed no special risk. Common symptoms (burning urination, genital discharge, ulceration) were not associated with infection in this study. This implies that syndromic analysis algorithms may not be helpful. In this study, having sex with multiple sexual partners (not commercial sex workers) posed little additional risk for chlamydial infection. Infections were not being passed through casual sex networks. Similarly, for Chinese women in this study, self-employment, sales/clerical work, alcohol consumption, previous STD infection, spousal violence, and childhood sexual contact all failed as significant risk factors for chlamydial infection. For these women, since the major risk was associated with the behavior of their husband/steady partner, examining their own behavior was unhelpful.

However, our study has several limitations, including incomplete sampling of migrants, underrepresentation of men in their early 20s, a small number of primary sampling units, few rural respondents, and only 37 men who tested positive for chlamydial infection. Perhaps half of all migrants are not in government registers at their place of destination.[52] And, conversely, many men and some women in their early 20s may have left their original place of residence and could not be located by interviewers. This unregistered and unlocatable population could be engaging in more risky behavior than our data suggest. Thus, our results could understate the degree of risk among young migrants, particularly in large cities and in southern coastal locales to which many of these migrants move.[26] Moreover, the sample design, which includes a sparse set of primary sampling units, few rural respondents, and few men with chlamydial infection, produces large design effects and wide CIs for some results. This implies that we have probably found fewer significant risk factors than would occur in a larger sample, more focused on those younger than 45 years and with a wider array of rural and urban primary sampling units.

CONCLUSION

China has a hidden epidemic of *C trachomatis*. This epidemic is both a danger in itself and a marker of possible paths of the HIV/AIDS epidemic as it moves into heterosexual transmission networks. The chlamydial epidemic is concentrated in commercial sex networks, with socially active men who earn a high income and transmit these infections to their wives and other steady sex partners. The concentration of chlamydial infections in commercial sex networks suggests the possibility of targeted campaigns to reduce the STD burden among commercial sex workers and to increase AIDS awareness and condom use among both sex workers and their clients.

Author Contributions: *Study concept and design:* Parish, Laumann, Cohen, Pan, Zheng, Hoffman.
Acquisition of data: Laumann, Cohen, Pan, Zheng, Hoffman.
Analysis and interpretation of data: Parish, Laumann, Cohen, Hoffman, Wang, Ng.
Drafting of the manuscript: Parish, Cohen, Hoffman, Wang, Ng.
Critical revision of the manuscript for important intellectual content: Laumann, Cohen, Pan, Zheng, Hoffman.
Statistical expertise: Parish, Laumann, Wang.
Obtained funding: Parish, Laumann, Cohen, Zheng.
Administrative, technical, or material support: Laumann, Cohen, Pan, Zheng, Hoffman, Wang, Ng.
Study supervision: Hoffman.
Funding/Support: Primary support was provided by grant RO1 HD34157 from the National Institute of Child Health and Human Development. Additional support was provided by grant P30 HD18288 to the University of Chicago from the National Institute of Child Health and Human Development Population Research Center; grant P30 AI50410 to the University of North Carolina from the National Institutes of Health Fogarty Center; grant D43 TW01039 to the University of North Carolina from the National Institutes of Health Center for AIDS Research; and grant U19 AI31496 to the University of North Carolina from the National Institutes of Health STD Cooperative Research Center. Abbott Laboratories donated the ligase chain reaction testing device.
Acknowledgment: Fang Li played a vital role in the collection and initial analysis of these data.

REFERENCES

1. Hershatter G. *Dangerous Pleasures: Prostitution and Modernity in Twentieth-Century Shanghai.* Berkeley: University of California Press; 1997.
2. Cohen MS, Henderson GE, Aiello P, Zheng H. Successful eradication of sexually transmitted diseases in the People's Republic of China: implications for the 21st Century. *J Infect Dis.* 1996;174:S223-S229.
3. Cohen MS, Gao P, Fox K, Henderson GE. Sexually transmitted diseases in the People's Republic of China in Y2K. *Sex Transm Dis.* 2000;27:143-145.
4. Chen XS, Gong XD, Liang GJ, Zhang GC. Epidemiologic trends of sexually transmitted diseases in China. *Sex Transm Dis.* 2000;27:138-145.
5. Plafker T. China admits its AIDS crisis. *BMJ.* 2001;323:714.
6. Sun S. AIDS prevention urged. *China Daily*. March 9, 2002. Available at: http://archives.hst.org.za/sea-aids/msg00177.html. Accessibility verified February 4, 2003.
7. UNAIDS China Office. Observations on China's year 2000 AIDS situation. Available at: http://www.unchina.org/unaids/key8.html. Accessed May 8, 2002.
8. Choi K, Zheng X, Qu S, Yiee K, Mandel J. HIV risk among patients attending sexually transmitted disease clinics in China. *AIDS Behav.* 2000;4:111-119.
9. van den Hoek A, Fu Y, Dukers N, et al. High prevalence of syphilis and other sexually transmitted diseases among sex workers in China: potential for fast spread of HIV. *AIDS.* 2001;15:753-759.
10. Wang J, Jiang B, Siegal H, Falck R, Carlson R. Level of AIDS and HIV knowledge and sexual practices among sexually transmitted disease patients in China. *Sex Transm Dis.* 2001;28:171-175.
11. Chinese Center for Disease Control and Preven-

tion. Year 2001 national sexually transmitted disease situation. Available at: http://chinaids.org.cn/index_yqjc_blbg.asp?sn=240. Accessed January 2, 2003.
12. Fenton KA, Korovessis C, Johnson AM, et al. Sexual behaviour in Britain: reported sexually transmitted infections and prevalent genital *Chlamydia trachomatis* infection. *Lancet.* 2001;358:1851-1854.
13. Korenromp E, Sudaryo MK, de Vlas SJ, et al. What proportion of episodes of gonorrhoea and chlamydia become symptomatic. *Int J STD AIDS.* 2002;13:91-101.
14. Morré S, van Valkengoed IGM, Moes RM, Boeke AJP, Meijer CJLM, van den Brule AJC. Determination of *Chlamydia trachomatis* prevalence in an asymptomatic screening population: performances of the LCx and COBAS Amplicor test with urine specimens. *J Clin Microbiol.* 1999;37:3092-3096.
15. Turner CF, Rogers SM, Miller HG, et al. Untreated gonococcal and chlamydial infection in a probability sample of adults. *JAMA.* 2002;287:726-733.
16. Levy PS, Lemeshow S. *Sampling of Populations: Methods and Applications*. 3rd ed. New York, NY: Wiley; 1999.
17. Laumann EO, Gagnon JH, Michael RT, Michaels S. *The Social Organization of Sexuality: Sexual Practices in the United States*. Chicago, Ill: University of Chicago Press; 1994.
18. Parish WL, Laumann EO. Chinese Health and Family Life Survey. Available at: http://www.src.uchicago.edu/DATALIB/DLproj/chfls.html. Accessibility verified February 3, 2003.
19. China National Census Office. *1995 National 1% Population Sample Survey Data*. Beijing: China Statistical Press; 1997.
20. State Statistical Bureau. *China Population Statistics Yearbook 1999*. Beijing: China Statistical Press; 1999.
21. Kish L, Frankel MR. Inference from complex samples. *J R Stat Soc.* 1974;B36:1-37.
22. Skinner CJ, Holt D, Smith TMF. *Analysis of Complex Surveys*. New York, NY: Wiley; 1989.
23. *STATA Reference Manual, Release 7*, vol. 4. College Station, Tex: STATA Corp; 2001.
24. Long JS. *Regression Models for Categorical and Limited Dependent Variables*. Thousand Oaks, Calif: Sage Publications; 1997.
25. Belsley DA, Kuh E, Welsch RE. *Regression Diagnostics: Identifying Influential Data and Sources of Collinearity*. New York, NY: Wiley; 1980.
26. China Population Census Office. *Tabulation on the 2000 Population Census of the People's Republic of China.* Beijing: China Statistics Press; 2002.
27. Centers for Disease Control and Prevention. Chlamydia in the United States. Available at: http://www.cdc.gov/nchstp/dstd/Fact_Sheets/chlamydia_facts.htm. Accessibility verified February 3, 2003.
28. van Valkengoed IGM, Morré SA, van den Brules AJC, et al. Low diagnostic accuracy of selective screening criteria for asymptomatic *Chlamydia trachomatis* infections in the general population. *Sex Transm Infect.* 2000;76:375-380.
29. Paxton LA, Sewankambo N, Gray R, et al. Asymptomatic non-ulcerative genital tract infections in a rural Ugandan population. *Sex Transm Infect.* 1998;74:421-425.
30. Dolcini MM, Catania JA. Psychosocial profiles of women with risky sexual partners: the national AIDS behavioral surveys (NABS). *AIDS Behav.* 2000;4:297-308.
31. Gielen A, Fogarty LA, Armstrong K, et al. Promoting condom use with main partners: a behavioral intervention trial for women. *AIDS Behav.* 2001;5:193-204.
32. van Duynhoven Y, van de Laar MJ, Schop WA, Mouton JW, van der Meijden WI, Sprenger MJ. Different demographic and sexual correlates for chlamydial infection and gonorrhoea in Rotterdam. *Int J Epidemiol.* 1997;26:1373-1385.
33. Fonck K, Kidula N, Kirui P, et al. Pattern of sexually transmitted diseases and risk factors among women attending an STD referral clinic in Nairobi, Kenya. *Sex Transm Dis.* 2000;27:417-423.
34. Gangakhedkar RR, Bentley ME, Divekar AD, et al. Spread of HIV infection in married monogamous women in India. *JAMA.* 1997;278:2090-2092.
35. Hanenberg R, Rojanapithayakorn W. Changes in prostitution and the AIDS epidemic in Thailand. *AIDS Care.* 1998;10:69-79.
36. Klouman E, Masenga E, Sam N, Klepp K. Chlamydial infection in males and conseqences for their female sexual partners, an example from rural Kilimanjaro, Tanzania. *Int J STD AIDS.* 2002;13:234-237.
37. Lim LL, ed. *The Sex Sector: The Economic and Social Bases of Prostitution in Southeast Asia.* Geneva, Switzerland: International Labour Office; 1998.
38. Tarantola DJM. HIV/AIDS: international perspective. *AIDS Patient Care STD.* 2001;15:439-441.
39. Solomon S, Kumarasamy N, Ganesh AK, Amalraj RE. Prevalence and risk factors of HIV-1 and HIV-2 infection in urban and rural areas in Tamil Nadu, India. *Int J STD AIDS.* 1998;9:98-103.
40. Younis N, Khattab H, Zurayk H, El-Mouelhy M, Amin MF. A community study of gynecological and related morbidities in rural Egypt. *Stud Fam Plann.* 1993;24:175-186.
41. Pulerwitz J, Izazola-Licea J-A, Gortmaker S. Extrarelational sex among Mexican men and their partners' risk of HIV and other sexually transmitted diseases. *Am J Public Health.* 2001;91:1650-1652.
42. Jha P, Nagelkerke NJD, Ngugi EN, et al. Reducing HIV transmission in developing countries. *Science.* 2001;292:224-225.
43. Wen C. No condoms please, we're Chinese. Available at: http://ww2.aegis.org/news/ips/2002/Ip020402.html. Accessed January 6, 2003.
44. Cheng Y, Li Z, Wang X, et al. Introductory study on female condom use among sex workers in China. *Contraception.* 2002;66:179-186.
45. Radcliffe KW, Ahmad S, Goilleran G, Ross JDC. Demographic and behavioural profile of adults infected with chlamydia: a case-control study. *Sex Transm Infect.* 2001;77:265-270.
46. Howell M, Quinn T, Gaydos C. Screening for *Chlamydia trachomatis* in asymptomatic women attending family planning clinics: a cost-effectiveness analysis of three strategies. *Ann Intern Med.* 1998;128:277-284.
47. Groseclose SL, Zaidi AA, DeLisle SJ, Levine WC, St Louis ME. Estimated incidence and prevalence of genital *Chlamydia trachomatis* infections in the United States, 1996. *Sex Transm Dis.* 1999;26:339-344.
48. Pierpoint T, Thomas B, Judd A, Brugha R, Taylor-Robinson D, Renton A. Prevalence of *Chlamydia trachomatis* in young men in north west London. *Sex Transm Infect.* 2000;76:273-276.
49. Caraël M. Sexual behaviour. In: Cleland JG, Ferry B, eds. *Sexual Behaviour and AIDS in the Developing World: Social Aspects of AIDS*. London, England: Taylor & Francis; 1995.
50. Laumann EO, Youm Y. Racial/ethnic group differences in the prevalence of sexually transmitted diseases in the United States: a network explanation. *Sex Transm Dis.* 1999;26:250-261.
51. Ali MM, Cleland JG, Carael M. Sexual risk behavior in urban populations of Northeastern Africa. *AIDS Behav.* 2001;5:343-352.
52. Zhang L. The interplay of gender, space, and work in China's floating population. In: Entwisle B, Henderson G, eds. *Re-Drawing Boundaries: Work, Households, and Gender in China.* Berkeley: University of California Press; 2000:171-196.