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## Changing trends of HIV, syphilis, hepatitis C infections and behavioral factors among female sex workers in Chongqing, China: findings of 6 serial surveillance surveys

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4 1 **Changing trends of HIV, syphilis, hepatitis C infections and behavioral**  
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6 2 **factors among female sex workers in Chongqing, China: findings of 6**  
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9 3 **serial surveillance surveys**  
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4 27 **ABSTRACT**

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6 28 **Objectives:** To explore prevalence and changing trends of HIV, syphilis, hepatitis C (HCV)  
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8 29 infections and risk behaviors among FSWs, and to provide reference and theoretical basis for  
9  
10 30 formulating targeted interventions.

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13 31 **Design:** Six consecutive cross-sectional surveys

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16 32 **Setting:** Chongqing, China

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19 33 **Participants:** FSWs were included if they 1) were aged  $\geq 16$  years; 2) provided commercial sex  
20  
21 34 for money or goods during the previous one month; 3) were willing to participate this survey  
22  
23 35 and could provide verbal informed consent. This study included 13791 of 13810 participants  
24  
25 36 recruited between 2013 and 2018.

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28 37 **Primary and secondary outcome measures:** HIV/syphilis/HCV infection status

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30  
31 38 **Results:** The six-year average prevalence of HIV/syphilis/HCV was 0.3%, 1.7%, and 0.7%,  
32  
33 39 respectively. HIV and HCV prevalence among FSWs in Chongqing was stable during the  
34  
35 40 study period, but prevalence of syphilis had an increasing trend, particularly among low-tier  
36  
37 41 and middle-tier FSWs. Improvements in AIDS-related knowledge, condom use, injecting  
38  
39 42 drug use and participation in AIDS services were observed, but there was no change in  
40  
41 43 prevalence of drug use. HIV infection was correlated with no condom use in the last  
42  
43 44 commercial sex (aOR=3.43) and syphilis infection (aOR=4.94). Syphilis infection was  
44  
45 45 correlated with inconsistent condom use (aOR=1.30), HIV infection (aOR=5.90), HCV  
46  
47 46 infection (aOR=7.71), and STI diagnosis in the past year (aOR=3.50). HCV infection was  
48  
49 47 associated with injecting drug use (aOR=9.02) and syphilis infection (aOR=7.57).

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51  
52 48 **Conclusions:** More comprehensive interventions targeted FSWs to promote condom use and  
53  
54 49 sexual health, to prevent and control HIV, syphilis and other STI, particularly those focus on  
55  
56 50 the low-tier and middle-tier FSWs, should be implemented.

57  
58 51 **Keywords:** Female sex workers (FSWs), HIV, Syphilis, Sexually transmitted infection (STI),  
59  
60 52 China

### 53 **Strengths and limitations of this study**

54 This study is based on surveillance data for 6 consecutive years, with a large sample size.

55 The infection status was determined by the health staff of the professional institution.

56 However, the cross-sectional study design limits interpretation of those trends.

57 Behavioral data was collected through self-reported questionnaire which may lead to bias.

58

### 59 **INTRODUCTION**

60 Worldwide, female sex workers (FSWs) are considered to be one of the most vulnerable  
61 groups to HIV infection. A global meta-analysis found HIV prevalence among FSWs was  
62 estimated at of 10.4% (95% confidence interval [CI] 9.5–11.5%), and varies across regions.<sup>1</sup> In  
63 low and middle-income countries, the estimated prevalence of HIV infection was 11.8% (95%  
64 CI 11.6–12.0%), 13.5 times higher than that among the general women.<sup>2</sup> Female sex work  
65 leads to a global HIV burden of 15% for women, resulting in more than 100,000 deaths per  
66 year.<sup>3</sup> And due to many factors, including multiple sexual partners, low social status, and  
67 unprotected sex behaviors, FSWs also bear a disproportionate burden of other sexually  
68 transmitted infections (STI) such as syphilis.<sup>4 5</sup> The estimated global prevalence of syphilis  
69 among women aged 15–49 years was 0.5% (0.4–0.6%) in 2012.<sup>6</sup> However, WHO reported that  
70 the median reported syphilis prevalence among FSWs globally was 3.2% (range 0.0–35.2%),  
71 and four countries reported syphilis infection was 20% or higher.<sup>7</sup>

72 In China, heterosexual sex has becoming the primary transmission mode of HIV which  
73 nearly accounting for 70% of newly reported HIV/AIDS cases in 2017;<sup>8</sup> and commercial  
74 heterosexual sex networks play a vital role in HIV and other STI epidemics. Since the reform  
75 and opening up in the 1980s, sex industry has re-emerged and flourished, and the incidence  
76 of STI has risen sharply.<sup>5 9</sup> There are an estimated 4 million FSWs,<sup>10</sup> with a HIV prevalence of  
77 0.6% (0–10.3%) and a rate of positive for at least one STI of 41.5% (13–90.6%).<sup>11</sup> Furthermore,  
78 according to a national probability survey, about 6.9% men aged 18–49 years have ever  
79 commercial sex during their lifetime.<sup>12</sup>

80 In response, Chinese Government carried out voluntary counseling and testing (VCT),  
81 STI services, condom promotion, and peer education among FSWs through the cooperation

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4 82 among Centers for Disease Control (CDC), community health services and medical  
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6 83 institutions.<sup>13</sup> In 1995, China established the national HIV sentinel surveillance system to  
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8 84 active monitor HIV prevalence among high-risk populations (e.g., FSWs, injected drug users)  
9  
10 85 and to guide the development of HIV prevention and control strategies.<sup>14–16</sup> After years of  
11  
12 86 development, the surveillance system has expanded in scope, from 42 sentinel sites in 1995 to  
13  
14 87 1888 in 2010, and combined biological and behavioral surveillance strategies, which included  
15  
16 88 sero-testing for HIV, syphilis and hepatitis C virus (HCV).<sup>17</sup> Surveillance data can help to  
17  
18 89 understand the epidemic status and trend of AIDS and STI among FSWs, which is necessary  
19  
20 90 for developing HIV or STI prevention programmes.<sup>18</sup> We found that there are some  
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22 91 epidemiological studies on FSWs, but little is known about its epidemic trend.

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24 92 Based on the surveillance data in Chongqing, the first aim of the study was to identify  
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26 93 prevalence and changing trends of HIV, syphilis, and HCV infections over time. Moreover, to  
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28 94 provide reference for formulating interventions to control AIDS and STI, this study explored  
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30 95 trends in sexual behaviours of FSWs, and discussed risk factors for prevalent STI over the 5  
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32 96 year period.

## 33 34 35 98 **METHODS**

### 36 37 99 **Study sites**

38  
39 100 Chongqing, located in the southwest of China, is one of four Chinese municipalities  
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41 101 directly controlled by the central government. It covers an area of about 82400 km<sup>2</sup> and has a  
42  
43 102 population of more than 30 million. It is the political and economic center of western China  
44  
45 103 and a city with obvious urban-rural dual structure. A study using the network scale-up  
46  
47 104 method reported that, FSWs were estimated to account for 0.4% of women aged 15–49 years  
48  
49 105 in Chongqing, and clients of FSWs represented 2% of males aged 15–49 years.<sup>19</sup>

### 50 51 106 **Study design**

52  
53 107 Sentinel surveillance collects HIV, syphilis and HCV prevalence and high-risk behaviors  
54  
55 108 information through cross-sectional surveys. The data we analyzed in this study were  
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57 109 sentinel surveillance data among FSWs in Chongqing from 2013 to 2018.

### 58 59 110 **Participant selection and data collection**

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4 111 The detailed procedures of data collection were following Operational Manual for the  
5  
6 112 Implementation Program of National AIDS Sentinel Surveillance established by NCAIDS.  
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8 113 Serial cross-sectional surveys were conducted from April to June each year at seven sentinel  
9  
10 114 surveillance sites in Chongqing (Yuzhong District, Jiulongpo District, Wanzhou District,  
11  
12 115 Dianjiang, Hechuan, Wansheng and Youyang). The sample size of each site was 400  
13  
14 116 participants. In order to obtain a representative sample of FSWs, the entire sampling process  
15  
16 117 went through the following three steps. First, a distribution map of known commercial  
17  
18 118 workplaces in the monitoring area was drawn to construct a sampling frame, and these  
19  
20 119 locations were categorized into low-, middle- and high-tier venues based on the average price  
21  
22 120 of each sex transaction. Then, those venues in each city were randomly selected by using the  
23  
24 121 proportional sampling selection process. The proportion of low-tier and middle-tier FSWs  
25  
26 122 among all participants was at least 10% and 40%, respectively. FSWs were recruited if they  
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28 123 met the inclusion criteria: 1) participants were aged  $\geq 16$  years; 2) provided commercial sex  
29  
30 124 for money or goods during the previous one month; 3) were willing to participate this survey  
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32 125 and could provide verbal informed consent.

33 126 All participants completed an anonymous, standard interviewer administered,  
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35 127 face-to-face questionnaire. After each interview, 3-5 ml venous blood of each participants  
36  
37 128 were collected for HIV, syphilis and HCV antibody detection. And the blood sample was  
38  
39 129 linked to the questionnaire by a unique identification code assigned to the participant.

## 40 130 **Measures**

### 41 131 Questionnaire

42  
43  
44  
45 132 The questionnaire was used to collect FSWs' socio-demographic characteristics, HIV  
46  
47 133 knowledge and behaviors.

48  
49 134 (1) Socio-demographic characteristics, including year of birth, marital status, household  
50  
51 135 registration, ethnicity, and education level were collected.

52  
53 136 (2) HIV-related knowledge of participants was assessed by 8 questions with "yes", "no"  
54  
55 137 or "don't know" as answers. Those questions including HIV transmission (e.g., "Does  
56  
57 138 mosquito bite spread AIDS") and means of AIDS prevention (e.g., "Can the correct use of  
58  
59 139 condoms reduce the spread of AIDS"). Those questions were updated from 2016 which took  
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4 140 new drugs and deliberate transmission of AIDS into consideration. Only right responses were  
5  
6 141 scored as 1 point, incorrect responses and “don’t know” responses did not earn any points.  
7  
8 142 Cronbach’s alpha was 0.706 and 0.739 before and after questions changing.

9  
10 143 (3) Participants’ behavioral factors were also collected, including questions regarding  
11  
12 144 condom use in last commercial sex, condom use with clients in the past month, drug use  
13  
14 145 during their lifetime, STI diagnose in the last year, and participation in AIDS services.  
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16 146 Consistent condom use in the past month, in this study, was defined as always using a  
17  
18 147 condom during commercial intercourse.

#### 19 20 148 Laboratory testing

21  
22 149 HIV, syphilis, and HCV infection status were detected among all participants by trained  
23  
24 150 laboratory technician. Initial screening for HIV, syphilis, and HCV antibodies was conducted  
25  
26 151 using Enzyme-linked Immunosorbent Assay (ELISA) method (ELISA-1). If the result was  
27  
28 152 negative, no further re-examination would be carried out, and infection status was recorded  
29  
30 153 as negative. If the result was positive, HIV or HCV infection would be confirmed by another  
31  
32 154 ELISA method (ELISA-2) while syphilis infection confirmed by non-specific detection method  
33  
34 155 - Tolidine Red Unheated Serum Test (TRUST). Positive results can be determined only if  
35  
36 156 both tests were positive.

#### 37 38 157 **Data analysis**

39  
40 158 First, chi-square test was conducted to test the differences of HIV, syphilis, and HCV  
41  
42 159 prevalence by various demographic characteristics and behavioral factors. In addition,  
43  
44 160 changing trends of HIV, syphilis, HCV infections and behavioral factors over time were  
45  
46 161 assessed using Cochran-Armitage trend test. Moreover, multivariate logistic regression was  
47  
48 162 conducted to identify HIV, syphilis, and HCV infection related risk-factors using stepwise  
49  
50 163 elimination. Odds ratios (ORs) and 95% CIs of each significant risk factors were also  
51  
52 164 determined, unadjusted and adjusted for socio-demographic factors. All statistical analyses  
53  
54 165 were carried out by using Statistical Analysis Software, version 9.2 (SAS Institute  
55  
56 166 Incorporated, Cary, North Carolina, USA).

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#### 59 60 168 **RESULTS**

169 **Socio-demographic characteristic**

170 This study included 13791 of 13810 participants recruited between 2013 and 2018. As  
 171 shown in Table 1, nearly half of participants (46.7%) worked in middle-tier venues, 39.7% in  
 172 low-tier venues, and 13.6% in high-tier venues. The median age was 28 years and most  
 173 (87.2%) of them was between 20 and 45 years of age. The majority of participants were local  
 174 (91.0%) and belong to Han (90.0%). Less than one third of them had high school or above  
 175 education and half (54.7%) had a junior middle school education. Most participants work in  
 176 the current location 1~6 months (33.0%) and work in current city during the last job (61.3%).

177 **Table 1.** Prevalence of HIV, syphilis and HCV infection by demographic and  
 178 behavioral characteristics among FSWs in Chongqing, China.

| Characteristics                             | % (N)*      | HIV                   |                     | Syphilis              |                     | HCV                   |                     |
|---|-------------|-----------------------|---------------------|-----------------------|---------------------|-----------------------|---------------------|
|   |             | Prevalence<br>% (n/N) | P value             | Prevalence<br>% (n/N) | P value             | Prevalence<br>% (n/N) | P value             |
| <b>Overall</b>                              | 16791       | 0.3 (45/16791)        |                     | 1.7 (291/16791)       |                     | 0.7 (121/16791)       |                     |
| 95%CI                                       |             | 0.2 - 0.4             |                     | 1.5 - 1.9             |                     | 0.6 - 0.9             |                     |
| <b>Typology</b>                             |             |                       |                     |                       |                     |                       |                     |
| Low-tier                                    | 39.7(6672)  | 0.4(27/6672)          | 0.019               | 2.5(169/6672)         | <0.001              | 1.1(72/6672)          | <0.001              |
| Middle-tier                                 | 46.7(7835)  | 0.2(13/7835)          | 0.025 <sup>a</sup>  | 1.3(100/7835)         | <0.001 <sup>a</sup> | 0.5(43/7835)          | <0.001 <sup>a</sup> |
| High-tier                                   | 13.6(2284)  | 0.2(5/2284)           |                     | 1.0(22/2284)          |                     | 0.3(6/2284)           |                     |
| <b>Age group(years)</b>                     |             |                       |                     |                       |                     |                       |                     |
| <20   | 6.7(1128)   | 0.1(1/1128)           | <0.001              | 0.9(10/1128)          | <0.001              | 0.4(5/1128)           | 0.208               |
| 20-45                                       | 87.2(14645) | 0.2(30/14645)         | <0.001 <sup>a</sup> | 1.7(246/14645)        | <0.001 <sup>a</sup> | 0.8(112/14645)        | 0.971 <sup>a</sup>  |
| >45   | 6.1(1018)   | 1.4(14/1018)          |                     | 3.4(35/1018)          |                     | 0.4(4/1018)           |                     |
| <b>Education level</b>                      |             |                       |                     |                       |                     |                       |                     |
| primary school<br>or below                  | 19.2(3225)  | 0.7(22/3225)          | <0.001              | 2.9(94/3225)          | <0.001              | 0.7(23/3225)          | 0.995               |
| junior middle<br>school                     | 54.7(9191)  | 0.2(19/9191)          | <0.001 <sup>a</sup> | 1.6(147/9191)         | <0.001 <sup>a</sup> | 0.7(66/9191)          | 0.917 <sup>a</sup>  |
| high school or<br>above                     | 26.1(4375)  | 0.1(4/4375)           |                     | 1.1(50/4375)          |                     | 0.7(32/4375)          |                     |
| <b>Marital status</b>                       |             |                       |                     |                       |                     |                       |                     |
| Never been<br>married                       | 36.0(6053)  | 0.1(5/6053)           | <0.001              | 1.0(62/6053)          | <0.001              | 0.5(29/6053)          | <0.001              |
| Married<br>living together<br>as if married | 42.7(7168)  | 0.4(31/7168)          |                     | 1.9(136/7168)         |                     | 0.6(40/7168)          |                     |
|   | 10.4(1751)  | 0.1(1/1751)           |                     | 1.9(34/1751)          |                     | 1.5(26/1751)          |                     |

|    |  |             |               |        |                |        |                |        |
|----|--|-------------|---------------|--------|----------------|--------|----------------|--------|
| 1  |  |             |               |        |                |        |                |        |
| 2  |  |             |               |        |                |        |                |        |
| 3  |  |             |               |        |                |        |                |        |
| 4  | Divorced/Widowed   | 10.8(1819)  | 0.4(8/1819)   |        | 3.2(59/1819)   |        | 1.4(26/1819)   |        |
| 5  |  |             |               |        |                |        |                |        |
| 6  | <b>Household registration(hukou)</b>                           |             |               |        |                |        |                |        |
| 7  |  |             |               |        |                |        |                |        |
| 8  | Local  | 91.0(15274) | 0.3(40/15274) | 0.821  | 1.6(247/15274) | <0.001 | 0.7(112/15274) | 0.540  |
| 9  | Not local  | 9.0(1517)   | 0.3(5/1517)   |        | 2.9(44/1517)   |        | 0.6(9/1517)    |        |
| 10 |  |             |               |        |                |        |                |        |
| 11 | <b>Ethnicity</b>   |             |               |        |                |        |                |        |
| 12 | Minority   | 10.0(1674)  | 0.2(3/1674)   | 0.623  | 0.7(11/1674)   | <0.001 | 0.1(1/1674)    | 0.001  |
| 13 | Han  | 90.0(15116) | 0.3(42/15116) |        | 1.9(280/15116) |        | 0.8(120/15116) |        |
| 14 |  |             |               |        |                |        |                |        |
| 15 | <b>Local working time</b>                                      |             |               |        |                |        |                |        |
| 16 |  |             |               |        |                |        |                |        |
| 17 | more than 1 year   | 26.7(4475)  | 0.3(14/4475)  | 0.208  | 2.3(102/4475)  | 0.008  | 1.0(43/4475)   | 0.035  |
| 18 |  |             |               |        |                |        |                |        |
| 19 | 6~12 months  | 29.6(4975)  | 0.2(8/4975)   |        | 1.4(70/4975)   |        | 0.5(25/4975)   |        |
| 20 | 1~6 months   | 33.0(5535)  | 0.3(15/5535)  |        | 1.7(92/5535)   |        | 0.8(44/5535)   |        |
| 21 |  |             |               |        |                |        |                |        |
| 22 | less than 1 month  | 10.8(1805)  | 0.4(8/1805)   |        | 1.5(27/1805)   |        | 0.5(9/1805)    |        |
| 23 |  |             |               |        |                |        |                |        |
| 24 |  |             |               |        |                |        |                |        |
| 25 |  |             |               |        |                |        |                |        |
| 26 | <b>Location of previous job</b>                                |             |               |        |                |        |                |        |
| 27 |  |             |               |        |                |        |                |        |
| 28 | Other provinces  | 11.3(1896)  | 0.1(2/1896)   | 0.022  | 1.8(34/1896)   | 0.602  | 0.5(9/1896)    | 0.001  |
| 29 | Other cities in Chongqing                                      | 16.2(2728)  | 0.1(2/2728)   |        | 2.0(55/2728)   |        | 1.3(36/2728)   |        |
| 30 | Current city   | 61.3(10297) | 0.3(32/10297) |        | 1.7(173/10297) |        | 0.6(65/10297)  |        |
| 31 | No previous work   | 11.1(1870)  | 0.5(9/1870)   |        | 1.6(29/1870)   |        | 0.6(11/1870)   |        |
| 32 |  |             |               |        |                |        |                |        |
| 33 |  |             |               |        |                |        |                |        |
| 34 |  |             |               |        |                |        |                |        |
| 35 |  |             |               |        |                |        |                |        |
| 36 | <b>HIV knowledge</b>   |             |               |        |                |        |                |        |
| 37 |  |             |               |        |                |        |                |        |
| 38 | <6   | 13.0(2179)  | 0.4(8/2179)   | 0.337  | 1.9(42/2179)   | 0.456  | 0.7(16/2179)   | 0.936  |
| 39 | >=6  | 87.0(14612) | 0.3(37/14612) |        | 1.7(249/14612) |        | 0.7(105/14612) |        |
| 40 |  |             |               |        |                |        |                |        |
| 41 | <b>Used condom at last commercial sex</b>                      |             |               |        |                |        |                |        |
| 42 | No   | 15.7(2612)  | 0.7(19/2612)  | <0.001 | 1.8(48/2612)   | 0.698  | 0.4(11/2612)   | 0.046  |
| 43 | Yes  | 84.3(14050) | 0.2(26/14050) |        | 1.7(243/14050) |        | 0.8(110/14050) |        |
| 44 |  |             |               |        |                |        |                |        |
| 45 | <b>Consistent condom use in the last month</b>                 |             |               |        |                |        |                |        |
| 46 |  |             |               |        |                |        |                |        |
| 47 | No   | 46.3(7703)  | 0.4(32/7703)  | 0.001  | 2.0(155/7703)  | 0.017  | 0.6(43/7703)   | 0.017  |
| 48 | Yes  | 53.7(8921)  | 0.1(13/8921)  |        | 1.5(136/8921)  |        | 0.9(78/8921)   |        |
| 49 |  |             |               |        |                |        |                |        |
| 50 | <b>Drug use</b>  |             |               |        |                |        |                |        |
| 51 | No   | 96.7(16183) | 0.3(45/16183) | 0.412  | 1.7(279/16183) | 0.423  | 0.7(109/16183) | <0.001 |
| 52 | Yes  | 3.3(551)    | 0.0(0/551)    |        | 2.2(12/551)    |        | 2.2(12/551)    |        |
| 53 |  |             |               |        |                |        |                |        |
| 54 | <b>STI diagnosis in the last 12 months</b>                     |             |               |        |                |        |                |        |
| 55 |  |             |               |        |                |        |                |        |
| 56 | No   | 97.8(16388) | 0.3(45/16388) | 0.620  | 1.6(268/16388) | <0.001 | 0.7(114/16388) | 0.016  |
| 57 | Yes  | 2.2(367)    | 0.0(0/367)    |        | 6.3(23/367)    |        | 1.9(7/367)     |        |
| 58 |  |             |               |        |                |        |                |        |
| 59 | <b>Received AIDS prevention services in the last 12 months</b> |             |               |        |                |        |                |        |
| 60 |  |             |               |        |                |        |                |        |

|     |             |               |       |                |       |                |       |
|-----|-------------|---------------|-------|----------------|-------|----------------|-------|
| No  | 10.9(1829)  | 0.2(3/1829)   | 0.362 | 1.3(24/1829)   | 0.144 | 0.5(10/1829)   | 0.352 |
| Yes | 89.1(14962) | 0.3(42/14962) |       | 1.8(267/14962) |       | 0.7(111/14962) |       |

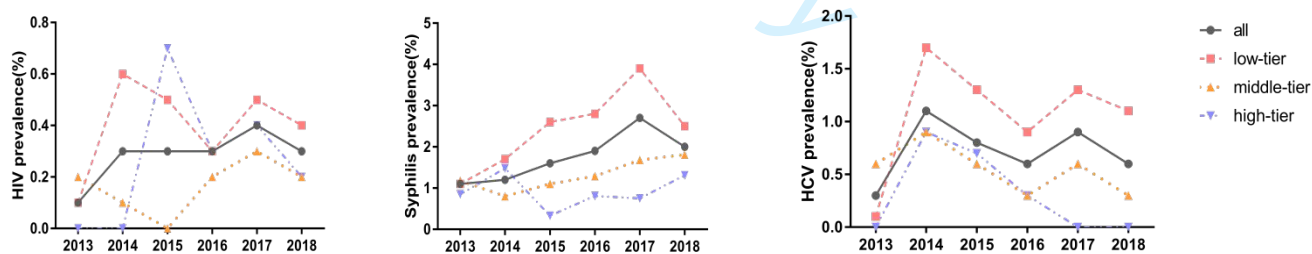
179 \* The sum of numbers in some subgroups was less than 16791 because some participants refused  
 180 to respond to some questions; <sup>a</sup> p for trend, tested by Cochran-Armitage trend test.

181 **Prevalence and changing trend of HIV infections**

182 As Table 1 showed, the overall prevalence of HIV infection among the study population  
 183 was 0.3% (95%CI, 0.2%-0.4%). And HIV prevalence had an decreasing trend among FSWs  
 184 with higher education level, higher tier, and younger age. The prevalence was 0.7% among  
 185 FSWs with primary school or below, 0.2% among FSWs with junior middle school, and 0.1%  
 186 among FSWs with high school or above. The HIV prevalence was significantly lower among  
 187 FSWs used condom in last commercial sex than that among FSWs not using condom (0.2% vs  
 188 0.7%, p<0.001). And FSWs who used condom inconsistently had a higher HIV prevalence  
 189 than those with consistent condom use (0.4% vs 0.1%, p=0.001).

190 In addition, we, based on the 6 serial surveillance surveys, tested time trend of HIV,  
 191 syphilis and HCV prevalence by types of venues among FSWs in Chongqing from 2013 to  
 192 2018. The HIV prevalence among FSWs in Chongqing, which ranged from 0.1 % to 0. 4%  
 193 during the study years, had no significant changes over time (p=0.129). And it is also no  
 194 significant time trend among low-tier/middle-tier/high-tier FSWs (p=0.498, 0.366, 0.423,  
 195 respectively) (Figure 1).

196 **Figure 1.** HIV, syphilis and HCV prevalence among FSWs from 2013 to 2018 in  
 197 Chongqing.



198

199 **Prevalence and changing trend of syphilis infections**

200 Overall, the syphilis prevalence among FSWs was 1.7% (95%CI, 1.5% - 1.9%). The  
 201 syphilis prevalence also increased among FSWs with less education, lower tier, and older age.

202 Han FSWs had higher prevalence than ethnic minority FSWs (1.9% vs 0.7%,  $p<0.001$ ); local  
203 FSWs had lower prevalence than FSWs from other places (1.6% vs 2.9%,  $p<0.001$ ). FSWs who  
204 reported STI diagnosis in the last 12 months had a significant higher syphilis prevalence than  
205 those who did not report (6.3% vs 1.6%,  $p<0.001$ ).

206 In addition, an increasing trend of syphilis prevalence among FSWs in Chongqing was  
207 observed (from 1.1 % in 2013 to 2.0 % in 2018,  $p<0.001$ ). This trend was also found in low-tier  
208 FSWs (from 1.1 % in 2013 to 2.5 % in 2018,  $p<0.001$ ) and middle-tier FSWs (from 1.2 % in 2013  
209 to 1.8 % in 2018,  $p=0.026$ ), but not in the high-tier group ( $p=0.713$ ).

### 210 **Prevalence and changing trend of HCV**

211 The HCV prevalence among FSWs in Chongqing ranged from 0.3 % to 1.1% between  
212 2013 to 2018, and was 0.7% (95%CI, 0.6% - 0.9%) overall. There was not a significant changing  
213 trend of HCV infection by year both overall and among subgroups. But HCV prevalence tend  
214 to decrease among FSWs in higher-tier venues ( $p<0.001$ ); low-tier FSWs, middle-tier FSWs,  
215 high-tier FSWs had a prevalence of 1.1%, 0.5%, 0.3%, respectively. FSWs of Han ethnicity had  
216 a higher prevalence than ethnic minority FSWs (0.8% vs 0.1%,  $p=0.001$ ). And HCV infection  
217 among FSWs who reported drug use, diagnosis of STI higher than those who reported not  
218 (2.2% vs 0.7%,  $p<0.001$ ; 1.9% vs 0.7%,  $p=0.016$ , respectively). FSWs who used condom in last  
219 commercial sex or used condom consistently had a lower infection rate.

### 220 **Changing trend of behavioral factors**

221 As table 2 showed, overall more than 80% participants know AIDS knowledge well, and  
222 used condom in their last commercial sexual behavior. Nearly 90% received at least one of the  
223 following three AIDS services in the last year, including 1)condom promotion and  
224 distribution, AIDS counseling and testing, 2) community drug maintenance therapy, clean  
225 needle supply/exchange, 3) peer education. In addition, only 50% of participants used  
226 condom consistently with clients in the last month. Approximately 3% reported drug use and  
227 2% reported had diagnosed STI in the past year.

228 We also examined the changingtrend of FSWs' behaviors, and found that no significant  
229 changes over time was observed in drug use reported by FSWs. However, there were  
230 significant improvements over time in AIDS awareness, condom use, participation in AIDS

231 services and self-reported STI diagnosis in last year among FSWs.

232 **Table 2.** Behavioral characteristics of FSWs from 2013 to 2018 in Chongqing

| Variables                             |     | 2013       | 2014       | 2015       | 2016       | 2017       | 2018       | overall     | P      | P for  |
|---------------------------------------|-----|------------|------------|------------|------------|------------|------------|-------------|--------|--------|
|                                       |     | %(n)       | %(n)       | %(n)       | %(n)       | %(n)       | %(n)       | %(n)        | value  | trend  |
| HIV know-ledge(>=6)                   | Yes | 86.1(2405) | 83.6(2338) | 91.7(2562) | 84.0(2350) | 87.6(2457) | 89.1(2500) | 87.0(14612) | <0.001 | <0.001 |
|                                       | No  | 13.9(388)  | 16.4(458)  | 8.3(231)   | 16.0(449)  | 12.4(348)  | 10.9(305)  | 13.0(2179)  |        |        |
| condom use in the last commercial sex | Yes | 79.7(2167) | 77.4(2134) | 93.8(2604) | 83.4(2335) | 87.0(2439) | 84.5(2371) | 84.3(14050) | <0.001 | <0.001 |
|                                       | No  | 20.3(552)  | 22.6(625)  | 6.2(171)   | 16.6(464)  | 13.0(366)  | 15.5(434)  | 15.7(2612)  |        |        |
| CCU in the past month                 | Yes | 41.7(1130) | 51.2(1406) | 69.7(1925) | 60.1(1682) | 47.7(1337) | 51.4(1441) | 53.7(8921)  | <0.001 | <0.001 |
|                                       | No  | 58.3(1578) | 48.8(1341) | 30.3(835)  | 39.9(1117) | 52.3(1468) | 48.6(1364) | 46.3(7703)  |        |        |
| Drug use                              | Yes | 2.9(81)    | 4.2(116)   | 2.7(74)    | 4.6(129)   | 2.2(63)    | 3.1(88)    | 3.3(551)    | <0.001 | 0.322  |
|                                       | No  | 97.1(2705) | 95.8(2631) | 97.3(2718) | 95.4(2670) | 97.8(2742) | 96.9(2717) | 96.7(16183) |        |        |
| Injecting drug use                    | Yes | 1.3(35)    | 1.2(32)    | 0.6(18)    | 1.5(43)    | 0.7(19)    | 0.4(11)    | 0.9(158)    | <0.001 | 0.002  |
|                                       | No  | 98.8(2754) | 98.9(2760) | 99.4(2774) | 98.5(2756) | 99.3(2786) | 99.6(2794) | 99.1(16624) |        |        |
| STI diagnosis in the past year        | Yes | 3.8(106)   | 3.6(100)   | 1.5(43)    | 1.8(50)    | 1.1(31)    | 1.3(37)    | 2.2(367)    | <0.001 | <0.001 |
|                                       | No  | 96.2(2671) | 96.4(2679) | 98.5(2747) | 98.2(2749) | 98.9(2774) | 98.7(2768) | 97.8(16388) |        |        |
| AIDS services                         | Yes | 80.0(2235) | 86.0(2405) | 94.4(2637) | 93.4(2615) | 92.7(2600) | 88.1(2470) | 89.1(14962) | <0.001 | <0.001 |
|                                       | No  | 20.0(558)  | 14.0(391)  | 5.6(156)   | 6.6(184)   | 7.3(205)   | 11.9(335)  | 10.9(1829)  |        |        |

233 CCU: consistent condom use.

### 234 **Correlates of HIV, syphilis and HCV infections**

235 Multivariate logistic regression analysis results (Table 3) showed that, 1) HIV infection  
 236 was significantly and positively associated with no condom use in the last commercial sex  
 237 (aOR=3.43, 95% CI, 1.88-6.28) and syphilis infection (aOR=4.94, 95% CI, 1.98-12.34); 2) syphilis  
 238 infection was significantly and positively associated with inconsistent condom use in the past  
 239 month (aOR=1.30, 95% CI, 1.02-1.65), STI diagnosis in the past year (aOR=3.50, 95% CI,  
 240 2.22-5.50), HIV infection (aOR=5.90, 95% CI, 2.41-14.42) and HCV infection (aOR=7.71, 95% CI,  
 241 4.41-13.48); 3) HCV infection was significantly and positively associated with injecting drug  
 242 use (aOR=9.02, 95% CI, 4.49-18.09) and syphilis infection (aOR=7.57, 95% CI, 4.32-13.27).

243 **Table 3.** Associations between behavioral characteristics and HIV, syphilis and HCV infection

| Characteristics | HIV |     | Syphilis |     | HCV |     |
|-----------------|-----|-----|----------|-----|-----|-----|
|                 | OR  | aOR | OR       | aOR | OR  | aOR |

|   | (95%CI)             | (95%CI)             | (95%CI)             | (95%CI)             | (95%CI)             | (95%CI)             |
|---|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| No condom use in the last commercial sex  | 3.97(2.19,7.19)***  | 3.43(1.88,6.28)***  | N/A                 | N/A                 | N/A                 | N/A                 |
| Inconsistent condom use in the past month | N/A                 | N/A                 | 1.30(1.03,1.64)*    | 1.30(1.02,1.65)*    | 0.63(0.43,0.92)*    | 9.02(4.49,19.21)    |
| Injecting drug use                        | N/A                 | N/A                 | N/A                 | N/A                 | 8.18***             | 8.09***             |
| STI diagnosis in the past year            | N/A                 | N/A                 | 3.75(2.40,5.87)***  | 3.50(2.22,5.50)***  | N/A                 | N/A                 |
| HIV infection                             | 8.68(3.63,20.74)*** | 4.94(1.98,12.34)*** | 1.91***             | 4.42***             | 9.09(5.26,15.71)*** | 7.57(4.32,13.27)*** |
| Syphilis infection                        | N/A                 | N/A                 | 8.81(5.09,15.71)*** | 7.71(4.41,13.48)*** | N/A                 | N/A                 |
| HCV infection                             | N/A                 | N/A                 | 5.25***             | 3.48***             | N/A                 | N/A                 |

244 aOR: Adjusted for socio-demographic characteristic (age, education level, marital status and type of  
245 venues); \* p<0.05, \*\* p<0.01, \*\*\* p<0.001.

246

## 247 DISCUSSION

248 FSWs are considered to be at high risk of HIV infection and other STI and contribute  
249 disproportionately to the transmission. As an identifiable population, surveillance of STI and  
250 risk behaviors among FSWs is of great significance to understanding the potential of  
251 spreading HIV to the general population, to assessing and improving interventions targeted  
252 at FSWs.<sup>18</sup> Although it is critical to analysis and know prevalence and changing trend of HIV,  
253 syphilis, HCV and relevant behaviors among FSWs, few studies reported that in Chongqing,  
254 China. In this study, we examined prevalence and changing trends of HIV, syphilis, HCV and  
255 behaviors by using sentinel surveillance data of Chongqing FSWs from 2013 to 2018.

256 Our study shows that HIV prevalence among FSWs in Chongqing was relatively stable  
257 with a annual average HIV infection rate of 0.3% from 2013 to 2018, which was similar to  
258 0.22% among Chinese FSWs in 2014,<sup>9</sup> but much higher than China's current estimated  
259 national HIV prevalence rate (0.0598%).<sup>20</sup> And HIV infection is associated with not using  
260 condoms (aOR = 3.43) and syphilis infection (aOR = 4.94). Consistent condom use is one of the  
261 most effective ways to prevent AIDS, and its protection rate can reach 80% based on studies

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3  
4 262 of persons during heterosexual sex with an HIV-positive partner.<sup>21</sup> The 100% Condom Use  
5  
6 263 Programme (CUP) has been implemented in Chongqing since 2006. This project promoted the  
7  
8 264 condom use of FSW. We also found that more and more FSWs used condoms consistently,  
9  
10 265 but the percentage of FSW who insist on using condoms was less than 60%. This suggests that  
11  
12 266 condoms still need to be promoted among FSWs.

13  
14 267 Notably, the results also indicated a worrying upward trend of syphilis infection (from  
15  
16 268 1.1 % in 2013 to 2.0 % in 2018), particularly among low-tier and middle-tier FSWs. Syphilis, as  
17  
18 269 the third most prevalent notifiable infectious disease in category A and B in China, has been  
19  
20 270 on the rise since the 1990s.<sup>22</sup> The reported total syphilis rate in China increased from  
21  
22 271 0.2/100,000 in 1993 to 32.86/100,000 in 2013.<sup>22</sup> The reported incidence of syphilis in Chongqing  
23  
24 272 also showed an upward trend, with a reported incidence of 40.38/100,000 in 2014.<sup>23</sup> However,  
25  
26 273 researches found that the increase of reported syphilis cases in Chongqing in recent years is  
27  
28 274 due to the increase of latent syphilis, which may be related to the large-scale screening of  
29  
30 275 syphilis in medical institutions, the training of syphilis diagnosis standards and reporting  
31  
32 276 requirements and the improvement of laboratory conditions and laboratory diagnosis level.<sup>24</sup>  
33  
34 277 The increase of syphilis infection rate in FSW may also be related to the strengthening of  
35  
36 278 syphilis detection, but it still needs attention. FSWs with syphilis were nearly five times more  
37  
38 279 likely to be infected with HIV, and seven times more likely to be infected with HCV than  
39  
40 280 FSWs without syphilis. And syphilis infection was correlated with HIV (aOR = 5.90), HCV  
41  
42 281 infection (aOR = 7.71) and STI infection in last year (aOR = 3.50), which may due to their  
43  
44 282 shared transmission routes, co-risk factors and adverse interaction.<sup>25</sup> So more efforts are in  
45  
46 283 need to strengthen comprehensive and combined intervention of AIDS, syphilis and other STI  
47  
48 284 for key groups.

49 285 HCV prevalence was fluctuated from year to year with the six-year average infection rate  
50  
51 286 of 0.7%, but no significant trend was found. This result is in agreement with previous study  
52  
53 287 conducted in Guangxi.<sup>26</sup> But a similar study used national data reported HIV and HCV  
54  
55 288 prevalence among FSWs in China decreased from 2008 to 2012;<sup>27</sup> the differences may be due  
56  
57 289 to differences in scope of study area and study period. Similar to previous study, we showed  
58  
59 290 a strong association between injecting drug use and HCV infection,<sup>28</sup> and the sharing of  
60  
291 291 needles may be the main and underlying route of HCV transmission. Fortunately, the



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4 292 prevalence of injection drug use among FSWs appears to have decreased, but no significant  
5  
6 293 improvement of drug use was found.

7 294 In addition, as previous studies found, lower-tier FSWs bear heavier burden of HIV,  
8  
9 295 syphilis, and HCV than FSWs in higher-tier venues.<sup>27</sup> FSWs with less education, older age  
10  
11 296 also had a higher prevalence of HIV and syphilis. And low-tier FSWs were found to tend to  
12  
13 297 be older women and low education.<sup>29</sup> So low-tier FSWs with low education probably had  
14  
15 298 insufficient knowledge about those diseases, less awareness about sex health, and poor  
16  
17 299 communication skills to condom use.<sup>30</sup> And they may serving more clients who also had low  
18  
19 300 education, had low awareness, and were unwilling to use condom, particularly elderly man.<sup>26</sup>  
20  
21 301 <sup>31</sup> Elderly man in China had a increasing HIV infection rate because of their commercial sex  
22  
23 302 and unwilling to use condom.<sup>32 33</sup> The two high-risk populations, low-tier FSWs and elderly  
24  
25 303 man, may have an effect on each other and increase HIV infection rates. Thus, future  
26  
27 304 intervention programs should specified and targeted based on the needs of the different tier  
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29 305 FSWs, and pay more attention on low-tier FSWs and their clients. What's more, sex work is  
30  
31 306 illegal and highly stigmatized in China, so FSWs face much barriers to participant in  
32  
33 307 HIV/AIDS related services, such as fear of being arrested, fear of discrimination and  
34  
35 308 awkwardness.<sup>34</sup> AIDS intervention services need to cooperate more with NGOs, increase  
36  
37 309 condom promotion, and jointly increase awareness of other STIs such as syphilis.

38  
39 310 Our study has several limitations. First, the data we used was based on serial  
40  
41 311 cross-sectional surveillance surveys, therefore we may find trends of HIV, syphilis and HCV  
42  
43 312 infection without exact reasons of those changes. Second, the data were collected mainly  
44  
45 313 through self-reported questionnaire, which raises concern about recall bias, reporting bias  
46  
47 314 and social desirability bias. For example, respondents may conceal the truth when answering  
48  
49 315 sensitive questions, such as drug use, which is illegal in China. Third, considering the  
50  
51 316 acceptability and simplicity of the questionnaire, we did not collect some information that  
52  
53 317 may be relevant to the infection and transmission, such as sexual violence, alcohol use and  
54  
55 318 condom use within non-commercial partnerships.

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58  
59 320 **CONCLUSIONS**

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4 321 In conclusion, HIV and HCV prevalence among FSWs in Chongqing remained stable  
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6 322 during the study period, but syphilis had an upward trend among FSWs in low-tier and  
7  
8 323 middle-tier venues. Although factors including knowledge, condom use, injecting drug use  
9  
10 324 and STI diagnosis were improved, nearly half of FSWs used condom inconsistently. Thus,  
11  
12 325 more comprehensive interventions targeted FSWs to promote condom use and sexual health,  
13  
14 326 to prevent and control HIV, syphilis and other STIs, particularly those focus on the low-tier  
15  
16 327 and middle-tier FSWs, should be implemented.

328

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20  
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26  
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28  
29 334 participated in the interpretation of results. LH wrote the first draft of the manuscript. LH  
30  
31 335 HQ, HZ, DJ and MY revised the manuscript. All authors have read and approved the  
32  
33 336 manuscript.

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41 340 **Competing interests** None declared.

44 341 **Patient consent for publication** Not required.

46 342 **Ethics approval** This survey was reviewed and approved by the Institutional Review Board  
47  
48 343 of the National Center for AIDS Prevention and Control (NCAIDS), Center for Disease  
49  
50 344 Control (CDC), China, and the medical ethics committee of Chongqing Medical University  
51  
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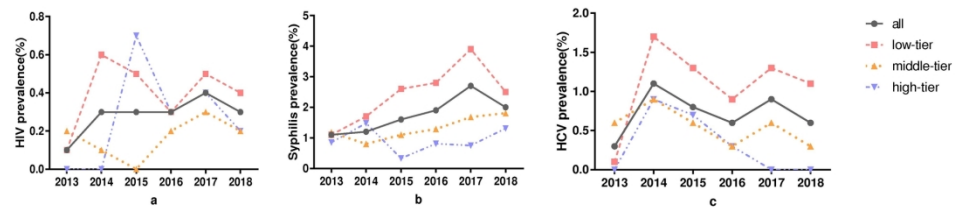


Figure 1. HIV, syphilis and HCV prevalence among FSWs from 2013 to 2018 in Chongqing.  
175x47mm (300 x 300 DPI)

**STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies***

| Section/Topic                | Item # | Recommendation   | Reported on page # |
|------------------------------|--------|--|--------------------|
| <b>Title and abstract</b>    | 1      | (a) Indicate the study's design with a commonly used term in the title or the abstract   | 1-2                |
|                              |        | (b) Provide in the abstract an informative and balanced summary of what was done and what was found  | 1-2                |
| <b>Introduction</b>          |        |  |                    |
| Background/rationale         | 2      | Explain the scientific background and rationale for the investigation being reported   | 3-4                |
| Objectives                   | 3      | State specific objectives, including any prespecified hypotheses   | 4                  |
| <b>Methods</b>               |        |  |                    |
| Study design                 | 4      | Present key elements of study design early in the paper  | 4                  |
| Setting                      | 5      | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection  | 4                  |
| Participants                 | 6      | (a) Give the eligibility criteria, and the sources and methods of selection of participants  | 5                  |
| Variables                    | 7      | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable   | 5-6                |
| Data sources/<br>measurement | 8*     | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | 5-6                |
| Bias                         | 9      | Describe any efforts to address potential sources of bias  | 14                 |
| Study size                   | 10     | Explain how the study size was arrived at  | 5                  |
| Quantitative variables       | 11     | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why   | --                 |
| Statistical methods          | 12     | (a) Describe all statistical methods, including those used to control for confounding  | 6                  |
|                              |        | (b) Describe any methods used to examine subgroups and interactions  | 6                  |
|                              |        | (c) Explain how missing data were addressed  | 6                  |
|                              |        | (d) If applicable, describe analytical methods taking account of sampling strategy   | --                 |
|                              |        | (e) Describe any sensitivity analyses  | --                 |
| <b>Results</b>               |        |  |                    |

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|--------------------------|-----|--|-------|
| Participants             | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed            | 7     |
|                          |     | (b) Give reasons for non-participation at each stage   | --    |
|                          |     | (c) Consider use of a flow diagram   | --    |
| Descriptive data         | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders   | 7-9   |
|                          |     | (b) Indicate number of participants with missing data for each variable of interest  | --    |
| Outcome data             | 15* | Report numbers of outcome events or summary measures   | 9-10  |
| Main results             | 16  | (a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | 9-10  |
|                          |     | (b) Report category boundaries when continuous variables were categorized  | --    |
|                          |     | (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period   | --    |
| Other analyses           | 17  | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses   | 11    |
| <b>Discussion</b>        |     |  |       |
| Key results              | 18  | Summarise key results with reference to study objectives   | 14    |
| Limitations              | 19  | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias   | 14    |
| Interpretation           | 20  | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence                                   | 12-14 |
| Generalisability         | 21  | Discuss the generalisability (external validity) of the study results  | 14    |
| <b>Other information</b> |     |  |       |
| Funding                  | 22  | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based  | 15    |

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).

# BMJ Open

## Changing trends of HIV, syphilis, HCV infections and behavioral factors among female sex workers in Chongqing, China: findings of 6 serial surveillance surveys

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4 1 **Changing trends of HIV, syphilis, HCV infections and behavioral factors**  
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6 2 **among female sex workers in Chongqing, China: findings of 6 serial**  
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8 3 **surveillance surveys**  
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13 5 **Ling Hu<sup>1,2</sup>, Rongrong Lu<sup>3</sup>, Guohui Wu<sup>3</sup>, Hua Zhu<sup>1,2</sup>, Hongfang Qiu<sup>1,2</sup>, Dan Jing<sup>1,2</sup>, and**  
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4 27 **ABSTRACT**

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6 28 **Objectives:** To explore prevalence and changing trends of HIV, syphilis, hepatitis C (HCV)  
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8 29 infections and risk behaviors among female sex workers (FSWs), and to provide reference  
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10 30 and theoretical basis for formulating targeted interventions.

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13 31 **Design:** Six consecutive cross-sectional surveys

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16 32 **Setting:** Chongqing, China

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19 33 **Participants:** FSWs were included if they (1) were aged  $\geq 16$  years, (2) provided commercial  
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21 34 sex for money or goods during the previous one month, and (3) were willing to participate  
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23 35 this survey and could provide verbal informed consent. This study included 16791 of 16810  
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25 36 participants recruited between 2013 and 2018.

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28 37 **Primary and secondary outcome measures:** The prevalence of HIV/syphilis/HCV infection

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31 38 **Results:** HIV and HCV prevalence among FSWs in Chongqing was stable during the study  
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33 39 period, but prevalence of syphilis had an increasing trend, particularly among low-tier and  
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35 40 middle-tier FSWs. Improvements in AIDS-related knowledge, condom use, injecting drug use  
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37 41 and participation in AIDS services were observed, but there was no change in prevalence of  
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39 42 drug use. HIV infection was correlated with no condom use in the last commercial sex  
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41 43 (aOR=3.48) and syphilis infection (aOR=4.88). Syphilis infection was correlated with  
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43 44 inconsistent condom use (aOR=1.30), HIV infection (aOR=5.88), HCV infection (aOR=7.68),  
44  
45 45 and STI diagnosis in the past year (aOR=3.81). HCV infection was associated with injecting  
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47 46 drug use (aOR=8.91) and syphilis infection (aOR=7.88).

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50 47 **Conclusions:** More comprehensive interventions targeted FSWs to promote condom use and  
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52 48 sexual health, to prevent and control HIV, syphilis and other STI, particularly those focus on  
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54 49 the low-tier and middle-tier FSWs, should be implemented.

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56 50 **Keywords:** Female sex workers (FSWs), HIV, Syphilis, Sexually transmitted infection (STI),  
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58 51 China

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60 52 **Strengths and limitations of this study**

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4 53 ● The study involved six consecutive years of sentinel surveillance among FSWs in  
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6 54 Chongqing with a large sample size.  
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8 55 ● This study provides valuable information about the prevalence and trends of STIs  
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10 56 among FSWs in Chongqing, and helps to formulate and improve relevant intervention  
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12 57 strategies.  
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14 58 ● However, causality cannot be determined due to the cross-sectional design.  
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16 59 ● There may be recall bias and social desirability bias as a result of the use of self-reported  
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18 60 measures of condom use, drug use and other behavior.

## 61 INTRODUCTION

62 Worldwide, female sex workers (FSWs) are considered to be one of the most vulnerable  
63 groups to HIV, syphilis and other sexually transmitted infections (STI) infection.<sup>1 2</sup> A global  
64 meta-analysis found HIV prevalence among FSWs was estimated at 10.4% (95% confidence  
65 interval (CI) 9.5–11.5%).<sup>3</sup> WHO reported that the median reported syphilis prevalence  
66 among FSWs globally was 3.2% (range 0.0–35.2%), and four countries reported syphilis  
67 infection was 20% or higher.<sup>4</sup>

68 Since China's reform and opening up, sex industry has re-emerged due to economic  
69 growth, population migration, and changes in sexual attitudes.<sup>5 6</sup> A large number of rural  
70 migrants moved to cities for better job opportunities. But those rural women found that the  
71 labor force was saturated or the wages were not high enough, and then sex work with quick  
72 financial return became an option.<sup>7</sup> There are an estimated 4 million FSWs;<sup>8</sup> and about 6.9%  
73 men aged 18–49 years have ever had commercial sex during their lifetime.<sup>9</sup> Most FSWs in  
74 China are mobile, have both commercial and non-commercial sex partners and use condom  
75 inconsistently.<sup>6</sup> The incidence of STI such as syphilis has dramatically increased along with  
76 the prosperity of the sex trade.<sup>2 10</sup> Heterosexual sex has replaced intravenous drug use (IDU)  
77 and commercial blood/plasma collection as the primary transmission mode of HIV in China.<sup>11</sup>  
78 Among the newly reported HIV infections from January to October 2019, heterosexual  
79 transmission accounted for 73.7%, much higher than other transmission ways.<sup>12</sup> A review also  
80 reported that FSWs in China had a median HIV prevalence of 0.6% (0–10.3%) and a rate of  
81 positive for at least one STI of 41.5% (13–90.6%).<sup>13</sup>

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4 82 Sex work is still illegal in China. Thus, much sex work takes place in informal venues and  
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6 83 in combination with other work to cover up illegality. There are a variety of forms of sex  
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8 84 work venues, usually including karaoke halls (KTV), night clubs, bars, hair salons, saunas,  
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10 85 foot massage parlors, and hotels. It was found that different sex work settings are associated  
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12 86 with the risk of HIV/STI infection. And the average price of each sex transaction are often  
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14 87 used by Chinese researchers to categorize FSWs into high, middle, and low tiers. The size of  
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16 88 different-tier FSWs may be related to the local economic level. In Jiangmen City, more than  
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18 89 60% of FSWs was high-tier FSW, while the proportion of low-tier FSWs was less than 10%;<sup>14</sup>  
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20 90 but in Jianshui County, the proportion of low-tier FSWs was close to 30%.<sup>15</sup> The proportion of  
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22 91 lower-tier FSWs may vary from region to region, but previous studies have shown that they  
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24 92 have higher risk of HIV infection than other FSWs.<sup>16 17</sup>

25 93 Chinese government has provided voluntary HIV counseling and testing (VCT), STI  
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27 94 services, condom promotion, and peer education among FSWs through the cooperation  
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29 95 among Centers for Disease Control (CDC), community health services, and medical  
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31 96 institutions.<sup>18</sup> The "Four Frees and One Care" policy helps treat AIDS patients with financial  
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33 97 difficulties by providing free antiviral drugs. In 1995, China established the national HIV  
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35 98 sentinel surveillance system to active monitor HIV prevalence among high-risk populations  
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37 99 (e.g., FSWs, injected drug users) and to guide the development of HIV prevention and control  
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39 100 strategies.<sup>19-21</sup> After years of development, the surveillance system has expanded in scope,  
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41 101 from 42 sentinel sites in 1995 to 1888 in 2010, and combined biological and behavioral  
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43 102 surveillance strategies, which included sero-testing for HIV, syphilis and hepatitis C virus  
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45 103 (HCV).<sup>22</sup> Surveillance data can help to understand the epidemic status and trend of AIDS and  
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47 104 STI among FSWs, which is necessary for developing HIV or STI prevention programmes.<sup>23</sup>  
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49 105 According to China's surveillance data, the average prevalence of HIV/syphilis/HCV among  
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51 106 FSWs from 2010 to 2015 was estimated at 0.25%, 2.54% and 0.72%, respectively.<sup>24</sup> The  
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53 107 prevalence varied from province to province and the southwest province had higher  
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55 108 prevalence of STI.<sup>16 25</sup> For example, although HIV prevalence among FSWs was lower than  
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57 109 0.05% in most provinces (such as, Heilongjiang, Hebei) in 2012, it exceeded 1% in the same  
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59 110 year in Yunnan and Guangxi.<sup>16</sup>

60 111 Chongqing, located in the southwest of China, is one of four Chinese municipalities

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4 112 directly controlled by the central government. It is geographically close to Yunnan and  
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6 113 Guangxi and has large population contacts with Yunnan and Guangxi. It is the political and  
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8 114 economic center of Western China and a city with obvious urban–rural dual structure and  
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10 115 prosperous sex industry. A study using the network scale-up method estimated that FSWs  
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12 116 accounted for 0.4% of women aged 15–49 years in Chongqing, and clients of FSWs  
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14 117 represented 2% of men aged 15–49 years.<sup>26</sup> Although HIV prevalence among FSWs in  
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16 118 Chongqing, 2012 was estimated at 0.25%, lower than that in other high-risk groups such as  
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18 119 men who have sex with men (17.03%) and injecting drug users (7.35%).<sup>27</sup> But since 2007,  
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20 120 heterosexual transmission has become the main way of HIV transmission in Chongqing.<sup>28</sup> Of  
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22 121 the 6352 newly diagnosed HIV/AIDS cases reported in Chongqing, 2015, 75.08% were  
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24 122 infected through heterosexual transmission.<sup>28</sup> Therefore, it is very important to understand  
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26 123 the prevalence and trends of STIs among FSWs in Chongqing.

27 124 Based on the surveillance data in Chongqing, the first aim of the study was to identify  
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29 125 prevalence and changing trends of HIV, syphilis, and HCV infections over time. Moreover, to  
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31 126 provide reference for formulating interventions to control AIDS and STI, this study explored  
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33 127 trends in sexual behaviors of FSWs, and discussed risk factors for prevalent STI over the 5  
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35 128 year period.

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## 39 130 **METHODS**

### 41 131 **Study design**

42  
43 132 Sentinel surveillance collects HIV, syphilis and HCV prevalence and high-risk behaviors  
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45 133 information through cross-sectional surveys. The data we analyzed in this study were  
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47 134 sentinel surveillance data among FSWs in Chongqing from 2013 to 2018.

### 49 135 **Participant selection and data collection**

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51 136 The detailed procedures of data collection followed the Operational Manual for the  
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53 137 Implementation Program of National AIDS Sentinel Surveillance established by the National  
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55 138 Center for AIDS Prevention and Control (NCAIDS).<sup>29</sup> Serial cross-sectional surveys were  
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57 139 conducted from April to June each year at seven sentinel surveillance sites in Chongqing  
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59 140 (Yuzhong District, Jiulongpo District, Wanzhou District, Dianjiang, Hechuan,

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141 Qijiang(Wansheng) and Youyang) (Figure 1). The sample size of each site was 400  
142 participants. The entire sampling process went through the following three steps. First, a  
143 distribution map of known commercial workplaces in the monitoring area was drawn to  
144 construct a sampling frame, and these locations were categorized into low-, middle- and  
145 high-tier venues based on the average price of each sex transaction. Then, those venues in  
146 each city were randomly selected by the proportional sampling selection process. The  
147 proportion of low-tier FSWs and middle-tier FSWs among all participants was at least 10%  
148 and 40%, respectively. FSWs were recruited if they met the inclusion criteria: (1) participants  
149 were aged  $\geq 16$  years, (2) provided commercial sex for money or goods during the previous  
150 one month, and (3) were willing to participate this survey and could provide verbal informed  
151 consent.

152 All participants completed an anonymous, standard interviewer administered, and  
153 face-to-face questionnaire. After each interview, 3-5 ml venous blood of each participant was  
154 collected for HIV, syphilis and HCV antibody detection. And the blood sample was linked to  
155 the questionnaire by a unique identification code assigned to the participant.

## 156 **Measures**

### 157 Questionnaire

158 The questionnaire was used to collect FSWs' socio-demographic characteristics, HIV  
159 knowledge and behaviors.

160 (1) Socio-demographic characteristics, including year of birth, marital status, household  
161 registration, ethnicity, and education level were collected.

162 (2) HIV-related knowledge of participants was assessed by 8 questions with "yes", "no"  
163 or "don't know" as answers. Those questions have been updated since 2016 which took  
164 new-type drugs and intentional transmission of HIV/AIDS into consideration. Only correct  
165 responses were scored as 1 point; incorrect responses and "don't know" responses did not  
166 earn any points. Cronbach's alpha was 0.706 and 0.739 before and after questions changing.

167 (3) Participants' behavioral factors were also collected, including questions regarding  
168 condom use in last commercial sex, condom use with clients in the past month, drug use  
169 during their lifetime, STI diagnose in the last year, and participation in AIDS services.

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4 170 Consistent condom use (CCU) in the past month in this study, was defined as always using a  
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6 171 condom during commercial intercourse.

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8 172 Laboratory testing

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10 173 In all surveys, venous blood samples were tested for HIV, syphilis, and HCV by trained  
11  
12 174 laboratory technician. Initial screening for HIV, syphilis, and HCV antibodies was conducted  
13  
14 175 using Enzyme-linked Immunosorbent Assay (ELISA) method (ELISA-1). If the result was  
15  
16 176 negative, no further re-examination would be carried out, and infection status was recorded  
17  
18 177 as negative. If the result was positive, HIV or HCV infection would be confirmed by another  
19  
20 178 ELISA method (ELISA-2) while syphilis infection confirmed by non-specific detection method  
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22 179 - Tolidine Red Unheated Serum Test (TRUST). Positive results can be determined only if  
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24 180 both tests were positive.

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26 181 Quality Assurance

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28 182 All investigators were strictly trained before the survey to ensure that they were familiar  
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30 183 with the questionnaire structure and mastered the unified investigation standards and  
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32 184 requirements. After the investigation, the investigator carefully reviewed the questionnaire  
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34 185 and promptly corrected the missing items, wrong items, and logical errors. Experts from the  
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36 186 Chongqing Center for Disease Control and Prevention went to the investigation site for  
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38 187 guidance and inspection to ensure the quality. All laboratory tests were conducted at  
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40 188 designated and certified laboratory at local CDC or hospitals.

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42 189 **Data analysis**

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44 190 First, socio-demographic characteristics of participants were presented using descriptive  
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46 191 statistics by survey year and overall.. In addition, trends of HIV, syphilis, HCV infections and  
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48 192 behavioral factors over time were assessed using Cochran-Armitage trend test. Moreover,  
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50 193 multivariable logistic regression was conducted to identify HIV, syphilis, and HCV infection  
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52 194 related risk-factors using stepwise elimination. Odds ratios (ORs) and 95% CIs of each  
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54 195 significant risk factor were also determined, unadjusted and adjusted for socio-demographic  
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56 196 factors. All statistical analyses were carried out by using Statistical Analysis Software, version  
57  
58 197 9.2 (SAS Institute Incorporated, Cary, North Carolina, USA).

59  
60 198 **RESULTS**



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3 199 **Socio-demographic characteristic**  
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5 200 This study included 16791 of 16810 participants recruited between 2013 and 2018. Table 1  
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7 201 depicted all participants' demographic characteristics stratified by year of survey. Among  
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9 202 them, nearly half of participants (46.7%) worked in middle-tier venues, 39.7% in low-tier  
10  
11 203 venues, and 13.6% in high-tier venues. The median age was 28 years and most (87.2%) of  
12  
13 204 them was between 20 and 45 years of age. The majority of participants were in Chongqing  
14  
15 205 households (91.0%) and belong to Han (90.0%). Less than one third of them had high school  
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17 206 or above education and half (54.7%) had a junior middle school education. Most participants  
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19 207 work in the current location 1~6 months (33.0%) and work in current city during the last job  
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21 208 (61.3%).  
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Table 1. Socio-demographic characteristics of female sex workers stratified by survey year (N, %)

| Characteristics                      | 2013<br>N(%) | 2014<br>N(%) | 2015<br>N(%) | 2016<br>N(%) | 2017<br>N(%) | 2018<br>N(%) | Total<br>N(%) |
|--------------------------------------|--------------|--------------|--------------|--------------|--------------|--------------|---------------|
| <b>Overall</b>                       | 2793(16.6)   | 2796(16.7)   | 2793(16.6)   | 2799(16.7)   | 2805(16.7)   | 2805(16.7)   | 16791(100.0)  |
| <b>Age group(years)</b>              |              |              |              |              |              |              |               |
| <20                                  | 285(10.2)    | 226(8.1)     | 206(7.4)     | 228(8.1)     | 87(3.1)      | 96(3.4)      | 1128(6.7)     |
| 20-45                                | 2404(86.1)   | 2451(87.7)   | 2442(87.4)   | 2412(86.2)   | 2521(89.9)   | 2415(86.1)   | 14645(87.2)   |
| >45                                  | 104(3.7)     | 119(4.3)     | 145(5.2)     | 159(5.7)     | 197(7.0)     | 294(10.5)    | 1018(6.1)     |
| <b>Marital status</b>                |              |              |              |              |              |              |               |
| Never been married                   | 1131(40.5)   | 1143(40.9)   | 1102(39.5)   | 1106(39.5)   | 734(26.2)    | 837(29.8)    | 6053(36.0)    |
| Married                              | 1148(41.1)   | 1104(39.5)   | 1207(43.2)   | 1152(41.2)   | 1279(45.6)   | 1278(45.6)   | 7168(42.7)    |
| Living together as if married        | 275(9.8)     | 308(11.0)    | 260(9.3)     | 307(11.0)    | 305(10.9)    | 296(10.6)    | 1751(10.4)    |
| Divorced/Widowed                     | 239(8.6)     | 241(8.6)     | 224(8.0)     | 234(8.4)     | 487(17.4)    | 394(14.0)    | 1819(10.8)    |
| <b>Household registration(hukou)</b> |              |              |              |              |              |              |               |
| Chongqing                            | 2518(90.2)   | 2559(91.5)   | 2533(90.7)   | 2547(91.0)   | 2580(92.0)   | 2537(90.4)   | 15274(91.0)   |
| Other provinces                      | 275(9.8)     | 237(8.5)     | 260(9.3)     | 252(9.0)     | 225(8.0)     | 268(9.6)     | 1517(9.0)     |
| <b>Ethnicity</b>                     |              |              |              |              |              |              |               |
| Minority                             | 253(9.1)     | 266(9.5)     | 308(11.0)    | 295(10.5)    | 280(10.0)    | 272(9.7)     | 1674(10.0)    |
| Han                                  | 2539(90.9)   | 2530(90.5)   | 2485(89.0)   | 2504(89.5)   | 2525(90.0)   | 2533(90.3)   | 15116(90.0)   |
| <b>Education level</b>               |              |              |              |              |              |              |               |
| Primary school or below              | 512(18.3)    | 524(18.7)    | 581(20.8)    | 506(18.1)    | 595(21.2)    | 507(18.1)    | 3225(19.2)    |
| Junior middle school                 | 1664(59.6)   | 1570(56.2)   | 1367(48.9)   | 1509(53.9)   | 1635(58.3)   | 1446(51.6)   | 9191(54.7)    |
| High school or above                 | 617(22.1)    | 702(25.1)    | 845(30.3)    | 784(28.0)    | 575(20.5)    | 852(30.4)    | 4375(26.1)    |
| <b>Typology</b>                      |              |              |              |              |              |              |               |
| Low-tier                             | 973(34.8)    | 955(34.2)    | 1043(37.3)   | 1193(42.6)   | 1347(48.0)   | 1161(41.4)   | 6672(39.7)    |
| Middle-tier                          | 1347(48.2)   | 1504(53.8)   | 1448(51.8)   | 1236(44.2)   | 1192(42.5)   | 1108(39.5)   | 7835(46.7)    |

|                                 |            |            |            |            |            |            |             |
|---------------------------------|------------|------------|------------|------------|------------|------------|-------------|
| High-tier                       | 473(16.9)  | 337(12.1)  | 302(10.8)  | 370(13.2)  | 266(9.5)   | 536(19.1)  | 2284(13.6)  |
| <b>Local working time</b>       |            |            |            |            |            |            |             |
| More than 1 year                | 651(23.3)  | 566(20.2)  | 751(26.9)  | 673(24.0)  | 888(31.7)  | 946(33.7)  | 4475(26.7)  |
| 6~12 months                     | 635(22.7)  | 672(24.0)  | 899(32.2)  | 1018(36.4) | 918(32.7)  | 833(29.7)  | 4975(29.6)  |
| 1~6 months                      | 1097(39.3) | 1204(43.1) | 888(31.8)  | 778(27.8)  | 814(29.0)  | 754(26.9)  | 5535(33.0)  |
| Less than 1 month               | 409(14.6)  | 354(12.7)  | 255(9.1)   | 330(11.8)  | 185(6.6)   | 272(9.7)   | 1805(10.8)  |
| <b>Location of previous job</b> |            |            |            |            |            |            |             |
| Other provinces                 | 334(12.0)  | 257(9.2)   | 354(12.7)  | 305(10.9)  | 353(12.6)  | 293(10.4)  | 1896(11.3)  |
| Other cities in Chongqing       | 330(11.8)  | 569(20.4)  | 549(19.7)  | 572(20.4)  | 356(12.7)  | 352(12.5)  | 2728(16.2)  |
| Current city                    | 1699(60.8) | 1627(58.2) | 1629(58.3) | 1576(56.3) | 1894(67.5) | 1872(66.7) | 10297(61.3) |
| No previous work                | 430(15.4)  | 343(12.3)  | 261(9.3)   | 346(12.4)  | 202(7.2)   | 288(10.3)  | 1870(11.1)  |
| <b>HIV knowledge</b>            |            |            |            |            |            |            |             |
| <6                              | 388(13.9)  | 458(16.4)  | 231(8.3)   | 449(16.0)  | 348(12.4)  | 305(10.9)  | 2179(13.0)  |
| >=6                             | 2405(86.1) | 2338(83.6) | 2562(91.7) | 2350(84.0) | 2457(87.6) | 2500(89.1) | 14612(87.0) |

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213 **Trends of HIV, syphilis, and HCV prevalence**

214 During the study period, the overall prevalence of HIV, syphilis, and HCV infection  
 215 among the study population was 0.27% (95%CI, 0.19%-0.35%), 1.73% (95%CI, 1.54% - 1.93%),  
 216 and 0.72% (95%CI, 0.59%-0.85%), respectively. Low-tier FSWs had higher prevalence of HIV,  
 217 HCV, and syphilis, with the six-year average prevalence of HIV, HCV, and syphilis at 0.40%,  
 218 2.53%, and 1.08%, respectively ( $p=0.019$ ,  $p<0.001$ ,  $p<0.001$ ). The HIV prevalence among FSWs  
 219 in Chongqing, which ranged from 0.14 % to 0.43% during the study years, had no significant  
 220 changes over time ( $p=0.129$ ) (Figure 2). And there was also no significant time trend found  
 221 among low-tier / middle-tier / high-tier FSWs ( $p=0.498$ , 0.366, 0.423, respectively) (Table 2).  
 222 The HCV prevalence among FSWs in Chongqing ranged from 0.32 % to 1.14% between 2013  
 223 to 2018, with no significant trend. In each subgroup, no significant changing trend of HCV  
 224 infection by year was found, too (Figure 3). Unlike HIV and HCV, a total of 1.11%, 1.18%,  
 225 1.58%, 1.86%, 2.67% and 2.00% of the respondents were confirmed to be infected with syphilis  
 226 from 2013 to 2018, showing an upward trend ( $p<0.001$ ). This trend was also found in low-tier  
 227 FSWs (from 1.13 % in 2013 to 2.50 % in 2018,  $p<0.001$ ) and middle-tier FSWs (from 1.19 % in  
 228 2013 to 1.81 % in 2018,  $p=0.026$ ), but not in the high-tier group ( $p=0.713$ ).

229 Table 2. HIV, syphilis and HCV prevalence among FSWs from 2013 to 2018 in  
 230 Chongqing.

| Variables                | 2013<br>%(n) | 2014<br>%(n) | 2015<br>%(n) | 2016<br>%(n) | 2017<br>%(n) | 2018<br>%(n) | Total<br>%(n) | P<br>value | P for<br>trend |
|--------------------------|--------------|--------------|--------------|--------------|--------------|--------------|---------------|------------|----------------|
| <b>HIV positive</b>      |              |              |              |              |              |              |               |            |                |
| All                      | 0.14(4)      | 0.25(7)      | 0.25(7)      | 0.25(7)      | 0.43(12)     | 0.29(8)      | 0.27(45)      | 0.486      | 0.128          |
| Low tier                 | 0.10(1)      | 0.63(6)      | 0.48(5)      | 0.25(3)      | 0.52(7)      | 0.43(5)      | 0.40(27)      | 0.406      | 0.496          |
| Middle tier              | 0.22(3)      | 0.07(1)      | 0.00(0)      | 0.24(3)      | 0.34(4)      | 0.18(2)      | 0.17(13)      | 0.201      | 0.364          |
| High tier                | 0.00(0)      | 0.00(0)      | 0.66(2)      | 0.27(1)      | 0.38(1)      | 0.19(1)      | 0.22(5)       | 0.329      | 0.423          |
| <b>Syphilis positive</b> |              |              |              |              |              |              |               |            |                |
| All                      | 1.11(31)     | 1.18(33)     | 1.58(44)     | 1.86(52)     | 2.67(75)     | 2.00(56)     | 1.73(291)     | <0.001     | <0.001         |
| Low tier                 | 1.13(11)     | 1.68(16)     | 2.59(27)     | 2.77(33)     | 3.93(53)     | 2.50(29)     | 2.53(169)     | <0.001     | <0.001         |
| Middle tier              | 1.19(16)     | 0.80(12)     | 1.10(16)     | 1.29(16)     | 1.68(20)     | 1.81(20)     | 1.28(100)     | 0.209      | 0.026          |
| High tier                | 0.85(4)      | 1.48(5)      | 0.33(1)      | 0.81(3)      | 0.75(2)      | 1.31(7)      | 0.96(22)      | 0.713      | 0.713          |
| <b>HCV positive</b>      |              |              |              |              |              |              |               |            |                |
| All                      | 0.32(9)      | 1.14(32)     | 0.82(23)     | 0.57(16)     | 0.89(25)     | 0.57(16)     | 0.72(121)     | 0.005      | 0.86           |
| Low tier                 | 0.10(1)      | 1.68(16)     | 1.25(13)     | 0.92(11)     | 1.34(18)     | 1.12(13)     | 1.08(72)      | 0.021      | 0.163          |

|             |         |          |         |         |         |         |          |       |       |
|-------------|---------|----------|---------|---------|---------|---------|----------|-------|-------|
| Middle tier | 0.59(8) | 0.86(13) | 0.55(8) | 0.32(4) | 0.59(7) | 0.27(3) | 0.55(43) | 0.354 | 0.12  |
| High tier   | 0.00(0) | 0.89(3)  | 0.66(2) | 0.27(1) | 0.00(0) | 0.00(0) | 0.26(6)  | 0.031 | 0.249 |

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232 **Changing trend of behavioral factors**

233 Of the whole survey population, more than 80% know HIV-related knowledge well, and  
 234 used condom in their last commercial sex (Table 3). Nearly 90% received at least one of the  
 235 following three AIDS-related services in the last year, including (1) condom promotion and  
 236 distribution, AIDS counseling and testing, (2) community drug maintenance therapy, clean  
 237 needle supply/exchange, and (3) peer education. In addition, about half of participants used  
 238 condom consistently with clients in the last month. Approximately 3% reported drug use and  
 239 2% reported had diagnosed STI in the past year.

240 We also examined the changing trends of FSWs' behaviors, and found that no significant  
 241 change over time was observed in drug use reported by FSWs. However, there were  
 242 significant improvements over time in HIV-related knowledge, condom use, participation in  
 243 AIDS services, and self-reported STI diagnosis in last year among FSWs.

244 **Table 3.** Behavioral characteristics of FSWs from 2013 to 2018 in Chongqing

| Variables                                      |     | 2013<br>%(n) | 2014<br>%(n) | 2015<br>%(n) | 2016<br>%(n) | 2017<br>%(n) | 2018<br>%(n) | overall<br>%(n) | P<br>value | P for<br>trend |
|--|-----|--------------|--------------|--------------|--------------|--------------|--------------|-----------------|------------|----------------|
| HIV know-<br>ledge ( $\geq 6$ )                | Yes | 86.1(2405)   | 83.6(2338)   | 91.7(2562)   | 84.0(2350)   | 87.6(2457)   | 89.1(2500)   | 87.0(14612)     | <0.001     | <0.001         |
|  | No  | 13.9(388)    | 16.4(458)    | 8.3(231)     | 16.0(449)    | 12.4(348)    | 10.9(305)    | 13.0(2179)      |            |                |
| condom use<br>in the last<br>commercial<br>sex | Yes | 79.7(2167)   | 77.4(2134)   | 93.8(2604)   | 83.4(2335)   | 87.0(2439)   | 84.5(2371)   | 84.3(14050)     | <0.001     | <0.001         |
|  | No  | 20.3(552)    | 22.6(625)    | 6.2(171)     | 16.6(464)    | 13.0(366)    | 15.5(434)    | 15.7(2612)      |            |                |
| CCU in the<br>past month                       | Yes | 41.7(1130)   | 51.2(1406)   | 69.7(1925)   | 60.1(1682)   | 47.7(1337)   | 51.4(1441)   | 53.7(8921)      | <0.001     | <0.001         |
|  | No  | 58.3(1578)   | 48.8(1341)   | 30.3(835)    | 39.9(1117)   | 52.3(1468)   | 48.6(1364)   | 46.3(7703)      |            |                |
| Drug use                                       | Yes | 2.9(81)      | 4.2(116)     | 2.7(74)      | 4.6(129)     | 2.2(63)      | 3.1(88)      | 3.3(551)        | <0.001     | 0.322          |
|  | No  | 97.1(2705)   | 95.8(2631)   | 97.3(2718)   | 95.4(2670)   | 97.8(2742)   | 96.9(2717)   | 96.7(16183)     |            |                |
| Injecting<br>drug use                          | Yes | 1.3(35)      | 1.2(32)      | 0.6(18)      | 1.5(43)      | 0.7(19)      | 0.4(11)      | 0.9(158)        | <0.001     | 0.002          |
|  | No  | 98.8(2754)   | 98.9(2760)   | 99.4(2774)   | 98.5(2756)   | 99.3(2786)   | 99.6(2794)   | 99.1(16624)     |            |                |
| STI diagnosis<br>in the past<br>year           | Yes | 3.8(106)     | 3.6(100)     | 1.5(43)      | 1.8(50)      | 1.1(31)      | 1.3(37)      | 2.2(367)        | <0.001     | <0.001         |
|  | No  | 96.2(2671)   | 96.4(2679)   | 98.5(2747)   | 98.2(2749)   | 98.9(2774)   | 98.7(2768)   | 97.8(16388)     |            |                |
| HIV-related                                    | Yes | 80.0(2235)   | 86.0(2405)   | 94.4(2637)   | 93.4(2615)   | 92.7(2600)   | 88.1(2470)   | 89.1(14962)     | <0.001     | <0.001         |

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|----------|----|-----------|-----------|----------|----------|----------|-----------|------------|
| services | No | 20.0(558) | 14.0(391) | 5.6(156) | 6.6(184) | 7.3(205) | 11.9(335) | 10.9(1829) |
|----------|----|-----------|-----------|----------|----------|----------|-----------|------------|

245 CCU: consistent condom use.

246 **Correlates of HIV, syphilis and HCV infections**

247 Multivariable logistic regression analysis results (Table 4) showed that, (1) HIV infection  
 248 was significantly and positively associated with no condom use in the last commercial sex  
 249 (adjusted OR (aOR) =3.48, 95% CI, 1.90-6.37) and syphilis infection (aOR=4.88, 95% CI,  
 250 1.95-12.18); (2) syphilis infection was significantly and positively associated with inconsistent  
 251 condom use in the past month (aOR=1.30, 95% CI, 1.02-1.65), STI diagnosis in the past year  
 252 (aOR=3.81, 95% CI, 2.40-6.03), HIV infection (aOR=5.88, 95% CI, 2.40-14.41) and HCV infection  
 253 (aOR=7.68, 95% CI, 4.37-13.49); (3) HCV infection was significantly and positively associated  
 254 with injecting drug use (aOR=8.91, 95% CI, 4.45-17.86) and syphilis infection (aOR=7.88, 95%  
 255 CI, 4.49-13.83).

256 **Table 4.** Associations between behavioral characteristics and HIV, syphilis and HCV infection

| Behavioral characteristics                             | HIV Positive      |                   |                   | Syphilis Positive |                   |                   | HCV Positive       |                   |                   |
|--|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|--------------------|-------------------|-------------------|
|  | OR(95%CI)         |                   | aOR(95%CI)        | OR(95%CI)         |                   | aOR(95%CI)        | OR(95%CI)          |                   | aOR(95%CI)        |
|  | Univariate        | Multivariate      |                   | Univariate        | Multivariate      |                   | Univariate         | Multivariate      |                   |
| No condom use in the last commercial sex (yes vs. no)  | 3.95(2.19,7.15)*  | 3.97(2.19,7.19)*  | 3.48(1.90,6.37)*  | 1.06(0.78,1.45)   |                   |                   | 0.54(0.29,1.00)    |                   |                   |
| Inconsistent condom use in the past month (yes vs. no) | 2.86(1.50,5.45)*  |                   |                   | 1.33(1.05,1.67)*  | 1.30(1.03,1.64)*  | 1.30(1.02,1.65)*  | 0.64(0.44,0.93)*   | 0.63(0.43,0.92)*  | 0.72(0.49,1.05)   |
| Drug use (yes vs. no)                                  | 0.32(0.02,5.24)   |                   |                   | 1.27(0.71,2.28)   |                   |                   | 3.28(1.80,6.00)*   |                   |                   |
| Injecting drug use (yes vs. no)                        | 1.15(0.07,18.91)  |                   |                   | 1.87(0.76,4.59)   |                   |                   | 10.05(5.16,19.59)* | 9.21(4.67,18.18)* | 8.91(4.45,17.86)* |
| STI diagnosis in the past year                         | 0.49(0.03,7.98)   |                   |                   | 4.02(2.59,6.24)*  | 3.75(2.40,5.87)*  | 3.81(2.40,6.03)*  | 2.78(1.29,6.00)*   |                   |                   |
| HIV-related services (yes vs. no)                      | 1.71(0.53,5.53)   |                   |                   | 1.37(0.90,2.08)   |                   |                   | 1.36(0.71,2.60)    |                   |                   |
| HIV positive   |                   |                   |                   | 8.89(3.74,21.17)* | 9.17(3.84,22.19)* | 5.88(2.40,14.41)* | 1.51(0.09,25.29)   |                   |                   |
| Syphilis positive                                      | 8.89(3.73,21.17)* | 8.68(3.63,21.17)* | 4.88(1.95,12.18)* |                   |                   |                   | 9.09(5.30,16.00)*  | 9.09(5.26,16.00)* | 7.88(4.49,14.41)* |

|   |              |             |        |             |             |             |        |        |
|---|--------------|-------------|--------|-------------|-------------|-------------|--------|--------|
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| 2 |              |             |        |             |             |             |        |        |
| 3 | (yes vs. no) | 1.16)*      | 0.74)* | 2.18)*      |             | 5.58)*      | 5.71)* | 3.83)* |
| 4 |              |             |        |             |             |             |        |        |
| 5 | HCV positive | 1.50(0.09,2 |        | 9.09(5.30,1 | 8.81(5.09,1 | 7.68(4.37,1 |        |        |
| 6 |              |             |        |             |             |             |        |        |
| 7 | (yes vs. no) | 4.83)       |        | 5.59)*      | 5.25)*      | 3.49)*      |        |        |

8 257 aOR: adjusted odds ratio, adjusted for socio-demographic characteristic (age, education level,  
9 258 marital status, typology and survey year); \* p<0.05.

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## 11 260 DISCUSSION

12 261 FSWs are considered to be at high risk of HIV infection and other STI and contribute  
13 262 disproportionately to the transmission. As an identifiable population, surveillance of STI and  
14 263 risk behaviors among FSWs is of great significance to understanding the potential of  
15 264 spreading HIV to the general population, to assessing and improving interventions targeted  
16 265 at FSWs.<sup>23</sup> Although it is critical to analysis and know prevalence and changing trend of HIV,  
17 266 syphilis, HCV and relevant behaviors among FSWs, few studies reported that in Chongqing,  
18 267 China. In this study, we examined prevalence and changing trends of HIV, syphilis, HCV and  
19 268 behaviors of Chongqing FSWs by using sentinel surveillance data from 2013 to 2018.

20 269 Our study showed that HIV prevalence among FSWs in Chongqing was relatively stable  
21 270 with an annual average HIV prevalence at 0.27% from 2013 to 2018, which was similar to  
22 271 0.22% among Chinese FSWs in 2014,<sup>10</sup> but much higher than China's current estimated  
23 272 national HIV prevalence among general population (0.0598%).<sup>30</sup> And the prevalence of HIV  
24 273 among FSWs in Chongqing is at a relatively high level in China, which is higher than that in  
25 274 most provinces such as Beijing,<sup>31</sup> Liaoning,<sup>32</sup> and Hainan,<sup>33</sup> and lower than in Sichuan,<sup>34</sup>  
26 275 Yunnan,<sup>35</sup> and Guangxi.<sup>36</sup> HCV prevalence was fluctuated between 2013 to 2018 with the  
27 276 six-year average prevalence of 0.72%, but no significant trend was found. This result is in  
28 277 agreement with previous study conducted in Guangxi.<sup>36</sup> However, a previous study using  
29 278 national data reported that from 2008 to 2012, the overall HIV and HCV prevalence among  
30 279 FSWs in mainland China showed a decreasing trend;<sup>16</sup> the differences may due to differences  
31 280 in scope of study area and study period.

32 281 Notably, the results also indicated a worrying upward trend of syphilis infection (from  
33 282 1.11 % in 2013 to 2.00 % in 2018), particularly among low-tier and middle-tier FSWs. Syphilis,  
34 283 as the third most prevalent notifiable infectious disease in category A and B in China, has

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4 284 been on the rise since the 1990s.<sup>37</sup> The reported total syphilis rate in China increased from  
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6 285 0.2/100,000 in 1993 to 32.86/100,000 in 2013.<sup>37</sup> The reported incidence of syphilis in Chongqing  
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8 286 also showed an upward trend, with a reported incidence of 40.38/100,000 in 2014.<sup>38</sup> However,  
9  
10 287 researcher found that the increase of reported cases of syphilis in Chongqing in recent years  
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12 288 may be related to large-scale syphilis screening by medical institutions, training on national  
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14 289 standards for syphilis diagnosis and reporting, and the improvement of laboratories.<sup>39</sup> The  
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16 290 increase of syphilis prevalence among FSWs may also be related to the strengthening of  
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18 291 syphilis detection, but it still needs attention. Consistent with previous studies, FSW infected  
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20 292 with syphilis has a higher risk of HIV or HCV infection, and HIV or HCV infection is also a  
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22 293 risk factor for syphilis infection.<sup>36</sup> FSWs with syphilis were nearly five times more likely to be  
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24 294 infected with HIV, and seven times more likely to be infected with HCV than FSWs without  
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26 295 syphilis. This may due to their shared transmission routes, co-risk factors and adverse  
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28 296 interaction.<sup>40</sup> So more efforts are in need to strengthen comprehensive and combined  
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30 297 intervention of AIDS, syphilis and other STI for key groups.

31 298 During the study period, the proportion of FSWs who used condoms increased slightly,  
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33 299 and condom use was associated with a lower HIV or syphilis infection risk. Consistent  
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35 300 condom use is one of the most effective ways to prevent AIDS, and its protection rate can  
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37 301 reach 80% based on studies of persons during heterosexual sex with an HIV-positive  
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39 302 partner.<sup>41</sup> The 100% Condom Use Programme (CUP) has been implemented in Chongqing  
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41 303 since 2006 and has shown a promotion effect. We also found that more and more FSWs  
42  
43 304 practiced consistent condom use, but in 2018 only half of FSWs reported the consistent use of  
44  
45 305 condoms in the last month. This proportion was lower than that in Liaoning and Hainan.<sup>32</sup>  
46  
47 306 <sup>33</sup>Previous studies indicated that clients' low support for and negative norms toward condom  
48  
49 307 use may be the main reason for the inconsistent condom use of FSWs.<sup>42-44</sup> In order to make  
50  
51 308 money or to establish a closer long-term relationship with clients, FSWs often compromise  
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53 309 with their clients on condom use. Thus, in addition to raising FSWs' awareness regarding  
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55 310 HIV/STI prevention and improving the skills to negotiate condom use, it is also important to  
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57 311 promote HIV intervention programs targeting clients and others.

58 312 There was no significant increase or decrease trend in drug use among FSWs. The  
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60 313 average prevalence of drug use was 3.3%, while the national prevalence among FSWs was



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4 314 reported at 1.2%.<sup>16</sup> The prevalence of injecting drug use seems to be declining, at 0.4% in 2018.  
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6 315 Injecting drug use may exacerbate unsafe sexual behaviors and structural risks, leading to  
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8 316 increased risk of HIV and other STI.<sup>45 46</sup> In 2017, the detection rate of HIV, syphilis and HCV  
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10 317 among drug users in Chongqing was respectively 5.4%, 5.9% and 44.9%, which was much  
11  
12 318 higher than that of the general population.<sup>47</sup> Compared with FSWs and injecting drug users,  
13  
14 319 FSWs who inject drugs exposed to both sexual and blood transmission routes are at a higher  
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16 320 risk of contracting HIV and syphilis.<sup>36 48</sup> Similar to previous study, results showed a strong  
17  
18 321 association between injecting drug use and HCV infection,<sup>49</sup> and the sharing of needles may  
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20 322 be the main and underlying route of HCV transmission. Drugs and prostitution are involved  
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22 323 relevant laws and ethics, so HIV prevention programs and outreach for FSWs may require  
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24 324 more thinking and attention to the individual's external risk environment and risk factors.

25  
26 325 In addition, as previous studies found, lower-tier FSWs bear heavier burden of HIV,  
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28 326 syphilis, and HCV than FSWs in higher-tier venues.<sup>16</sup> FSWs with less education, older age  
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30 327 also had a higher prevalence of HIV and syphilis. And low-tier FSWs were found to tend to  
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32 328 be older women and low education.<sup>50</sup> So low-tier FSWs with low education probably had  
33  
34 329 insufficient knowledge about those diseases, less awareness about sex health, and poor  
35  
36 330 communication skills to condom use.<sup>51</sup> And they may serving more clients who also had low  
37  
38 331 education, had low awareness, and were unwilling to use condom, particularly elderly man.<sup>17</sup>

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40 332 <sup>36</sup> Thus, future intervention programs should specified and targeted based on the needs of the  
41  
42 333 different tier FSWs, and pay more attention on low-tier FSWs and their clients. What's more,  
43  
44 334 sex work is illegal and highly stigmatized in China, so FSWs face much barriers to participant  
45  
46 335 in HIV/AIDS related services, such as fear of being arrested, fear of discrimination and  
47  
48 336 awkwardness.<sup>52</sup> AIDS intervention services need to cooperate more with Non-Governmental  
49  
50 337 Organizations (NGOs), increase condom promotion, and jointly increase awareness of other  
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52 338 STIs such as syphilis.

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54 339 Our study had several limitations. First, the data we used were based on serial  
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56 340 cross-sectional surveillance surveys; therefore we may find trends of HIV, syphilis and HCV  
57  
58 341 infection without exact reasons of those changes. And the survey was anonymous.  
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60 342 Respondents who participated in a cross-sectional survey in a certain year may also  
343 participate in subsequent cross-sectional surveys, but we have no way to estimate proportion

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4 344 of FSWs repeatedly participated in our study. Third, the data were collected mainly through  
5 345 self-reported questionnaires, which raise concerns about recall bias, reporting bias and social  
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7 346 desirability bias. For example, respondents may conceal the truth when answering sensitive  
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9 347 questions, such as drug use, which is illegal in China.  
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## 14 349 CONCLUSIONS

16  
17 350 In conclusion, HIV and HCV prevalence among FSWs in Chongqing remained stable  
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19 351 during the study period, but syphilis had an upward trend among FSWs in low-tier and  
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21 352 middle-tier venues. Although factors including knowledge, condom use, injecting drug use  
22  
23 353 and STI diagnosis were improved, nearly half of FSWs used condom inconsistently. Thus,  
24  
25 354 more comprehensive interventions targeted FSWs to promote condom use and sexual health,  
26  
27 355 to prevent and control HIV, syphilis and other STIs, particularly those focus on the low-tier  
28  
29 356 and middle-tier FSWs, should be implemented.  
30  
31 357

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33  
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38

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40  
41 362 involved in the design and conducting of the survey. LH and MY analyzed the data. LH, HZ,  
42  
43 363 DJ, and HQ participated in the interpretation of results. LH wrote the first draft of the  
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45 364 manuscript. LH, HQ, HZ, DJ, GW, RL, and MY revised the manuscript. All authors have read  
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47 365 and approved the manuscript.  
48

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54

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56

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58  
59 371 or conduct, or reporting, or dissemination plans of this research.  
60

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 376 (IRB number:2017016).

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523 Figure 1. The location of seven sentinel surveillance sites in Chongqing.

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525 Figure 2. Prevalence of HIV, syphilis, and HCV among FSWs in Chongqing by survey year.

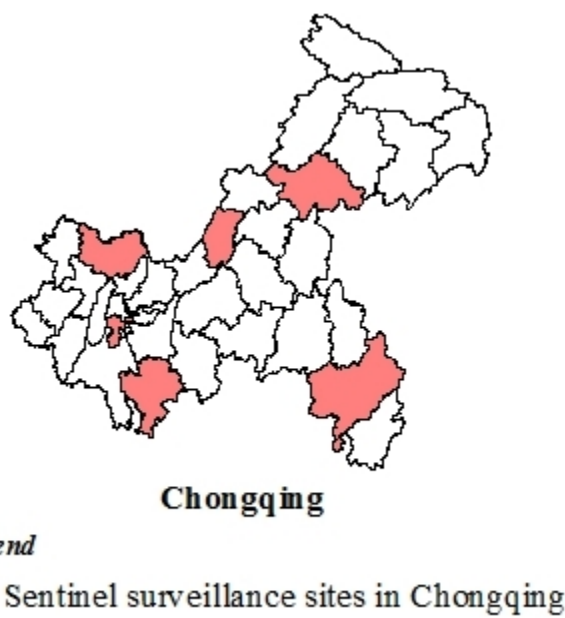
526 Bars show prevalence (percent); error bars show 95% confidence intervals.

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528 Figure 3. Prevalence of HIV, syphilis, and HCV among FSWs in Chongqing by typology and

529 survey year.

For peer review only



28 Figure 1. The location of seven sentinel surveillance sites in Chongqing.

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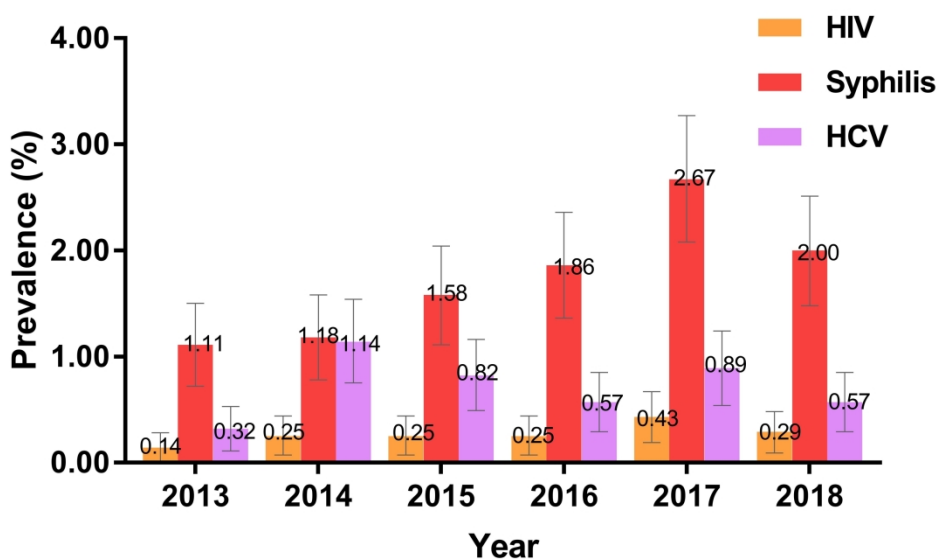
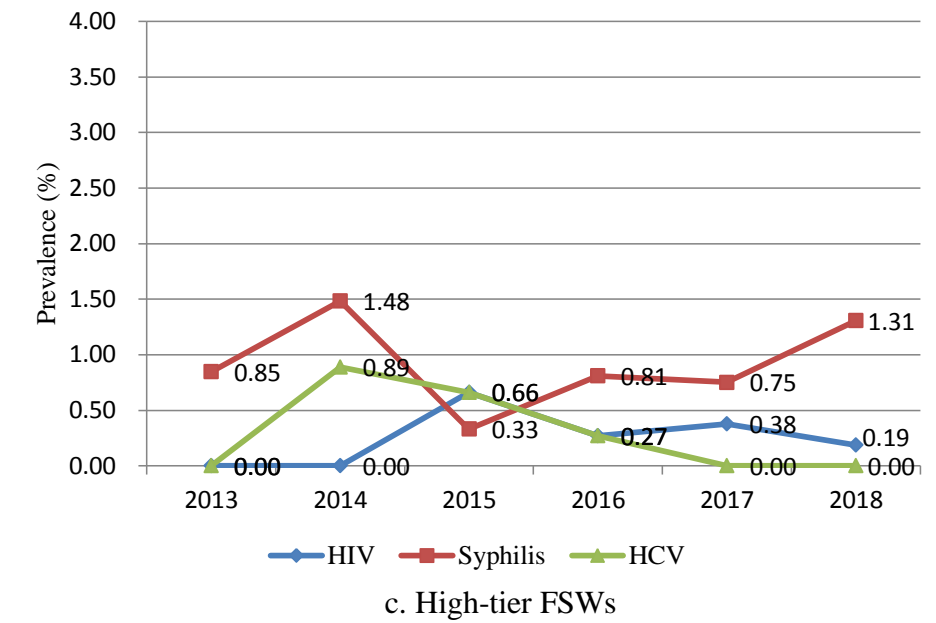
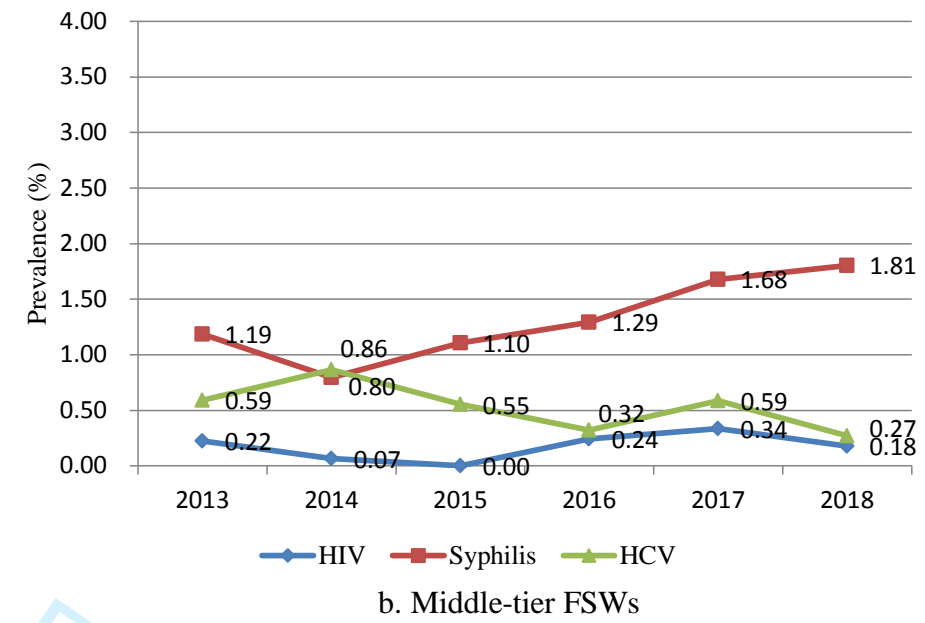
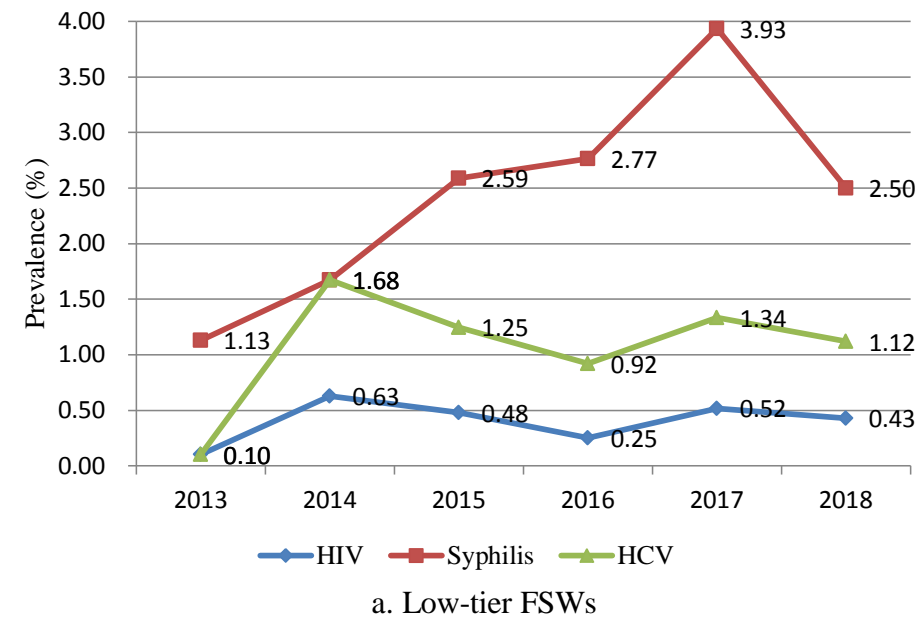


Figure 2. Prevalence of HIV , syphilis, and HCV among FSWs in Chongqing by survey year. Bars show prevalence (percent); error bars show 95% confidence intervals.

125x76mm (600 x 600 DPI)



For peer review only

**STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies***

| Section/Topic                | Item # | Recommendation   | Reported on page # |
|------------------------------|--------|--|--------------------|
| <b>Title and abstract</b>    | 1      | (a) Indicate the study's design with a commonly used term in the title or the abstract   | 1-2                |
|                              |        | (b) Provide in the abstract an informative and balanced summary of what was done and what was found  | 1-2                |
| <b>Introduction</b>          |        |  |                    |
| Background/rationale         | 2      | Explain the scientific background and rationale for the investigation being reported   | 3-4                |
| Objectives                   | 3      | State specific objectives, including any prespecified hypotheses   | 4                  |
| <b>Methods</b>               |        |  |                    |
| Study design                 | 4      | Present key elements of study design early in the paper  | 4                  |
| Setting                      | 5      | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection  | 4                  |
| Participants                 | 6      | (a) Give the eligibility criteria, and the sources and methods of selection of participants  | 5                  |
| Variables                    | 7      | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable   | 5-6                |
| Data sources/<br>measurement | 8*     | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | 5-6                |
| Bias                         | 9      | Describe any efforts to address potential sources of bias  | 14                 |
| Study size                   | 10     | Explain how the study size was arrived at  | 5                  |
| Quantitative variables       | 11     | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why   | --                 |
| Statistical methods          | 12     | (a) Describe all statistical methods, including those used to control for confounding  | 6                  |
|                              |        | (b) Describe any methods used to examine subgroups and interactions  | 6                  |
|                              |        | (c) Explain how missing data were addressed  | 6                  |
|                              |        | (d) If applicable, describe analytical methods taking account of sampling strategy   | --                 |
|                              |        | (e) Describe any sensitivity analyses  | --                 |
| <b>Results</b>               |        |  |                    |

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| Participants             | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed            | 7     |
|                          |     | (b) Give reasons for non-participation at each stage   | --    |
|                          |     | (c) Consider use of a flow diagram   | --    |
| Descriptive data         | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders   | 7-9   |
|                          |     | (b) Indicate number of participants with missing data for each variable of interest  | --    |
| Outcome data             | 15* | Report numbers of outcome events or summary measures   | 9-10  |
| Main results             | 16  | (a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | 9-10  |
|                          |     | (b) Report category boundaries when continuous variables were categorized  | --    |
|                          |     | (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period   | --    |
| Other analyses           | 17  | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses   | 11    |
| <b>Discussion</b>        |     |  |       |
| Key results              | 18  | Summarise key results with reference to study objectives   | 14    |
| Limitations              | 19  | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias   | 14    |
| Interpretation           | 20  | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence                                   | 12-14 |
| Generalisability         | 21  | Discuss the generalisability (external validity) of the study results  | 14    |
| <b>Other information</b> |     |  |       |
| Funding                  | 22  | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based  | 15    |

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).

# BMJ Open

## Changing trends of HIV, syphilis, HCV infections and behavioural factors among female sex workers in Chongqing, China: findings from six serial surveillance surveys

|                                 |  |
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| Date Submitted by the Author:   | 11-Sep-2020  |
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| <b>Primary Subject Heading</b>: | Public health  |
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| Keywords:                       | HIV & AIDS < INFECTIOUS DISEASES, Public health < INFECTIOUS DISEASES, Epidemiology < INFECTIOUS DISEASES  |
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4 1 **Changing trends of HIV, syphilis, HCV infections and behavioural**  
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13 5 **Ling Hu<sup>1,2,†</sup>, Guohui Wu<sup>3, †</sup>, Rongrong Lu<sup>3</sup>, Hua Zhu<sup>1,2</sup>, Hongfang Qiu<sup>1,2</sup>, Dan Jing<sup>1,2</sup>,**  
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4 27 **ABSTRACT**

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6 28 **Objectives:** To explore the prevalence and changing trends of HIV, syphilis, hepatitis C virus  
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8 29 (HCV) infections and risk behaviors among female sex workers (FSWs), and to provide  
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10 30 reference and theoretical basis for formulating targeted interventions.

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13 31 **Design:** Six consecutive cross-sectional surveys.

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16 32 **Setting:** Chongqing, China.

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19 33 **Participants:** FSWs were included if they (1) were aged  $\geq 16$  years, (2) provided commercial  
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21 34 sex for money or goods during the previous month, and (3) were willing to participate in the  
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23 35 survey and could provide verbal informed consent. This study included 16791 of 16810  
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25 36 participants recruited between 2013 and 2018.

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28 37 **Primary and secondary outcome measures:** The prevalence of HIV/syphilis/HCV infection.

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31 38 **Results:** The HIV and HCV prevalence among FSWs in Chongqing was stable during the  
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33 39 study period, but the prevalence of syphilis had an increasing trend, particularly among low-  
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35 40 and middle-tier FSWs. Improvements in HIV-related knowledge, condom use, injecting drug  
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37 41 use and participation in HIV-related services were observed. However, no change was found  
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39 42 in the prevalence of drug use. HIV infection was correlated with no condom use in the last  
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41 43 commercial sex (aOR 3.48, 95%CI 1.90 to 6.37) and syphilis infection (aOR 4.88, 95%CI 1.95 to  
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43 44 12.18). Syphilis infection was correlated with inconsistent condom use (aOR 1.30, 95%CI 1.02  
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45 45 to 1.65), HIV infection (aOR 5.88, 95%CI 2.40 to 14.41), HCV infection (aOR 7.68, 95%CI 4.37  
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47 46 to 13.49), and STI diagnosis in the past year (aOR 3.81, 95%CI 2.40 to 6.03). HCV infection was  
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49 47 associated with injecting drug use (aOR 8.91, 95%CI 4.45 to 17.86) and syphilis infection (aOR  
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51 48 7.88, 95%CI 4.49 to 13.83).

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53 49 **Conclusions:** Comprehensive interventions targeting FSWs, particularly low- and middle-tier  
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55 50 FSWs, should be increasingly implemented to prevent and control HIV, syphilis and other  
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57 51 STIs.  
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**Keywords:** Female sex workers (FSWs), HIV, Syphilis, Sexually transmitted infections (STIs), China

#### **Strengths and limitations of this study**

- The study involved six consecutive years of sentinel surveillance among FSWs in Chongqing with a large sample size.
- This study provides valuable information about the prevalence and trends of STIs among FSWs in Chongqing, and helps to formulate and improve relevant intervention strategies.
- However, causality could not be determined due to the cross-sectional design.
- Recall bias and social desirability bias may be present due to the use of self-reported measures of condom use, drug use and other behaviour.

#### **INTRODUCTION**

The HIV/AIDS pandemic, one of the major public health problems all over the world, is highly heterogeneous among different populations and regions. Compared with adult women, female sex workers (FSWs) bear a higher burden of HIV, with an estimated HIV prevalence of 10.4% (95% confidence interval [CI] 9.5–11.5%).<sup>1</sup> They are also considered one of the most vulnerable groups to acquisition of other sexually transmitted infections (STIs) such as syphilis.<sup>2</sup>

After the implementation of reform and opening up in the late 1970s, the sex industry has re-emerged in China due to economic growth, population migration, and changes in sexual attitudes.<sup>3 4</sup> A large number of rural migrants moved to cities for enhanced job opportunities. However, those rural women found that the labour force was saturated or the wages were not high enough; then, sex work with quick financial return became an option.<sup>5</sup> The estimated number of FSWs was 4 million;<sup>6</sup> and approximately 6.9% of men aged 18–49 years have had commercial sex during their lifetime.<sup>7</sup> The incidence of STIs, such as syphilis, has dramatically increased along with the prosperity of the sex trade.<sup>8 9</sup> Heterosexual sex has replaced intravenous drug use and commercial blood/plasma collection as the primary transmission mode of HIV in China.<sup>10</sup> Among the newly reported HIV infections in January–October 2019, heterosexual transmission accounted for 73.7%, much higher than other transmission routes.<sup>11</sup> A review also reported that FSWs in China had a median HIV

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4 82 prevalence of 0.6% (0%–10.3%) and a rate of positive for at least one STI of 41.5% (13%–  
5 83 90.6%).<sup>12</sup>

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7 84 As a developing country with a population of 1.4 billion, China faces more challenges in  
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9 85 responding to the AIDS and STIs epidemic. The prevalence varies from province to province  
10 86 and Southwest provinces have a higher prevalence of STI.<sup>13 14</sup> For example, although HIV  
11 87 prevalence among FSWs was lower than 0.05% in most provinces (such as Heilongjiang and  
12 88 Hebei) in 2012, it exceeded 1% in the same year in Yunnan and Guangxi.<sup>13</sup> Furthermore, sex  
13 89 work is still illegal in China. Thus, it takes place in informal venues, including night clubs,  
14 90 hair salons, foot massage parlors and hotels, which is always combined with other works to  
15 91 cover up its illegality. This hinders the implementation of related interventions and reduces  
16 92 their effects. Different sex work settings are associated with the risk of HIV/STI infection. The  
17 93 average price of each sex transaction is often used by Chinese researchers to categorise FSWs  
18 94 into high, middle and low tiers. The size of different-tier FSWs may be related to the local  
19 95 economic level. In Jiangmen City, more than 60% of FSWs was high-tier FSW, while the  
20 96 proportion of low-tier FSWs was less than 10%.<sup>15</sup> However, in Jianshui County, the  
21 97 proportion of low-tier FSWs was close to 30%.<sup>16</sup> The proportion of low-tier FSWs may vary  
22 98 from region to region, but previous studies have shown that they have higher risk of HIV  
23 99 infection than other FSWs.<sup>13 17</sup>

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39 100 The Chinese government has provided voluntary HIV counselling and testing, STIs  
40 101 services, condom promotion and peer education among FSWs through the cooperation of  
41 102 Centers for Disease Control (CDC), community health services and medical institutions.<sup>18</sup> The  
42 103 'Four Frees and One Care' policy helps treat patients with AIDS who have financial  
43 104 difficulties by providing free antiviral drugs. In 1995, China established the national HIV  
44 105 sentinel surveillance system to actively monitor HIV prevalence among high-risk populations  
45 106 (e.g. FSWs and injecting drug users) and guide the development of HIV prevention and  
46 107 control strategies.<sup>19–21</sup> After years of development, the surveillance system has expanded its  
47 108 scope from 42 sentinel sites in 1995 to 1888 in 2010, and combined biological and behavioural  
48 109 surveillance strategies, which included sero-testing for HIV, syphilis and hepatitis C virus  
49 110 (HCV).<sup>22</sup> Surveillance data could help understand the epidemic status and trend of HIV and  
50 111 STIs among FSWs, which is necessary for developing HIV or STIs prevention programmes.<sup>23</sup>

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4 112 According to China's surveillance data, the overall prevalence of HIV/syphilis/HCV among  
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6 113 FSWs showed a downward trend from 2010 to 2015.<sup>24</sup> However, there may be diverse trends  
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8 114 in different geographic regions of China, and there has been less work on understanding  
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10 115 trends of STIs among FSWs in underdeveloped southwest areas.

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12 116 Chongqing, located in Southwest China, is one of the four Chinese municipalities  
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14 117 directly controlled by the central government. It is geographically close to Yunnan and  
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16 118 Guangxi and it has large population contacts with Yunnan and Guangxi. It is the political and  
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18 119 economic centre of Western China and a city with obvious urban-rural dual structure and  
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20 120 prosperous sex industry. A study using the network scale-up method estimated that FSWs  
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22 121 accounted for 0.4% of women aged 15-49 years in Chongqing, and the clients of FSWs  
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24 122 represented 2% of men aged 15-49 years.<sup>25</sup> The HIV prevalence among FSWs in Chongqing in  
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26 123 2012 was estimated at 0.25%, lower than that among other high-risk groups, such as men who  
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28 124 have sex with men (17.03%) and injecting drug users (7.35%).<sup>26</sup> However, FSWs can transmit  
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30 125 STIs to numerous clients and then to the general population, which pose a great challenge to  
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32 126 public health. Heterosexual transmission has become the main route of HIV transmission in  
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34 127 Chongqing since 2007.<sup>27</sup> Of the 6352 newly diagnosed HIV/AIDS cases reported in Chongqing  
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36 128 in 2015, 75.08% were infected through heterosexual transmission.<sup>27</sup> Therefore, understanding  
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38 129 the prevalence and trends of STIs among FSWs in Chongqing is highly important.

39 130 On the basis of the surveillance data in Chongqing, this study was aimed to identify the  
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41 131 prevalence and changing trends of HIV, syphilis and HCV infections among FSWs over time.  
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43 132 This study also explored the trends in sexual behaviours of FSWs and discussed the risk  
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45 133 factors for prevalent STIs over a 6-year period in order to provide reference for formulating  
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47 134 interventions to control AIDS and STIs.

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## 50 51 136 **METHODS**

### 52 53 137 **Study design**

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55 138 Sentinel surveillance was conducted collect HIV, syphilis and HCV prevalence and  
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57 139 high-risk behaviour information through cross-sectional surveys. The data analysed in this  
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59 140 study were sentinel surveillance data among FSWs in Chongqing from 2013 to 2018.

### 141 **Participant selection and data collection**

142 The detailed procedures of data collection followed the Operational Manual for the  
143 Implementation Program of National AIDS Sentinel Surveillance established by the National  
144 Center for AIDS Prevention and Control.<sup>28</sup> As shown in Figure 1, serial cross-sectional  
145 surveys were conducted from April to June each year at seven sentinel surveillance sites in  
146 Chongqing (Yuzhong District, Jiulongpo District, Wanzhou District, Dianjiang, Hechuan,  
147 Qijiang [Wansheng] and Youyang). The sample size of each site was 400 participants. The  
148 entire sampling process went through the following three steps. First, a distribution map of  
149 known commercial workplaces in the monitoring area was drawn to construct a sampling  
150 frame and these locations were categorised into low-, middle- and high-tier venues on the  
151 basis of the average price of each sex transaction. Then, these venues in each city were  
152 randomly selected through proportional sampling. The proportions of low- and middle-tier  
153 FSWs among all participants were at least 10% and 40%, respectively. The FSWs were  
154 recruited if they met the inclusion criteria as follows: participants (1) were aged  $\geq 16$  years,  
155 (2) provided commercial sex for money or goods during the previous month, and (3) were  
156 willing to participate in the survey and could provide verbal informed consent.

157 All participants completed an anonymous, standard interviewer-administered and  
158 face-to-face questionnaire. After each interview, 3–5 mL of venous blood was collected from  
159 each participant for HIV, syphilis and HCV antibody detection. The blood sample was linked  
160 to the questionnaire by a unique identification code assigned to the participant.

### 161 **Measures**

#### 162 Questionnaire

163 A questionnaire was used to collect the socio-demographic characteristics, HIV  
164 knowledge and behaviour of the FSWs.

165 (1) Socio-demographic characteristics, including year of birth, marital status, household  
166 registration, ethnicity and education level were collected.

167 (2) The HIV-related knowledge of participants was assessed using eight questions  
168 with 'yes', 'no' or 'don't know' as answers. The questions have been updated since 2016 and  
169 took new-type drugs and intentional transmission of HIV/AIDS into consideration. Only

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4 170 correct responses were scored as 1 point, whereas incorrect responses and 'don't know'  
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6 171 responses did not earn any point. The Cronbach's alpha values were 0.706 and 0.739 before  
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8 172 and after the questions were changed, respectively.

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10 173 (3) The participants' behavioural factors were also collected, including questions  
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12 174 regarding condom use in last commercial sex, condom use with clients in the past month,  
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14 175 drug use during their lifetime, STI diagnosis in the last year and participation in HIV-related  
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16 176 services. In this study, consistent condom use (CCU) in the past month was defined as always  
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18 177 using condom during commercial intercourse.

#### 19 20 178 Laboratory testing

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22 179 In all surveys, the venous blood samples were tested for HIV, syphilis and HCV by  
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24 180 trained laboratory technicians. Initial screening for HIV, syphilis and HCV antibodies was  
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26 181 conducted using Enzyme-linked Immunosorbent Assay (ELISA) method (ELISA-1). When the  
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28 182 result was negative, no further re-examination was carried out and infection status was  
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30 183 recorded as negative. When the result was positive, HIV or HCV infection was confirmed by  
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32 184 another ELISA method (ELISA-2) while syphilis infection was confirmed using a non-specific  
33  
34 185 detection method called toluidine red unheated serum test (TRUST). The results were  
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36 186 determined as positive only when both tests were positive.

#### 37 38 187 Quality assurance

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40 188 All investigators were strictly trained before the survey to ensure that they familiarized  
41  
42 189 the questionnaire structure and mastered the unified investigation standards and  
43  
44 190 requirements. After the investigation, the investigators carefully reviewed the questionnaires  
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46 191 and promptly corrected the missing items, wrong items and logical errors. Experts from the  
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48 192 Chongqing Center for Disease Control and Prevention went to the investigation site for  
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50 193 guidance and inspection to ensure quality. All laboratory tests were conducted at designated  
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52 194 and certified laboratories in local CDC or hospitals.

#### 53 54 195 **Data analysis**

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56 196 The socio-demographic characteristics of participants were presented using descriptive  
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58 197 statistics by survey year. In addition, the trends of HIV, syphilis, HCV infections and  
59  
60 198 behavioural factors over time were assessed using Cochran–Armitage trend test.

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4 199 Multivariable logistic regression was conducted to identify related risk-factors of HIV,  
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6 200 syphilis and HCV infection by using stepwise elimination. The odds ratios (ORs) and 95% CIs  
7  
8 201 of each significant risk factor were also determined, unadjusted and adjusted for  
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10 202 socio-demographic factors. All statistical analyses were carried out using Statistical Analysis  
11  
12 203 Software, version 9.2 (SAS Institute Incorporated, Cary, North Carolina, USA).

#### 13 14 204 **Patient and public involvement**

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16 205 Patients and/or the public were not involved in the design, or conduct, or reporting, or  
17  
18 206 dissemination plans of this research.

## 19 20 21 22 208 **RESULTS**

### 23 24 209 **Socio-demographic characteristics**

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26 210 This study included 16791 of 16810 participants recruited between 2013 and 2018. Table 1  
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28 211 depicted all the participants' demographic characteristics stratified by year of survey. Nearly  
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30 212 half of the participants (46.7%) worked in middle-tier venues, 39.7% worked in low-tier  
31  
32 213 venues, and 13.6% worked in high-tier venues. The median age was 28 years and most  
33  
34 214 (87.2%) of them were between 20 and 45 years of age. The majority of the participants were in  
35  
36 215 Chongqing households (91.0%) and belong to Han (90.0%). Less than one third of them had  
37  
38 216 high school or above education and half (54.7%) had a junior middle school education. Most  
39  
40 217 participants have worked in the current location for 1~6 months (33.0%).

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Table 1. Socio-demographic characteristics of female sex workers stratified by survey year (N, %)

| Characteristics                      | 2013<br>N(%) | 2014<br>N(%) | 2015<br>N(%) | 2016<br>N(%) | 2017<br>N(%) | 2018<br>N(%) | Total<br>N(%) |
|--------------------------------------|--------------|--------------|--------------|--------------|--------------|--------------|---------------|
| <b>Overall</b>                       | 2793(16.6)   | 2796(16.7)   | 2793(16.6)   | 2799(16.7)   | 2805(16.7)   | 2805(16.7)   | 16791(100.0)  |
| <b>Age group(years)</b>              |              |              |              |              |              |              |               |
| <20                                  | 285(10.2)    | 226(8.1)     | 206(7.4)     | 228(8.1)     | 87(3.1)      | 96(3.4)      | 1128(6.7)     |
| 20-45                                | 2404(86.1)   | 2451(87.7)   | 2442(87.4)   | 2412(86.2)   | 2521(89.9)   | 2415(86.1)   | 14645(87.2)   |
| >45                                  | 104(3.7)     | 119(4.3)     | 145(5.2)     | 159(5.7)     | 197(7.0)     | 294(10.5)    | 1018(6.1)     |
| <b>Marital status</b>                |              |              |              |              |              |              |               |
| Never been married                   | 1131(40.5)   | 1143(40.9)   | 1102(39.5)   | 1106(39.5)   | 734(26.2)    | 837(29.8)    | 6053(36.0)    |
| Married                              | 1148(41.1)   | 1104(39.5)   | 1207(43.2)   | 1152(41.2)   | 1279(45.6)   | 1278(45.6)   | 7168(42.7)    |
| Living together as if married        | 275(9.8)     | 308(11.0)    | 260(9.3)     | 307(11.0)    | 305(10.9)    | 296(10.6)    | 1751(10.4)    |
| Divorced/Widowed                     | 239(8.6)     | 241(8.6)     | 224(8.0)     | 234(8.4)     | 487(17.4)    | 394(14.0)    | 1819(10.8)    |
| <b>Household registration(hukou)</b> |              |              |              |              |              |              |               |
| Chongqing                            | 2518(90.2)   | 2559(91.5)   | 2533(90.7)   | 2547(91.0)   | 2580(92.0)   | 2537(90.4)   | 15274(91.0)   |
| Other provinces                      | 275(9.8)     | 237(8.5)     | 260(9.3)     | 252(9.0)     | 225(8.0)     | 268(9.6)     | 1517(9.0)     |
| <b>Ethnicity</b>                     |              |              |              |              |              |              |               |
| Minority                             | 253(9.1)     | 266(9.5)     | 308(11.0)    | 295(10.5)    | 280(10.0)    | 272(9.7)     | 1674(10.0)    |
| Han                                  | 2539(90.9)   | 2530(90.5)   | 2485(89.0)   | 2504(89.5)   | 2525(90.0)   | 2533(90.3)   | 15116(90.0)   |
| <b>Education level</b>               |              |              |              |              |              |              |               |
| Primary school or below              | 512(18.3)    | 524(18.7)    | 581(20.8)    | 506(18.1)    | 595(21.2)    | 507(18.1)    | 3225(19.2)    |
| Junior middle school                 | 1664(59.6)   | 1570(56.2)   | 1367(48.9)   | 1509(53.9)   | 1635(58.3)   | 1446(51.6)   | 9191(54.7)    |
| High school or above                 | 617(22.1)    | 702(25.1)    | 845(30.3)    | 784(28.0)    | 575(20.5)    | 852(30.4)    | 4375(26.1)    |
| <b>Typology</b>                      |              |              |              |              |              |              |               |
| Low-tier                             | 973(34.8)    | 955(34.2)    | 1043(37.3)   | 1193(42.6)   | 1347(48.0)   | 1161(41.4)   | 6672(39.7)    |
| Middle-tier                          | 1347(48.2)   | 1504(53.8)   | 1448(51.8)   | 1236(44.2)   | 1192(42.5)   | 1108(39.5)   | 7835(46.7)    |

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|---------------------------------|------------|------------|------------|------------|------------|------------|-------------|
| High-tier                       | 473(16.9)  | 337(12.1)  | 302(10.8)  | 370(13.2)  | 266(9.5)   | 536(19.1)  | 2284(13.6)  |
| <b>Local working time</b>       |            |            |            |            |            |            |             |
| More than 1 year                | 651(23.3)  | 566(20.2)  | 751(26.9)  | 673(24.0)  | 888(31.7)  | 946(33.7)  | 4475(26.7)  |
| 6~12 months                     | 635(22.7)  | 672(24.0)  | 899(32.2)  | 1018(36.4) | 918(32.7)  | 833(29.7)  | 4975(29.6)  |
| 1~6 months                      | 1097(39.3) | 1204(43.1) | 888(31.8)  | 778(27.8)  | 814(29.0)  | 754(26.9)  | 5535(33.0)  |
| Less than 1 month               | 409(14.6)  | 354(12.7)  | 255(9.1)   | 330(11.8)  | 185(6.6)   | 272(9.7)   | 1805(10.8)  |
| <b>Location of previous job</b> |            |            |            |            |            |            |             |
| Other provinces                 | 334(12.0)  | 257(9.2)   | 354(12.7)  | 305(10.9)  | 353(12.6)  | 293(10.4)  | 1896(11.3)  |
| Other cities in Chongqing       | 330(11.8)  | 569(20.4)  | 549(19.7)  | 572(20.4)  | 356(12.7)  | 352(12.5)  | 2728(16.2)  |
| Current city                    | 1699(60.8) | 1627(58.2) | 1629(58.3) | 1576(56.3) | 1894(67.5) | 1872(66.7) | 10297(61.3) |
| No previous work                | 430(15.4)  | 343(12.3)  | 261(9.3)   | 346(12.4)  | 202(7.2)   | 288(10.3)  | 1870(11.1)  |
| <b>HIV knowledge</b>            |            |            |            |            |            |            |             |
| <6                              | 388(13.9)  | 458(16.4)  | 231(8.3)   | 449(16.0)  | 348(12.4)  | 305(10.9)  | 2179(13.0)  |
| >=6                             | 2405(86.1) | 2338(83.6) | 2562(91.7) | 2350(84.0) | 2457(87.6) | 2500(89.1) | 14612(87.0) |

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## 222 **Trends of HIV, syphilis and HCV prevalence**

223 During the study period, the overall prevalence of HIV, syphilis and HCV infection  
224 among the study population was 0.27% (95%CI 0.19% to 0.35%), 1.73% (95%CI 1.54% to  
225 1.93%) and 0.72% (95%CI 0.59% to 0.85%), respectively. Low-tier FSWs had higher prevalence  
226 of HIV, HCV and syphilis, with 6-year average prevalence rates of 0.40%, 2.53% and 1.08%,  
227 respectively ( $p = 0.019$ ,  $p < 0.001$ ,  $p < 0.001$ ). The HIV prevalence among FSWs in Chongqing,  
228 which ranged from 0.14% to 0.43% during the study years, had no significant changes over  
229 time ( $p = 0.129$ , Figure 2). No significant time trend was found among low-/ middle-/high-tier  
230 FSWs ( $p = 0.498$ , 0.366 and 0.423, respectively). The HCV prevalence among FSWs in  
231 Chongqing ranged from 0.32% to 1.14% between 2013 and 2018, with no significant trend. In  
232 each subgroup, no significant changing trend of HCV infection by year was found (Figure 3).  
233 Unlike HIV and HCV, a total of 1.11%, 1.18%, 1.58%, 1.86%, 2.67% and 2.00% of the  
234 respondents were confirmed to be infected with syphilis from 2013 to 2018, showing an  
235 upward trend ( $p < 0.001$ ). This trend was also found in low-tier FSWs (from 1.13% in 2013 to  
236 2.50% in 2018,  $p < 0.001$ ) and middle-tier FSWs (from 1.19% in 2013 to 1.81% in 2018,  $p =$   
237 0.026), but not in high-tier FSWs ( $p = 0.713$ ).

## 238 **Changing trends of behavioral factors**

239 Of the whole survey population, more than 80% exhibited HIV-related knowledge and  
240 used condom in their last commercial sex (Table 2). Nearly 90% received at least one of the  
241 following three HIV-related services in the last year: (1) condom promotion and distribution  
242 and AIDS counselling and testing, (2) community drug maintenance therapy and clean  
243 needle supply/exchange, and (3) peer education. In addition, about half of the participants  
244 used condom consistently with clients in the last month. Approximately 3% reported drug  
245 use, and 2% reported STI diagnosis in the past year.

246 The changing trends of FSWs' behaviours were also examined, and results showed no  
247 significant change over time in drug use reported by FSWs. However, significant  
248 improvements over time were found in HIV-related knowledge, condom use, participation in  
249 HIV-related services, and self-reported STI diagnosis in the last year among the FSWs.

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**Table 2.** Behavioural characteristics of FSWs from 2013 to 2018 in Chongqing

| Variables                             |     | 2013       | 2014       | 2015       | 2016       | 2017       | 2018       | overall     | P      | P for  |
|---------------------------------------|-----|------------|------------|------------|------------|------------|------------|-------------|--------|--------|
|                                       |     | %(n)       | %(n)       | %(n)       | %(n)       | %(n)       | %(n)       | %(n)        | value  | trend  |
| HIV know-ledge (>=6)                  | Yes | 86.1(2405) | 83.6(2338) | 91.7(2562) | 84.0(2350) | 87.6(2457) | 89.1(2500) | 87.0(14612) | <0.001 | <0.001 |
|                                       | No  | 13.9(388)  | 16.4(458)  | 8.3(231)   | 16.0(449)  | 12.4(348)  | 10.9(305)  | 13.0(2179)  |        |        |
| condom use in the last commercial sex | Yes | 79.7(2167) | 77.4(2134) | 93.8(2604) | 83.4(2335) | 87.0(2439) | 84.5(2371) | 84.3(14050) | <0.001 | <0.001 |
|                                       | No  | 20.3(552)  | 22.6(625)  | 6.2(171)   | 16.6(464)  | 13.0(366)  | 15.5(434)  | 15.7(2612)  |        |        |
| CCU in the past month                 | Yes | 41.7(1130) | 51.2(1406) | 69.7(1925) | 60.1(1682) | 47.7(1337) | 51.4(1441) | 53.7(8921)  | <0.001 | <0.001 |
|                                       | No  | 58.3(1578) | 48.8(1341) | 30.3(835)  | 39.9(1117) | 52.3(1468) | 48.6(1364) | 46.3(7703)  |        |        |
| Drug use                              | Yes | 2.9(81)    | 4.2(116)   | 2.7(74)    | 4.6(129)   | 2.2(63)    | 3.1(88)    | 3.3(551)    | <0.001 | 0.322  |
|                                       | No  | 97.1(2705) | 95.8(2631) | 97.3(2718) | 95.4(2670) | 97.8(2742) | 96.9(2717) | 96.7(16183) |        |        |
| Injecting drug use                    | Yes | 1.3(35)    | 1.2(32)    | 0.6(18)    | 1.5(43)    | 0.7(19)    | 0.4(11)    | 0.9(158)    | <0.001 | 0.002  |
|                                       | No  | 98.8(2754) | 98.9(2760) | 99.4(2774) | 98.5(2756) | 99.3(2786) | 99.6(2794) | 99.1(16624) |        |        |
| STI diagnosis in the past year        | Yes | 3.8(106)   | 3.6(100)   | 1.5(43)    | 1.8(50)    | 1.1(31)    | 1.3(37)    | 2.2(367)    | <0.001 | <0.001 |
|                                       | No  | 96.2(2671) | 96.4(2679) | 98.5(2747) | 98.2(2749) | 98.9(2774) | 98.7(2768) | 97.8(16388) |        |        |
| HIV-related services                  | Yes | 80.0(2235) | 86.0(2405) | 94.4(2637) | 93.4(2615) | 92.7(2600) | 88.1(2470) | 89.1(14962) | <0.001 | <0.001 |
|                                       | No  | 20.0(558)  | 14.0(391)  | 5.6(156)   | 6.6(184)   | 7.3(205)   | 11.9(335)  | 10.9(1829)  |        |        |

251 CCU: consistent condom use.

252 **Correlates of HIV, syphilis and HCV infections**

253 Multivariable logistic regression analysis results (Table 3) showed that, (1) HIV infection  
 254 was significantly and positively associated with no condom use in the last commercial sex  
 255 (adjusted OR [aOR] 3.48, 95% CI 1.90 to 6.37) and syphilis infection (aOR 4.88, 95% CI 1.95 to  
 256 12.18); (2) syphilis infection was significantly and positively associated with inconsistent  
 257 condom use in the past month (aOR 1.30, 95% CI 1.02 to 1.65), STI diagnosis in the past year  
 258 (aOR 3.81, 95% CI 2.40 to 6.03), HIV infection (aOR 5.88, 95% CI 2.40 to 14.41) and HCV  
 259 infection (aOR 7.68, 95% CI 4.37 to 13.49); (3) HCV infection was significantly and positively  
 260 associated with injecting drug use (aOR 8.91, 95% CI 4.45 to 17.86) and syphilis infection (aOR  
 261 7.88, 95% CI 4.49 to 13.83).

262 **Table 3.** Associations between behavioural characteristics and HIV, syphilis and HCV  
 263 infection

| Behavioural characteristics | HIV Positive |            | Syphilis Positive |            | HCV Positive |            |
|-----------------------------|--------------|------------|-------------------|------------|--------------|------------|
|                             | OR(95%CI)    | aOR(95%CI) | OR(95%CI)         | aOR(95%CI) | OR(95%CI)    | aOR(95%CI) |

|                      | Univariate  | Multivariate | 5%CI )      | Univariate  | Multivariate | %CI )       | Univariate  | Multivariate | CI )        |
|----------------------|-------------|--------------|-------------|-------------|--------------|-------------|-------------|--------------|-------------|
| 6 No condom use      |             |              |             |             |              |             |             |              |             |
| 7 in the last        | 3.95(2.19,7 | 3.97(2.19,7  | 3.48(1.90,6 | 1.06(0.78,1 |              |             | 0.54(0.29,1 |              |             |
| 8 commercial sex     | .15)*       | .19)*        | .37)*       | .45)        |              |             | .00)        |              |             |
| 9 (yes vs. no)       |             |              |             |             |              |             |             |              |             |
| 10 Inconsistent      |             |              |             |             |              |             |             |              |             |
| 11 condom use in     | 2.86(1.50,5 |              |             | 1.33(1.05,1 | 1.30(1.03,1  | 1.30(1.02,1 | 0.64(0.44,0 | 0.63(0.43,0  | 0.72(0.49,1 |
| 12 the past month    | .45)*       |              |             | .67)*       | .64)*        | .65)*       | .93)*       | .92)*        | .05)        |
| 13 (yes vs. no)      |             |              |             |             |              |             |             |              |             |
| 14 Drug use (yes     | 0.32(0.02,5 |              |             | 1.27(0.71,2 |              |             | 3.28(1.80,6 |              |             |
| 15 vs. no)           | .24)        |              |             | .28)        |              |             | .00)*       |              |             |
| 16 Injecting drug    | 1.15(0.07,1 |              |             | 1.87(0.76,4 |              |             | 10.05(5.16, | 9.21(4.67,1  | 8.91(4.45,1 |
| 17 use (yes vs. no)  | 8.91)       |              |             | .59)        |              |             | 19.59)*     | 8.18)*       | 7.86)*      |
| 18 STI diagnosis in  | 0.49(0.03,7 |              |             | 4.02(2.59,6 | 3.75(2.40,5  | 3.81(2.40,6 | 2.78(1.29,6 |              |             |
| 19 the past year     | .98)        |              |             | .24)*       | .87)*        | .03)*       | .00)*       |              |             |
| 20 HIV-related       |             |              |             |             |              |             |             |              |             |
| 21 services (yes     | 1.71(0.53,5 |              |             | 1.37(0.90,2 |              |             | 1.36(0.71,2 |              |             |
| 22 vs. no)           | .53)        |              |             | .08)        |              |             | .60)        |              |             |
| 23 HIV positive      |             |              |             | 8.89(3.74,2 | 9.17(3.84,2  | 5.88(2.40,1 | 1.51(0.09,2 |              |             |
| 24 (yes vs. no)      |             |              |             | 1.17)*      | 1.91)*       | 4.41)*      | 5.29)       |              |             |
| 25 Syphilis positive | 8.89(3.73,2 | 8.68(3.63,2  | 4.88(1.95,1 |             |              |             | 9.09(5.30,1 | 9.09(5.26,1  | 7.88(4.49,1 |
| 26 (yes vs. no)      | 1.16)*      | 0.74)*       | 2.18)*      |             |              |             | 5.58)*      | 5.71)*       | 3.83)*      |
| 27 HCV positive      | 1.50(0.09,2 |              |             | 9.09(5.30,1 | 8.81(5.09,1  | 7.68(4.37,1 |             |              |             |
| 28 (yes vs. no)      | 4.83)       |              |             | 5.59)*      | 5.25)*       | 3.49)*      |             |              |             |

264 aOR: adjusted odds ratio, adjusted for socio-demographic characteristic (age, education level,  
265 marital status, typology and survey year); \* p < 0.05.

266

## 267 DISCUSSION

268 FSWs are considered to be at high risk of HIV infection and other STIs and contribute  
269 disproportionately to the transmission. Surveillance of STIs and risk behaviour among FSWs  
270 is highly important for the understanding of the potential of spreading HIV to the general  
271 population and the assessment and improvement of interventions targeted at FSWs.<sup>23</sup>  
272 Although analysing and knowing the prevalence and changing trends of HIV, syphilis, HCV  
273 and relevant behaviours among FSWs are critical, only few studies have been reported in  
274 Chongqing, China. Thus, in the present study, the prevalence and changing trends of HIV,  
275 syphilis, HCV and behaviour of Chongqing FSWs were examined using sentinel surveillance  
276 data from 2013 to 2018.

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4 277 The results showed that the HIV prevalence among FSWs in Chongqing was relatively  
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6 278 stable, with an annual average of 0.27% from 2013 to 2018, similar to 0.22% among Chinese  
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8 279 FSWs in 2014<sup>9</sup> but much higher than China's current estimated national HIV prevalence  
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10 280 among general population (0.0598%).<sup>29</sup> The prevalence of HIV among FSWs in Chongqing is  
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12 281 higher than that in most provinces such as Beijing,<sup>30</sup> Liaoning<sup>31</sup> and Hainan,<sup>32</sup> but lower than  
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14 282 that in Sichuan,<sup>33</sup> Yunnan<sup>34</sup> and Guangxi.<sup>35</sup> HCV prevalence fluctuated between 2013 and  
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16 283 2018, with a 6-year average of 0.72%, but no significant trend was found. This result was in  
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18 284 concordance with that of a previous study conducted in Guangxi.<sup>35</sup> However, a previous  
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20 285 study using national data reported that from 2008 to 2012, the overall HIV and HCV  
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22 286 prevalence among FSWs in mainland China showed a decreasing trend;<sup>13</sup> the differences may  
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24 287 be due to the differences in scope of study area and study period.

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26 288 The results also indicated a worrying upward trend of syphilis infection (from 1.11% in  
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28 289 2013 to 2.00% in 2018), particularly among low- and middle-tier FSWs. As the third most  
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30 290 prevalent notifiable infectious disease in categories A and B in China, syphilis has been on the  
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32 291 rise since the 1990s.<sup>36</sup> The reported total syphilis rate in China increased from 0.2/100,000 in  
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34 292 1993 to 32.86/100,000 in 2013.<sup>36</sup> The reported incidence of syphilis in Chongqing also showed  
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36 293 an upward trend, with a reported incidence of 40.38/100,000 in 2014.<sup>37</sup> However, researchers  
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38 294 found that the increase in reported cases of syphilis in Chongqing in recent years may be  
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40 295 related to large-scale syphilis screening by medical institutions, training on national  
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42 296 standards for syphilis diagnosis and reporting, and laboratory improvement.<sup>38</sup> The increase  
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44 297 in syphilis prevalence among FSWs may also be related to the strengthening of syphilis  
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46 298 detection, but it still needs attention. In agreement with previous studies, the FSWs infected  
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48 299 with syphilis have a higher risk of HIV or HCV infection, and HIV or HCV infection is a risk  
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50 300 factor of syphilis infection.<sup>35</sup> FSWs with syphilis were nearly five times more likely to be  
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52 301 infected with HIV, and seven times more likely to be infected with HCV than FSWs without  
53  
54 302 syphilis. This phenomenon may be due to their shared transmission routes, co-risk factors  
55  
56 303 and adverse interaction.<sup>39</sup> Thus, efforts should be increased to strengthen the comprehensive  
57  
58 304 and combined intervention of AIDS, syphilis and other STIs for key groups.

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60 305 During the study period, the proportion of FSWs who used condoms increased slightly,  
306 and condom use was associated with decreased HIV or syphilis infection risk. CCU is one of

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4 307 the most effective ways to prevent HIV infection, and its protection rate can reach 80% based  
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6 308 on studies of persons during heterosexual sex with an HIV-positive partner.<sup>40</sup> The 100%  
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8 309 Condom Use Programme has been implemented in Chongqing since 2006 and has shown a  
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10 310 promotional effect. The number of FSWs who practiced CCU increased. However, in 2018,  
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12 311 only half of FSWs reported consistent use of condoms in the last month. This proportion was  
13  
14 312 lower than that in Liaoning and Hainan.<sup>31 32</sup> Previous studies indicated that clients' low  
15  
16 313 support and negative norms towards condom use may be the main reason for the  
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18 314 inconsistent condom use of FSWs.<sup>41-43</sup> FSWs often compromise with their clients on condom  
19  
20 315 use to earn money or establish a closer long-term relationship with clients. Thus, in addition  
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22 316 to raising FSWs' awareness regarding HIV/STI prevention and improving their skills to  
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24 317 negotiate condom use, promoting HIV intervention programs targeting clients of FSWs and  
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26 318 others is also essential.

27 319 No significant increasing or decreasing trend in drug use was observed among FSWs.  
28  
29 320 The average prevalence of drug use was 3.3%, while the national prevalence among FSWs  
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31 321 was reported at 1.2%.<sup>13</sup> The prevalence of injecting drug use seemed to be declining during  
32  
33 322 the study period. Injecting drug use may exacerbate unsafe sexual behaviour and structural  
34  
35 323 risks, leading to increased risk of HIV and other STIs.<sup>44 45</sup> In 2017, the detection rates of HIV,  
36  
37 324 syphilis and HCV among drug users in Chongqing were 5.4%, 5.9% and 44.9%, respectively,  
38  
39 325 much higher than those among the general population.<sup>46</sup> FSWs who inject drugs are exposed  
40  
41 326 to sexual and blood transmission routes and at a higher risk of contracting HIV and syphilis  
42  
43 327 than other FSWs and injecting drug users.<sup>35 47</sup> Similar to previous studies, the present study  
44  
45 328 showed a strong association between injecting drug use and HCV infection,<sup>48</sup> and sharing of  
46  
47 329 needles may be the main and underlying route of HCV transmission. Drugs and prostitution  
48  
49 330 involve relevant laws and ethics. Thus, HIV prevention programs and outreach for FSWs may  
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51 331 require enhanced thinking and increased attention to the individual's external risk  
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53 332 environment and risk factors.

54 333 In addition, as previous studies have shown, lower-tier FSWs bear heavier burden of  
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56 334 HIV, syphilis and HCV than higher-tier FSWs,<sup>13</sup> which may be attributed to the  
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58 335 socio-demographic characteristics of lower-tier FSWs and their clients. It's found that low-tier  
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60 336 FSWs generally have older age and lower education, which are often associated with higher

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337 prevalence of HIV and syphilis.<sup>49</sup> Low-tier FSWs with low education probably had  
338 insufficient knowledge about those diseases, less awareness about sex health, and poor  
339 communication skills for condom use.<sup>50</sup> And they may be serving more clients who also had  
340 low education, had low awareness, and were unwilling to use condom, particularly elderly  
341 man.<sup>17 35</sup> Thus, future intervention programs should be specified and targeted based on the  
342 needs of FSWs under different tiers, and pay more attention to low-tier FSWs and their clients.  
343 In addition, sex work is illegal and highly stigmatised in China; thus, FSWs face several  
344 barriers, such as fear of being arrested, fear of discrimination and awkwardness, to  
345 participant in AIDS related services.<sup>51</sup> AIDS intervention services must further cooperate with  
346 non-governmental organizations, increase condom promotion, and jointly increase awareness  
347 of other STIs such as syphilis.

348 This study had several limitations. Firstly, the data we used were based on serial  
349 cross-sectional surveillance surveys; therefore, trends of HIV, syphilis and HCV infection  
350 without exact reasons behind the changes were possibly found. Secondly, the survey was  
351 anonymous. Respondents who participated in a cross-sectional survey in a certain year may  
352 also participate in subsequent cross-sectional surveys. However, estimating the proportion of  
353 FSWs who repeatedly participated in this study was not possible. Thirdly, the data were  
354 collected mainly through self-reported questionnaires, which raise concerns about recall bias,  
355 reporting bias and social desirability bias. For example, respondents may conceal the truth  
356 when answering sensitive questions, such as drug use, which is illegal in China.

357

## 358 CONCLUSIONS

359 In conclusion, the HIV and HCV prevalence among FSWs in Chongqing remained stable  
360 during the study period, but syphilis had an upward trend among FSWs in low- and  
361 middle-tier venues. Although factors such as knowledge, condom use, injecting drug use and  
362 STI diagnosis were improved, nearly half of FSWs used condom inconsistently. Thus, more  
363 effective interventions for promoting CCU among FSWs and their clients are needed to  
364 reduce the spread of HIV/STIs, and more attention must be paid to low- and middle-tier  
365 FSWs.

366

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371 involved in the design and conducting of the survey. LH and MY analyzed the data. LH, HZ,  
372 DJ and HQ participated in the interpretation of results. LH wrote the first draft of the  
373 manuscript. LH, HQ, HZ, DJ, GW, RL and MY revised the manuscript. All authors have read  
374 and approved the manuscript.

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378 **Competing interests** None declared.

379 **Patient consent for publication** Not required.

380 **Ethics approval** This survey was reviewed and approved by the Institutional Review Board  
381 of the National Center for AIDS Prevention and Control (NCAIDS), Center for Disease  
382 Control (CDC), China, and the medical ethics committee of Chongqing Medical University  
383 (IRB number:2017016).

384 **Data availability statement** No additional data available.

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4 531 Figure 1. The location of seven sentinel surveillance sites in Chongqing.

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7 533 Figure 2. Prevalence of HIV, syphilis, and HCV among FSWs in Chongqing by survey year.

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9 534 Bars show prevalence (percent); error bars show 95% confidence intervals.

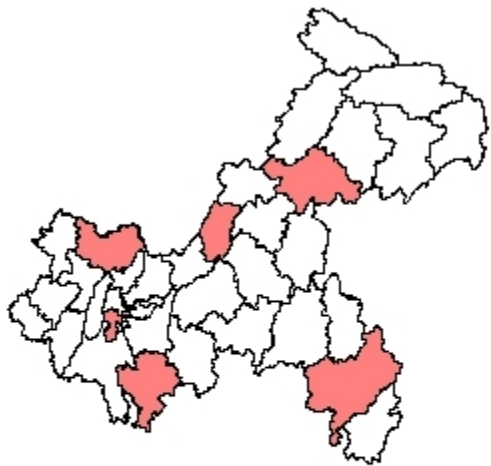
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**Chongqing**

*Legend*

■ Sentinel surveillance sites in Chongqing

Figure 1. The location of seven sentinel surveillance sites in Chongqing.

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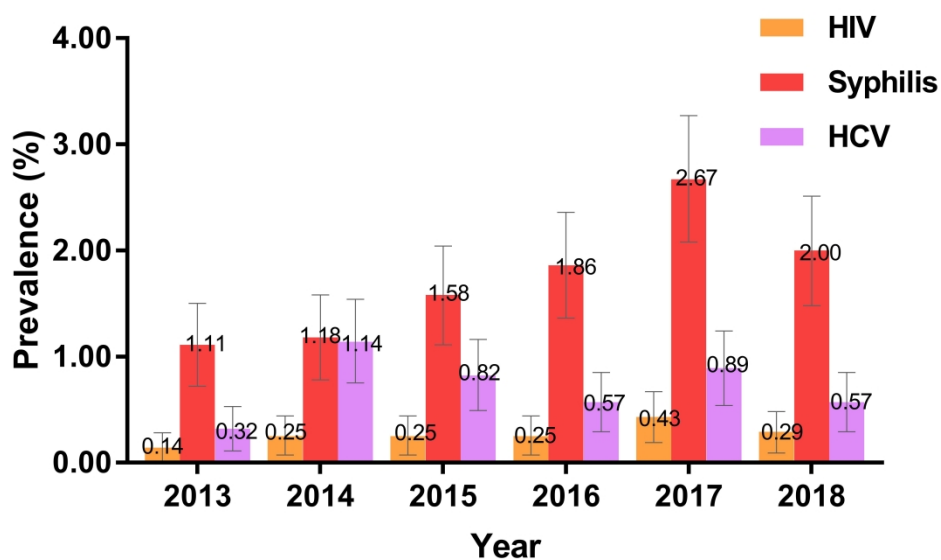
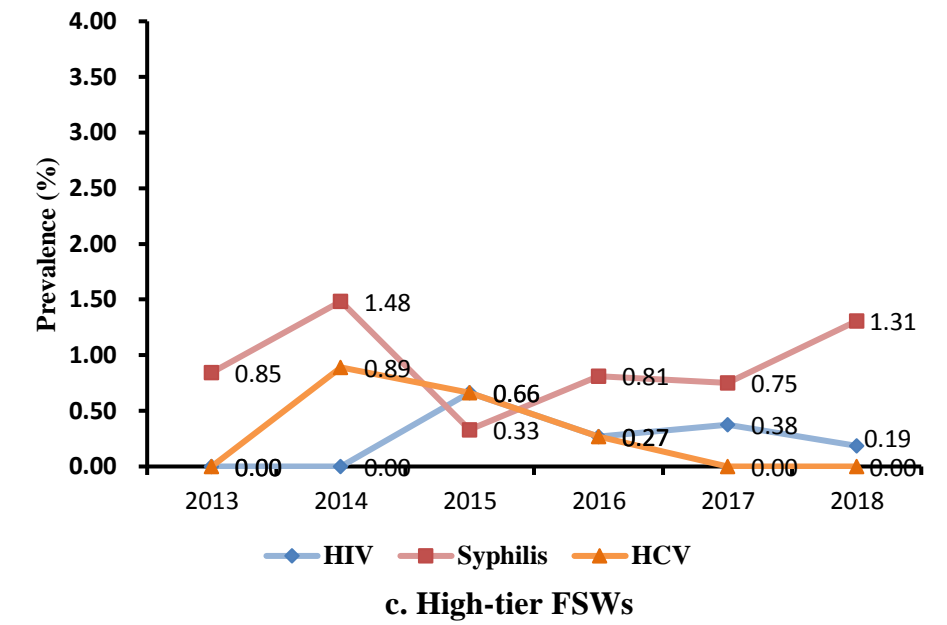
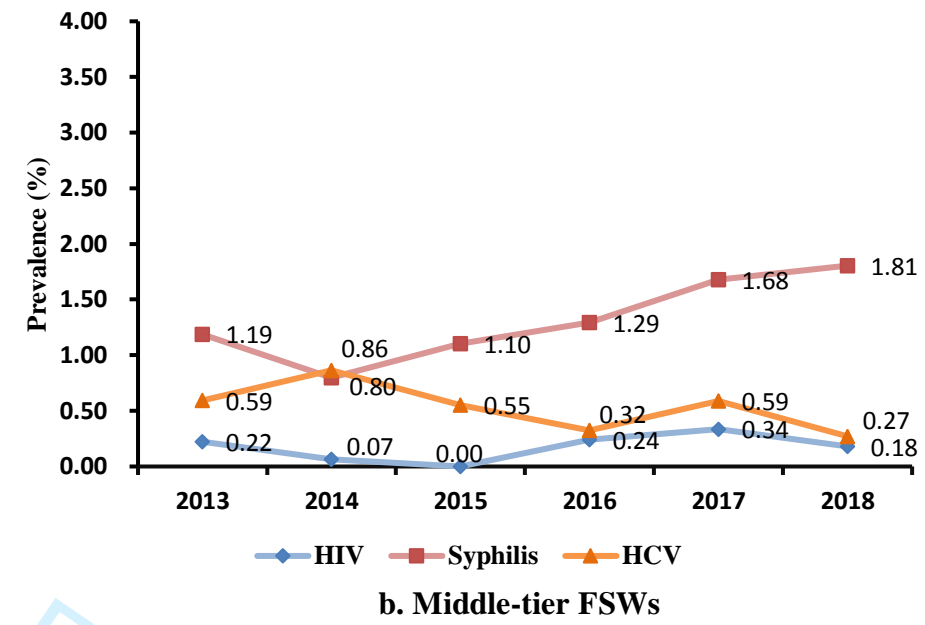
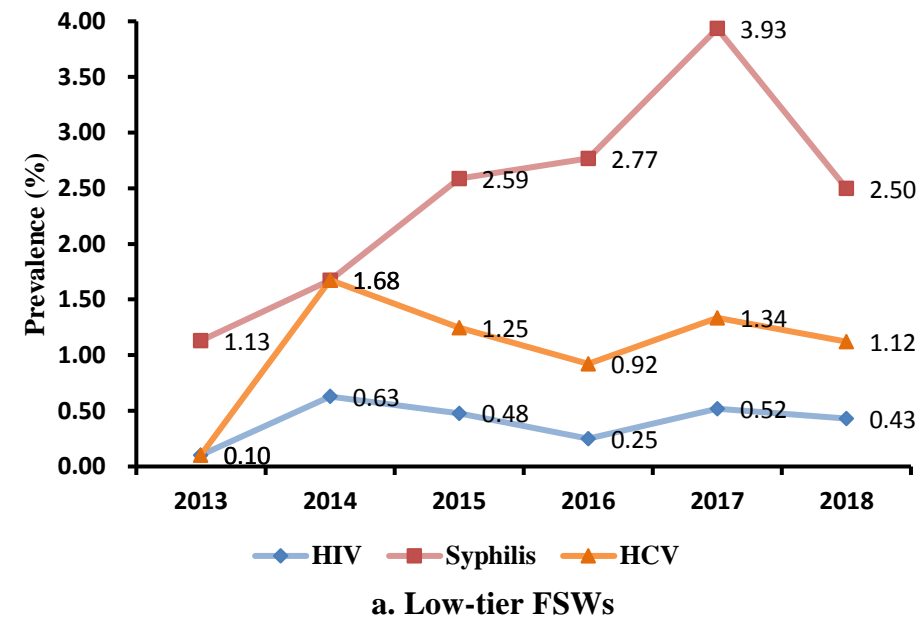


Figure 2. Prevalence of HIV , syphilis, and HCV among FSWs in Chongqing by survey year. Bars show prevalence (percent); error bars show 95% confidence intervals.

125x76mm (1200 x 1200 DPI)



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**STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies***

| Section/Topic                | Item # | Recommendation   | Reported on page # |
|------------------------------|--------|--|--------------------|
| <b>Title and abstract</b>    | 1      | (a) Indicate the study's design with a commonly used term in the title or the abstract   | 1-2                |
|                              |        | (b) Provide in the abstract an informative and balanced summary of what was done and what was found  | 1-2                |
| <b>Introduction</b>          |        |  |                    |
| Background/rationale         | 2      | Explain the scientific background and rationale for the investigation being reported   | 3-4                |
| Objectives                   | 3      | State specific objectives, including any prespecified hypotheses   | 4                  |
| <b>Methods</b>               |        |  |                    |
| Study design                 | 4      | Present key elements of study design early in the paper  | 4                  |
| Setting                      | 5      | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection  | 4                  |
| Participants                 | 6      | (a) Give the eligibility criteria, and the sources and methods of selection of participants  | 5                  |
| Variables                    | 7      | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable   | 5-6                |
| Data sources/<br>measurement | 8*     | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | 5-6                |
| Bias                         | 9      | Describe any efforts to address potential sources of bias  | 14                 |
| Study size                   | 10     | Explain how the study size was arrived at  | 5                  |
| Quantitative variables       | 11     | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why   | --                 |
| Statistical methods          | 12     | (a) Describe all statistical methods, including those used to control for confounding  | 6                  |
|                              |        | (b) Describe any methods used to examine subgroups and interactions  | 6                  |
|                              |        | (c) Explain how missing data were addressed  | 6                  |
|                              |        | (d) If applicable, describe analytical methods taking account of sampling strategy   | --                 |
|                              |        | (e) Describe any sensitivity analyses  | --                 |
| <b>Results</b>               |        |  |                    |

|                          |     |  |       |
|--------------------------|-----|--|-------|
| Participants             | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed            | 7     |
|                          |     | (b) Give reasons for non-participation at each stage   | --    |
|                          |     | (c) Consider use of a flow diagram   | --    |
| Descriptive data         | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders   | 7-9   |
|                          |     | (b) Indicate number of participants with missing data for each variable of interest  | --    |
| Outcome data             | 15* | Report numbers of outcome events or summary measures   | 9-10  |
| Main results             | 16  | (a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | 9-10  |
|                          |     | (b) Report category boundaries when continuous variables were categorized  | --    |
|                          |     | (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period   | --    |
| Other analyses           | 17  | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses   | 11    |
| <b>Discussion</b>        |     |  |       |
| Key results              | 18  | Summarise key results with reference to study objectives   | 14    |
| Limitations              | 19  | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias   | 14    |
| Interpretation           | 20  | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence                                   | 12-14 |
| Generalisability         | 21  | Discuss the generalisability (external validity) of the study results  | 14    |
| <b>Other information</b> |     |  |       |
| Funding                  | 22  | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based  | 15    |

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).