Changes in Prevalence of HIV or Syphilis among Male Sex Workers and Non-Commercial Men Who Have Sex with Men in Shenzhen, China: Results of a Second Survey

Yuanwei Huang¹, Yanting Zhang¹, Ke Li¹*, Jin Zhao²*

¹ Department of Preventive Medicine, Shantou University Medical College, Shantou, Guangdong, China,
² Shenzhen Center for Disease Control and Prevention, Guangdong, China

* keli1122@126.com (KL); szhaojin@gmail.com (JZ)

Abstract

Background

A previous time-location sampling survey (TLS) was performed in 2008 to evaluate the HIV or syphilis infection rate among male sex workers (MSWs) and non-commercial men who have sex with men (ncMSM) in Shenzhen, China. This is a second TLS performed in 2014. This article describes the findings and changes in the prevalence of HIV and syphilis.

Methods

TLS was used to collect information as a second cross-sectional survey to an earlier TLS assessment. Data on behavior (e.g., sexual history and sexual behavior) were analyzed. Blood specimens were drawn for HIV and syphilis testing. To determine the changes in the prevalence of HIV and syphilis, we analyzed these results and compared them to the results of our first survey.

Results

A total of 965 participants were recruited, including 489 MSWs and 476 ncMSM. Overall, the prevalence of HIV was 9.7%: 2.9% for MSWs and 16.8% for ncMSM (P < 0.001). 10.9% of the 965 participants tested positive for syphilis: 4.5% among MSWs and 17.4% among ncMSM (P < 0.001). The HIV prevalence in MSWs decreased from 4.5% in 2008 to 2.9% in 2014 (P = 0.143) but increased in ncMSM (7.0% in 2008 vs 16.8% in 2014, P < 0.001). Decreased syphilis rates were observed in both MSWs (12.9% in 2008 vs 4.5% in 2014, P < 0.001) and ncMSM (20.2% in 2008 vs 17.4% in 2014, P = 0.221).

Conclusions

Overall, there was a decline in the prevalence of HIV and syphilis in MSWs but not in ncMSM. The study indicated the need for continued efforts to improve public health, particularly to counter the rising rate of HIV in ncMSM.
Introduction

The HIV epidemic among men who have sex with men (MSM) has become a social issue in China. The prevalence of HIV infection among MSM increased from 5.98% in 2010 to 7.75% in 2014 [1, 2]. In 2015, the HIV prevalence among MSM has exceeded 8%, 27.2% of the newly diagnosed HIV-positive cases in China were attributed to MSM. Some MSM have double sexual behavior and resulted in transmitting the epidemic to general populations [3].

Shenzhen is a developed and commercialized city in southern China and is a bridge linking Hong Kong to mainland China. Because of Shenzhen’s job opportunities, the city attracts migrants, including MSM, from different parts of China. The city has more than 12 million migrants, which account for 87% of the total population [4]. The MSM population grew rapidly, with approximately 100,000 MSM living in the city [5]. The large number of MSM led to the emergence of a subgroup of MSM, male sex workers (MSWs). MSWs (also known as money boys) are hired to provide commercial sex services to males and sometimes to female clients [6]. Approximately 380,000 MSWs exist in China [7], with the number of MSWs in Shenzhen exceeding 4,000 [5]. MSWs engage repeatedly in sexual activities and are at particularly high risk of HIV infection [8]. The study conducted by Tang W. et al revealed that the prevalence of HIV and syphilis are high among MSWs in urban China [9].

Due to the high mobility of MSM population and active sexual activities in Shenzhen, to explore the changes of HIV/AIDS epidemic among MSM in this city could have great significance for China. In 2008, we first carried out a time-location sampling survey (TLS) to recruit both MSWs and non-commercial men who have sex with men (ncMSM) in Shenzhen [10]. The results indicated that MSWs and ncMSM showed differences in some sexual characteristics or behaviors [10]. This study was a second TLS conducted in 2014. This article presents an overview of current HIV prevalence and related behaviors and explores the changes in the prevalence of HIV/syphilis among MSWs and ncMSM in Shenzhen.

Methods

The TLS method

TLS is a venue-based sampling based on clusters. In TLS, a primary-sampling unit is defined as the combination of site and time, and the same site may be included in the sampling frame more than once, at different times of the day or week. Detailed methods were described previously [4, 5]. The method has been used to sample different high-risk groups [4, 5, 11].

Data collection

The parallel recruitment was conducted from June to November 2014. All the venues (e.g., bars, massage centers and saunas) providing sex for MSM were surveyed. In total, 46 MSM venues were included in our sampling frame, with 20 selected per month. As described in detailed previously [10], we recruited MSWs with the following criteria: (1) > 18 years old, (2) lived in Shenzhen for more than 1 month at the time of survey and (3) provided commercial sex services to males in the previous month. The inclusion criteria for MSM were (1) having homosexual activities in Shenzhen in the previous 6 months and not having been paid for male–male sex.

Eligible participants had to sign a consent form at the start of survey, then they were invited to complete a platform-assisted questionnaire. The questionnaire collected data on demographics and sexual behaviors (S1 and S2 Tables). After the questionnaire interview, blood
samples were taken by staff of the Shenzhen Center for Disease Control and Prevention (CDC) for HIV and syphilis testing.

As described in detailed previously [5, 10]. The testing was performed according to standard procedures provided by the Shenzhen CDC laboratory. HIV was tested by using a rapid test (Determine HIV-1/2/O, Abbott Laboratories, IL) and enzyme linked immunosorbent assay (Wantai Biotech Inc., Beijing) for screening and western blot analysis (Genlabs Diagnostics, Singapore) for confirmation. Syphilis was tested with the rapid plasma regain method (Rongsheng Biotech Inc., Shanghai) for qualitative screening and Treponema pallidum particle agglutination assay (Fujirebio Inc, Japan) for confirmation.

Data Analysis

Descriptive analysis was undertaken using SPSS 17.0 (SPSS Inc., Chicago, IL) to compare social and sexual behavioral characteristics of MSWs and ncMSM. Pearson chi-square, or non-parametric tests as applicable, were performed to find out factors related to HIV infection in the 2 groups. Then, we used multiple logistic regression analysis to determine the association between risk factors and HIV-syphilis infection in MSWs and MSM. Variables included in the analysis were from prior knowledge and from the results of univariate analysis (P < 0.2). For the MSWs, we added 3 additional variables: number of commercial male clients, selling sex to women and duration of sex work. P < 0.05 was considered statistically significant (S3 Table).

Ethics approve and informed consent

The study was approved by the Internal Review Board of the Shenzhen Center for Disease Control and Prevention (2012006). Written informed consent was obtained from all participants included in the study.

Results

HIV/Syphilis/sexually transmitted infections

We recruited 965 eligible participants (489 MSWs and 476 ncMSM). A total of 94 were HIV-seropositive (9.7%; 95% confidence interval [CI] 7.9–11.6%); 2.9% for MSWs (95%CI: 1.4–4.3%) and 16.8% for ncMSM (95%CI 13.5–20.2%) (P < 0.001). Overall, 105 participants were syphilis-positive (10.9%; 95%CI 8.9–12.9%); 4.5% for MSWs (95%CI 2.7–6.3%) and 17.4% for ncMSM (95%CI 14.0–20.9%) (P < 0.001). A large proportion of both MSWs and ncMSM who were HIV-positive were also syphilis-positive (18.2% for MSWs and 42.2% for ncMSM). There was a significant greater proportion of ncMSM reporting ever having being diagnosed with sexually transmitted infections (STIs) (9.7% for ncMSM and 0.8% for MSWs) (Table 1).

Sociodemographic Characteristics

All sociodemographic characteristics differed between MSWs and ncMSM (Table 1). NcMSM had an older age (≥30 years) (57.6% for ncMSM and 5.9% for MSWs) and generally had lived in Shenzhen for a longer time (>2 years) (61.1% for ncMSM and 27.2% for MSWs) compared to MSWs. MSW's tended to have higher monthly income. A large proportion of both MSWs and ncMSM who were HIV-positive had a low level of education (5.1% for MSWs and 25.5% for ncMSM) as did a large proportion of ncMSM with older age (>30 years old) (19.7% for ncMSM and 6.9% for MSWs), low monthly income (<3000, RMB) [18.5% for ncMSM and 6.1% for MSWs] and self-identified as bisexual (24.8% for ncMSM and 0% for MSWs).
Table 1. HIV infection and demographic/sexual behavior characteristics in MSWs and ncMSM.

| Participants, n(%) | P        | HIV-positive, n(%) |
|-------------------|----------|-------------------|
|                   | MSWs(n = 489) | ncMSM(n = 476) | MSWs(n = 14) | ncMSM(n = 80) |
| HIV-positive      | 14(2.9) | 80(16.8) | <0.001<sup>1</sup> | |
| Syphilis-positive |         | <0.001<sup>1</sup> | |
| Yes               | 22(4.5) | 83(17.4) | 4(18.2)<sup>2</sup> | 35(42.2)<sup>2</sup> |
| No                | 467(95.5) | 393(82.6) | 10(2.1) | 45(11.5) |
| Ever diagnosed with STIs | <0.001<sup>1</sup> | |
| Yes               | 4(0.8) | 46(9.7) | 1(25.0)<sup>4</sup> | 8(17.4) |
| No                | 485(99.2) | 430(90.3) | 13(2.7) | 72(16.7) |
| Age, years        |         | <0.001<sup>5</sup> | |
| <20               | 17(3.5) | 6(1.2) | 1(5.9) | 1(16.7)<sup>5</sup> |
| 20–29             | 443(90.6) | 196(41.2) | 12(2.7) | 25(12.8) |
| ≥30               | 29(5.9) | 274(57.6) | 1(3.4) | 54(19.7) |
| Length of stay in Shenzhen, years | <0.001<sup>1</sup> | |
| <1                | 119(24.3) | 111(23.3) | 4(3.4) | 22(19.8) |
| 1–2               | 237(48.5) | 74(15.6) | 6(2.5) | 17(23.0) |
| >2                | 133(27.2) | 291(57.6) | 4(3.0) | 41(14.1) |
| Venue type of recruitment | <0.001<sup>1</sup> | |
| Bar               | 315(64.4) | 112(23.5) | 7(2.2)<sup>4</sup> | 7(8.3)<sup>3</sup> |
| Dorm-based venue  | 161(32.9) | 102(21.4) | 5(3.1) | 10(9.8) |
| Recreational center | 10(2.1) | 175(36.8) | 1(10.0) | 46(26.3) |
| Sauna             | 3(0.6) | 87(18.3) | 1(33.3) | 17(19.5) |
| Education         | <0.001<sup>5</sup> | |
| Junior high school or less | 117(23.9) | 102(21.4) | 6(5.1)<sup>7</sup> | 26(25.5)<sup>6</sup> |
| Senior high school | 287(58.7) | 161(33.8) | 7(2.4) | 34(21.1) |
| College or above  | 85(17.4) | 213(44.7) | 1(1.2) | 20(9.4) |
| Employment        | <0.001<sup>1</sup> | |
| Unemployed/part-time/retired | 37(7.6) | 67(14.1) | 1(2.7) | 11(16.4) |
| Full-time employed | 451(92.2) | 397(83.4) | 13(2.9) | 67(16.9) |
| Student           | 1(0.2) | 12(2.5) | 0(0) | 2(16.7) |
| Monthly income, RMB | <0.001<sup>5</sup> | |
| ≤3000             | 66(13.5) | 108(22.7) | 4(8.1) | 20(18.5)<sup>5</sup> |
| 3001–5000         | 168(34.4) | 234(49.2) | 5(3.0) | 44(18.8) |
| >5000             | 255(52.1) | 134(28.1) | 5(2.0) | 16(11.9) |
| Marital status    | <0.001<sup>1</sup> | |
| Married           | 20(4.1) | 135(28.4) | 2(10.0) | 28(20.7) |
| Unmarried         | 469(95.9) | 341(71.6) | 12(2.4) | 52(15.2) |
| Sexual orientation | <0.001<sup>1</sup> | |
| Gay               | 312(63.8) | 319(67.0) | 10(3.2) | 44(13.8)<sup>4</sup> |
| Bisexual          | 42(8.6) | 105(22.1) | 0(0) | 26(24.8) |
| Heterosexual or unsure | 135(27.6) | 52(10.9) | 4(3.0) | 10(19.2) |
| Anal sex role     | <0.001<sup>1</sup> | |
| Insertive only    | 218(44.6) | 188(39.5) | 7(3.2)<sup>4</sup> | 25(13.3) |
| Receptive only    | 23(4.7) | 67(14.1) | 3(13.0) | 10(14.9) |
| Both              | 248(50.7) | 221(46.4) | 4(1.6) | 45(20.4) |
| Gender of the first sexual partner | 0.141<sup>1</sup> | 0.009<sup>6</sup> | |
| Male              | 355(72.6) | 325(68.3) | 10(2.8) | 43(13.2)<sup>4</sup> |
| Female            | 134(27.4) | 151(31.7) | 4(3.0) | 3(24.5) |
| Age at sex debut, years | 0.009<sup>6</sup> | |
| <18               | 127(26.0) | 69(14.5) | 2(1.6) | 11(15.9) |
| 19–25             | 349(71.4) | 305(64.1) | 10(2.9) | 48(15.7) |
| >26               | 13(2.7) | 102(21.4) | 2(15.4) | 21(20.6) |

(Continued)
Table 1. (Continued)

|                                | Participants, n(%) | P       | HIV-positive, n(%) |
|--------------------------------|--------------------|---------|--------------------|
|                                | MSWs (n = 489)     | n=476   | MSWs (n = 14)      | n=80               |
| Male sex partner<sup>a</sup>   |                    |         |                    |
| 0                              | 158(32.3)          | 71(14.9)| 4(2.5)             | 13(18.3)           |
| 1                              | 62(12.7)           | 138(29.0)| 2(3.2)             | 16(11.6)           |
| >1                             | 269(55.0)          | 267(56.1)| 8(3.0)             | 51(19.1)           |
| Female sex partner<sup>a</sup> |                    |         |                    |
| 0                              | 426(87.1)          | 436(92.2)| 12(2.8)            | 73(16.7)           |
| 1                              | 19(3.9)            | 34(7.2) | 1(5.3)             | 7(20.6)            |
| >1                             | 44(9.0)            | 3(0.6)  | 1(2.3)             | 0(0)               |
| Had one-night stand with male partner<sup>a</sup> |         |         |                    |
| Yes                            | 296(60.5)          | 305(64.1)| 7(2.4)             | 58(19.0)           |
| No                             | 193(39.5)          | 171(35.9)| 7(3.6)             | 22(12.9)           |
| Group sex<sup>b</sup>          |                    |         |                    |
| Yes                            | 36(7.4)            | 56(11.8)| 0(0)               | 13(23.2)           |
| No                             | 453(92.6)          | 420(88.2)| 14(3.1)            | 67(16.0)           |
| Commercial male partner<sup>a</sup> |         |         |                    |
| ≤4                             | 21(43.1)           | -       | 8(3.8)             | -                  |
| >4                             | 278(56.9)          | -       | 6(2.2)             | -                  |
| Sold sex to women<sup>a</sup>  |                    |         |                    |
| Yes                            | 37(7.6)            | -       | 0(0)               | -                  |
| No                             | 452(92.4)          | -       | 14(3.1)            | -                  |
| Duration of sex work, years    |                    |         |                    |
| <1                             | 135(27.6)          | -       | 1(0.7)             | -                  |
| 1–3                            | 313(64.0)          | -       | 10(3.2)            | -                  |
| >3                             | 41(8.4)            | -       | 3(7.3)             | -                  |
| Condom use with male sex partner<sup>a</sup> |         |         |                    |
| Yes                            | 400(81.8)          | 348(73.1)| 8(2.0)<sup>4</sup> | 61(17.5)           |
| No                             | 89(18.2)           | 128(26.9)| 6(6.7)             | 19(14.8)           |
| Condom use with female sex partner<sup>a</sup> |         |         |                    |
| Yes                            | 53(10.8)           | 20(4.2) | 2(3.8)             | 5(25.0)            |
| No                             | 436(89.2)          | 456(95.8)| 12(2.8)            | 75(16.4)           |
| Ever used illicit drugs        |                    |         |                    |
| Yes                            | 128(26.2)          | 189(39.7)| 6(4.7)             | 24(12.7)           |
| No                             | 361(73.8)          | 287(60.3)| 8(2.2)             | 56(19.5)           |
| Had a previous HIV test        |                    |         |                    |
| Yes                            | 373(76.3)          | 306(64.3)| 7(1.9)<sup>4</sup> | 36(11.8)<sup>3</sup>|
| No                             | 116(23.7)          | 170(35.7)| 7(6.0)             | 44(25.9)           |

<sup>1</sup> Two-sided chi-square test of proportions
<sup>2</sup> HIV-positive rate
<sup>3</sup> P<0.001 and
<sup>4</sup> P<0.05 by chi-square test of rate of HIV infection in different categories of MSWs and ncMSM
<sup>5</sup> Non-parametric test
<sup>6</sup> P<0.001 and
<sup>7</sup> P<0.05 by non-parametric test of rate of HIV infection in different categories of MSWs and ncMSM
<sup>8</sup> Within 6 months

STI, sexually transmitted infection

doi:10.1371/journal.pone.0167619.t001
Sexual Practices

Both similarities and differences in sexual behaviors were observed in the 2 compared groups (Table 1). 63.8% MSWs and 67.0% ncMSM self-identified as gay or homosexual. In the previous 6 months, 55.0% MSWs and 56.1% ncMSM had more than one male sex partner. A greater proportion of both MSWs (60.5%) and ncMSM (64.1%) had one-night-stand sex with a male partner. 7.4% of MSWs and 11.8% of ncMSM reported engaging in group sex. A slightly higher proportion of MSWs than ncMSM reported condom use during male sex (81.8% vs 73.1%), and more MSWs than ncMSM reported the use of condoms during female sex (10.8% for MSWs and 4.2% for ncMSM). More ncMSM than MSWs reported having used illicit drugs (39.7% vs 26.2%). In addition, 64.0% of MSWs engaged in sex work for 1 to 3 years, 8.4% longer than 3 years. 56.9% MSWs reported having more than 4 male clients, but only a few (7.6%) had sold sex to women in the past 6 months.

For MSWs, HIV infection rates were high for those with receptive anal intercourse or not using condoms during male sex and previous HIV test. HIV infection rates were high for ncMSM who reported their first sex partner as female and no previous HIV test.

The comparisons with previous survey

Table 2 presents the HIV and syphilis infection rate for each group and compares with this data with the previous data collected in 2008. The syphilis-positive rate in MSWs significantly decreased [12.9% in 2008 vs 4.5% in 2014 (P<0.001)]. In addition, the HIV-infection rate in MSWs [4.5% in 2008 vs 2.9% in 2014 (P = 0.143)] and the syphilis-positive rate in ncMSM [20.2% in 2008 vs 17.4% in 2014 (P = 0.221)] also decreased. However, a significantly increased HIV-infection rate was observed in ncMSM [7.0% in 2008 vs 16.8% in 2014 (P<0.001)].

Factors correlated with HIV infection of MSWs and ncMSM

In the univariate analyses (unadjusted models) (Table 3), HIV infection among MSWs was positively associated with syphilis infection (OR = 10.2, 95%CI: 2.9–35.5), previous HIV testing (OR = 3.4; 95%CI: 1.2–9.8), taking both receptive and insertive anal sex role (OR = 9.2; 95%CI: 1.9–43.8), and reporting ever having been diagnosed with STIs (OR = 12.1; 95%CI: 1.2–124.3), but condom use in male–male sex was less likely to be HIV infection (OR = 0.3; 95%CI: 0.1–0.8). For ncMSM, syphilis infection (OR = 5.6; 95%CI: 3.3–9.6), receiving a higher education (college above) (OR = 2.6; 95%CI: 1.4–4.7) and first sex with male partner (OR = 2.1; 95%CI: 1.3–3.4) were associated with HIV-positivity, but previous HIV testing

### Table 2. A comparison with the data from the previous survey.

|                  | **MSWs, n(%)** |                  | **ncMSM, n(%)** |                  |
|------------------|---------------|------------------|---------------|----------------|
|                  | Survey in 2008(n = 850) | Survey in 2014(n = 498) | P              | Survey in 2008(n = 801) | Survey in 2014(n = 476) | P              |
| HIV-positive     |               |                  | 0.143         |                  |               | 0.000         |
| Yes             | 38(4.5)       | 14(2.9)          |               | 56(7.0)          | 80(16.8)       |               |
| No              | 812(95.5)     | 475(97.1)        |               | 745(93.0)        | 396(83.2)       |               |
| Syphilis-positive|               |                  | 0.000         |                  |               | 0.221         |
| Yes             | 110(12.9)     | 22(4.5)          |               | 162(20.2)        | 83(17.4)        |               |
| No              | 740(87.1)     | 467(95.5)        |               | 639(79.8)        | 393(82.6)       |               |

TLS, time-location sampling survey

1 Two-sided chi-square test of proportions

doi:10.1371/journal.pone.0167619.t002
and elder in age (>30) (OR = 0.6; 95%CI: 0.4–0.9) were negatively associated with HIV infection.

In multivariate regression analysis (Table 3), most of the HIV associations remained significant. Syphilis infection (adjusted OR [aOR] = 9.0; 95%CI: 2.4–33.5) and reporting ever having being diagnosed with STIs (aOR = 13.9; 95%CI: 1.5–134.6) were independently associated with HIV infection in MSWs, but condom use in male–male sex (aOR = 0.3; 95%CI: 0.1–0.9) was protective. Syphilis infection (aOR = 5.9; 95%CI: 3.2–10.9), having a higher education (college above) (aOR = 2.1; 95%CI: 1.0–4.2) and first sex with male partner (aOR = 2.1; 95%CI: 1.2–3.9) were positively associated with HIV infection in ncMSM, but having had an HIV test (aOR = 0.4; 95%CI: 0.2–0.7) was a protective factor.

In logistic regression analyses evaluating the risk factors for combined HIV infection (Table 4), syphilis infection, reporting ever having being diagnosed with STIs, having a higher monthly income and being married were associated with HIV-positivity. After controlling for MSM type, syphilis infection and having a higher education such as senior high school, college or above were associated with an increased HIV infection.

**Discussion**

The current study provides updated data about HIV and syphilis prevalence for MSWs and ncMSM. Our finding confirmed that the prevalence of HIV and syphilis were reduced in MSWs but not in ncMSM.

For MSWs, the overall prevalence of HIV decreased from 4.5% to 2.9% and the syphilis-positive rate decreased from 12.9% to 4.5% compared with 2008. The prevalence of HIV and syphilis in MSWs in Shenzhen were lower than MSWs in other parts in China [12]. Many factors may contribute to the reduction in the prevalence of HIV among MSWs but not among ncMSM. First, condom use in MSWs was increased. In the survey, we found a higher rate of condom use by MSWs than ncMSM during male sex. Therefore, the risk of HIV infection was reduced by this protective behavior. Second, because the sole aim of sex for most MSWs was to earn money rather than pursuit of sexual gratification, MSWs were more likely to adopt...
### Table 4. Factors correlated with combined HIV infection.

| Characteristics                        | HIV+/total | Univariate OR(95%CI) | P | Adjusted for MSM type OR(95%CI) | P |
|----------------------------------------|------------|----------------------|---|---------------------------------|---|
| Syphilis-positive                       |            |                      |   |                                 |   |
| No                                     | 55/860     | 1                    |   |                                 |   |
| Yes                                    | 39/105     | 8.6(5.3,14.0)        | 0.000 | 6.1(3.7,10.1) | 0.000 |
| Ever diagnosed with STIs               |            |                      |   |                                 |   |
| No                                     | 85/915     | 1                    |   |                                 | NS |
| Yes                                    | 9/50       | 2.1(1.0,4.6)         | 0.048 |                                 |   |
| Age, years                             |            |                      |   |                                 |   |
| <20                                    | 2/23       | 1                    |   |                                 | NS |
| 20–29                                  | 36/639     | 0.4(0.1,1.18)        | 0.250 |                                 | NS |
| >30                                    | 56/303     | 0.3(0.2,0.4)         | 0.000 | 0.6(0.3,0.9) | 0.024 |
| Education                              |            |                      |   |                                 |   |
| Junior high school or less             | 32/219     | 1                    |   |                                 | NS |
| Senior high school                     | 41/448     | 2.3(1.3,4.0)         | 0.006 | 3.5(1.9,6.4) | 0.000 |
| College or above                       | 21/298     | 1.3(0.8,2.3)         | 0.309 | 2.4(1.4,4.4) | 0.002 |
| Employment                             |            |                      |   |                                 |   |
| Full-time employed                     | 80/848     | 1                    |   |                                 | NS |
| Unemployed/part-time/retired           | 12/104     | 0.6(0.1,2.6)         | 0.474 |                                 | NS |
| Student                                | 2/13       | 0.7(0.1,3.6)         | 0.688 |                                 | NS |
| Monthly income, RMB                    |            |                      |   |                                 |   |
| ≤3000                                  | 24/174     | 1                    |   |                                 | NS |
| 3001–5000                              | 49/402     | 2.8(1.5,5.2)         | 0.001 |                                 | NS |
| >5000                                  | 21/389     | 2.4(1.4,4.1)         | 0.001 |                                 | NS |
| Marital status                         |            |                      |   |                                 |   |
| Unmarried                              | 64/810     | 1                    |   |                                 | NS |
| Married                                | 30/155     | 2.8(1.7,4.5)         | 0.000 |                                 | NS |
| Sexual orientation                     |            |                      |   |                                 |   |
| Gay                                    | 54/631     | 1                    |   |                                 | NS |
| Bisexual                               | 26/147     | 1.2(0.6,2.1)         | 0.641 |                                 | NS |
| Heterosexual or unsure                 | 14/187     | 2.7(1.3,5.3)         | 0.006 |                                 | NS |
| Anal sex role                          |            |                      |   |                                 |   |
| Insertive only                         | 32/406     | 1                    |   |                                 | NS |
| Receptive only                         | 13/90      | 0.7(0.5,1.2)         | 0.193 |                                 | NS |
| Both                                   | 49/469     | 1.4(0.7,2.8)         | 0.217 |                                 | NS |
| Gender of first sexual partner         |            |                      |   |                                 |   |
| Female                                 | 41/285     | 1                    |   |                                 | NS |
| Male                                   | 53/680     | 0.5(0.3,0.7)         | 0.002 | 0.5(0.3,0.8) | 0.005 |
| Age at sex debut, years                |            |                      |   |                                 |   |
| ≤18                                    | 15/196     | 1                    |   |                                 | NS |
| 19–25                                  | 58/653     | 0.4(0.2,0.8)         | 0.006 |                                 | NS |
| >26                                    | 21/115     | 0.4(0.3,0.8)         | 0.003 |                                 | NS |
| Male sex partner¹                      |            |                      |   |                                 |   |
| 0                                      | 17/229     | 1                    |   |                                 | NS |
| 1                                      | 18/200     | 0.6(0.4,1.1)         | 0.132 |                                 | NS |
| >1                                     | 59/536     | 0.8(0.5,1.4)         | 0.429 |                                 | NS |
| Female sex partner¹                    |            |                      |   |                                 |   |
| 0                                      | 85/865     | 1                    |   |                                 | NS |

(Continued)
protective behavior compared with ncMSM, thus protecting their health and decreasing their risk of infection.

For MSWs, HIV-positivity was positively associated with previous HIV testing by logistic regression analysis. The reasons for higher HIV infection rate in those HIV testers may be explained as follows. MSWs engaged in high-risk work. Due to self-protection awareness and were more likely to be knowledgeable about AIDS [13], these workers were more willing to undergo frequent HIV testing. We found more MSWs underwent HIV testing compared with ncMSM. However, the study showed that repeat testers are more likely to engage in high-risk sexual behavior than non-repeat testers [13]. So for MSWs, frequent testing might be associated with risky behaviors (sex work). In contrast, we found a higher HIV infection rate in ncMSM who reported no previous HIV testing. This is a significant problem, as non-testers may not be aware of their HIV infection status, and infected non-testers can unknowingly transmit the disease to their partners [14], thereby leading to a high rate of HIV infection.

For ncMSM, a notable finding was that the HIV-infection rate increased from 7.0% to 16.8%. The HIV prevalence in ncMSM in Shenzhen was higher than ncMSM in other regions in China [9, 15]. Overall, HIV has continued to spread rapidly among MSM in China [16, 17]. Many ncMSM in our study have been infected elsewhere but were tested and found to be positive in Shenzhen. For one thing, most MSM are not Shenzhen natives (in our study, 19.8% infected ncMSM living in Shenzhen for less 1 year, 23.0% of these people living in this city for 1 to 2 years), they come from different parts of China. NcMSM usually have male-male sex

| Characteristics                        | HIV+/total | Univariate OR(95%CI) P | Adjusted for MSM type OR(95%CI) P |
|----------------------------------------|------------|------------------------|----------------------------------|
| 1                                      | 8/53       | 5.0(0.7,36.8) 0.113    | NS                               |
| >1                                     | 1/47       | 8.2(0.9,68.1) 0.052    | NS                               |
| Had one-night stand with male partner  |            |                        |                                  |
| No                                     | 29/364     | 1                      | 1                                |
| Yes                                    | 65/601     | 1.4(0.9,2.2) 0.148     | NS                               |
| Group sex                              |            |                        |                                  |
| No                                     | 81/873     | 1                      | 1                                |
| Yes                                    | 13/92      | 1.6(0.9,3.0) 0.135     | NS                               |
| Condom use with male sex partner       |            |                        |                                  |
| No                                     | 25/217     | 1                      | 1                                |
| Yes                                    | 69/748     | 0.8(0.5,1.3) 0.315     | NS                               |
| Condom use with female sex partner     |            |                        |                                  |
| No                                     | 87/892     | 1                      | 1                                |
| Yes                                    | 7/73       | 0.9(0.4,2.2) 0.964     | NS                               |
| Ever used illicit drugs                |            |                        |                                  |
| No                                     | 64/648     | 1                      | 1                                |
| Yes                                    | 30/317     | 1.0(0.6,1.5) 0.839     | NS                               |
| Had a previous HIV test                |            |                        |                                  |
| No                                     | 51/543     | 1                      | 1                                |
| Yes                                    | 43/422     | 1.1(0.7,1.7) 0.679     | 0.5(0.3,0.8) 0.006               |

1 Within 6 months
OR, odds ratio
NS, not significant

doi:10.1371/journal.pone.0167619.t004
elsewhere and then possibly continue homosexual activities in Shenzhen. In contrast to ncMSM, MSWs may provide commercial sex services only in Shenzhen or start their sex work career in Shenzhen. Once MSWs have earned enough money, they may stop this work and/or leave Shenzhen. Therefore, the HIV-infection risk in ncMSM was much higher than in MSWs. Our study found that ncMSM were more likely than MSWs to be HIV- or syphilis-positive. Additionally, most ncMSM do not stay in Shenzhen for a long time. Due to high liquidity of the population and the difficulty in identification of ncMSM (due to social stigma), there are few effective intervention strategies to target this population. For this reason, the spread of HIV in ncMSM may not be well-controlled.

We found that the syphilis positive rate in ncMSM decreased from 20.2% to 17.4% compared with the results of the previous survey in 2008. The prevalence of syphilis was 10.9% among MSM (95% CI: 9.8–12.1%) during 2010 to 2013 in China [18]. Therefore, the syphilis infection rate in Shenzhen maintains at a stable level, but shows a general tendency of decline. In addition, the results indicated a higher rate of HIV infection for ncMSM who were syphilis-positive. Because of the shared transmission routes of the 2 infections and because of adverse interactions—syphilis facilitates both HIV transmission and acquisition [19]—the co-infection rate of syphilis and HIV is high. HIV can alter the clinical manifestations of syphilis and, in turn, syphilis induces immune activation and favors viral replication, so it may accelerate HIV transmission [20, 21]. Syphilis–HIV co-infection remains a major public health issue, especially among MSM [22].

There are limitations of this study. Our study was not a cohort study, but two cross-sectional studies. The included population may vary between the two studies, precluding direct comparison of HIV infection rate and behavioral changes. However, due to the high liquidity and instability of the MSWs and ncMSM populations in Shenzhen, performing a cohort study was impossible. Therefore, a series of cross-sectional studies was a reasonable alternative.

In summary, compared with the data from the previous survey in 2008, both the HIV-infection and syphilis-positive rates were decreased in MSWs. Additionally, the syphilis-positive rate in ncMSM was also decreased. However, we detected a possible increasing prevalence of HIV among ncMSM. The rising rate of HIV in ncMSM show targeted interventions for this group still need to be strengthened and improved to combat this public health problem.

**Supporting Information**

S1 Table. The survey questions in Chinese.
(DOCX)

S2 Table. The survey questions in English.
(DOCX)

S3 Table. The dataset for analysis.
(XLS)

**Acknowledgments**

The authors thank all participants, MSM volunteers from the 258 Rainbow Workgroup, and the staff of Shenzhen Center for Disease Control and Prevention laboratory.

**Author Contributions**

Conceptualization: JZ KL.

Data curation: YH YZ.
Formal analysis: YH YZ.

Funding acquisition: JZ.

Investigation: YH YZ.

Methodology: JZ KL YH.

Project administration: JZ KL.

Resources: JZ.

Supervision: JZ KL.

Visualization: YH JZ YZ.

Writing – original draft: YH YZ.

Writing – review & editing: YH.

References

1. Cui Y, Guo W, Li D, Wang L, Shi CX, Brookmeyer R, et al. Estimating HIV incidence among key affected populations in China from serial cross-sectional surveys in 2010–2014. Journal of the International AIDS Society. 2016; 19(1):20609. Epub 2016/03/19. PubMed Central PMCID: PMC4796775. doi: 10.7448/IAS.19.1.20609 PMID: 26989062

2. Zhang L, Chow EP, Jing J, Zhuang X, Li X, He M, et al. HIV prevalence in China: integration of surveillance data and a systematic review. The Lancet Infectious diseases. 2013; 13(11):955–63. Epub 2013/10/11. doi: 10.1016/S1473-3099(13)70245-7 PMID: 24107261

3. Liu S, Zhao J, Rou K, Chen L, Cai W, Li L, et al. A survey of condom use behaviors and HIV/STI prevalence among venue-based money boys in Shenzhen, China. AIDS and behavior. 2012; 16(4):835–46. Epub 2011/07/30. PubMed Central PMCID: PMCPmc3224195. doi: 10.1007/s10461-011-9978-y PMID: 21800179

4. Cai WD, Zhao J, Zhao JK, Raymond HF, Feng YJ, Liu J, et al. HIV prevalence and related risk factors among male sex workers in Shenzhen, China: results from a time-location sampling survey. Sexually transmitted infections. 2010; 86(1):15–20. Epub 2009/10/27. doi: 10.1136/sti.2009.037440 PMID: 19854703

5. Zhao J, Cai WD, Chen L, Zhao JK, Gan YX, Zi YY, et al. A comparison of HIV infection and related risks among male sex workers in different venues in Shenzhen, China. AIDS and behavior. 2011; 15(3):635–42. Epub 2010/08/17. doi: 10.1007/s10461-010-9786-9 PMID: 20711650

6. Meng X, Anderson AF, Wang L, Li Z, Guo W, Lee Z, et al. An exploratory survey of money boys and HIV transmission risk in Jilin Province, PR China. AIDS research and therapy. 2010; 7:17. Epub 2010/06/23. PubMed Central PMCID: PMCPmc2898659. doi: 10.1186/1742-6405-7-17 PMID: 20565763

7. He N, Wong FY, Huang ZJ, Ding Y, Fu C, Smith BD, et al. HIV risks among two types of male migrants in Shanghai, China: money boys vs. general male migrants. AIDS (London, England). 2007; 21 Suppl 8:S73–9. Epub 2008/01/10.

8. Tun W, de Mello M, Pinho A, Chinaglia M, Diaz J. Sexual risk behaviours and HIV seroprevalence among male sex workers who have sex with men and non-sex workers in Campinas, Brazil. Sexually transmitted infections. 2008; 84(6):455–7. Epub 2008/11/26. doi: 10.1136/sti.2008.031336 PMID: 19028946

9. Tang W, Mahapatra T, Liu F, Fu G, Yang B, Tucker JD, et al. Burden of HIV and Syphilis: A Comparative Evaluation between Male Sex Workers and Non-Sex-Worker Men Who Have Sex with Men in Urban China. PLoS one. 2015; 10(5):e0126604. Epub 2015/05/12. PubMed Central PMCID: PMCPmc4427281. doi: 10.1371/journal.pone.0126604 PMID: 25961721

10. Zhao J, Cai WD, Gan YX, Zhang Y, Yang ZR, Cheng JQ, et al. A comparison of HIV infection and related risk factors between money boys and noncommercial men who have sex with men in Shenzhen, China. Sexually transmitted diseases. 2012; 39(12):942–8. Epub 2012/11/30. doi: 10.1097/OLQ.0b013e31826f356f PMID: 23191947

11. Zhao J, Cai R, Chen L, Cai W, Yang Z, Richardus JH, et al. A comparison between respondent-driven sampling and time-location sampling among men who have sex with men in Shenzhen, China. Archives of sexual behavior. 2015; 44(7):2055–65. Epub 2014/09/23. doi: 10.1007/s10508-014-0350-y PMID: 25239658
12. Chen L, Mahapatra T, Fu G, Huang S, Zheng H, Tucker JD, et al. Male Clients of Male Sex Workers in China: An Ignored High-Risk Population. Journal of acquired immune deficiency syndromes (1999). 2016; 71(3):316–22. Epub 2016/02/13. PubMed Central PMCID: PMCPmc4755356.

13. Bai X, Xu J, Yang J, Yang B, Yu M, Gao Y, et al. HIV prevalence and high-risk sexual behaviours among MSM repeat and first-time testers in China: implications for HIV prevention. Journal of the International AIDS Society. 2014; 17:18848. Epub 2014/07/06. PubMed Central PMCID: PMCPmc4082255. doi: 10.7448/IAS.17.1.18848 PMID: 24993457

14. Shi TX, Zhang BC, Li XF, Xu JX, Wang N, Yu ZZ, et al. [Study on the high risk behaviors related to AIDS among men who have sex with men in the floating population]. Zhonghua liu xing bing xue za zhi = Zhonghua liuxingbingxue zazhi. 2009; 30(7):668–71. Epub 2009/12/05. PMID: 19957586

15. Huan X, Hao C, Yan H, Guan W, Xu X, Yang H, et al. High prevalence of HIV and syphilis among men who have sex with men recruited by respondent-driven sampling in a city in Eastern China. Asia-Pacific journal of public health / Asia-Pacific Academic Consortium for Public Health. 2015; 27(2):Np854–65. Epub 2013/03/29.

16. Wu Z, Wang Y, Detels R, Rotheram-Borus MJ. China AIDS policy implementation: reversing the HIV/AIDS epidemic by 2015. International journal of epidemiology. 2010; 39 Suppl 2:i1–3. Epub 2010/12/09. PubMed Central PMCID: PMCPmc2992622.

17. Zhang X, Wang C, Hengwei W, Li X, Li D, Ruan Y, et al. Risk factors of HIV infection and prevalence of co-infections among men who have sex with men in Beijing, China. AIDS (London, England). 2007; 21 Suppl 8:S53–7. Epub 2008/01/10.

18. Huang Q, Li Q, Li Y, Zeng G, Cui X, Yan P, et al. [Prevalence of HIV infection and syphilis, sexual behaviors and awareness of HIV/AIDS related knowledge among men who have sex with men in China: a Meta-analysis of data collected from 2010 to 2013]. Zhonghua liu xing bing xue za zhi = Zhonghua liuxingbingxue zazhi. 2015; 36(11):1297–304. Epub 2016/02/07. PMID: 26850255

19. Shimelis T, Lemma K, Ambachew H, Tadesse E. Syphilis among people with HIV infection in southern Ethiopia: sero-prevalence and risk factors. BMC infectious diseases. 2015; 15:189. Epub 2015/04/18. PubMed Central PMCID: PMCPmc4496018. doi: 10.1186/s12879-015-0919-7 PMID: 25884178

20. Stevenson J, Heath M. Syphilis and HIV infection: an update. Dermatologic clinics. 2006; 24(4):497–507, vi. Epub 2006/10/03. doi: 10.1016/j.det.2006.06.013 PMID: 1701778

21. Ghanem KG. Evaluation and Management of Syphilis in the HIV-Infected Patient. Current infectious disease reports. 2010; 12(2):140–6. Epub 2011/02/11. doi: 10.1007/s11908-010-0083-6 PMID: 21308510

22. Chow EP, Wilson DP, Zhang L. HIV and syphilis co-infection increasing among men who have sex with men in China: a systematic review and meta-analysis. PLoS one. 2011; 6(8):e22768. Epub 2011/08/23. PubMed Central PMCID: PMCPmc3156129. doi: 10.1371/journal.pone.0022768 PMID: 21857952