

RESEARCH ARTICLE

Prevalence and Trends of HIV, Syphilis, and HCV in Migrant and Resident Men Who Have Sex with Men in Shandong, China: Results from a Serial Cross-Sectional Study

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Abstract

Background

Migrant men who have sex with men (MSM) have a higher predisposition for HIV transmission. We aimed to determine and compare the prevalence and trends of HIV, Syphilis, and HCV between migrant and resident MSM in Shandong, China.

Methods

A serial cross-sectional study was conducted in eight cities in Shandong, China from 2010 to 2014. The surveys collected information on demographics, HIV-related knowledge, and HIV-related behaviors including the serologic status of HIV, syphilis, and HCV. Bivariate and multivariable logistic regressions were used to determine differences between migrant and resident MSM.

Results

The overall prevalence of HIV among the 15,705 MSM (14120 were resident, 1580 were migrant and 5 were missing) was 2.6%, with an increase of 1.0% in 2010 to 4.4% in 2014. Prevalence of HIV was higher among migrant MSMs (5.5%) compared to resident MSMs (2.3%). Compared to residents, migrants also had higher prevalence of syphilis (7.5% vs 4.9%) and HCV (1.1% vs 0.6%). We found that there was an increase in the proportion of migrant MSM engaging in anal sex [adjusted OR (AOR) = 1.41 in migrants vs 1.12 in residents], condom use during last anal sex (AOR = 1.14 in residents, *P for trend* = 0.32), consistent condom use (AOR = 1.04 residents, *P for trend* = 0.11) and drug use (AOR = 1.51 in migrants and 1.29 among residents). Except in the year 2011, receiving some health services in last year was significant for people who were HIV-positive compared to negative. (*P for trend* < 0.05).

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Conclusions

Prevalence of HIV increased in resident as well as migrant MSMs. The migrant MSMs had higher STIs compared to resident MSMs and therefore, should be targeted for effective interventions aimed at reducing their risk behaviors. Deeper understanding of the role of migration in health issues is required for combating the persistently high and gradually increasing HIV burden in MSM in China.

Introduction

Sexually transmitted infections (STIs) including HIV, syphilis and HCV are major global health problems in men who have sex with men (MSM)[1]. Despite the overall decline in HIV incidence, developed nations such have witnessed a rise in incidence among MSM[[2, 3]. There is also evidence of a sustained epidemic of STI continuing in MSM in several other countries[1]. These contrast sharply with the overall increasing prevalence of HIV in MSM in China [3]. In addition, the reports indicate that MSM engaging in high-risk sexual behaviors has changed over a period of time in China[1]. This is fueled by dramatic demographic shifts seen in China, as most of the men migrate from rural to urban areas in search of employment. As a result, internal migration within China is established as a major factor influencing the distribution of the HIV epidemic in China.

Several studies have documented that migrants have high risky sexual behaviors and STIs than non-migrants [4][5]. Male Migrants seek sexual relationships in the area of the workplace; become part of a newer sexual network, which may in part explain the rise in STI incidence[6]. The higher risk of STIs in migrants may be borne out of ignorance about; safe sex practices, available health services for prevention and therefore, are less likely to utilize the STI prevention services. In addition, migrants might also be infected prior to their migration[7]., The accurate data on the quantum of change in the prevalence of STIs over time and documentation on shifts in sexual behaviors in the migrant and resident MSMs are largely unavailable. By examining the trends in HIV/STIs and sexual behaviors in migrant and resident MSM in Shandong, China; this study aims to fill the knowledge gap and aims to help in understanding the requirement for setting policy priorities.

Methods

Design

We conducted a serial cross-sectional study using data collected from sentinel surveillance systems in eight different cities between 2010 and 2014 in Shandong, China. The study protocol was standardized and was uniformly implemented in all the surveillance sites. Staff members were trained in a standardized manner using an approved training module. We followed multistage mixed method sampling; wherein, recruitment was done through snowballing using the venues and internet.

Participants

The included participants were men aged 18 years or older, have had sex with another man during the past year and provided informed consent for participating in the study. In order to avoid duplicate measurements, the individuals who had taken part in the study in the same year were excluded. The snowball sampling comprised of identifying MSM who were eligible

and soliciting information from them to recommend others who might be eligible. We used probability proportional to size for selection sampling based on the available samples in each study city. This was supported by a comprehensive list made available by the Centers to Disease Control (CDC); that contained maps of all potential meeting places for sexual partners of MSMs. We categorized these venues into two groups. The first one (Group A) comprised of pubs, discos, tearooms, clubs, bathhouses, and saunas. The second group (B) included places such as parks, public restrooms, and public lawns. The prerequisite numbers of venues in each selected city were selected from both groups using the method of probability proportional to size. In contrast, we used notifications regarding the study in Internet-based sampling; wherein, invitations for participation were sent to the online audience including posting on local MSM community-based organizations. We sought the help of discussion forums of local gay websites and online chat rooms for greater participation.

Sample size

Based on recommendations of the WHO [8], we estimated that 250 to 400 persons are required to be recruited in each city. The sample size was calculated by using the formula:

$$n_i = \frac{\left(z_{1-\frac{\alpha}{2}}^2 p(1-p) \right)}{e^2}$$
, where, $z_{1-\frac{\alpha}{2}}^2 = 1.96$ at the 95% confidence level; p is the expected proportion of patients with the outcome (e.g. HIV prevalence in Jinan); e^2 is the expected half-width of the interval [5, 9]. Thereby, we recruited 250 in two cities of Heze and Zibo and 400 in other four cities.

Behavioral measures

Using a structured and pretested protocol, we collected data about demographics, sexual practices, and correlates of HIV and different STIs. We defined *migrant* MSM as those participants who had residency outside of Shandong Province, while resident MSM had residency within Shandong Province. Sexual practices included having intercourse with both male and female partners, frequency of condom use during sex, condom use during last anal or vaginal sex in the past 6 months. Information on commercial anal intercourse, condom use in the past 6 months, and history of injecting drugs (yes or no) were also collected. HIV-related knowledge was evaluated using eight questions. Answering six or more questions correctly (75% or higher) was defined as having adequate HIV-related knowledge. Data on apportionment of free condom/oils, needle exchange, care programs, guidelines, treatment, coordinating and testing for HIV/STIs was collected. No unique identification information was preserved and all the interviews were anonymous.

Serologic measures

Subsequent to conducting interviews, five milliliters of venous blood was collected from every member for confirming the status of HIV, HCV, and syphilis. For both HIV and HCV, one test positive for respective Enzyme-Linked Immunosorbent Assay (ELISA) test (ELISA-1) was used for screening purpose; while, diagnostic after positive for (ELISA-2). In the case of Syphilis, antibodies were screened utilizing an ELISA test but a Rapid Plasma Reagin (RPR) was used to confirm ELISA positives. All screening and corroborative tests were carried out in the research facilities at the CDC, Shandong province.

Data analysis

Trained data entry operators double entered the data using the software EpiData 3.0; with necessary logic checks were performed centrally. We used SAS (SAS Institute, version 9.4.) for all the statistical analysis. Descriptive analyses were conducted to determine the distribution of socio-demographic factors of participants and to calculate the prevalence of HIV, syphilis, and HCV. Cochran-Armitage Trend tests were conducted to examine trends in HIV, syphilis, HCV prevalence, as well as the behaviors of the participants. Bivariate and multivariable logistic regressions (odds ratios (OR) and corresponding 95% confidence intervals (CI) were conducted to test the trends over time. Chi-square tests were used to test differences of factors associated with HIV/STIs between HIV positive and negative tests each year.

Ethical statement

"Written informed consent was obtained from each participant prior to the interview and blood collection. The study was carried out in accordance with approved guidelines. The study protocol, inform contents and procedures were reviewed and approved by the Institutional Review Board of the Shandong Centers for Disease Control and Prevention (15–1221). The anonymous data ([S1 Dataset](#)) and informed consents were kept confidential.

Results

Demographic characteristics

Overall, the data comprised of 15,705 participants from 8 study sites between 2010 and 2014. During the study period, each city met the minimum size requirement. For example, among a total of 3060 participants in 2014, 321 were in Heze, 329 in Zibo, equivalent to 400 or more in Binzhou, Yantai, Jinan, Jinin, Liaocheng and Qingdao. Among the participants, 89.9% were residents of Shandong and 10.1% were migrants. From 2010 to 2014, the proportion of migrants decreased from 11.4 to 8.9% ($P < 0.05$). The study population comprised of predominately younger people (62% of residents and 64% of migrants were aged between 20 and 29). A majority of the residents 9419 (66.7%), as well as migrants 1147 (72.7%), were never married. More than a third had a college education or higher (6174, 39.3%). Compared to migrants, resident MSM was more likely to find partners through a park or public restrooms (27.6% for residents and 17.4% for migrants) ([Table 1](#)).

Prevalence trends of HIV, syphilis, and HCV

The overall prevalence of HIV increased from 1% to 4.4% during 2010–14, ($P < 0.01$); it rose from 0.9 to 4.0% ($P < 0.01$) in residents and 2.3 to 8.9% in migrants ($P < 0.01$). The average prevalence of HIV was 2.6% (414). Both bivariate and multivariable models indicated increasing trend of HIV prevalence over years (unadjusted Odds Ratio (uOR) = 1.42, 95% CI: 1.31–1.55, Adjusted Odds Ratio (AOR) = 1.40, 95% CI: 1.28–1.52 in residents, while uOR = 1.43, 95%CI: 1.22–1.69, AOR = 1.44, 95%CI: 1.22–1.70 in migrants). In addition, the infection rate of HIV in migrants was much higher than in residents ([Table 2](#)).

Prevalence of syphilis and HCV did not change much. Despite no change in the overall prevalence of syphilis (5.1%); the prevalence was consistently higher in migrants compared to residents (6.5% to 8.3% in migrants, $P = 0.71$ vs. 4.4% to 5.9% in residents, $P = 0.28$). Less than 1% of participants were HCV positive, with higher rates in migrants (0% to 2%, $P = 0.14$) compared to residents (0.4% to 0.8%, $P = 0.44$). Bivariate and multivariable analyses indicated that there was no significant change in syphilis and HCV prevalence.

Table 1. Demographic characteristics of MSM recruited between 2010 and 2014 in Shandong (N = 15705).

| Characteristics | 2010 | | 2011 | | 2012 | | 2013 | | 2014 | | Total | |
|------------------------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|
| | (N = 3087) | | (N = 3192) | | (N = 3202) | | (N = 3164) | | (N = 3060) | | (N = 15705) | |
| | Resident (%) | Migrant (%) | Resident (%) | Migrant (%) | Resident (%) | Migrant (%) | Resident (%) | Migrant (%) | Resident (%) | Migrant (%) | Resident (%) | Migrant (%) |
| Percent of the class | 88.6 | 11.4 | 89.4 | 10.6 | 89.9 | 10.1 | 90.8 | 9.2 | 91.1 | 8.9 | 89.9 | 10.1 |
| Age(years) | | | | | | | | | | | | |
| <20 | 4.4 | 6.3 | 6.0 | 8.3 | 5.0 | 5.0 | 3.6 | 3.4 | 6.5 | 4.8 | 5.1 | 5.7 |
| 20–29 | 74.2 | 71.6 | 61.1 | 62.8 | 55.7 | 56.3 | 59.8 | 61.7 | 58.5 | 65.9 | 61.8 | 63.8 |
| 30–39 | 16.1 | 17.3 | 23.7 | 20.6 | 29.8 | 30.7 | 25.9 | 23.3 | 26.3 | 22.3 | 24.4 | 22.7 |
| 40–49 | 4.6 | 3.7 | 7.8 | 7.1 | 7.7 | 6.5 | 8.6 | 8.9 | 6.4 | 7.0 | 7.0 | 6.5 |
| ≥50 | 0.7 | 1.1 | 1.4 | 1.2 | 1.8 | 1.5 | 2.1 | 2.7 | 2.3 | 0.0 | 1.7 | 1.3 |
| Marital status | | | | | | | | | | | | |
| Single | 75.8 | 82.1 | 64.4 | 73.4 | 58.1 | 61.3 | 67.0 | 68.8 | 68.7 | 77.3 | 66.7 | 72.7 |
| Married | 20.6 | 16.2 | 31.8 | 22.2 | 38.6 | 32.5 | 27.8 | 26.4 | 26.4 | 16.5 | 29.2 | 22.7 |
| Widowed | 3.6 | 1.7 | 3.8 | 4.4 | 3.3 | 6.2 | 5.2 | 4.8 | 4.9 | 6.2 | 4.1 | 4.6 |
| Education | | | | | | | | | | | | |
| Senior High School or lower | 59.6 | 66.8 | 60.6 | 67.0 | 61.2 | 64.4 | 62.8 | 56.8 | 58.3 | 44.3 | 60.7 | 60.6 |
| College or Above | 40.4 | 33.2 | 39.4 | 33.0 | 37.8 | 35.6 | 37.2 | 43.2 | 41.7 | 55.7 | 39.3 | 39.4 |
| Venues | | | | | | | | | | | | |
| Pub, Disco, Tearoom, or Club | 26.3 | 29.6 | 23.6 | 21.5 | 18.7 | 21.3 | 26.8 | 24.5 | 28.5 | 16.5 | 24.7 | 22.9 |
| Bathhouse | 8.9 | 13.6 | 15.5 | 21.2 | 22.6 | 22.9 | 13.0 | 12.1 | 7.0 | 7.7 | 13.5 | 15.9 |
| Park/Public Restroom | 24.8 | 14.5 | 26.3 | 14.8 | 32.0 | 21.8 | 25.0 | 16.6 | 29.6 | 20.1 | 27.6 | 17.4 |
| Internet | 13.8 | 7.9 | 9.8 | 4.7 | 6.1 | 4.9 | 8.8 | 3.4 | 15.3 | 22.7 | 10.7 | 8.4 |
| Others | 26.2 | 34.4 | 24.8 | 37.8 | 20.6 | 29.1 | 26.4 | 43.4 | 19.6 | 33.0 | 23.5 | 35.4 |

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Table 2. HIV, syphilis, and HCV prevalence from 2010 to 2014 in Shandong, 2010–2014 (N = 15705).

| Variables | 2010 (%) | 2011 (%) | 2012 (%) | 2013 (%) | 2014 (%) | P for Trend | Crude OR (95%CI) | Adjusted OR* (95%CI) | P for adjusted model |
|-----------------|----------|----------|----------|----------|----------|-------------|------------------|----------------------|----------------------|
| HIV | | | | | | | | | |
| Resident | 0.9 | 1.8 | 1.8 | 3.1 | 4.0 | <0.01 | 1.42 (1.31–1.55) | 1.40 (1.28–1.52) | <0.01 |
| Migrant | 2.3 | 3.3 | 5.6 | 8.9 | 8.4 | <0.01 | 1.43 (1.22–1.69) | 1.44 (1.22–1.70) | <0.01 |
| All | 1.0 | 1.9 | 2.2 | 3.6 | 4.4 | <0.01 | 1.41 (1.31–1.52) | 1.39 (1.29–1.49) | <0.01 |
| Syphilis | | | | | | | | | |
| Resident | 4.4 | 4.5 | 5.1 | 5.9 | 4.4 | 0.28 | 1.03 (0.98–1.09) | 1.01 (0.95–1.07) | 0.77 |
| Migrant | 6.5 | 8.3 | 7.4 | 8.2 | 7.3 | 0.71 | 1.02 (0.90–1.17) | 1.04 (0.90–1.19) | 0.62 |
| All | 4.7 | 4.9 | 5.3 | 6.1 | 4.5 | 0.33 | 1.03 (0.98–1.08) | 1.01 (0.96–1.06) | 0.83 |
| HCV | | | | | | | | | |
| Resident | 0.4 | 0.7 | 0.8 | 0.7 | 0.6 | 0.44 | 1.06 (0.91–1.23) | 1.04 (0.90–1.21) | 0.58 |
| Migrant | 2.0 | 0.9 | 1.6 | 0.0 | 1.1 | 0.14 | 0.77 (0.54–1.10) | 0.73 (0.50–1.06) | 0.10 |
| All | 0.6 | 0.7 | 0.9 | 0.6 | 0.7 | 0.97 | 1.00 (0.88–1.15) | 0.99 (0.86–1.13) | 0.84 |

Note:

* Multivariate models were adjusted for the following variables: age, marital status (ref = married) and education.

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Behaviors for MSM

Overall, 77.6% of residents and 88.7% of migrants admitted that they had engaged in anal sex in the past 6 months. The increase was significant in residents (72.4% in 2010 to 82.1% in 2012, $P < 0.01$) as well in migrants (80.5% in 2010 to 94.9% in 2014, $P < 0.01$). (AOR = 1.12, 95%CI: 1.01–1.15 in residents, while AOR = 1.41, 95%CI: 1.25–1.60 in migrants). The use of condoms during last anal intercourse with other men increased from 76.8% in 2010 to 85.3% in 2013 for residents (AOR = 1.14, 95%CI: 1.10–1.17). About 51.6% of residents and 44.1% of migrants consistently used condoms during anal sex in the last 6 months. This proportion increased from 49.3% in 2011 to 53.9% in 2014 (AOR = 1.04, 95%CI: 1.02–1.07) in residents and no significant increase was seen in migrants. The proportion of consistent condom use was lower in migrants than in residents.

About one quarter of participants admitted engaging in vaginal intercourse with female, ranged between 22.8% (2010) to 32.7% (in 2012) and 22.9% (in 2014). This proportion changed little and significantly decreased only in the resident (AOR = 0.93, 95%CI: 0.90–0.99). Few (1.5% of residents and 3.6% of migrants) participants used drugs; the proportion increased (0.6% in 2010 to 2.4% in 2012, AOR = 1.29, 95%CI: 1.17–1.43 in both the residents and migrants (0.3% in 2010 to 5.6% in 2012, AOR = 1.51, 95%CI: 1.23–1.86) (Table 3).

Related factors of HIV infection

Anal sex in the past 6 months was associated with HIV infection in three years (2011, 2013, 2014). Use of condoms during last anal sex and consistent condom use in the last six months were negatively related to HIV infection in 2010 and 2012. Consistent condom use during commercial anal sex was also negatively associated with HIV infection in 2010, 2013, and 2014. Receiving any kind of HIV-related services in the past year was negatively associated HIV infection in 2011 (Table 4).

Discussion

Our study assessed the predominance, and patterns in HIV and different STIs in the migrant and resident MSMs of Shandong, China. The results extend the available evidence by using a serial cross-sectional design and evaluating MSM across multi-center study design. We report that STIs are highly prevalent in migrant MSM populations compared to resident MSM, with an increasing trend of HIV prevalence in both the migrants and residents. In addition, the prevalence of high-risk sexual behaviors, namely engaging in anal sex and consistent condom use (excluding migrants), increased in both subgroups.

The overall prevalence of HIV in Shandong MSM was 2.6%, an increase from figures reported in two studies conducted in 2008 and 2011 [9, 10]. However, the prevalence of HIV in Shandong MSM is considerably lower than in many other provinces or cities in China. For example, the prevalence of HIV was 7.7% among Beijing MSM in 2014, which is consistent with results from a meta-analysis in 2009 [10]. Internationally, the pooled HIV prevalence in MSM ranges from 3% (95% CI 2.4%–3.6%) in the Middle East and North Africa region to 25.4% (21.4%–29.5%) in the Caribbean [1]. Although the overall prevalence of HIV was low in Shandong, there has been a substantial increase in HIV, with a doubling of the prevalence among MSM since 2010. To reverse this trend, comprehensive strategies are targeted at increasing HIV testing, linkage to care, and retention in care are needed.

Our study indicated that the prevalence of HIV/STIs was higher in migrant MSM than in resident MSM. Similar evidence is available from other studies suggesting higher odds of acquiring or transmitting HIV/STIs in migrants compared to general population. [11, 12] This finding may be due to several reasons. First, migrant MSM is less likely to have a stable sexual

Table 3. Behaviors of MSM in Shandong, China, 2010–2014 (N = 15705).

| Variables | 2010 (%) | 2011 (%) | 2012 (%) | 2013 (%) | 2014 (%) | P for Trend | Crude OR (95%CI) | Adjusted OR* (95%CI) | P for Adjusted Model | |
|---|----------|----------|----------|----------|----------|-------------|------------------|----------------------|----------------------|--|
| Engaged in anal sex in the last 6 months | | | | | | | | | | |
| Resident | 72.4 | 74.9 | 82.1 | 77.4 | 80.9 | <0.01 | 1.12 (1.01–1.15) | 1.12 (1.09–1.15) | <0.01 | |
| Migrant | 80.5 | 88.7 | 90.5 | 91.1 | 94.9 | <0.01 | 1.40 (1.24–1.58) | 1.41 (1.25–1.60) | <0.01 | |
| All | 73.3 | 76.3 | 83.0 | 78.6 | 82.2 | | | | | |
| Used condom during last anal intercourse with male | | | | | | | | | | |
| Resident | 76.8 | 82.4 | 83.6 | 85.3 | 84.1 | <0.01 | 1.13 (1.09–1.16) | 1.14 (1.10–1.17) | <0.01 | |
| Migrant | 75.9 | 70.4 | 81.7 | 76.6 | 76.5 | 0.32 | 1.04 (0.96–1.13) | 1.06 (0.97–1.15) | 0.20 | |
| All | 76.7 | 81.1 | 83.4 | 84.5 | 83.4 | | | | | |
| Consistent used condom during anal sex in the last 6 months | | | | | | | | | | |
| Resident | 51.3 | 49.3 | 50.0 | 53.6 | 53.9 | <0.01 | 1.04 (1.02–1.06) | 1.04 (1.02–1.07) | <0.01 | |
| Migrant | 44.5 | 38.6 | 43.0 | 48.3 | 47.1 | 0.11 | 1.06 (0.99–1.14) | 1.06 (0.98–1.34) | 0.16 | |
| All | 50.6 | 48.2 | 49.3 | 53.1 | 53.3 | | | | | |
| Engaged in commercial anal sex with male in the last 6 months | | | | | | | | | | |
| Resident | 9.8 | 11.8 | 20.2 | 11.2 | 9.3 | 0.39 | 0.98 (0.95–1.02) | 0.98 (0.95–1.02) | 0.25 | |
| Migrant | 28.0 | 27.1 | 24.6 | 22.4 | 17.7 | <0.01 | 0.87 (0.80–0.95) | 0.94 (0.86–1.02) | 0.15 | |
| All | 11.9 | 13.4 | 20.6 | 12.2 | 10.1 | | | | | |
| Used condom at last commercial anal intercourse | | | | | | | | | | |
| Resident | 71.5 | 73.9 | 87.0 | 90.2 | 81.2 | <0.01 | 1.30 (1.17–1.43) | 1.31 (1.18–1.45) | <0.01 | |
| Migrant | 74.0 | 59.3 | 86.8 | 87.7 | 70.8 | 0.11 | 1.18 (0.99–1.40) | 1.15 (0.96–1.39) | 0.14 | |
| All | 72.1 | 70.8 | 87.0 | 89.8 | 79.6 | | | | | |
| Consistent used condom during commercial anal sex in the last 6 months | | | | | | | | | | |
| Resident | 32.1 | 27.2 | 31.8 | 43.0 | 30.8 | 0.07 | 1.08 (0.99–1.16) | 1.07 (0.99–1.16) | 0.11 | |
| Migrant | 29.5 | 28.6 | 39.5 | 58.5 | 25 | 0.07 | 1.16 (0.99–1.35) | 1.18 (0.99–1.41) | 0.06 | |
| All | 31.4 | 27.5 | 32.7 | 45.7 | 29.9 | | | | | |
| Engaged in vaginal sex in the last 6 months | | | | | | | | | | |
| Resident | 22.9 | 30.1 | 33.1 | 23.1 | 23.0 | <0.01 | 0.96 (0.94–0.99) | 0.93 (0.90–0.96) | <0.01 | |
| Migrant | 22.2 | 20.9 | 29.3 | 24.0 | 22.0 | 0.64 | 1.02 (0.94–1.11) | 1.00 (0.90–1.10) | 0.94 | |
| All | 22.8 | 29.2 | 32.7 | 23.2 | 22.9 | | | | | |
| Used condom during last vaginal intercourse | | | | | | | | | | |
| Resident | 53.5 | 56.8 | 54.8 | 59.0 | 61.7 | <0.01 | 1.08 (1.03–1.32) | 1.10 (1.04–1.16) | <0.01 | |
| Migrant | 61.0 | 60.6 | 44.9 | 53.6 | 65.0 | 0.89 | 0.99 (0.85–1.15) | 1.05 (0.88–1.25) | 0.59 | |
| All | 54.3 | 57.2 | 53.9 | 58.4 | 62.1 | | | | | |
| Consistent used condom during vaginal sex in the last 6 months | | | | | | | | | | |
| Resident | 20.7 | 38.0 | 23.3 | 22.1 | 34.5 | 0.17 | 1.04 (0.98–1.10) | 1.05 (0.99–1.11) | 0.09 | |
| Migrant | 41.6 | 30.0 | 18.7 | 21.4 | 46.7 | 0.77 | 0.98 (0.83–1.15) | 1.00 (0.84–1.19) | 0.99 | |
| All | 23.0 | 37.5 | 22.9 | 22.1 | 35.5 | | | | | |
| Used drug in lifetime | | | | | | | | | | |
| Resident | 0.6 | 0.6 | 2.4 | 2.0 | 1.8 | <0.01 | 1.23 (1.17–1.44) | 1.29 (1.17–1.43) | <0.01 | |
| Migrant | 0.3 | 2.9 | 5.6 | 4.1 | 5.5 | <0.01 | 1.43 (1.17–1.75) | 1.51 (1.23–1.86) | <0.01 | |
| All | 0.6 | 0.9 | 2.7 | 2.2 | 2.1 | | | | | |

Note:

* Multivariate models were adjusted for the following variables: age, marital status (ref = married), education.

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Table 4. HIV-related knowledge, services, and behaviors for HIV negative and positive MSM in Shandong, 2010–2014 (N = 15705).

| Variables | 2010 | | 2011 | | 2012 | | 2013 | | 2014 | | |
|---|-------|--------------------------|------|--------------------------|------|--------------------------|-------|--------------------------|------|--------------------------|-------|
| Engaged in anal sex in the last 6 months | | | | | | | | | | | |
| HIV- | 73.2 | (2213/3019) | 76.1 | (2367/3111) ^a | 82.8 | (2569/3104) | 78.0 | (2376/3046) ^a | 81.6 | (2388/2925) ^a | <0.01 |
| HIV+ | 86.2 | (25/29) | 88.3 | (53/60) | 91.6 | (65/71) | 95.6 | (109/114) | 94.1 | (127/135) | 0.04 |
| Used condom during last anal intercourse with male | | | | | | | | | | | |
| HIV- | 76.8 | (2314/3012) | 81.4 | (2522/3100) ^a | 83.4 | (2589/3106) | 84.9 | (2574/3033) ^a | 84.1 | (2450/2915) ^a | <0.01 |
| HIV+ | 63.3 | (19/30) | 67.0 | (40/58) | 85.9 | (61/71) | 74.3 | (84/113) | 68.7 | (92/134) | 0.88 |
| Consistent used condom during anal sex in the last 6 months | | | | | | | | | | | |
| HIV- | 56.6 | (1527/3020) | 48.6 | (1509/3108) ^a | 49.2 | (1529/3105) | 53.46 | (1629/3047) ^a | 54.2 | (1582/2919) ^a | <0.01 |
| HIV+ | 44.8 | (13/29) | 31.0 | (18/58) | 50.7 | (36/71) | 43.0 | (49/114) | 33.6 | (45/134) | 0.40 |
| Engaged in commercial anal sex with male in the last 6 months | | | | | | | | | | | |
| HIV- | 11.8 | (355/3002) | 13.3 | (413/3102) | 20.6 | (635/3083) | 12.1 | (368/3039) | 9.9 | (289/2924) | 0.01 |
| HIV+ | 19.4 | (6/29) | 18.3 | (11/60) | 22.5 | (16/71) | 15.0 | (17/113) | 14.2 | (19/134) | 0.19 |
| Used condom during last commercial anal intercourse | | | | | | | | | | | |
| HIV- | 72.2 | (255/353) | 70.0 | (289/413) ^a | 86.8 | (546/629) | 90.4 | (329/364) | 80.3 | (232/289) | <0.01 |
| HIV+ | 166.7 | (4/6) | 100 | (12/12) | 93.8 | (15/16) | 76.5 | (13/17) | 68.4 | (13/19) | 0.15 |
| Consistent used condom during commercial anal sex in the last 6 months | | | | | | | | | | | |
| HIV- | 30.9 | (109/353) | 26.6 | (110/413) ^a | 31.8 | (202/630) ^a | 44.75 | (162/362) | 30.1 | (87/289) | 0.01 |
| HIV+ | 50.0 | (3/6) | 63.6 | (7/11) | 68.8 | (11/16) | 64.7 | (11/17) | 26.3 | (5/19) | 0.08 |
| Engaged in vaginal sex in the last 6 months | | | | | | | | | | | |
| HIV- | 22.8 | (690/3027) | 29.3 | (914/3120) | 32.8 | (1019/3107) | 23.3 | (709/3046) | 22.9 | (669/2923) | 0.02 |
| HIV+ | 22.6 | (7/31) | 24.2 | (15/62) | 26.8 | (19/71) | 20.2 | (23/114) | 23.0 | (31/135) | 0.73 |
| Used condom during last vaginal intercourse | | | | | | | | | | | |
| HIV- | 54.9 | (374/681) | 57.6 | (518/900) | 54.1 | (539/997) | 58.5 | (413/706) | 62.4 | (415/665) | 0.01 |
| HIV+ | 14.3 | (1/7) | 33.3 | (5/15) | 47.4 | (9/19) | 56.5 | (13/23) | 54.8 | (17/31) | 0.03 |
| Consistent used condom during vaginal sex in the last 6 months | | | | | | | | | | | |
| HIV- | 23.2 | (159/685) | 37.9 | (343/905) | 23.1 | (233/1010) | 21.9 | (155/707) | 35.1 | (233/664) | 0.46 |
| HIV+ | 14.3 | (1/7) | 13.3 | (2/15) | 11.1 | (2/18) | 26.1 | (6/23) | 45.2 | (14/31) | <0.01 |
| Used drug in lifetime | | | | | | | | | | | |
| HIV- | 0.6 | (17/3042) | 0.9 | (27/3128) | 2.6 | (83/3131) | 2.2 | (68/3050) | 2.2 | (63/2925) | <0.01 |
| HIV+ | 0.0 | (0/32) | 1.6 | (1/62) | 7.0 | (5/71) | 1.8 | (2/114) | 0.7 | (1/135) | 0.49 |
| Correct HIV-related knowledge | | | | | | | | | | | |
| HIV- | 83.3 | (2533/3042) | 87.7 | (2744/3128) | 86.5 | (2707/3131) | 90.6 | (2763/3050) | 88.6 | (2592/2925) | <0.01 |
| HIV+ | 84.4 | (27/32) | 85.5 | (53/62) | 87.3 | (62/71) | 95.6 | (109/114) | 88.9 | (120/135) | 0.18 |
| Being received any kind of HIV-related services in last year | | | | | | | | | | | |
| HIV- | 75.3 | (2290/3042) ^a | 70.0 | (2188/3128) | 78.1 | (2446/3131) ^a | 77.9 | (2375/3050) ^a | 80.9 | (2367/2925) ^a | <0.01 |
| HIV+ | 56.3 | (18/32) | 62.9 | (39/62) | 66.2 | (47/71) | 67.5 | (77/114) | 60.7 | (82/135) | 0.87 |

Note:

^a represents statistical significance ($P < 0.05$).

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partner and may have multiple partners, increasing the risk for HIV/STIs[1]. Infected migrants may also serve as a bridge population for HIV/STIs transmission when they return to their area of residence[13]. Second, migrants in China are mainly from rural or poor towns [14], often poorly educated and working in low-paid jobs[15]. Lower levels of education attainment may make them less aware of HIV risk and safe sex practices[16]. Third, social isolation can increase the migrant’s the risk of acquiring HIV/STIs[17]. HIV diagnosis through targeted HIV testing campaigns can help reduce the risk of onward sexual transmission[16, 18].

In contrast with available evidence in China, we found comparatively lower proportion (about 49.1% overall) anal intercourse without using condoms [18, 19]. Not using the condom is a definitive risk factor for HIV; and hence partly explains the lower prevalence of HIV in Shandong. We also observed an increasing trend of drug use during the study period; with migrants affected nearly twice as residents. Since Drug use predisposes MSM for higher risk for HIV/STIs [20], efforts should be undertaken to address the problem.

Despite the strength of being a large study with serial cross-sectional design, there were also some limitations. Firstly, data collection was relayed on retrospective self-reporting and this may lead to recall bias. Second, the sensitivity of sexually related questions could lead to reporting bias. Third, we were limited by the unavailability of response rates in our study; and the effect of mobility of population between cities within Shandong was not available. Fourth, we did not evaluate the proportion of the participants who were selected in multiple years, and if HIV positive persons are sampled in multiple years; this might explain the increase in prevalence. However, one important purpose of Chinese surveillance system is to identify new HIV cases and to report identified cases for further action. Since the proportion of HIV-positive persons sampled in multiple years was consistently low, its influence on the overall trend is minimal.

Conclusion

In conclusion, STIs are highly prevalent among migrant MSM compared to residents. Engaging in unprotected anal sex in migrants might be the driver of the high STIs in Shandong. The migrant MSM should be targeted for effective interventions aimed at reducing their risk behaviors. Deeper understanding of the role of migration in health issues is required for combating the persistently high and gradually increasing HIV burden in Men who have sex with Men in China.

Supporting Information

S1 Dataset.
(XLSX)

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References

1. Beyrer C, Baral SD, van Griensven F, Goodreau SM, Chariyalertsak S, Wirtz AL, et al. Global epidemiology of HIV infection in men who have sex with men. *The Lancet*. 2012; 380(9839):367–77.
2. Smith A, Le B, Finlayson T, Oster A, DiNenno E. Prevalence and awareness of HIV infection among men who have sex with men—21 cities, United States, 2008. *Morbidity and Mortality Weekly Report*. 2010; 59(37):1201–7. PMID: [20864920](#)
3. Sullivan PS, Hamouda O, Delpech V, Geduld JE, Prejean J, Semaille C, et al. Reemergence of the HIV epidemic among men who have sex with men in North America, Western Europe, and Australia, 1996–2005. *Annals of epidemiology*. 2009; 19(6):423–31. doi: [10.1016/j.annepidem.2009.03.004](#) PMID: [19460672](#)
4. Qin Q, Tang W, Ge L, Li D, Mahapatra T, Wang L, et al. Changing trend of HIV, Syphilis and Hepatitis C among Men Who Have Sex with Men in China. *Scientific Reports*. 2016; 6.
5. Wang B, Li X, Stanton B, Liu Y, Jiang S. Socio-demographic and behavioral correlates for HIV and syphilis infections among migrant men who have sex with men in Beijing, China. *AIDS care*. 2013; 25(2):249–57. doi: [10.1080/09540121.2012.701714](#) PMID: [22788859](#)
6. He Q, Peng W-J, Zhang J-Q, Wang B-X, Wang J. Prevalence of unprotected anal intercourse and unprotected vaginal intercourse among HIV-positive men who have sex with men in China: a meta-analysis. *Sexually transmitted infections*. 2011:sextrans-2011-050230.
7. Mao H, Ma W, Lu H, Wang L, Zheng H, Zhu Y, et al. High incidence of HIV and syphilis among migrant men who have sex with men in Beijing, China: a prospective cohort study. *Bmj Open*. 2014; 4(9):e005351. doi: [10.1136/bmjopen-2014-005351](#) PMID: [25227626](#)
8. Song Y, Li X, Zhang L, Fang X, Lin X, Liu Y, et al. HIV-testing behavior among young migrant men who have sex with men (MSM) in Beijing, China. *AIDS care*. 2011; 23(2):179–86. doi: [10.1080/09540121.2010.487088](#) PMID: [21259130](#)
9. Sentinel CH. Guidelines for Conducting HIV Sentinel Serosurveys among Pregnant Women and Other Groups.
10. Wang WW, Fan CC. Success or failure: selectivity and reasons of return migration in Sichuan and Anhui, China. *Environment and Planning A*. 2006; 38(5):939–58.
11. Tao X, Gai R, Zhang X, Zhang N, Zheng W, Xu A, et al. Prevalence of HIV infection and HIV-related sex risk behaviors in men who have sex with men in Shandong Province, China. *Bioscience trends*. 2008; 2(3):97–100. PMID: [20103910](#)
12. Meng X, Zou H, Beck J, Xu Y, Zhang X, Miao X, et al. Trends in HIV prevalence among men who have sex with men in China 2003–09: a systematic review and meta-analysis. *Sexual health*. 2013; 10(3):211–9. doi: [10.1071/SH12093](#) PMID: [23611402](#)
13. Zou X, Chow EP, Zhao P, Xu Y, Ling L, Zhang L. Rural-to-urban migrants are at high risk of sexually transmitted and viral hepatitis infections in China: a systematic review and meta-analysis. *BMC infectious diseases*. 2014; 14(1):1.
14. Yang X, Derlega VJ, Luo H. Migration, behaviour change and HIV/STD risks in China. *AIDS care*. 2007; 19(2):282–8. doi: [10.1080/09540120600909414](#) PMID: [17364411](#)
15. Estcourt CS, Marks C, Rohrsheim R, Johnson AM, Donovan B, Mindel A. HIV, sexually transmitted infections, and risk behaviours in male commercial sex workers in Sydney. *Sexually transmitted infections*. 2000; 76(4):294–8. doi: [10.1136/sti.76.4.294](#) PMID: [11026887](#)
16. Han K-Q, Huang C-C, Han W-J. Social mobility of migrant peasant workers in China. *Sociology Mind*. 2011; 1(04):206.

17. Guo Y, Li X, Song Y, Liu Y. Bisexual behavior among Chinese young migrant men who have sex with men: implications for HIV prevention and intervention. *AIDS care*. 2012; 24(4):451–8. doi: [10.1080/09540121.2011.613914](https://doi.org/10.1080/09540121.2011.613914) PMID: [22085021](https://pubmed.ncbi.nlm.nih.gov/22085021/)
18. Wong F, Huang Z, He N, Smith B, Ding Y, Fu C, et al. HIV risks among gay-and non-gay-identified migrant money boys in Shanghai, China. *AIDS care*. 2008; 20(2):170–80. doi: [10.1080/09540120701534707](https://doi.org/10.1080/09540120701534707) PMID: [18293125](https://pubmed.ncbi.nlm.nih.gov/18293125/)
19. Wang W, Wei C, Buchholz ME, Martin MC, Smith BD, Huang ZJ, et al. Prevalence and risks for sexually transmitted infections among a national sample of migrants versus non-migrants in China. *International journal of STD & AIDS*. 2010; 21(6):410–5.
20. Cohen MS, Chen YQ, McCauley M, Gamble T, Hosseinipour MC, Kumarasamy N, et al. Prevention of HIV-1 infection with early antiretroviral therapy. *New England journal of medicine*. 2011; 365(6):493–505. doi: [10.1056/NEJMoa1105243](https://doi.org/10.1056/NEJMoa1105243) PMID: [21767103](https://pubmed.ncbi.nlm.nih.gov/21767103/)