

The Threshold at Which Elderly Men from Rural China Who Visit Female Sex Workers Are Significantly More at Risk of Becoming HIV-Positive

Yi Yang^{1*}, ShuangFeng Fan², Shu Liang³, Yang Liu⁴, Yuan Li⁵, Jing Xi⁶

Background: HIV prevalence of elderly (≥50 years old) men in China has been steadily increasing, mainly through the sexual transmission route, but sexual behaviors of elderly men in China are far from well-studied.

Objectives: In order to make clear how many sexual partners (SPs) are too many for elderly (≥50 years old) men from rural China becoming HIV-positive.

Methods: We conducted a case-control study: 99 newly HIV (+) vs. 88 HIV (-) elderly men with similar age who visited female sex workers (FSW). Receiver-operating characteristics (ROC) curves and backward binary logistic regression was applied.

Results: We found out cases had more SPs (315.66±401.33) than controls (14.63±25.63) in their lifetime, mainly commercial SPs (313.98±401.38 vs. 12.81±25.85), similarly in the last three years. AUCs for HIV infection at number of accumulated SPs and of commercial SPs were 0.89 and 0.90, and correspondingly 0.79 and 0.81 in the last three years. Cut-off values were identified as 51.5, 52.5, 5.5 and 4.5 based on Youden's indexes (0.715, 0.705, 0.612 and 0.601). Risky factors for HIV infection among elderly men who visit FSW were having 52-2002 SPs in their lifetime (AOR (95%CI): 56.33(11.36-279.25)), having 5-289 commercial SPs in the last three years (11.55(2.78-47.94)), and having 3000 YUAN and above (9.02(2.04-39.96)) and 2000-2999 YUAN (4.21(1.05-16.85)) monthly income, not receiving HIV-related health education (3.57(1.1-11.64)).

Conclusion: In conclusion, ≥52 SPs in their lifetime and ≥5 FSW in the last three years are too many for elderly men from rural China becoming HIV-positive.

Background

China is facing big challenges to ending the AIDS epidemic as a public health threat.^{1,2} One of the biggest challenges is that HIV prevalence of elderly (≥50 years old) men has been steadily increasing,³⁻⁵

at a much higher rate than the general population,⁶ and elderly people living with HIV (PLHIV) carry a heavy disease burden. During 2015 to 2019, more than 45 percent of elderly PLHIV cases in China⁷ are late detected (CD4+ cell count <350/μL, or AIDS).⁸ Due to immune functional decline, increased

¹School of Management Chengdu University of Traditional Chinese Medicine 1166 Liutai Avenue, Wenjiang District Chengdu, China, 611137

²Department of HIV/AIDS prevention Chengdu Center for Disease Control and Prevention No.4, Longxiang Road, Wuhou District Chengdu, China, 610000

³Institute of HIV/AIDS prevention Sichuan Center for Disease Control and Prevention No.6, Zhongxue Road, Wuhou District Chengdu, China, 610000

⁴Department of HIV/AIDS prevention Chengdu Center for Disease Control and Prevention No.4, Longxiang Road, Wuhou District Chengdu, China, 610000

⁵School of Public Health Chengdu University of Traditional Chinese Medicine 1166 Liutai Avenue, Wenjiang District Chengdu, China, 611137

⁶Department of HIV/AIDS prevention Chengdu Center for Disease Control and Prevention No.4, Longxiang Road, Wuhou District Chengdu, China, 610000

Address correspondence to: Yi Yang, School of Management Chengdu University of Traditional Chinese Medicine 1166 Liutai Avenue, Wenjiang District Chengdu, China, 611137 (thehanyang@163.com).

Financial Disclosures: This study was supported by National Natural Science Foundation of China (Grant #81803300) and humanities and social science projects of the Ministry of Education of China (Grant #18YJA840018).

0024-7758 © Journal of Reproductive Medicine®, Inc.

The Journal of Reproductive Medicine®

vulnerability to infections,⁹ and multiple morbidity,¹⁰ HIV-positive elderly men quickly progress into AIDS or even death.^{3,9} Based on data from national HIV Sentinel Surveillance System (NHSSS),^{3,5} heterosexual transmission has been widely accepted as the major route for HIV epidemics in China.

Sexual behaviors of elderly men in China are far from well-studied. Due to convention¹¹ and stigma, Chinese,¹² especially elderly people, do not talk about sex. Previous studies of sexual behaviors in China mainly focus on 20-50-year-old group¹³⁻¹⁹. Elderly men in China, who are considered as sexually inactive²⁰ and have been excluded from the priority of HIV prevention programs,²¹⁻²⁴ were not recognized and listed as a key prevention group until 2017.²⁵ Compared with other age groups, elderly men have minimal knowledge about AIDS,²⁶ and condom use among them is even lower.^{13, 27} Moreover, it is estimated that men who have sex with men (MSM) account for 1.73% of 18-64-year-old men in China,²⁸ and HIV infection among them continues to expand just as in most countries.²⁹ The contributions of heterosexual behavior and homosexual behavior in HIV infection among elderly men in China is not clear. It is also not clear which kinds of heterosexual behavior play the most important roles in infection rates: commercial heterosexual behavior, non-commercial extramarital sexual behavior, or casual heterosexual behavior? More importantly, what is the number of sexual partners (SPs) after which elderly men (≥ 50) from rural China who visit female sex workers are significantly more at risk of becoming HIV-positive? Are there certain methods to find out the cut-off points for “high-risk” groups?

Receiver-operating characteristics (ROC) curves have been applied to evaluate the accuracy (sensitivity and specificity) of parameters in predicting the risks of obtaining HIV infection, and identify the most suitable cut-off points for prediction.^{30, 31} Located in southwest of China, Sichuan province is one of the few provinces heavily affected by the HIV epidemic.¹ There are two major characteristics of HIV epidemics in Sichuan: HIV prevalence consistently increasing among the elderly population and high prevalence of HIV infection among MSM in Chengdu,

the capital city. The proportion of elderly men in the population is less than 40%³² and elderly people in Sichuan accounted for less than 5% of PLHIV in 2005, and over 40% in 2017, and 59.2% in 2019.^{1,5} Pooled HIV prevalence among female sex workers (FSW) in Southwest of China is estimated as 1%-3%.³³ The overall HIV prevalence among MSM in Chengdu between 2009 and 2014 was 15.5%.³⁴ Between 2012 and 2018, the HIV incidence density among MSM decreased annually, but the total incidence density was as high as 5.95% (95% CI: 5.37-6.56)/100 person-years.³⁵ Moreover, in 2013, 17.9% of MSM reported that they had sex with both men and women (MSM/W), and living in Chengdu was identified as a risk factor.³⁶

METHODS

This study was a case-control study with 99 cases and 88 controls who visited FSW in their lifetime. This study was approved by the institutional review board (IRB) from affiliated hospital of Chengdu University of Traditional Chinese Medicine (approval number: 2019KL-008).

Study Site

One out of five PLHIV in Sichuan are from Chengdu. With the coverage of sentinel surveillance improving¹ and a population of around 800,000,³⁷ rural County A in Chengdu was ranked as one of the top five counties in the number of PLHIV, mainly among male individuals.

Case Group

The selection criteria included: (1) ≥ 50 years old; (2) male; (3) lived at their current address for at least six months; (4) newly diagnosed HIV (+); (5) self-reported visiting FSW in their lifetime; (6) willing to participate the study.

During April 2019 and October 2020, 115 elderly men from 8 townships in County A were confirmed as HIV (+), and 114 participated the study. In their lifetime, 106 of 114 (92.98%) in case group reported visiting FSW. We obtained 99 cases' numbers of different types of accumulated

sexual partners and sexual partners in the last three years in detail.

Control Group

The selection criteria included: (1) ≥ 50 years old; (2) male; (3) lived at their current address for at least six months; (4) HIV (-); (5) self-report visiting FSW in their lifetime; (6) willing to participate the study. During June to July 2019, a cross-sectional study from the same townships of case was conducted, 802 men were recruited, and 797(99.38%) questionnaires were reliable, and among them 795 were HIV (-).³⁸ 88 of 795(11.07%) HIV (-) respondents admitted visiting FSW in their lifetime.

Data Collection

A written informed consent was completed before the investigation. Local slang was used to refer sexual behaviors. An in-depth interview with one case was conducted by one skilled medical staff member from County A Center for Disease Prevention and Control (CDC). In total, two medical staff members conducted the surveys in separate rooms in the CDC, the county infectious hospital, or township health centers according to cases' convenience. A 30-minute face-to-face structured interview with a control was conducted in a separate room at the village health centers to make sure the respondents felt comfortable to talk about their sexual behaviors by one well-trained male interviewer.

Measures

Basic information: demographic characteristics, migration experiences.

Biology: sexual desire changes after the age of 50 (no sexual need/decline/no change/increase).

Psychology: sexual identity (heterosexual/homosexual/bisexual).

Sexual behavior

Numbers of different types of accumulated sexual partners and sexual partners in the last three years were measured, including fixed sexual partners (spouse/girlfriend), extramarital heterosexual

partners (relationship last at least three months), casual heterosexual partners, and commercial heterosexual partners. In order to help respondents feel comfortable about the survey, homosexual behavior was measured by asking only whether they had homosexual behaviors or not, without asking the specific number.

Health Services

The HIV (-) study group was asked whether they had heard of AIDS before the investigation. Then, HIV-related health education (HRHE) was measured in detail, including whether they got HRHE before, what kind of health educator provided HRHE before their HIV confirmation for cases and before the investigation for controls, including health workers from CDC, health workers from township health center/village doctors, doctors from other hospitals, their children/grandchildren's teachers (primary school and high schools), township civil servants, village cadres, pharmacy staff, HIV-related service volunteers, and others.

ROC

Receiver-operating characteristics (ROC) curves were plotted to establish cut-off values of numbers of different sexual partners associated with HIV infection. The validity of the model was measured by the area under the curve (AUC). The more AUC approaches 1, the more the data is well modelled. Based on Youden's indexes (Sensitivity + Specificity - 1), the most suitable cut-off values were identified. The more Youden's index approaches to 1, the more accurately the cut-off points can distinguish the difference.

Data Analysis

Frequencies for nominal variables, mean, and standard deviation for interval variables were assessed. T test and Chi-square tests/Fisher's exact test were used to examine the relationships between HIV infection and independent variables. Binary logistic regression with backward selection was applied to examine factors associated with HIV infection, including all factors with $p < 0.05$ in

in bivariate analyses. Adjusted odds ratio (AOR) and 95% confidence intervals were calculated. Factors with AOR greater than one was categorized as risk factors, and less than one as protective factors.

RESULTS

Basic information

The age was 63.28 ± 8.62 for cases, 61.63 ± 7.08 for controls. The difference was not statistically significant ($t=1.43$, $P=0.16$), nor were the differences of types of residencies, education levels, marital statuses, monthly expenses for entertainment and migration experiences between two groups ($P>0.05$). In terms of latest occupations, types of living, monthly income, the differences between two groups were statistically significant ($P<0.05$). Details are showed in Table 1.

Table 1: Basic Characteristics Comparison Between HIV (+) vs. HIV (-) Elderly Men in Chengdu, China (n=187, n (%))

	HIV (+) (n=99)	HIV (-) (n=88)	χ^2	P
type of residency			3.23	0.07
city	10(10.1)	3(3.41)		
rural	89(89.9)	85(96.59)		
Education level			1.97	0.85
illiterate	16(16.16)	16(18.18)		
Primary school drop outs	35(35.35)	25(28.41)		
Primary school	14(14.14)	14(15.91)		
Junior high school drop outs	13(13.13)	9(10.23)		
Junior high school	19(19.19)	22(25)		
Senior high school/technical school	2(2.02)	2(2.27)		
Marital status			1.34	0.51
never married	68(68.69)	63(71.59)		
married	4(4.04)	6(6.82)		
single(divorce/widow/separated)	27(27.27)	19(21.59)		
Latest occupation				<0.01*
Farm workers/workers	89(89.9)	62(70.45)		
Government employees	8(8.08)	20(22.73)		
Other	2(2.02)	6(6.82)		
Living with				<0.047*
Only spouse	25(25.25)	33(37.5)		
Spouses and other family members (parents or children)	32(32.32)	33(37.5)		
Only other family members (parents or children)	23(23.23)	8(9.09)		
Nobody	16(16.16)	13(14.77)		
In facilities	1(1.01)	1(1.14)		
other	2(2.02)	0(0)		
Monthly income			14.97	<0.01
<1000YUAN	26(26.26)	43(48.86)		
1000-1999YUAN	21(21.21)	21(23.86)		
2000-2999YUAN	19(19.19)	12(13.64)		
3000YUAN and above	33(33.33)	12(13.64)		
Monthly expense for entertainment				0.49*
<500YUAN	56(56.57)	54(61.36)		
500-999YUAN	26(26.26)	27(30.68)		
1000-1499YUAN	10(10.1)	4(4.55)		
1500-1999YUAN	3(3.03)	1(1.14)		
2000YUAN and above	4(4.04)	2(2.27)		
Migration history			0.52	0.77
More than one year ago	54(54.55)	48(54.55)		
Within the past one year	26(26.26)	20(22.73)		

HIV-related Health Education

22 of 99 (22.22%) cases had gotten HRHE before, lower than controls (50/88, 56.82%) (P<0.05). Neither cases nor controls had gotten HRHE from pharmacies, HIV-related service volunteers and their children/grandchildren’s teachers (primary school and high schools). Controls had gotten HRHE more from health workers from township health center/village doctors (60.00%), health workers from CDC (36.00%), and less from others (8.00%) than cases (4.50%,0.0% and 86.36%) (P<0.05), details are showed in Table 2.

Sexual Desire Changes, Sexual Identity and Homosexual Behavior

Sexual desire after the age of 50 for 74.75% (74/99) cases and 77.27% (68/88) controls declined. The difference between cases and controls was not statistically significant (P>0.05). 99 of 99 (100%) cases and 86 of 88 (97.73%) controls reported themselves as heterosexual, and 2 of 88 (2.27%) controls reported as bisexual. The difference between cases and controls was not statistically significant (P>0.05). 2 of 99(2.02%) cases and 2 of 88(2.27%) controls were involved in homosexual behaviors (P>0.05).

Table 2: HIV-related Health Educator Comparison Between HIV (+) vs. HIV (-) Elderly Men in Chengdu, China (n=72, n (%))

	HIV (+) (n=22)	HIV (-) (n=50)	χ^2	P
Health workers from CDC	0(0)	18(36.00)	10.56	<0.01
Health workers from township health center/village doctors	1(4.50)	30(60.00)	19.16	<0.01
Doctors from other hospitals	0(0)	2(4.00)		1.00*
Township civil servants	0(0)	8(16.00)		0.10*
Village cadres	1(4.55)	7(14.00)		0.42*
Others	19(86.36)	4(8.00)	43.16	<0.01

Number of Sexual Partners

Cases had more sexual partners (mainly commercial sexual partners) than controls in their lifetime and in the last three years (P<0.01; P<0.01). Details are showed in Table 3.

AUCs for HIV infection for accumulated number of sexual partners and of commercial sexual partners were 0.89 (95% CI, 0.84-0.94, P<0.01) and 0.90 (95% CI, 0.85-0.94, P<0.01). The counterpart AUCs in the last three years were 0.79(95% CI, 0.72-0.86, P<0.01) and 0.81(95% CI, 0.74-0.87, P<0.01). Details are showed in Table 4 and Figure 1.

Based on Youden’s indexes (0.715, 0.705, 0.612 and 0.601) and cut-off values of accumulated number of sexual partners and of commercial sexual partners, number of sexual partners and of commercial sexual partners in the last three years were identified as 51.5, 52.5, 5.5 and 4.5.

Correlation between numbers of sexual partners and HIV Infection

Risk factors for HIV infection among elderly men were: having 52-2002 sexual partners in them

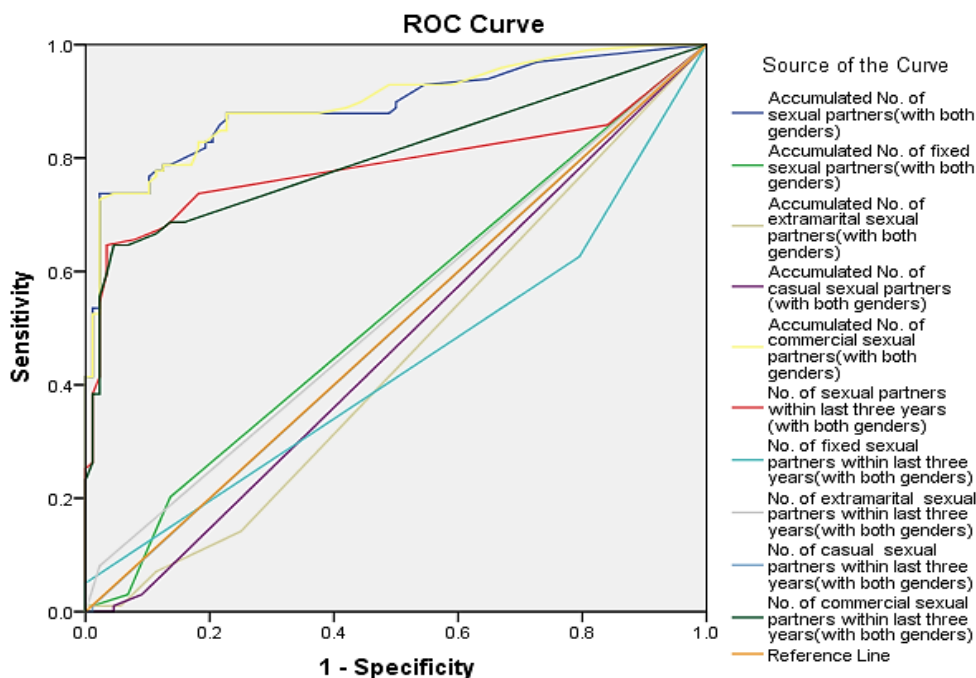
Table 3: Sexual Behaviors Comparison Between HIV (+) and HIV (-) Elderly Men in Chengdu, China (n=187, $\bar{X} \pm s$)

	HIV (+) (n=99)	HIV (-) (n=88)	t	P
Accumulated No. of sexual partners	315.66±401.33	14.63±25.63	7.45	<0.01
fixed sexual partners	1.19±0.67	1.15±0.67	0.45	0.65
extramarital sexual partners	0.44±2.55	0.44±0.92	0	1
casual sexual partners	0.04±0.24	0.23±0.87	-1.95	0.05
commercial sexual partners	313.98±401.38	12.81±25.85	7.45	<0.01
No. of sexual partners in the last three years	31.21±49.31	1.9±4.34	5.89	<0.01
fixed sexual partners	0.7±0.65	0.8±0.41	-1.26	0.21
extramarital sexual partners	0.08±0.27	0.02±0.15	1.83	0.07

Table 4: Area Under the Curve for HIV infection among Elderly Men in Chengdu, China (n=187)

	Area	95% Confidence Interval		P
		Lower Bound	Upper Bound	
Accumulated no. Of sexual partners	0.89	0.84	0.94	<0.01
Fixed sexual partners	0.53	0.45	0.61	0.49
Extramarital sexual partners	0.45	0.36	0.53	0.2
Casual sexual partners	0.47	0.39	0.55	0.47
Commercial sexual partners	0.9	0.85	0.94	<0.01
No. Of sexual partners in the last three years	0.79	0.72	0.86	<0.01
Fixed sexual partners	0.44	0.35	0.52	0.13
Extramarital sexual partners	0.53	0.45	0.61	0.49
Casual sexual partners	0.5	0.42	0.58	0.99
Commercial sexual partners	0.81	0.74	0.87	<0.01

Figure 1: ROC curve AUCs for number of sexual Partners



Diagonal segments are produced by ties.

Table 5: Association between HIV infection and related factors among Elderly Men in Chengdu, China, bivariate and multivariate analyses, backward logistic regression (n=187)

	UAOR (95%CI)	AOR (95%CI)
Monthly income (vs. <1000YUAN)		
1000-1999YUAN	1.65(0.76-3.6)	1.07(0.26-4.36)
2000-2999YUAN	2.62(1.1-6.26)	4.21(1.05-16.85)
3000YUAN and above	4.55(2-10.33)	9.02(2.04-39.96)
HIV-related Health Education (no vs. yes)	4.61(2.44-8.68)	3.57(1.1-11.64)
Accumulated No. of sexual partners (52-2002 vs. 1-51)	120.73(27.71-525.96)	56.33(11.36-279.25)
No. of commercial sexual partners in the last three years (5-289 vs. 0-4)	38.4(12.98-113.57)	11.55(2.78-47.94)

Note: Variable(s) entered on step 1: Accumulated No. of sexual partners Accumulated , No. of commercial sexual partners, No. of sexual partners in the last three years, No. of commercial sexual partners in the last three years, Latest occupation, living with, Monthly income, HIV-related Health Education

lifetime (AOR (95%CI): 56.33(11.36-279.25)); having 5-289 commercial sexual partners in the last three years (11.55(2.78-47.94)); having 3000 YUAN and above (9.02(2.04-39.96)) and 2000-2999 YUAN (4.21(1.05-16.85)) monthly income; and not receiving HRHE (3.57(1.1-11.64)). Details are showed in Table 5.

DISCUSSION

As a case-control study, this study is well organized, and proves that having more than 52 and above sexual partners in their lifetime and visiting more than 5 FSW in the last three years are the thresholds at which elderly men from rural China who visit FSW are significantly more at risk of becoming HIV-positive. In this study, 2 of 99 cases (2.02%) and 2 of 88 controls (2.27%) were MSM, a little higher than national level (1.73%).²⁸ 2 of 2 MSM cases self-reported as heterosexual identity, and 2 of 2 controls self-reported as bisexual. All of them were MSM/W. MSM in China are facing stigma and family pressure to get married and have children. Consequently, HIV (+) MSM transmit HIV infection from their homosexual partners^{29,39} to their wives⁴⁰.

These factors do not cause HIV infection, but influence elderly men's experience of visiting FSW, especially number of sexual partners. In this study, around 80 percent of the respondents from both groups had migration experience. Back to 1980s, they were 20-50-year-old, sexually active, and migrated alone, easy to be involved in high-risk sexual behaviors such as visiting FSW and having sex with men to fulfil their emotional and sexual needs.^{11,13-19}

Without doubt, HRHE helps elderly men avoid becoming HIV-positive. Instead of relying on informal channels (Other), getting HRHE from formal channels (health workers from CDC, health workers from township health center/village doctors) helps elderly men avoid HIV infection. However, compared with having multiple sexual partners and visiting FSW, the protective role of HRHE is small.

LIMITATIONS

In the current study, self-report behavior

information should be noted. Face-to-face interviews may heighten socially desirable responses such as low report of high-risk sexual behaviors. In order to confront the problems, our interviewers were well trained, interviews were conducted in separate rooms, and local slang was used.

Moreover, in-depth interviews were conducted by skilled medical staff members from County A CDC for case group, but by well-trained young male interviewers for control group. The case group was informed about their HIV positive statuses before the interview. In order to get professional suggestions from the interviewers for their future treatment if they agreed to take part in the study, report bias was at minimal level. Control group knew their HIV negative statuses after the interview. When they admitted visiting FSW in their lifetime, they were open to talk about their sexual experiences to our interviewers. In order to minimize informational bias due to different types of interviewers between two groups, interviewers were trained by the same trainers, only well-trained interviewers conducted the in-depth interview, and interviewers followed the same in-depth procedure.

Though we conduct census among HIV (+) elderly male population, due to limited sample size, we can't confirm our suspicion about the role of homosexual behavior in HIV infection among elderly men. We will continue to conduct researches to confirm our suspicion.

DECLARATIONS

Ethics approval and consent to participate

The institutional review board (IRB) from affiliated hospital of Chengdu University of Traditional Chinese Medicine approved the protocol (approval number: 2019KL-008). All methods were performed in accordance with the relevant guidelines and regulations including a statement. A written informed consent was completed before the investigation, and respondents agreed to participate the study and agreed that their information can be published anonymously if needed.

Consent for publication

NA.

Availability of data and materials

The datasets analyzed during the current study are available from the corresponding author on reasonable request.

Competing Interests

The authors declare that they have no competing interests.

Funding

This study was supported by National Natural Science Foundation of China (Grant #81803300) and humanities and social science projects of the Ministry of Education of China (Grant #18YJA840018).

Acknowledgments

We would like to acknowledge the contributions of township health centers, Pengzhou District CDC, and Chengdu CDC, and RuiPing Liao, Xia Wu, Na Li, Wei Xiao, Guotao Luo, Yunrui Bai, Xuesong Wang, Fengsheng Leng, Yiji Wan, Run Zhong Wang in the data collection. We also thank Rachel Anderson for editorial assistance.

REFERENCES

- Zhang L. Comprehensive HIV/AIDS Programs in Sichuan. *HIV/AIDS in China* 2019;629-651.
- Degenhardt L, Mathers BM, Wirtz AL et al. What has been achieved in HIV prevention, treatment and care for people who inject drugs, 2010-2012? A review of the six highest burden countries. *Int J Drug Policy* 2014;25:53-60.
- Qiao Y-c, Xu Y, Jiang D-X, et al. Epidemiological analyses of regional and age differences of HIV/AIDS prevalence in China, 2004–2016. *Int J Infect Dis* 2019;81:215-220.
- Liu H, Lin X, Xu Y, et al. Emerging HIV Epidemic Among Older Adults in Nanning, China. *AIDS Patient Care STDS* 2012;26:565-567.
- Fsya B, et al. Epidemiological and spatiotemporal analyses of HIV/AIDS prevalence among older adults in Sichuan, China between 2008 and 2019: A population-based study - ScienceDirect. *International Journal of Infectious Diseases* 2021.

- Wang YY, Yang Y, Chen C et al. Older adults at high risk of HIV infection in China: a systematic review and meta-analysis of observational studies. *PeerJ* 2020;8:e9731
- Kaifang M. Analysis on the late-diagnosis among newly detected HIV/AIDS cases aged 50 years or older in China from 2015 to 2019. *Chinese Journal of AIDS & STD* 2022;28:16-20.
- Boswell MT, Rowland-Jones SL. Delayed disease progression in HIV-2: the importance of TRIM5 α and the retroviral capsid. *Clin Exp Immunol* 2019;196:305-317.
- Leng SX, Margolick JB. Aging, sex, inflammation, frailty, and CMV and HIV infections. *Cell Immunol* 2020;348:104024.
- Smit M, Brinkman K, Geerlings S et al. Future challenges for clinical care of an ageing population infected with HIV: a modelling study. *Lancet Infect Dis* 2015;15:810-818.
- Zhang K, D Li, H Li, et al. Changing sexual attitudes and behaviour in China: implications for the spread of HIV and other sexually transmitted diseases. *AIDS Care* 1999;11:581-589.
- Genberg BL, Hlavka Z, Konda KA, et al. A comparison of HIV/AIDS-related stigma in four countries: Negative attitudes and perceived acts of discrimination towards people living with HIV/AIDS. *Soc Sci Med* 2009;68:2279-2287.
- Yang Y, Yang C, Latkin CA, et al. Condom Use During Commercial Sex Among Male Clients of Female Sex Workers in Sichuan China: A Social Cognitive Theory Analysis. *AIDS Behav* 2016;20:2309-2317.
- Tucker JD, Henderson GE, Wang TF, et al. Surplus men, sex work, and the spread of HIV in China. *Aids* 2005;19:539-547.
- Reilly KH, Wang J, Zhu Z, et al. HIV and associated risk factors among male clients of female sex workers in a Chinese border region. *Sex Transm Dis* 2012;39:750-755.
- Zhang C, Li X, Su S, et al. Prevalence of HIV, syphilis, and HCV infection and associated risk factors among male clients of low-paying female sex workers in a rural county of Guangxi, China: a cross-sectional study. *Sex Transm Infect* 2014;90:230-236.
- Lau JTF, Wang M, Wong HN, et al. Prevalence of bisexual Behaviors among men who have sex with men (MSM) in China and associations between condom use in MSM and heterosexual behaviors. *Sex Transm Dis* 2008;35:406-413.
- Song Y, Li X, Zhang L, et al. HIV-testing behavior among young migrant men who have sex with men (MSM) in Beijing, China. *AIDS Care* 2011;23:179-186.
- Wang B, Li X, Stanton B, et al. HIV-related risk behaviors and history of sexually transmitted diseases among male migrants who patronize commercial sex in China. *Sex Transm Dis* 2007; 34:1-8.
- Diokno AC, Brown MB, Herzog AR. Sexual function in the elderly. *Arch Intern Med* 1990; 150:197-200.
- Zhang L, Chow EPF, Jing J, et al. HIV prevalence in China: integration of surveillance data and a systematic review. *Lancet Infect Dis* 2013;13:955-963.
- Kang S-C, Hwang S-J, Wong W-W. Characteristics of human immunodeficiency virus infections among the elderly in Taiwan: a nationwide study. *J Chin Med Assoc* 2011;74:215-219.
- Jia ZW, Wang L, Chen RY, et al. Tracking the Evolution of HIV/AIDS in China from 1989-2009 to Inform Future Prevention and Control Efforts. *Plos One* 2011;6:e25671.
- Cui Y, CX Shi, Z Wu. Epidemiology of HIV/AIDS in China: recent trends. *Global Health Journal* 2017;1:26-32.
- Council OoCS. China's 13th Five-year Action plan for AIDS prevention and control. 2017.

26. Zhang T, Miao Y, Li L, et al. Awareness of HIV/AIDS and its routes of transmission as well as access to health knowledge among rural residents in Western China: a cross-sectional study. *Bmc Public Health* 2019;19:1630.
27. Tuddenham SA, Page KR, Chauk P, et al. Patients fifty years and older attending two sexually transmitted disease clinics in Baltimore, Maryland. *Int J STD AIDS* 2017;28:330-344.
28. Hu MG, CD Xu, Wang JF. Spatiotemporal Analysis of Men Who Have Sex With Men in Mainland China: Social App Capture-Recapture Method. *JMIR Mhealth Uhealth* 2020;8:e14800.
29. Beyrer C, Baral SD, Griensven Fv et al. Global epidemiology of HIV infection in men who have sex with men. *Lancet* 2012;380:367-377.
30. Lin Z-H, Xin Y-N, Dong Q-J, et al. Performance of the Aspartate Aminotransferase-to-Platelet Ratio Index for the Staging of Hepatitis C-Related Fibrosis: An Updated Meta-Analysis. *Hepatology* 2011;53:726-736.
31. Chou R, Spencer H, Bougatsos C et al. Preexposure Prophylaxis for the Prevention of HIV Infection Evidence Report and Systematic Review for the US Preventive Services Task Force. *JAMA* 2019;321:2214-2230.
32. Sichuan Statistics Bureau C. 2018 Sichuan Provincial Demographic Bulletin. 2019.
33. Baral SD, Wirtz A, Poteat T, et al. Was the HIV infection burden in female sex workers in China overestimated? reply. *Lancet Infect Dis* 2013;13:13-14.
34. Duan ZH, Shuangfeng F, Rong L, et al. Consistently high HIV prevalence among men who have sex with men in Chengdu city from 2009 to 2014. *Int J STD AIDS* 2016;27:1057-1062.
35. You XY, Gilmour S, Cao W, et al. HIV incidence and sexual behavioral correlates among 4578 men who have sex with men (MSM) in Chengdu, China: a retrospective cohort study. *Bmc Public Health* 2021;21:802.
36. She M, Zhang H, Wang J, et al. Associated factors for HIV and syphilis infection among men who have sex with men only and men who have sex with both men and women in cities of China. *Int J STD AIDS* 2013;24:293-300.
37. Statistics PBo. Statistical bulletin of national economic and social development of Pengzhou City in 2019. 2020.
38. Yang Y, Deng H, He H, et al. Lifetime commercial heterosexual behavior among HIV negative elderly men from rural Chengdu, China: a modified knowledgeattitude-practice perspective. *BMC Public Health* 2021;21:2095.
39. Patel P, Borkowf CB, Brooks JT, et al. Estimating per-act HIV transmission risk: a systematic review. *Aids* 2014;28:1509-1519.
40. Feng Y, Wu Z, Detels R. Evolution of Men Who Have Sex with Men Community and Experienced Stigma Among Men Who Have Sex with Men in Chengdu, China. *J Acquir Immune Defic Syndr* 2010;53:S98-S103.