

Homosexual identity and network overlap predictors of HIV infection among older men from rural China: a case-control study

Yi Yang ,¹ Yuan Li,² Shuangfeng Fan,³ Jia He,² Jing Xi,³ ShiJiao He³

To cite: Yang Y, Li Y, Fan S, et al. Homosexual identity and network overlap predictors of HIV infection among older men from rural China: a case-control study. *BMJ Public Health* 2024;**2**:e000781. doi:10.1136/bmjph-2023-000781

YY, YL and SF are joint first authors.

Received 30 November 2023
Accepted 24 April 2024

ABSTRACT

Background The number of newly reported older (≥ 50 years old) people living with HIV/AIDS in China has been steadily increasing, and heterosexual transmission has been identified as the major route.

Methods In this study, based on biopsychosocial model, a case-control study (74 cases vs 296 controls) was applied to find out predictors (21 potential ones) of HIV infection among older men from rural China. Binary logistic regression with backward selection was applied.

Results Out of 21 potential predictors of HIV infection, 4 were confirmed: receiving HIV-related health education (HRHE) (OR 0.449, 95% CI 0.238 to 0.848), self-reported homosexual identity (16.517 (95% CI 1.073 to 254.182)), visiting female sex workers (FSW) (58.427 (95% CI 7.895 to 432.403)), complete non-overlap of intimate social network and sexual network (2.912 (95% CI 1.372 to 6.177)), partial overlap (3.334 (95% CI 1.536 to 7.236)).

Discussion Findings from this study suggest current comprehensive prevention and control services need to be strengthened to provide effective HRHE including condom use to older men and help them to improve condom use, especially during visiting FSW and among self-reported homosexual older men. Moreover, increasing intimacy in their sexual relationships is necessary.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Heterosexual transmission has been identified as the major route of HIV infection among older men in China, and social support which helps to maintain well-being of older men is insufficient in China. Our main concern is whether older men get enough social support from their sexual partners or not.

WHAT THIS STUDY ADDS

⇒ Self-reported homosexual identity (16.517 (95% CI 1.073 to 254.182)), complete non-overlap of intimate social network and sexual network (2.912 (95% CI 1.372 to 6.177)), partial overlap (3.334 (95% CI 1.536 to 7.236)) are found out to be risky factors of HIV infection for older men in China.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Comprehensive prevention and control services should focus on both on commercial heterosexual transmission and on homosexual transmission at population level. Increasing intimacy in older men's sexual relationships is as necessary as HIV-related health education.



© Author(s) (or their employer(s)) 2024. Re-use permitted under CC BY-NC. Published by BMJ.

¹School of Management, Chengdu University of Traditional Chinese Medicine, Chengdu, Sichuan, China

²Chengdu University of Traditional Chinese Medicine, Chengdu, Sichuan, China

³Chengdu Center for Disease Control and Prevention, Chengdu, Sichuan, China

Correspondence to

Dr Yi Yang;
yangyi@cdutcm.edu.cn

INTRODUCTION

Globally, along with antiretroviral therapy (ART) scale-up, mortality and new cases of HIV decreasing results in increased prevalence of HIV since 2006.¹ By December 2020, there are approximately 37.7 million people living with HIV/AIDS (PLHIV) worldwide,² among which 8.1 million are older (≥ 50 years old),³ and it is estimated that in some country, the percentage of older male PLHIV will rise to 73% by 2030.⁴ There are about 1.40 million PLHIV in China,⁵ the number of newly reported older PLHIV in China has been steadily increasing,^{6 7} from 32 850 to 66 010 during 2015-2019,⁸ at a much higher rate than the general population and other age groups,⁹ and heterosexual transmission has

been identified as the major route.^{6 7 10} There are 486.58 million older population in China in 2020, accounting for 34.52% of the whole population.¹¹ According to a meta-analysis study, during 2010-2018, HIV infection rate in older people is 1.68% in China and 2.13% in west part of China.¹² Compared with other age groups, older men have minimal knowledge about HIV/AIDS,¹³ and condom use among them is extremely low.^{14 15} Currently, HIV-related health education (HRHE) and behavioural intervention among older people in China mainly adopts the knowledge-attitude-behaviour (KAP) model, and the knowledge and ability reservation of health educators are generally insufficient.¹⁰

Older men, whose sexual activities decline obviously after the age of 50¹⁶ and who

were excluded from the priority of HIV prevention programmes,^{17–20} were not recognised and listed as a key prevention group until 2017²¹ in China. Due to convention²² and stigma,²³ sex has been taken as procreation within a family context in China. Chinese, especially older people, do not talk about sex.^{22–24} Since the 1980s, when migrating alone, due to a lack of norms and values' control from original communities,^{14 22 25–30} sexual attitudes in China have changed to being an individual's responsibility as long as there is no foreseen negative impact on the well-being of others or the larger society.²² Having sexual behaviour is not only to fulfil physical needs but also emotional needs.^{14 22 25–30} The closer clients feel with female sex workers (FSW), the less they use condom consistently.¹⁴ Moreover, it is estimated that men who have sex with men (MSM) account for 1.73% of men aged 18–64 years in China.³¹ 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.³²

Conventionally, Chinese society is a patriarchy society where men are supposed to be strong and ready to give support to their intimate social networks.^{33 34} Social support which helps to maintain well-being^{35–38} for older men in China is insufficient. It is not clear the role of social and sexual network overlap in HIV Infection among older men from rural China. In order to find out the roles of sexual behaviours, sexual identity, health education, and especially social and sexual network overlap in HIV Infection among older men from rural China, a case–control study was conducted.

METHODS

Study site

HIV epidemic information was obtained through China National HIV Sentinel Surveillance System and analysed. Due to a large amount of PLHIV and increasing epidemic, a county-level city (city A) with a population around 810 000 in Chengdu was identified as the study site.³⁹

Study design, participant and procedures

We conducted a case–control study comparing newly diagnosed HIV-infected older men with HIV-uninfected older men.

Eligibility criteria for cases included (1) ≥ 50 years old, (2) male, (3) living in current address for at least 6 months, (4) newly diagnosed HIV (+) and (5) willing to participate in the study, and sign informed content. We also enrolled controls, those who were HIV (–). Exclusion criteria for both groups included (1) cannot speak clearly and (2) with mental problems and recall disability.

Sample size was calculated according to the formula $n = \frac{2(\mu_{\alpha} + \mu_{\beta})^2 s_c^2}{\delta^2}$, where μ_{α} is the value corresponding to the test level, δ is the difference between the overall mean of the two groups and s_c^2 is the combined variance of the two groups. The power of a test was taken as 80% and the test level as 0.05. According to our pilot study,

the overall mean value of intimacy in the case group was 3.68 with the variance as 1.808, and the control group was 2.71 with 1.440. The sample size of the case group (n_1) was calculated as 27, and 108 for control group (n_2) at 1: 4 ratios. During 2019–October 2020, 74 cases with 296 controls of the same ages were included. In total, there were 370 respondents in this study.

Eligible older men interested in participation provided informed consent after eligibility was confirmed. An in-depth interview in a separate room with one case was conducted by one skilled staff from local Centers for Disease Control and Prevention (CDC) within 1 month after cases' HIV diagnosis. Face-to-face interview with a questionnaire was conducted for one control by one well-trained male interviewer in a separate room either at village health centres or activity centres. Local slangs were used to refer sexual behaviours, such as 'hanging out with Miss(Xiaojie)' referring 'visiting FSW'. Both cases and controls' responses were recorded into same questionnaire. Cases were paid ¥40 (approximately US\$7) for participation, and controls got a big bottle of dish-washing liquid (approximately valued US\$2) for their participation. Condoms were also provided if needed.

HIV testing

Based on China National Guideline for Detection of HIV/AIDS, Dot immunocolloid gold rapid test (Yingke New Technology) or ELISA was used for HIV antibody test as HIV rapid testing. When HIV (+) results were obtained from HIV rapid testing, 3–5 mL cubital venous blood was sampled and sent to local HIV confirmation laboratory. Immunoblotting (westernblot (WB)) was applied for HIV antibody confirmatory test.

Measures

Based on biopsychosocial model,⁴⁰ the questionnaire included items on respondents' demographic characteristics, biological factors,^{6 7 10 28 30} psychological factors,^{14 22 25–32} social factors^{35–37} and health services.^{13 39} Moreover, overlap of intimate social network and sexual network was measured.

Biological factors

(1) Sexual desire changing after the age of 50? Response options are 'no sexual need', 'decline', 'not change', 'increase' and (2) high-risk sexual behaviours: lifetime experiences of visiting FSW, casual sexual behaviour/one night stand, non-commercial non-fixed heterosexual behaviour and homosexual behaviour.

Psychological factors

Sexual identity and sexual attitudes were used to reflect psychological factors.

1. Sexual identity was assessed by asking 'how do you identify yourself sexually?' Response options are heterosexual, homosexual and bisexual.
2. Sexual attitudes were assessed by asking respondents their attitude towards (people) visiting FSW, towards extramarital heterosexual behaviour and towards

homosexual behaviour. Response options of the former two are 'admire', 'it is understandable as a common human behaviour', 'undecided', 'could not accept' and 'strongly objection'. Response options of towards homosexual behaviour are 'it is understandable and has homosexual behaviour', 'it is understandable but not acceptable', 'could not accept', 'could not accept but be involved in', 'strongly objection' and 'do not know what homosexual behaviour is'.

Social factors included (1) whom did they live with; (2) daily entertainment: visiting tea-house with friends, playing mahjong, exercises, watching television (TV), tourism, having party with friends, dancing at squares and other.

Health services provision was measured by asking whether they got HRHE before the investigation.

Overlap of intimate social network and sexual network

Intimate social network was measured by asking respondents 'please nominate your current most intimate five social network member, starting from the most intimate one', characteristic information was obtained. Sexual network was measured by 'please nominate your most intimate ten sexual partners during the past 3 years, starting from the most intimate one', detail information was also obtained.

Intimate social network members and sexual network members were cross-checked. If a partner in social network and a partner in a sexual network conform to the following characteristics, the partner was regarded as the same person: (1) type of relationship, (2) gender, (3) age, (4) nationality, (5) marital status, (6) educational level, (7) profession and (8) history of migrant workers.

When the number of intimate social network members of the respondents is equal to or less than that of sexual network members, the sexual network members were taken as the reference. If all the intimate social network members of the respondents were their sexual network members, it was regarded as 'completely overlap' between his intimate social network and sexual network. If some of the intimate social network members were their sexual network members, it was regarded as 'partially overlap'. If the intimate social network members were not his sexual network members, they are regarded as 'complete non-overlap'.

When the number of intimate social network members of the respondents is more than that of sexual network members, the members of the intimate social network were taken as a reference. If some of the members of the sexual network are members of his intimate social network, it is regarded as 'partial overlap'. If all the members of the sexual network are not members of his intimate social network, it is regarded as 'complete non-overlap'.

Data analysis

Frequencies for nominal variables, mean and SD for interval variables were assessed. T-test and χ^2 tests/Fisher's

exact test as univariate analyses 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 with $p < 0.05$ in univariate analyses. Adjusted OR (AOR) and 95% CIs were calculated. Factors with AOR greater than 1 were categorised as risk factors and less than 1 as protective factors.

RESULTS

Demographic characteristics, social factors and health education

Most respondents were at the age of 60–69 (40.54%), primary school educated (50.81%), married (81.08%), held rural residency (96.22%), latest worked as a farm worker/migrant worker (81.35%), migrated more than 1 year ago (45.95%), currently had monthly income less than ¥1000 (47.30%) and spent less than ¥500 for entertainment (74.59%), lived with their spouses and other family members (parents or children%) (48.11%), took visiting tea-house with friends (68.92%) and watching TV (63.51%) as daily entertainment. And more than half (59.48%) received HRHE before the investigation.

Five demographic variables were associated with HIV infection: household residency, marital status, migration, monthly income, monthly expense for entertainment. Four social factor variables were associated with HIV infection: living with, and visiting tea-house with friends, exercising and watching TV as daily entertainment. HRHE was also associated with HIV infection. In the multivariate model, only HRHE (OR 0.449, 95% CI 0.238 to 0.848) was retained. Details are shown in [table 1](#).

Sexual desire change, sexual identity, attitude and high-risk sexual behaviours

Most of the respondents' sexual desire declined after the age of 50 years, and self-reported as heterosexual, held undecided attitude or could not accept towards visiting FSW. 37.57% of respondents did not know what homosexual behaviour is. 29.46% visited FSW, 4.86% practised casual sexual behaviour and 1.35% reported practising homosexual behaviour.

Sexual identity, attitude towards visiting FSW, attitude towards visiting FSW, attitude towards extramarital heterosexual behaviour and attitude towards homosexual behaviour, visiting FSW, casual sexual behaviour, non-commercial non-fixed behaviour and homosexual behaviour were associated with HIV infection. In the multivariate model, sexual identity (16.517 (95% CI 1.073 to 254.182)), visiting FSW (58.427 (95% CI 7.895 to 432.403)) and homosexual behaviour (16.517 (95% CI 1.073 to 254.182)) were retained. Details are shown in [table 1](#).

The overlap of intimate social network and sexual network

52.70% of the case group's intimate social network and sexual network were complete non-overlap, more than the control group (18.58%) ($p < 0.05$). In the multivariate

Table 1 Demographic characteristics, social factors and health education associated with HIV infection (n=370)

	Total (n=370)	Case (n=74)	Control (n=296)	χ^2	P value	Adjusted OR (95% CI)
Age				0.000	1.000	
50~	145 (39.19)	29 (39.19)	116 (39.19)			
60~	150 (40.54)	30 (40.54)	120 (40.54)			
70~	75 (20.27)	15 (20.27)	60 (20.27)			
Education level				3.775	0.287	
Primary school drop-outs	54 (14.59)	15 (20.27)	39 (13.18)			
Primary school	188 (50.81)	37(50.00)	151 (51.01)			
Junior high school	106 (28.65)	20 (27.03)	86 (29.05)			
Senior high school and above	22 (5.95)	2 (2.70)	20 (6.76)			
Marital status				15.557	<0.01*	
Married	300 (81.08)	49 (66.22)	251 (84.8)			
Never married	7 (1.89)	1 (1.35)	6 (2.03)			
Single (divorce/widow/separated)	63 (17.03)	24 (32.43)	39 (13.18)			
Household residency					< 0.01*	
Urban	14 (3.78)	9 (12.16)	5 (1.69)			
Rural	356 (96.22)	65 (87.84)	291 (98.31)			
Latest occupation				5.337	0.068	
Farm worker/migrant worker	301 (81.35)	66 (89.19)	235 (79.39)			
Government employee	12 (3.24)	3 (4.05)	9 (3.04)			
Other	57 (15.41)	5 (6.76)	52 (17.57)			
Migration history				10.572	0.005	
More than 1 year ago	170 (45.95)	40 (54.05)	130 (43.92)			
Within the past 1 year	67 (18.11)	19 (25.68)	48 (16.22)			
Never	133 (35.95)	15 (20.27)	118 (39.86)			
Monthly income				36.758	<0.01	
<¥1000	175 (47.30)	17 (22.97)	158 (53.38)			
¥1000–¥1999	82 (22.16)	14 (18.92)	68 (22.97)			
¥2000–¥2999	52 (14.05)	17 (22.97)	35 (11.82)			
≥¥3000	61 (16.49)	26 (35.14)	35 (11.82)			
Monthly expense for entertainment					<0.01*	
<¥500	276 (74.59)	40 (54.05)	236 (79.73)			
¥500–¥999	57 (15.41)	22 (29.73)	35 (11.82)			
¥1000–¥1499	21 (5.68)	7 (9.46)	14 (4.73)			
¥1500–¥1999	9 (2.43)	2 (2.70)	7 (2.36)			
≥¥2000	7 (1.89)	3 (4.05)	4 (1.35)			
Living with				51.841	<0.01	
Only spouse	122 (32.97)	21 (28.38)	101 (34.12)			
Spouses and other family members (parents or children)	178 (48.11)	20 (27.03)	158 (53.38)			
Only other family members (parents or children)	27 (7.3)	18 (24.32)	9 (3.04)			
Nobody	43 (11.62)	15 (20.27)	28 (9.46)			
Daily entertainment						
Visiting tea-house with friends	255 (68.92)	64 (86.49)	191 (64.53)	13.327	<0.01	
Playing mahjong	178 (48.11)	43 (58.11)	135 (45.61)	3.705	0.054	
Tourism	23 (6.22)	6 (8.11)	17 (5.74)		0.427*	
Having party with friends	60 (16.22)	14 (18.92)	46 (15.54)	0.497	0.481	

Continued

Table 1 Continued

	Total (n=370)	Case (n=74)	Control (n=296)	χ^2	P value	Adjusted OR (95% CI)
Exercises	56 (15.14)	3 (4.05)	53 (17.91)	8.843	<0.01	
Dancing at squares	1 (0.27)	0 (0.00)	1 (0.34)		1.000*	
Watching television	235 (63.51)	62 (83.78)	173 (58.45)	16.401	<0.01	
Other	72 (19.46)	18 (24.32)	54 (18.24)	1.397	0.237	
Receiving HIV-related health education	182 (59.48)	15 (20.27)	167 (71.98)	62.250	<0.01	0.449 (0.238 to 0.848)
Sexual desire				2.286	0.515	
No sexual need	40 (10.81)	7 (9.46)	33 (11.15)			
Decline	261 (70.54)	57 (77.03)	204 (68.92)			
Not change	67 (18.11)	10 (13.51)	57 (19.26)			
Increase	2 (0.54)	0 (0.00)	2 (0.68)			
Sexual identity					<0.01*	
Heterosexual	367 (99.19)	71 (95.95)	296(100)			1.00
Homosexual	3 (0.81)	3 (4.05)	0 (0.00)			16.517 (1.073 to 254.182)
Attitude towards visiting FSW				56.719	<0.01	
It is understandable as a common human behaviour	93 (25.14)	34 (45.95)	59 (19.93)			
Undecided	133 (35.95)	39 (52.7)	94 (31.76)			
Could not accept	113 (30.54)	1 (1.35)	112 (37.84)			
Strongly objection	31 (8.38)	0 (0.00)	31 (10.47)			
Attitude towards extramarital heterosexual behaviour	6 (1.63)	2 (2.82)	4 (1.35)	79.895	<0.01	
Admire						
It is understandable as a common human behaviour	51 (13.90)	5 (7.04)	46 (15.54)			
Undecided	149 (40.60)	61 (85.92)	88 (29.73)			
Could not accept	125 (34.06)	3 (4.23)	122 (41.22)			
Strongly objection	36 (9.81)	0 (0.00)	36 (12.16)			
Attitude towards homosexual behaviour				68.415	<0.01	
It is understandable and has homosexual behaviour	4 (1.08)	4 (5.41)	0 (0.00)			
It is understandable but not acceptable	29 (7.84)	0 (0.00)	29 (9.80)			
Could not accept	89 (24.05)	39 (52.70)	50 (16.89)			
Could not accept but be involved in	1 (0.27)	1 (1.35)	0 (0.00)			
Strongly objection	108 (29.19)	14 (18.92)	94 (31.76)			
Do not know what homosexual behaviour is	139 (37.57)	16 (21.62)	123 (41.55)			
Visiting FSW	109 (29.46)	70 (94.59)	39 (13.18)	188.846	<0.01	58.427 (7.895 to 432.403)
Casual sexual behaviour	18 (4.86)	9 (12.16)	9 (3.04)		<0.01*	
Non-commercial non-fixed heterosexual behaviour	23 (6.22)	9 (12.16)	14 (4.73)		0.028*	
homosexual behaviour	5 (1.35)	5 (6.76)	0 (0.00)		<0.01*	4.461 (0.979 to 20.334)
Overlap of intimate social network and sexual network						
Complete non-overlap	94 (25.41)	39 (52.70)	55 (18.58)	146.987	<0.001	2.912 (1.372 to 6.177)
Partial overlap	31 (8.38)	26 (35.14)	5 (1.69)			3.334 (1.536 to 7.236)
Complete overlap	245 (66.22)	9 (12.16)	236 (79.73)			1.00

*Fisher's exact test.
FSW, female sex workers.

model, the overlap of intimate social network and sexual network was retained (complete non-overlap: 2.912 (95% CI 1.372 to 6.177); Partial overlap: 3.334 (95% CI 1.536 to 7.236)). Details are shown in [table 1](#).

DISCUSSION

Both cases and controls in this study come from rural communities and represent older male population in China. At population level, our study confirms the function of commercial heterosexual behaviour as known^{6 7 10} and of self-reported homosexual identity^{31 32} in HIV transmission independently among older men from rural China. Instead of condom, intrauterine device for women has been main contraception method among married couples in China during 1979–2012, some older men never use condom in their whole life,^{24 38} condom use during visiting FSW is extremely low¹⁴ which put them at the risk of HIV infection. Multivariate model shows that homosexual identity is a risk factor, but not homosexual behaviour. Older men in Chengdu live in an environment where homosexual behaviours are tolerated.³² 4.05% of cases self-reported as homosexual and 6.76% reported having sex with men. In this study, we did not measure the frequency of homosexual behaviour. Self-reported homosexual identity implicitly reflects the frequency of homosexual behaviour. The frequency of homosexual behaviour among homosexual identified MSM is more than among heterosexual identified MSM.²⁸ The more frequently they have homosexual behaviour, the more possibility of HIV infection happens. Our previous study finds out that HIV-1 subtype CRF 55_01B which was first found out among MSM in China exists among older men at our study site,⁴¹ which provide molecular evidence for the role of homosexual behaviours in HIV transmission among older men. This study gives epidemiological evidence for the function of homosexual identity in HIV transmission among older men at population level. Moreover, older MSM/W play role of ‘bridge population’ as transmitting HIV infection from MSM to their heterosexual partners.^{28 30}

As expected, receiving HRHE is a protective factor^{13 38 39} for avoiding HIV infection. During 2006–2017, awareness rate of HIV/AIDS core knowledge among the older population in China was 51.0%,⁴² far from the target in 2017 as 90%.²¹ Even though comprehensive prevention and control has been targeting older male population since 2017,²¹ during 2019–2020, only 59.48% of older men got HRHE in this study. Health services provision is not effective and sufficient to reach older men to achieve the ‘90-90-90 targets’, namely 90% of PLHIV knowing their status, 90% of those diagnosed receiving sustained ART, and 90% of those receiving ART achieving viral suppression by 2020.⁴³ During 2016–2020, 92.9% of PLHIV in China received ART, and 96.1% of them achieve viral suppression,⁴⁴ better than the global level,² but the goal of knowing their status has not been achieved.⁴⁴

Overlap of intimate social network and sexual network reflect that older men get social support from their sexual partners which helps to maintain their well-being.^{35–37} Conventionally, Chinese men are supposed to be a ‘giver’ rather than a ‘receiver’.^{33 34} Older men get little support from intimate social network, even from family members.⁴⁵ In this study, 52.70% of cases’ intimate social network and sexual network were complete non-overlap, which means they did not receive social support from their sexual networks within the past 3 years. They are not close to their sexual partner, sexual behaviours are mainly commercial heterosexual behaviour (94.59%). At the same time, nearly 80% of controls have close relationships with their sexual partners, and overlap of intimate social network and sexual network help them avoid getting HIV infected. It is worth mentioning that we find out that emotional support is protective meanwhile material support only is risky for becoming HIV-positive among older men.³⁸

Therefore, in order to prevent HIV transmission among older men, current comprehensive prevention and control services²¹ need to be strengthened to provide effective HRHE to access older men effectively, and to help older men to improve condom use, especially visiting FSW and among self-reported homosexual older men. In a conventional patriarchy society, Chinese society needs to reconsider older men as vulnerable ‘older people’ first, then ‘men’. As ‘older people’, increasing intimacy in their sexual relationships is necessary to help them both avoid HIV infection and maintain well-being.^{35–37}

Limitations

In the current study, self-report behaviour information should be noted. In order to reduce report bias, 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. In order to minimise informational bias due to the 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 procedure.

Contributors YY: conceptualisation, funding acquisition, investigation, methodology, supervision, roles/writing—original draft, writing—review and editing. YY is the guarantor, who accepts full responsibility for the finished work and/or the conduct of the study, had access to the data, and controlled the decision to publish. YL and SF: methodology, project administration, writing—review and editing. JH, JX and SH: investigation, writing—review and editing. All authors are aware that they are being listed, have seen and approved the manuscript and accept responsibility for its content.

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).

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Consent obtained directly from patient(s).

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

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

ORCID iD

Yi Yang <http://orcid.org/0000-0003-2825-4144>

REFERENCES

- Frank TD, Carter A, Jahagirdar D, *et al*. Global, regional, and national incidence, prevalence, and mortality of HIV, 1980–2017, and forecasts to 2030, for 195 countries and territories: a systematic analysis for the global burden of diseases, injuries, and risk factors study 2017. *Lancet HIV* 2019;6:e831–59.
- UNAIDS. 2021 UNAIDS global AIDS update — confronting inequalities — lessons for pandemic responses from 40 years of AIDS. 2021.
- UNAIDS. Global data on HIV epidemiology and response. 2021. Available: <https://aidsinfo.unaids.org>
- 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;15:810–8.
- UNAIDS. Biennial report for UN joint programme on AIDS in China (2020–2021). 2022.
- 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;81:215–20.
- Liu H, Lin X, Xu Y, *et al*. Emerging HIV epidemic among older adults in Nanning, China. *AIDS Patient Care STDS* 2012;26:565–7.
- MA K, ZHANGX, Ge L, *et al*. Analysis on the late-diagnosis among newly detected HIV/AIDS cases aged 50 years or older in China from 2015 To2019. *Chinese Journal of AIDS & STD* 2022;28:16–20.
- 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.
- Yuan F-S, Liu L, Liu L-H, *et al*. Epidemiological and spatiotemporal analyses of HIV/AIDS prevalence among older adults in Sichuan, China between 2008 and 2019: a population-based study. *Int J Infect Dis* 2021;105:769–75.
- China, N.B.o.S.o. Age-specific and sex-specific population (year of 2020). 2021.
- Zhang HX, Han MJ, Zhou Y, *et al*. HIV infection rate in people aged 50 years and older in China: a meta-analysis. *Zhonghua Liu Xing Bing Xue Za Zhi* 2020;41:96–102.
- 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.
- 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;20:2309–17.
- Tuddenham SA, Page KR, Chaulk P, *et al*. Patients fifty years and older attending two sexually transmitted disease clinics in Baltimore, Maryland. *Int J STD AIDS* 2017;28:330–44.
- 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;13:955–63.
- 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;74:215–9.
- Jia Z, 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, Shi CX, Wu Z. Epidemiology of HIV/AIDS in China: recent trends. *Global Health Journal* 2017;1:26–32.
- Council, O.o.C.S. China's 13th five-year action plan for AIDS prevention and control. 2017.
- Zhang K, Beck EJ. Changing sexual attitudes and behaviour in China: implications for the spread of HIV and other sexually transmitted diseases. *AIDS Care* 1999;11:581–9.
- 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. *Social Science & Medicine* 2009;68:2279–87.
- Zou H, Xue H, Wang X, *et al*. Condom use in China: prevalence, policies, issues and barriers. *Sex Health* 2012;9:27–33.
- Tucker JD, Henderson GE, Wang TF, *et al*. Surplus men, sex work, and the spread of HIV in China. *AIDS* 2005;19:539–47.
- 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;39:750–5.
- 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;90:230–6.
- 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;35:406–13.
- 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;23:179–86.
- 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.
- Hu MG, Xu CD, 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.
- 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.
- Walker R, Millar J, Behind L. The status of women in contemporary China. *SI* 2020;8:1–9.
- Zhang W, Xu Z. Gender norms and household labor: time use in the context of social class differentiation in transitional China. *Review of Radical Political Economics* 2022;54:106–21.
- Saltzman LY, Hansel TC, Bordnick PS. Isolation, and social support factors in post-COVID-19 mental health. *Psychological Trauma: Theory, Research, Practice, and Policy* 2020;12:S55–7.
- Lindsay Smith G, Banting L, Eime R, *et al*. The association between social support and physical activity in older adults: a systematic review. *Int J Behav Nutr Phys Act* 2017;14:14.
- Abdoli N, Salari N, Darvishi N, *et al*. The global prevalence of major depressive disorder (MDD) among the elderly: a systematic review and meta-analysis. *Neurosci Biobehav Rev* 2022;132:1067–73.
- Yang Y, Liang S, Fan S, *et al*. Experiences of visiting female sex workers, social interaction, support and HIV infection among elderly men from rural China. *BMC Infect Dis* 2023;23:356.
- Yang Y, Deng H, He H, *et al*. Lifetime commercial heterosexual behavior among HIV negative elderly men from rural Chengdu, China: a modified knowledge-attitude-practice perspective. *BMC Public Health* 2021;21:1–9.
- Engel GL. The need for a new medical model: a challenge for Biomedicine. *Science* 1977;196:129–36.
- Zhong X, Yuan D, Liu Y, *et al*. Analysis of the characteristics of HIV-1 molecular transmission network among people aged 50 years and above in Pengzhou city of Sichuan province. *Zhonghua Liu Xing Bing Xue Za Zhi* 2022;43:1107–11.
- Wang C, *et al*. Awareness rate of HIV/AIDS core knowledge among the elderly: a meta-analysis. *Chin J AIDS STD* 2019;25:148–52.
- Zhang L, Liu L, Lai W, *et al*. Comprehensive HIV/AIDS programs in Sichuan. *HIV/AIDS in China* 2019:629–51.
- Han M, *et al*. “13th five-year” AIDS prevention and control to a new journey-China’s AIDS prevention and control review and outlook”. *Chin J AIDS STD* 2021;27:1327–31.
- Li Y, Liu Q, Yang Y, *et al*. A study on the association between family support and high-risk sexual behavior of elderly men in rural China. *Am J Mens Health* 2022;16:15579883221107729.