Letter to the Editor

Factors Affected HIV Testing and HIV Infection among Internet-based Self-testing MSM Who Never Tested for HIV in Beijing, China*

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Around half of the men who have sex with men (MSM) have never been tested for human immunodeficiency virus (HIV), even though the health authorities promoted a massive scale-up of HIV testing and counseling in health facilities[1]. HIV self-testing has been recommended by the World Health Organization as a user-friendly, convenient, rapid, and accurate approach to access HIV testing[2]. An internet-based provision of self-testing services may be critical to the rollout of HIV self-testing, but more research is needed.

The AIDS Healthcare Foundation (AHF) of China collaborated with the Tongzhi Welfare Group to explore factors that affected HIV testing and HIV infection among those who were never tested for HIV from January 2016 to December 2016 in Beijing, China. Peer educators conducted both online and offline promotional and recruitment activities. The participant eligibility criteria for inclusion were that they were at least 16 years of age, born biologically male, had engaged in anal sex with a man within the last six months, and returned their self-testing results. Eligible individuals were mailed a self-testing kit free of charge. The self-testing package was delivered to the address provided by participants within one to three days. Participants who submitted an HIV positive result were immediately contacted by a member of the study staff for an initial consult, and to arrange one-on-one peer navigation services for HIV confirmatory testing and initiation of antiretroviral therapy.

For the descriptive analysis, we separated the sociodemographic and risk behavior information by whether participants had never tested for HIV. Univariate and multivariable stepwise logistic regression analyses were performed to determine independent factors that correlated with those never tested for HIV. Variables significant at $P \le 0.20$ were selected for inclusion in the multivariable logistic model. We used similar methods to evaluate the factors correlated with HIV infection among MSM who were never tested for HIV. All statistical analyses were performed using SAS 9.4 (SAS Int. Cary, NC, USA).

Participants who used the self-testing kits without returning their self-testing results were not included because of the difficulty of determining the actual use of applied kits. A total of 4,366 participants completed an online screening survey, among whom 3,687 (84.4%) met the inclusion criteria. Those excluded included 12 females, 176 of whom had not had anal sex with a man in the last six months, and 491 of whom had not returned their self-testing results. Among the 3,687 eligible participants, the median age was 31 years (IQR, 28–36 years), 65.3% (2,409/3,687) had at least a college education, 88.7% (3,269/3,687) were single or unmarried, 7.3% (270/3,687) were students, and most participants (82.5%, 3,042/3,687) had monthly incomes of less than 750 USD.

Overall, 80.1% of participants (2,954/3,687) were never tested for HIV. Among those who had ever tested for HIV (19.9%, 733/3,687), 33.3% of them (244/733) had tested only once before, 20.2%

doi: 10.3967/bes2020.103

*This study was supported by the National Science and Technology Major Project Research of the 13th Five-Year [No. 2018ZX10101001-001-003]; National Natural Science Foundation of China [No. 81872674]; AIDS Healthcare Foundation (AHF) China program [No. 2016-P-001].

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(148/733) had tested twice, 36.8% (270/733) tested 3–5 times, and 9.7% (71/733) had tested more than five times.

Regarding sexual behaviors, the vast majority identified as 'gay' [83.6% (3,084/3,687)], and the median age of their sexual debut was 21 years (IQR, 20–23 years). Roughly the same percentage of participants reported having the primarily insertive or receptive role during anal sex [38.8% (1,430/3,687) and 39.2% (1,445/3,687), respectively]. Also, 67.0% (2,470/3,687) of men reported having at least two male anal sex partners in the last six months, with 23.7% (622/2,620) reporting five or more partners in the last month. Over a quarter (28.8%; 880/3,055) reported incorrect condoms use during anal sex in the last month.

The multivariate results indicate that participants with lower education had higher odds of having never been tested for HIV (9–12 years education: a*OR* = 1.52, 95% *CI*: 1.12–2.07; < 9 years education: a*OR* = 1.93, 95% *CI*: 1.32–2.82), compared with those with college and higher education. The likelihood of having never been tested for HIV was also higher for those with monthly incomes less than 750 USD (a*OR* = 4.78, 95% *CI*: 3.75–6.11), compared with participants with 750 USD or higher monthly incomes. They were identifying as gay (a*OR* = 1.89, 95% *CI*: 1.44–2.48) as opposed to being 'bisexual' or 'uncertain'. They reported at least two sexual partners in the last six months, with 2.92 (95% *CI*: 2.22–3.84) for two sexual partners and 3.53 (95% *CI*: 2.72–4.58) for three or more sexual partners, respectively, compared with only one anal sexual partner; incorrect condom use in anal sexual activity in the last month (a*OR* = 1.86, 95% *CI*: 1.42–2.43), relative to those condom users, were more likely to have never been tested for HIV. Further details are provided in Table 1.

Upon enrollment in this survey, 80.1% (2,954/3,687) of the participants reported having never been tested for HIV. The overall HIV prevalence among these participants was 8.3% (246/2,954). Participants reported being involved in at least five anal sexual activities in the last month (a*OR* = 1.49, 95% *CI*: 1.03–2.15), and those who were aged less than 25 years (a*OR* = 4.19, 95% *CI*: 2.62–6.71) had a higher odds of HIV infection, relative to those who with less than five anal sexual activities in the last month and were aged between 25 to 34 years, respectively (Table 2).

Table 1. Factors associated with having never been tested for HIV among internet-based self-testing MSM

Variable	Total participants *n* (%) (*N* = 3,687)	Never tested for HIV, *n* (%) (*N* = 2,954)	Ever tested for HIV, *n* (%) (*N* = 733)	Univariate *OR* (95% *CI*)	*P* value	Multivariate *OR* (95% *CI*)	*P* value
Demographic							
Age (years)							
< 25	334 (9.0)	229 (7.8)	105 (14.3)	ref			
25–34	2,322 (63.0)	1,833 (62.0)	489 (66.7)	1.72 (1.34–2.21)	< 0.0001		
≥ 35	1,031 (28.0)	892 (30.2)	139 (19.0)	2.94 (2.20–3.94)	< 0.0001		
Education (years)							
< 9	554 (15.1)	501 (17.0)	53 (7.2)	3.00 (2.23–4.04)	< 0.0001	1.93 (1.32–2.82)	0.0007
9–12	724 (19.6)	624 (21.1)	100 (13.6)	1.98 (1.57–2.49)	< 0.0001	1.52 (1.12–2.07)	0.0077
≥ 12	2,409 (65.3)	1,829 (61.9)	580 (79.2)	ref		ref	
Marital status							
Single/unmarried	3,269 (88.7)	2,648 (89.6)	621 (84.7)	1.56 (1.24–1.97)	0.0002		
Married/cohabitating/ divorced/widowed	418 (11.3)	306 (10.4)	112 (15.3)	ref			
Occupation							
Students	270 (7.3)	172 (5.8)	98 (13.4)	ref		ref	
All occupations except students	3,417 (92.7)	2,782 (94.2)	635 (86.6)	2.50 (1.92–3.25)	< 0.0001	2.91 (2.04–4.15)	< 0.0001
Monthly income (USD)							
< 750	3,042 (82.5)	2,582 (87.4)	460 (62.8)	4.12 (3.42–4.96)	< 0.0001	4.78 (3.75–6.11)	< 0.0001
≥ 750	645 (17.5)	372 (12.6)	273 (37.2)	ref		ref	

Continued

Variable	Total participants *n* (%) (*N* = 3,687)	Never tested for HIV, *n* (%) (*N* = 2,954)	Ever tested for HIV, *n* (%) (*N* = 733)	Univariate *OR* (95% *CI*)	*P* value	Multivariate *OR* (95% *CI*)	*P* value
Sexual behaviors							
Age of sexual debut (years)							
< 18	224 (6.1)	154 (5.2)	70 (9.6)	0.52 (0.39–0.70)	< 0.0001		
≥ 18	3,463 (93.9)	2,800 (94.8)	663 (90.4)	ref			
Sexual orientation							
Gay	3,084 (83.6)	2,532 (85.7)	552 (75.3)	1.97 (1.62–2.40)	< 0.0001	1.89 (1.44–2.48)	< 0.0001
Bisexual/Uncertainty	603 (16.4)	422 (14.3)	181 (24.7)	ref		ref	
Anal sex role							
Exclusively insertive	700 (19.0)	573 (19.4)	127 (17.3)	ref			
Mostly insertive	730 (19.8)	575 (19.5)	155 (21.2)	0.82 (0.63–1.07)	0.142		
Almost half insertive and half receptive	812 (22.0)	608 (20.6)	204 (27.8)	0.66 (0.52–0.85)	0.001		
Mostly receptive	729 (19.8)	594 (20.1)	135 (18.4)	0.98 (0.75–1.28)	0.855		
Exclusively receptive	716 (19.4)	604 (20.5)	112 (15.3)	1.20 (0.90–1.58)	0.210		
No. of anal sexual partners in the last six months							
1	642 (20.6)	379 (15.5)	263 (39.8)	ref		ref	
2	988 (31.7)	803 (32.7)	185 (28.0)	3.01 (2.41–3.77)	< 0.0001	2.92 (2.22–3.84)	< 0.0001
≥ 3	1,482 (47.6)	1,270 (51.8)	212 (32.1)	4.16 (3.36–5.15)	< 0.0001	3.53 (2.72–4.58)	< 0.0001
No. of anal sex acts in the last month							
< 5	1,998 (76.3)	1,830 (76.1)	168 (78.5)	ref			
≥ 5	622 (23.7)	576 (23.9)	46 (21.5)	1.15 (0.82–1.61)	0.421		
Correct condom uses in the last month							
Yes	2,175 (71.2)	1,744 (68.7)	431 (83.5)	ref		ref	
No	880 (28.8)	795 (31.3)	85 (16.5)	2.31 (1.81–2.96)	< 0.0001	1.86 (1.42–2.43)	< 0.0001

Table 2. Factors correlated with HIV infection among internet-based self-testing MSM who were never tested for HIV

Variable	Participants (*N* = 2,954)	Positive (*N* = 246)	Positive rate (%)	Univariate *OR* (95% *CI*)	*P* value	Multivariate *OR* (95% *CI*)	*P* value
Demographic							
Age (years)							
< 25	229	38	16.6	2.67 (1.81–3.96)	< 0.0001	4.19 (2.62–6.71)	< 0.0001
25–34	1,833	127	6.9	ref		ref	
≥ 35	892	81	9.1	1.34 (1.00–1.80)	0.048	1.12 (0.76–1.65)	> 0.05
Education (years)							
< 9	501	52	10.4	1.34 (0.96–1.86)	0.089		
9–12	624	48	7.7	0.96 (0.68–1.35)	0.817		
≥ 12	1,829	146	8.0	ref			
Marital status							
Single/unmarried	2,648	212	8.0	0.70 (0.48–1.02)	0.064		
Married/cohabitating/ divorced/widowed	306	34	11.1	ref			

Continued

Variable	Participants (*N* = 2,954)	Positive (*N* = 246)	Positive rate (%)	Univariate *OR* (95% *CI*)	*P* value	Multivariate *OR* (95% *CI*)	*P* value
Occupation							
Students	172	8	4.7	0.52 (0.25–1.07)	0.077		
All occupations except students	2,782	238	8.6	ref			
Monthly income (USD)							
< 750	2,582	201	7.8	ref			
≥ 750	372	45	12.1	1.63 (1.16–2.30)	0.005		
Sexual behaviors							
Age of sexual debut (years)							
< 18	154	12	7.8	0.93 (0.51–1.70)	0.805		
≥ 18	2,800	234	8.4	ref			
Sexual orientation							
Gay	2,532	195	7.7	ref			
Bisexual/Uncertainty	422	51	12.1	1.65 (1.19–2.29)	0.003		
Sex role							
Exclusively insertive	573	40	7.0	ref			
Mostly insertive	575	59	10.3	1.52 (1.00–2.32)	0.049		
Almost half insertive and half receptive	608	52	8.6	1.25 (0.81–1.91)	0.315		
Mostly receptive	594	47	7.9	1.15 (0.74–1.77)	0.545		
Exclusively receptive	604	48	7.9	1.15 (0.74–1.78)	0.529		
No. of anal sex partners in the last six months							
1	379	36	9.5	ref			
2	803	65	8.1	0.84 (0.55–1.29)	0.420		
≥ 3	1,270	93	7.3	0.75 (0.50–1.13)	0.167		
No. of anal sex acts in the last month							
< 5	1,830	100	5.5	ref		ref	
≥ 5	576	46	8.0	1.50 (1.05–2.16)	0.028	1.49 (1.03–2.15)	0.0337
Consistent condom uses in the last month							
Yes	1,744	131	7.5	1.19 (0.85–1.66)	0.321		
No	795	51	6.4	ref			

In this study, online promotion and home delivery of HIV self-testing kits targeted those who had never been previously tested for HIV (80.1%, 2,954/3,687). The proportion of participants who had never been tested for HIV in this online sample was much higher than other peer studies in China (50.6% among MSM in a nationwide online survey[3], 31.1% in Guangdong[4]), possibly because of the higher internet accessibility of MSM in Beijing, and the community-based organization (Tongzhi Welfare Group) rich in the online recruitment experience of MSM since 2013.

There was a complete lack of consensus in the literature about the subset of internet-based MSM who were reached and tested. Pan et al. reported that MSM, who were younger, had a higher education, higher income, and preferred receptive anal sexual roles were reached by internet-based surveys in Shenyang[5]. Internet MSM were younger, highly educated, self-identified as gay, correctly used condoms, and were reached in a cross-sectional survey of 61 cities in China[6]. The subset of internet-based MSM reached and tested in this survey had a higher education, had a middle

and low income, self-identified as gay, and reported a high number of anal sex partners. In addition, over a quarter of them failed to use condoms correctly during anal sexual activity. However, from a global perspective, the rates of never been previously tested for HIV among online samples of MSM recruited in higher-income settings are far lower on average (13% to 18% in the United States[7]; 20% in the UK[8]). These data highlight the need for novel interventions, such as HIV self-testing, to address this critical service gap.

For example, internet-based self-testing is an option for an MSM who reported a greater number of anal sex partners and is more inclined to opt-out of HIV testing. One possible explanation is that they are more concerned about an HIV positive result. More than one quarter (28.8%) of the participants failed to use condoms correctly during anal sex within the last month, comparable to the venue-based community study in Chengdu (25.5%)[9].

Findings from this study should be considered, although it has several limitations. First, online recruitment of hidden populations have known biases and cannot be generalized to the entire study population. Second, as with all collected data (sociodemographic, behaviors) were self-reported, social desirability bias may have existed. Third, the receipt of antiretroviral therapy, retention in care, and adherence to treatment of those internet-based MSM who self-tested as HIV positive were not recorded in this survey.

Our study demonstrated that online promotion and home delivery of HIV self-testing kits could target MSM who have never been tested for HIV. Findings from this study can significantly influence the future rollout of this approach in China and the adoption of this model in other settings.

Contributors BAO YG and XIAO D designed this study; JIN X, XIU X supervised all the implementation; XIAO D and DING ZW collected the data; JIN X performed the statistical analysis and drafted the manuscript; BAO YG, SMITH MK, CAO NX and XU JJ reviewed the manuscript, provided edits and comments.

Competing Interests None declared.

Participant Consent Obtained.

Ethics Approval Chinese Academy of Medical Sciences, Hospital for Skin Diseases and STI Control.

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Received: January 19, 2020;

Accepted: June 9, 2020

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