Vital Surveillances

Temporal and Spatial Trends in HIV Positivity Rate for VCT Clinics — China, 2015–2022

Yi Liu[1]; Rong Su[1]; Dongmin Li[1]; Shaorong Wang[1]; Mengjie Han[1,#]

ABSTRACT

Introduction: Human immunodeficiency virus (HIV) voluntary counseling and testing (VCT) clinics play a critical role in identifying and diagnosing HIV cases. This study aimed to describe the trend of HIV positivity rate (HPR) among Chinese VCT clinics between 2015 and 2022.

Methods: This study utilized data from the China Information System for Disease Control and Prevention to analyze the trend in the HPR for VCT clinics from 2015 to 2022. The HPR was calculated by dividing the number of newly-reported HIV cases by the number of HIV tests, multiplied by 100%. To identify temporal and spatial trends in the HPR, we employed joinpoint regression analysis and the Getis-Ord hotspot analysis.

Results: From 2015 to 2022, VCT clinics in China performed a total of 22,075,386 HIV tests, leading to the identification of 260,353 HIV cases, resulting in a HPR of 1.18%. The HPR consistently declined over the study period, with an average annual percent change (AAPC) of −7.5% (95% confidence interval: −12.6%, −2.2%, P<0.05). The number of HPR hotspots also decreased from 41 in 2015 to 23 in 2022. These HPR hotspots were primarily located in Yunnan, Sichuan, Guangdong, and Guangxi provincial-level administrative divisions (PLADs). Among the 31 PLADs, 16 showed a significant decrease in HPR during the study period (AAPC<0, P_{AAPC}<0.05).

Conclusions: VCT clinics in China have played a significant role in identifying HIV cases. The declining HPR observed in these clinics may indicates the progress has been made in some degree in mitigating HIV among high-risk populations. Therefore, it is crucial to further improving the utilization of VCT clinics for HIV testing.

Human immunodeficiency virus (HIV) voluntary counseling and testing (VCT) is the process in which individuals who suspect they may be at risk for HIV infection voluntarily seek HIV testing and related services through consultation with healthcare professionals. In 2004, China implemented the "four-free-one-care" policy, which included the establishment of VCT clinics. These clinics were set up in collaboration with the CDC and medical institutions (*1*). As of the end of 2020, China has successfully established a network of 11,319 VCT clinics nationwide (*2*). This extensive infrastructure serves as the cornerstone for providing HIV testing and associated behavioral interventions. It is primarily through these VCT clinics that individuals from high-risk populations are able to access essential HIV testing services. Monitoring the HIV cases reported by these VCT clinics can provide valuable insights into the trends in HIV prevalence among high-risk populations (*3*).

This study analyzes the trends in HIV testing and identify cases within VCT clinics in China from 2015 to 2022. The objective is to offer valuable insights concerning the spatial and temporal distribution patterns of the HIV positivity rate (HPR) among VCT clinics in China.

METHODS

Data Sources

Data on HIV testing and reported HIV cases from VCT clinics were obtained from the China Information System for Disease Control and Prevention. The data were collected annually and included the following variables: 1) geographical location of the VCT clinic, 2) number of HIV tests conducted, and 3) number of newly-reported HIV cases. It is important to highlight that the HIV cases included in the analysis met two simultaneous criteria:

they were Chinese cases, and they were reported within the period from January 1, 2015 to December 31, 2022.

Administrative division data were obtained from the National Bureau of Statistics, accessed on September 20, 2023, via the official website (http://www.stats.gov.cn/sj/tjbz/qhdm/). The analytical framework employed spatial units comprising a total of 367 units. These units consisted of 333 municipal-level administrative districts, 4 municipalities directly governed by the central government, and 30 counties under provincial jurisdiction.

Statistical Analysis

The HPR for VCT clinic was calculated using the following formula: $HPR = \frac{\text{Number of newly reported HIV cases}}{\text{Number of HIV tests}} \times 100\%$. The provincial-level administrative divisions (PLADs) with HPR exceeding the median value in 2015 were categorized as high HPR areas. Conversely, the PLADs below this threshold were labeled as low HPR areas. To examine the temporal trends of HPR from 2015 to 2022, we estimated the annual percent change (APC) and the average annual percent change (AAPC), along with their respective 95% confidence intervals (*CI*), by jointpoint regression. The assessment of spatial correlation in HPR was conducted using the Global Moran's *I* statistic. Under $P<0.05$, positive values of Moran's *I* indicated a positive spatial correlation. The Moran's *I* closer to 1 signified that neighboring spatial units exhibited greater similarity or clustered distribution. The Moran's *I* closer to 0 indicated a random spatial distribution. Getis-Ord (Gi*) hotspot analysis was used to identify hotspots (Z>1.96) and cold spots (Z<−1.96) of HPR. Statistical analyses were conducted in the R (version 4.1.1; R Core Team and the R Foundation for Statistical Computing, Vienna, Austria), Joinpoint Regression Program (version 4.9.0.1; National Cancer Institute, Bethesda, US), and Geoda (version 1.20.0; University of Chicago, Chicago, US), and all tests were two-tailed with statistical significance at $P<0.05$.

RESULTS

Trends in HIV Positivity Rate for VCT Clinics

Between 2015 and 2022, VCT clinics in China offered a total of 22,075,386 HIV tests, which led to the identification of 260,353 newly-reported HIV cases. These newly-reported cases accounted for 25.0% (260,353/1,043,165) of the total number of HIV cases reported in China during the same period (Table 1). The number of HIV tests showed a consistent increase from 2,397,271 in 2015 to 3,088,305 in 2018, representing a significant rise of 22.3%. However, there was a decline in 2019, with 2,797,414 tests performed in 2022, equivalent to 90.5% (2,797,414/3,088,305) of the 2018 level. Regarding newly-reported HIV cases, there was an upward trend from 33,423 cases in 2015 to 37,407 cases in 2019. However, this trend reversed in 2020, resulting in a decrease in the number of newly-reported cases. In 2022, there were 22,954 cases, accounting for 61.3% (22,954/37,407) of the 2019 count.

Temporal Trends in HPR from 2015 to 2022

Overall, the HPR for VCT clinics was 1.18% (260,353/22,075,386) between 2015 and 2022 (Table 1). During this period, there was a significant decline in the HPR (AAPC=−7.5%, 95% *CI*: −12.6%, −2.2%), dropping from 1.39% in 2015 to 0.82% in 2022, with a reduction of 41.01% (Table 1). The APC of HPR was −3.8% (95% *CI*: −12.4%, 5.6%) from 2015 to 2019. Following this period, the downward trend accelerated from 2020 to 2022 (APC=−12.2%, 95% *CI*: −26.2%, −12.2%).

None of the 31 PLADs demonstrated the trend of increase in the HPR between 2015 and 2022, as shown in Table 2. Based on the median HPR value (1.10%) observed in the 31 PLADs in 2015, 16 PLADs were classified as high HPR PLADs (HPR>1.10%), as depicted in Figure 1. The remaining 15 PLADs were

TABLE 1. HIV positivity rate for VCT clinics in China, 2015–2022.

Year	HIV tests times	HIV cases numbers	HPR (%)
2015	2,397,271	33,423	1.39
2016	2,504,262	36,066	1.44
2017	2,619,692	36,177	1.38
2018	3,088,305	36,419	1.18
2019	2,892,538	37,407	1.29
2020	2,809,969	28,498	1.01
2021	2,965,935	29,409	0.99
2022	2,797,414	22,954	0.82
Total	22,075,386	260,353	1.18

Abbreviation: HIV=human immunodeficiency virus; VCT=voluntary counseling and testing; HPR=HIV positivity rate.

TABLE 2. HIV positivity rate for VCT clinics and average annual percentage change, broken down by PLADs, 2015–2022.

Class	PLADs	HPR (%)		AAPC (%)	95% *CI* (%)	*P* value
		2015	2022			
Total		1.39	0.82	−7.5	(−12.6, −2.2)	0.006
High HPR-decline	Beijing	6.09	2.63	−12.6	(−18.1, −6.7)	<0.001
	Xinjiang	2.08	0.72	−11.0	(−15.5, −6.2)	0.002
	Hainan	2.04	0.86	−10.5	(−18.6, −1.5)	0.023
	Fujian	1.48	0.80	−10.3	(−14.9, −5.5)	0.002
	Yunnan	3.34	1.58	−7.8	(−12.3, −3.1)	0.007
	Henan	1.56	0.95	−7.6	(−10.0, −5.1)	<0.001
	Shanghai	2.50	1.50	−7.5	(−12.8, −1.9)	0.009
High HPR-no decline	Guizhou	1.23	0.58	−7.8	(−17.4, 2.8)	0.144
	Sichuan	2.03	0.93	−7.3	(−19.3, 6.4)	0.227
	Jiangsu	1.18	0.83	−6.9	(−15.4, 2.4)	0.142
	Chongqing	1.58	1.47	−6.8	(−15.0, 2.2)	0.112
	Hunan	1.88	1.03	−6.2	(−12.6, 0.6)	0.065
	Jilin	2.17	1.38	−5.9	(−13.9, 2.7)	0.174
	Guangxi	2.72	1.78	−4.9	(−12.3, 3.1)	0.221
	Guangdong	1.35	1.41	−2.1	(−15.7, 13.9)	0.790
	Tianjin	1.28	0.79	−1.0	(−9.4, 8.2)	0.789
Low HPR-decline	Xizang	0.93	0.16	−25.8	(−38.7, −10.3)	0.009
	Gansu	0.45	0.09	−17.4	(−23.2, −11.2)	0.001
	Liaoning	0.95	0.38	−13.4	(−21.7, −4.2)	0.005
	Inner Mongolia	0.65	0.26	−13.2	(−17.0, −9.2)	<0.001
	Shanxi	0.80	0.34	−11.3	(−15.8, −6.5)	0.001
	Qinghai	0.70	0.28	−10.1	(−16.1, −3.8)	0.009
	Shaanxi	0.76	0.47	−7.7	(−12.5, −2.6)	0.010
	Heilongjiang	0.95	0.56	−7.5	(−10.1, −4.7)	<0.001
	Shandong	0.72	0.48	−4.0	(−7.7, −0.2)	0.042
Low HPR-no decline	Hebei	0.43	0.33	−3.8	(−10.8, 3.7)	0.308
	Hubei	0.88	0.68	−3.8	(−10.3, 3.2)	0.281
	Ningxia	0.21	0.29	−2.8	(−10.9, 6.1)	0.462
	Anhui	0.89	0.73	−2.4	(−10.9, 6.8)	0.592
	Zhejiang	1.04	0.88	−2.1	(−4.8, 0.7)	0.120
	Jiangxi	0.78	0.60	−1.2	(−6.0, 3.8)	0.567

Abbreviation: HIV=human immunodeficiency virus; VCT=voluntary counseling and testing; PLADs=provincial-level administrative divisions; HPR=HIV positivity rate; AAPC=average annual percentage change.

categorized as low HPR PLADs (HPR<1.10%), also illustrated in Figure 1. Among the 16 high HPR PLADs, seven PLADs, namely Beijing, Shanghai, Fujian, and others, exhibited a statistically significant downward trend (AAPC<0, P_{AAPC}<0.05), with Beijing showing the most rapid decline in HPR (AAPC=−12.6%, 95% *CI*: −18.1%, −6.7%). Conversely, nine PLADs including Sichuan, Chongqing, Guangdong, and others, did not display a notable downward trend in HPR (P_{AAPC}>0.05). Of the 15 low HPR PLADs, nine, such as Shanxi, Inner Mongolia, Liaoning, and others, showed a downward trend in HPR (AAPC<0, P_{AAPC}<0.05). Notably, Xizang PLAD experienced the most substantial decline in HPR (AAPC=−25.8%, 95% *CI*: −38.7%, −10.3%). In contrast, six PLADs including Hebei, Jiangxi, Anhui, and others, showed a decrease in HPR, but the changes were not statistically significant (P_{AAPC}>0.05).

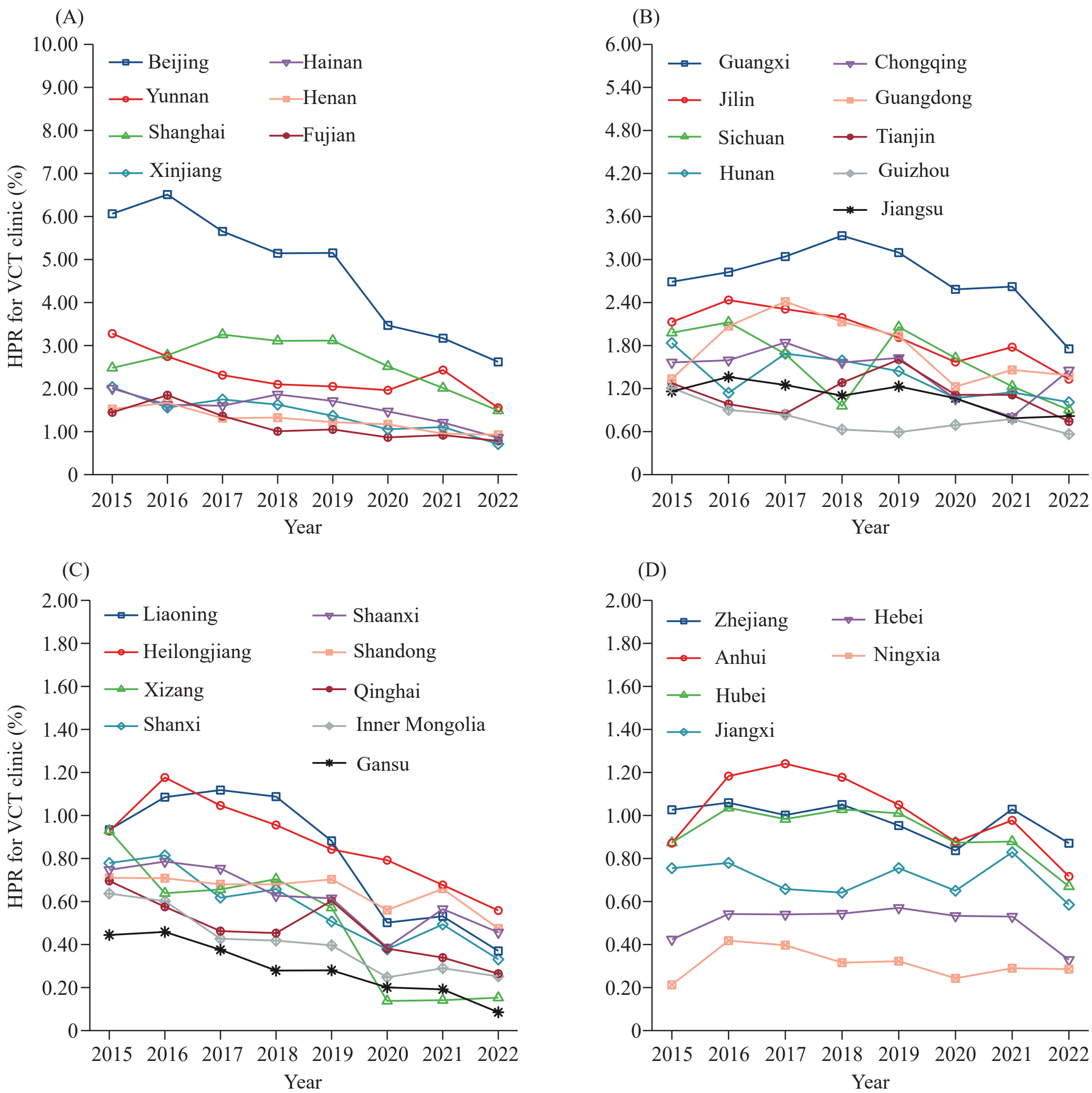

FIGURE 1. Trends in the HPR for VCT clinics from 2015 to 2022, broken down by PLADs. (A) High HPR-decline; (B) High HPR-no decline; (C) Low HPR-decline; and (D) Low HPR-no decline.

Abbreviation: HIV=human immunodeficiency virus; HPR=HIV positivity rate; VCT=voluntary counseling and testing; PLADs=provincial-level administrative divisions.

TABLE 3. The global autocorrelation of HIV positivity rate in 367 units, 2015–2022.

Year	Moran's *I*	*Z* Score	*P* value
2015	0.12	3.46	0.002
2016	0.02	0.84	0.128
2017	0.04	1.72	0.045
2018	0.12	3.86	0.007
2019	0.23	7.22	0.001
2020	0.17	5.30	0.003
2021	0.11	4.49	0.003
2022	0.18	6.20	0.001

Spatial Distribution of HPR

Between 2015 and 2022, the HPR for 367 study units had no spatial autocorrelation (Z=0.84, P=0.128) only in 2016 (Table 3). There was a decrease in the number of HPR hotspots over these years, declining from 41 in 2015 to 23 in 2022. In general, these HPR hotspots were predominantly concentrated in Yunnan, Sichuan, Guangdong, and Guangxi PLADs. Between 2015 and 2017, the hotspots predominantly appeared in Yunnan, Sichuan, Guangxi, and Guangdong PLADs. From 2018 onward, hotspot numbers decreased in Yunnan and Sichuan PLADs, whereas Xinjiang PLAD noted an increase. Between 2020 and

2022, the hotspots were mainly concentrated in Guangdong and Xinjiang PLADs. However, the distribution of cold spots remained relatively stable, mainly concentrated in the northern China, including Shanxi, Inner Mongolia, Ningxia, Shaanxi, Gansu, and Qinghai PLADs.

CONCLUSIONS

This study reveals that the number of HIV tests offered by VCT clinics in China exhibited an increase followed by a decrease between 2015 and 2022, while the HPR for VCT clinics exhibited an overall decrease. In 2012, China released the 12th Five-Year Plan for HIV Prevention and Control, which states that China would expand HIV testing, raise public awareness of HIV testing, and promote active testing (*4*). Nevertheless, the growth rate in HIV test numbers for VCT clinics has lagged behind that in medical institutions (*5*). This is mainly because VCT clinics are influenced by the individual initiative of visitors and external factors. Future efforts will likely concentrate on improving the convenience and privacy of VCT services. The number of HIV tests in 2020 and 2022 was significantly lower than in surrounding years, possibly related to the coronavirus disease 2019 (COVID-19) pandemic (*6*).

The present study observed a higher HPR in VCT clinics compared to medical institutions in a previous study (*5*). This discrepancy can primarily be attributed to the fact that VCT clinics primarily serve individuals engaged in high-risk sexual behaviors (*3*). In medical institutions, HIV testing mainly involves mandatory tests associated with surgeries and invasive procedures, and provider-initiated testing and counseling (PITC) services (*5*). It is important to note that the majority of individuals undergoing HIV tests in medical institutions belong to the general population, which typically exhibits a lower likelihood of HIV infection. Consequently, the efficiency of HIV testing in medical institutions is lower. Remarkably, VCT clinics identified 25.0% of all HIV cases, despite VCT testing constituting only 1.2% of the total annual HIV tests conducted in China (*7*). This underscores the critical role that VCT clinics play in identifying HIV cases in the country. Therefore, it is essential for VCT clinics to continue fulfilling this pivotal role, not only in terms of HIV case detection but also in promoting HIV testing awareness through online and offline combination.

Another significant finding is the overall decline in HPR. More than half of the 31 PLADs have shown a decreasing trend in HPR between 2015 and 2022. It may suggest that progress has been made in mitigating HIV epidemic among key populations through the implementation of the 13th Five-Year Plan for HIV prevention and control and the Implementation Program for Controlling the Spread of HIV (2019–2022) (*8*). In recent years, the Chinese government has consistently emphasized the importance of regular HIV testing and testing frequency among high-risk populations. Notable improvements in HIV testing rates have been observed among men who have sex with men (MSM) through referrals for testing by non-governmental organizations and educational outreach on social networking apps (*9*). The decline in HPR since 2020 can, in part, be attributed to the impact of the COVID-19 pandemic (*10*). Research has shown that concerns related to COVID-19 and the non-pharmacological interventions implemented by the government have reduced the likelihood of engaging in high-risk sexual behavior or meeting new sexual partners (*11*). Consequently, this reduction in high-risk behavior may have indirectly contributed to both a lower risk of HIV infection and a decrease in the demand for HIV testing, resulting in the decline in HPR. Moving forward, it is crucial to maintain active HIV surveillance and implement targeted interventions to prevent any resurgence of the HIV epidemic among key populations. PLADs that have not experienced a significant decline in HPR should consider exploring innovative operational approaches, such as integrating passive counseling and testing services with proactive outreach for HIV prevention.

Between 2015 and 2022, the distribution of hotspots and cold spots for HPR in China corresponded to the spatial distribution characteristics of the HIV epidemic (*12*). PLADs such as Sichuan, Yunnan, and Guangxi have been particularly affected by the HIV epidemic in China (*13*). As of 2017, the Chinese government has been implementing comprehensive HIV testing measures that cover the entire population in high HIV prevalence regions located in southwestern China. It is possible that this policy has indirectly resulted in a decrease in the proportion of HIV cases reported by VCT clinics in that area (*14*). Starting in 2018, new hotspots have appeared in Guangdong, Guangxi, and Xinjiang, consistent with previous research findings (*15*). These developments underline the importance of closely monitoring the HIV epidemic in these current hotspots and implementing targeted HIV surveillance and intervention activities.

This study had several limitations. First, the data on HIV tests for VCT clinics were reported as test counts rather than individual-level data. The characteristics of people receiving HIV testing in VCT clinics may vary in different years. Consequently, the proportion of individuals who undergo repeat testing at VCT clinics each year is unknown. This knowledge gap may result in an underestimation of the HPR. Second, the number of HIV tests conducted and newly-reported HIV cases are influenced by factors such as testing willingness, testing conditions, and accessibility. These factors may not fully capture the true HIV prevalence within key populations. Thus, the data may be subject to bias and may not provide a comprehensive depiction of the actual situation.ta may be subject to bias and may not provide a comprehensive depiction of the actual situation.

In conclusion, VCT clinics in China have played a significant role in detecting HIV cases. The decreasing HPR observed in these clinics may suggests that China has made notable strides in curbing HIV prevalence among high-risk populations. It is crucial to further improve the utilization of VCT clinics for the identification of HIV cases. Moving forward, it is vital to explore novel models for VCT services, such as integrating passive testing with proactive outreach services, to enhance their effectiveness.

Conflicts of interest: No conflicts of interest.

Acknowledgements: The provincial and local CDCs.

Funding: Supported by National Science and Technology Major Project of China (2017ZX10201101-002-006).

doi: 10.46234/ccdcw2024.002

[#] Corresponding author: Mengjie Han, mjhan@chinaaids.cn.

[1] National Center for AIDS/STD Control and Prevention, Chinese Center for Disease Control and Prevention, Beijing, China.

Submitted: October 30, 2023; Accepted: December 08, 2023

REFERENCES

1. Wu ZY, Chen JF, Scott SR, McGoogan JM. History of the HIV Epidemic in China. Curr HIV/AIDS Rep 2019;16(6):458 – 66. http://dx.doi.org/10.1007/s11904-019-00471-4.
2. Han MJ, Chen QF, Xu P, Shi Y. Forging ahead in the thirteenth five-year plan: a review and prospects of HIV/AIDS prevention and control in China. Chin J AIDS STD 2021;27(12):1327 – 31. http://dx.doi.org/10.13419/j.cnki.aids.2021.12.01. (In Chinese).
3. Costa AB, Viscardi LH, Feijo M, Fontanari AMV. HIV Voluntary Counseling and Testing (VCT-HIV) effectiveness for sexual risk-reduction among key populations: a systematic review and meta-analysis. eClinicalMedicine 2022;52:101612. http://dx.doi.org/10.1016/j.eclinm.2022.101612.
4. The State Council of the People’s Republic of China. Chinese 12th Five-Year Plan for HIV/AIDS Prevention and Control. https://www.gov.cn/gongbao/content/2012/content_2084242.htm. [2023-9-20]. (In Chinese).
5. Wang HX, Xu J, Zang CP. HIV/AIDS cases detection in medical institutions from 2016 to 2021 in China. Chin J AIDS STD 2023;29(2):157 – 60. http://dx.doi.org/10.13419/j.cnki.aids.2023.02.07. (In Chinese).
6. Zhao TM, Liu HX, Bulloch G, Jiang Z, Cao ZB, Wu ZY. The influence of the COVID-19 pandemic on identifying HIV/AIDS cases in China: an interrupted time series study. Lancet Reg Health West Pac 2023;36:100755. http://dx.doi.org/10.1016/j.lanwpc.2023.100755.
7. He N. Research progress in the epidemiology of HIV/AIDS in China. China CDC Wkly 2021;3(48):1022 – 30. http://dx.doi.org/10.46234/ccdcw2021.249.
8. The National Disease Prevention and Control Bureau. New advances of HIV/AIDS prevention and control efforts in 2019. Chin J AIDS STD 2019;25(12):1205. http://dx.doi.org/10.13419/j.cnki.aids.2019.12.01. (In Chinese).
9. Sun XD, Xiao YN, Peng ZH, Wang N. Frequent implementation of interventions may increase HIV infections among MSM in China. Sci Rep 2018;8(1):451. http://dx.doi.org/10.1038/s41598-017-18743-7.
10. Wu XS, Wu GH, Ma YM, Huang XJ, Yang YC, Cai YS, et al. The impact of COVID-19 non-pharmaceutical interventions on HIV care continuum in China: an interrupted time series analysis. Lancet Reg Health West Pac 2022;29:100569. http://dx.doi.org/10.1016/j.lanwpc.2022.100569.
11. Gleason N, Banik S, Braverman J, Coleman E. The impact of the COVID-19 pandemic on sexual behaviors: findings from a national survey in the United States. J Sex Med 2021;18(11):1851 – 62. http://dx.doi.org/10.1016/j.jsxm.2021.08.008.
12. Huang JF, Wu HC, Lin S, Lu LL, Zheng JL, Liu B, et al. Spatial-temporal analysis of HIV/AIDS and syphilis in mainland China from 2007 to 2017. J Med Virol 2022;94(7):3328 – 37. http://dx.doi.org/10.1002/jmv.27725.
13. Wang YL, Qin QQ, Ding ZW, Cai C, Guo W, Li DM, et al. Current situation of AIDS epidemic in China. Chin J AIDS STD 2017;23(4):330 – 3. http://dx.doi.org/10.13419/j.cnki.aids.2017.04.16. (In Chinese).
14. Liu ZF, Tang XF, Liu YF, Zhang LL, Yang YH, Zheng YL, et al. HIV prevention and health poverty alleviation — Liangshan prefecture, Sichuan province, China, 2017-2020. China CDC Wkly 2021;3(48):1031 – 5. http://dx.doi.org/10.46234/ccdcw2021.250.
15. Jing FS, Ye Y, Zhou Y, Zhou HC, Xu ZZ, Lu Y, et al. Modelling the geographical spread of HIV among MSM in Guangdong, China: a metapopulation model considering the impact of pre-exposure prophylaxis. Philos Trans Roy Soc A Math Phys Eng Sci 2022;380(2214):20210126. http://dx.doi.org/10.1098/rsta.2021.0126.