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ORIGINAL PAPER

Recent and Local HIV Infections among Newly Diagnosed Cases in Two Districts of Chongqing, China (2019–2021)

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Abstract

Newly diagnosed HIV cases often do not clearly indicate whether they are recent or long-standing infections. We collected the history of HIV antibody testing, sexual behavior and initial CD4 + T cell (CD4) count of newly diagnosed HIV/AIDS to determine the time and location of HIV infections. Of the included 612 cases, 17.3% were classified as recent HIV infection. Recent HIV infections were higher in cases aged < 30 (adjusted odds ratio [AOR] = 4.267, 95% Confidence Interval [CI] 1.856–9.813) and 30–49 (AOR = 2.847, 95%CI 1.356–5.977) vs. ≥50, and the transmission mode was men who have sex with men (MSM) (AOR = 4.130, 95%CI 1.815–9.399) was higher than heterosexual contact. Of the 582 cases, 80.8% were classified as local HIV infection (An infection occurred in the two survey districts). Local HIV infections were higher in cases being single and divorced/widowed (AOR = 2.511, 95% CI 1.271–4.962) vs. being married, residing in the survey districts ≥ 5 years (AOR = 168.962, 95%CI 64.942-439.593) vs. < 1 year, transmission mode was MSM (AOR = 8.669, 95%CI 2.668–28.163) vs. heterosexual contact, and acquired infections through spouses or steady partners (AOR = 11.493, 95%CI 3.236–40.819) vs. commercial partners. Both recent and local HIV infections were higher in cases whose transmission mode was MSM, we recommended using internet platforms and MSM dating apps for HIV education and intervention, promoting internet intervention tools to raise awareness about HIV and facilitate early detection.

Keywords HIV/AIDS · Recent infection · Local infection · Risk factors

Introduction

Since its initial identification in 1981, HIV/AIDS has progressively become a global public health concern [1, 2]. In 2022, an estimated data shown that there were 39 million people living with HIV/AIDS, and 1.3 million people became newly infected with HIV [3]. In 2014, the Joint United Nations Programme on HIV/AIDS (UNAIDS) set the "95-95-95" goals to end the HIV epidemic by 2030 [4]. China was considered as a low HIV prevalence country with an estimated prevalence of 0.1% [5, 6], achieving the "85-88-92" targets by 2017 [7]. In China, all new diagnosed HIV/AIDS are required to report in China Information System for Disease Control and Prevention, a nationwide, real-time, reporting system, which is managed by the National Center for AIDS/STD Control and Prevention (NCAIDS) of the Chinese Center for Disease Control and Prevention (China CDC). As of 2022, China had reported about 1.223 million people living with HIV/AIDS, including 107,000 newly reported cases [6].

There are typically delays between HIV infection and diagnosis [8], leading to uncertainties in distinguishing recent from long-standing infection. This impacts the accuracy of assessing epidemic trends. Identifying recent HIV infection (RHI) is crucial for monitoring HIV transmission, characterizing current risk factors, and evaluating prevention strategies [9–11]. The transmission risk of RHI is notably higher [12, 13], meaning that rapidly providing antiretroviral therapy to cases with RHI is more critical and cost-effective. A study has shown that the networks of those with recent infections were more likely to include others

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with recent infections than those with chronic HIV infections [14].

Various methods have been developed for differentiating between recent and long-standing HIV infection, including longitudinal follow-up of uninfected individuals and serological tests [15, 16], such as the BED-capture-enzyme immunoassay (BED-CEIA). Italy conducted a cohort study to estimate the proportion of RHI and identify associated factors [17]. The United States used a limiting antigen (LAg) avidity enzyme immunoassay to identify RHI for estimating cross-sectional HIV incidence [18]. However, cohort studies require large sample sizes and are costly, making them impractical for disease with low prevalence. Laboratory tests rely on lab technologies and are not feasible in areas lacking laboratory facilities.

This study explored a simpler method to identify RHI, aiming to quickly estimate the proportion of RHI among newly diagnosed cases and to identify factors associated with RHI. Our study also sought to determine the location of HIV infection to identify transmission hotspot, and implement measures to control new infection.

Methods

Participants and Procedure

This cross-sectional survey was conducted from January 2019 to June 2021 in Chongqing, China. Chongqing is located in southwestern of China, it's one of the four municipalities directly under the central government. As of 2020, the permanent resident population is 32.05 million in Chongqing [19]. In 2019, the number of newly reported HIV/AIDS in Chongqing ranked fifth in the country. At the end of 2019, Chongqing had reported a total of more than 49,000 HIV/AIDS, ranking sixth in the country.

This survey was carried out on HIV/AIDS reported in China Information System for Disease Control and Prevention from January 2019 to June 2021. Initially, we selected 18 districts in Chongqing with more than 200 newly reported HIV/AIDS in 2018. Considering the differences in transmission routes and recent HIV infections between urban and suburban districts, a stratified sampling method was used. These 18 districts were further categorized into 8 urban districts and 10 suburban districts, and one district was randomly selected from both the urban districts and the suburban districts, totaling two districts included in this survey.

Recruitment

Recruitment of participants was conducted in the local CDC. The patients inclusion criteria were: (1) Confirmed positive HIV antibody and reported in China Information System for Disease Control and Prevention; (2) Residing in the two survey districts ≥ 6 months and did not go outside during the investigation period; (3) Voluntary participation with informed consent. Cases outside the two survey districts during the investigation period or who refused to participate were excluded. Figure 1 showed a flowchart detailing the patient inclusion criteria. The study was approved by the Ethics Committee of the Chongqing CDC and conducted in accordance with the Helsinki Declaration of 1964.

Variables Definition

Identification of RHI. RHI generally refers to the phase up to 6/12 months after HIV infection [20–23]. For this study, RHI was defined as 12 months after HIV infection. We used a nested decision logic method to identify RHI, and if the infection met the following criteria can be classified as RHI: (1) A negative HIV antibody within 12 months prior to diagnosis. (2)An unsafe sexual behavior (This included unprotected commercial sexual behaviors, non-marital non-commercial casual sexual behaviors, and sexual behaviors with spouses or steady partners who are HIV/AIDS) in the past year, combined with a negative HIV antibody within 18 months prior to diagnosis. (3) In cases where both conditions cannot be determined, an initial CD4 + T cell (CD4) count ≥ 500 cells/μl was used as a criterion for RHI [24].

Identification of local HIV infection (LHR). An infection occurred in the two survey districts was defined as a LHR. The infection was classified as LHR if it met any of the following criteria: (1) A negative HIV antibody during residing in the two survey districts, and without subsequent unsafe behaviors outside the survey districts. (2) Resided continuously in the two survey districts for more than 1 year with the infection classified as RHI; (3) All unsafe sexual behaviors occurred in the two survey districts.

Data Collection

Data were collected via an anonymous, interviewer-administered questionnaire that was composed of socio-demographic background, history of HIV antibody test, information about population movements, and detailed sexual behaviors, including heterosexual behaviors and men who have sex with men (MSM). The main focus was to collect whether these sexual behaviors were commercial or non-commercial, the type of sexual partner, and the time and location of these sexual behaviors. A pre-investigation

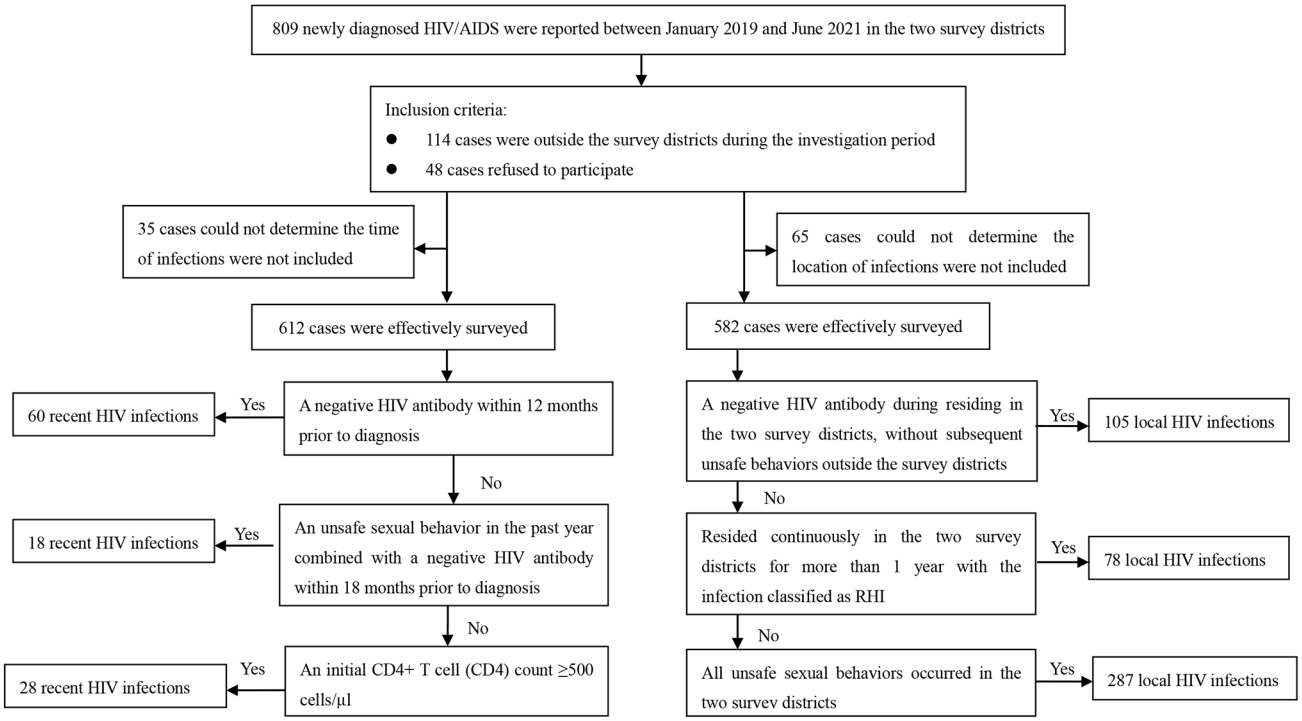

Fig. 1 Flowchart of the patients' inclusion criteria

was carried out to refine and enhance the questionnaire's effectiveness.

Quality Control

The survey was conducted at the time when the individual was confirmed positive for HIV antibody and reported in the China Information System for Disease Control and Prevention. It was conducted by experienced physicians specializing in HIV voluntary counseling and testing (VCT) and notification. To ensure the quality and accuracy of the data, the professionals reviewed the questionnaires.

Data Analysis

The data were entered into Epi Data 3.1 by two independent researchers and checked for consistency. Socio-demographic and sexual behavior characteristics were described using frequencies. Logistic regression analysis was used to estimate odds ratios for recent and local HIV infection. Variables showing preliminary evidence of association in univariate analysis were further analyzed using multivariable analysis to minimize individual-level misclassification risk. Statistical significance was set at two-sided P-values of ≤ 0.05. All statistical analyses were performed by IBM SPSS Statistics 23.0.

Results

Characteristics of Participants

Between January 2019 and June 2021, 809 HIV/AIDS were reported in the two districts of Chongqing, China. Of these, 114 cases were outside the two districts during the survey period and 48 cases refused to participate were excluded, leaving 647 participants. Further, 35 cases were also excluded due to the time of infections were indeterminate, resulting in an effective sample size of 612 cases. The majority of the participants were male, with a male-to-female ratio of 2.5:1. There were 49.5% participants were aged ≥ 50 years and 64.7% had an education level of junior high school or lower. The primary transmission mode was heterosexual contact (71.2%), and 40.7% acquired infections through temporary sexual partners. Over half of the samples (51.0%) were collected from medical institutions.

Proportion of Recent HIV Infection

Of the 612 cases, 106 (17.3%) were identified as recent infections, with 60 cases had HIV-negative test within the past 12 months prior to diagnosis, 18 cases had unsafe sexual behaviors in recent year, and had HIV-negative test within 18 months prior to diagnosis, and 28 cases' initial CD4 count ≥ 500 cells/ul. Recent HIV infections were higher

in cases aged < 30 (Adjusted Odds Ratio [AOR] = 4.267, 95% Confidence Interval [CI] 1.856–9.813) and 30–49 (AOR = 2.847, 95%CI 1.356–5.977) vs. ≥50, and the transmission mode was MSM was about four times higher (AOR = 4.130, 95%CI 1.815–9.399) than heterosexual contact (Table 1).

Proportion of Local HIV Infection

Among the initial 647 participants, 65 cases were excluded due to the location of infections were indeterminate, resulting in an effective sample size of 582 cases. Of these, 470 (80.8%) were identified as local infections, with 105 cases had HIV-negative test during residing in the two survey districts and without subsequent unsafe sexual behaviors outside the survey districts, 78 cases resided continuously in the two survey districts for more than 1 year and the infection classified as RHI, and 287 cases' all unsafe sexual behaviors occurred in the two survey districts. Local infections were higher in cases being single and divorced/widowed (AOR = 2.511, 95% CI 1.271–4.962) vs. being married, and were highest in cases residing in the survey districts ≥ 5 years (AOR = 168.962, 95%CI 64.942–439.593) vs. < 1 year. Besides, local infection was about eight times higher in cases whose transmission mode was MSM (AOR = 8.669, 95%CI 2.668–28.163) than heterosexual contact, and about eleven times higher in those acquired infection through spouses/steady partners (AOR = 11.493, 95%CI 3.236–40.819) than commercial partners (Table 2).

Table 1 Characteristics and factors associated with recent HIV infection among newly diagnosed HIV/AIDS in Chongqing, China between January 2019 and June 2021 ($n = 612$)

Characteristics	Recent infection(%)	Univariate analysis		Multivariable analysis	
		OR(95%CI)	*p* value	AOR(95%CI)	*p* value
Sex					
Female	5.2(9/174)	Ref		Ref	
Male	22.1(97/438)	5.215(2.570 – 10.584)	0.000	1.159(0.443–3.030)	0.763
Age, years					
≥ 50	4.3(13/303)	Ref		Ref	
30 ~ 49	21.0(38/181)	5.928(3.061 – 11.479)	0.000	2.847(1.356–5.977)	0.006
< 30	43.0(55/128)	16.807(8.716 – 32.410)	0.000	4.267(1.856–9.813)	0.001
Marital status					
Married	8.1(22/271)	Ref		Ref	
Single/divorced/widowed	24.6(84/341)	3.699(2.242 – 6.104)	0.000	0.968(0.486–1.927)	0.926
Education					
Junior high school and below	7.3(29/396)	Ref		Ref	
High school	25.8(23/89)	4.410(2.404 – 8.090)	0.000	1.305(0.600–2.837)	0.502
College or above	42.5(54/127)	9.361(5.585 – 15.690)	0.000	1.488(0.689–3.213)	0.312
Sample source					
Medical institution	9.6(30/312)	Ref		Ref	
VCT	22.6(45/199)	2.747(1.663–4.538)	0.000	1.707(0.949–3.071)	0.074
Specific survey	44.9(22/49)	7.659(3.891–15.076)	0.000	1.373(0.632–2.983)	0.423
Other	17.3(9/52)	1.967(0.874–4.427)	0.102	2.297(0.880–5.996)	0.090
Monthly income (CNY)					
≤ 3999	9.7(36/372)	Ref		Ref	
≥ 4000	29.2(70/240)	3.843(2.469 – 5.981)	0.000	1.277(0.729–2.237)	0.392
Length of residence, years					
≥ 5	13.4(54/403)	Ref		Ref	
1–4	26.5(30/113)	2.336(1.408–3.876)	0.000	0.815(0.417–1.591)	0.549
< 1	22.9(22/96)	1.921(1.102–3.349)	0.000	0.904(0.427–1.911)	0.791
Transmission mode					
Heterosexual contact	6.2(27/436)	Ref		Ref	
MSM	44.9(79/176)	12.337(7.560–20.134)	0.000	4.130(1.815–9.399)	0.001
Sexual partner					
Commercial partner	7.4(13/176)	Ref		Ref	
Spouse/steady partner	13.4(25/187)	1.935(0.956–3.914)	0.066	1.134(0.458–2.807)	0.785
Temporary partner	27.3(68/249)	4.711(2.509–8.844)	0.000	1.276(0.537–3.034)	0.581

Table 2 Characteristics and factors associated with local HIV infection among newly diagnosed HIV/AIDS in Chongqing, China between January 2019 and June 2021 ($n=582$)

Characteristics	Local infection(%)	Univariate analysis		Multivariable analysis	
		OR(95%CI)	*p* value	AOR(95%CI)	*p* value
Sex					
Female	78.4(337/430)	Ref		Ref	
Male	87.5(133/152)	1.932(1.134–3.291)	0.015	2.666(0.973–7.299)	0.056
Age, years					
< 30	82.3(102/124)	Ref		-	
30–49	73.2(123/168)	0.590(0.332–1.046)	0.071	-	
≥ 50	84.5(245/290)	1.174(0.671–2.055)	0.574	-	
Marital status					
Married	73.7(185/251)	Ref		Ref	
Single/divorced/widowed	86.1(285/331)	2.210(1.453–3.362)	0.000	2.511(1.271–4.962)	0.008
Education					
Junior high school and below	77.4(291/376)	Ref		Ref	
High school	81.4(70/86)	1.278(0.705–2.316)	0.419	0.870(0.314–2.412)	0.789
College or above	90.8(109/120)	2.894(1.488–5.631)	0.002	1.726(0.521–5.716)	0.372
Sample source					
Medical institution	77.4(226/292)	Ref		-	
VCT	82.6(157/190)	1.389(0.873–2.212)	0.166	-	
Specific survey	87.2(41/47)	1.996(0.812–4.906)	0.132	-	
Other	86.8(46/53)	1.919(0.828–4.450)	0.129	-	
Monthly income (CNY)					
≤ 3999	81.7(291/356)	Ref		-	
≥ 4000	79.2(179/226)	0.851(0.560–1.293)	0.449	-	
Length of residence, years					
< 1	28.4(25/88)	Ref		Ref	
1–4	72.4(76/105)	6.604(3.515–12.407)	0.000	13.412(5.368–33.511)	0.000
≥ 5	94.9(369/389)	46.494(24.373–88.692)	0.000	168.962(64.942–439.593)	0.000
Transmission mode					
Heterosexual contact	76.5(315/412)	Ref		Ref	
MSM	91.2(155/170)	3.182(1.787–5.665)	0.000	8.669(2.668–28.163)	0.000
Sexual partner					
Commercial partner	67.7(128/189)	Ref		Ref	
Spouse/ steady partner	94.4(136/144)	8.102(3.731–17.594)	0.000	11.493(3.236–40.819)	0.000
Temporary partner	82.7(206/249)	2.283(1.458–3.574)	0.000	1.245(0.539–2.875)	0.608

Discussion

In our study, identifying RHI primarily relied on a negative HIV antibody within 12 months prior to diagnosis. In cases without a HIV antibody test history, we conducted a comprehensive evaluation based on the unsafe sexual behaviors in the past year and initial CD4 count to identify RHI. This method is fast, feasible, and relatively accurate, independent of laboratory conditions, making it valuable for public health efforts in HIV prevention and control. Between January 2019 and June 2021, the proportion of RHI in two districts of Chongqing was 17.3%, lower than findings in other cities in China and in Germany [25–27]. This could be due to underreporting of unsafe sexual behaviors, leading to an underestimation of recent infection. The proportion of LHI was 80.8%, higher than the rate in Yiwu city, Zhenjiang province and Weifang city, Shandong province, China [25, 26], suggesting that local epidemic risk factors might not be well-controlled.

Recent HIV infections were primarily among individuals aged < 50, with the highest in < 30. We suggested intensifying HIV education in schools and leveraging the internet for outreach to increase awareness about HIV among young people. In addition, we recommended increasing education on VCT and special investigation spots to publicize where and how to take an HIV test, thus improving the accessibility and efficiency of HIV testing service. The transmission mode was MSM was higher than heterosexual contact, possibly due to more extensive intervention activities and studies conducted among MSM community in recent years in Chongqing, resulting in their earlier detection. Researches had shown an increasing trend of MSM community seeking sexual partners online, with some areas exceeding 80%

[28, 29], which presents both challenges and opportunities for MSM community intervention. We recommended using internet platforms and MSM dating apps for HIV education and intervention, promoting internet intervention tools [30] to raise awareness and facilitate early detection.

LHI were prevalent among cases acquired HIV infection through spouses or steady partners, due to many HIV/AIDS failing to promptly inform their spouses or steady partners about their infections [31, 32]. Urging HIV/AIDS to inform their spouses and steady partners and facilitating HIV testing for family-based infections should be implemented. The study also observed a higher proportion of LHI among the single and divorced or widowed, suggesting that efforts should be focus on strengthen HIV and sexually transmitted infections (STI) testing and providing counseling in key departments such as marriage registration offices, prenatal care clinics, and inpatient clinics. Moreover, we found that both recent and local HIV infections were mostly due to cases' transmission mode was MSM, indicating that MSM community were the key group, intervention for this group should be strengthened.

This study based on self-reported information, hence subjected to recall bias. For subjects without history of HIV antibody test or sexual behaviors, a CD4 count $\geq$ 500 cells/μl was used as a criterion for identifying RHI. The CD4 count decline might be faster in MSM than other groups [33, 34]. Given the high proportion of MSM cases in this study, the proportion of RHI might be underestimated. Additionally, determining LHI based on the duration of residence in the survey districts, combined with infection time and the history of sexual behaviors, did not account for the possibility of infections acquired during short-term movements such as business trips, holiday travels, or vacations, thus the proportion of LHI could potentially be overestimated.

Conclusions

Both recent and local HIV infections were higher in cases whose transmission mode was MSM, we recommend using internet platforms to raise awareness about HIV and facilitate early detection. Additionally, the majority of recent HIV infection was found in individuals aged < 50, with the highest in < 30. We need to intensify HIV education among young people and improve the accessibility and efficiency of HIV testing services. Local infections were higher in individuals acquired infection through spouses or steady partners, suggesting intervention for family-based infections should be strengthened.

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Declarations

Ethical Approval This study was approved by the Ethics Committee of Chongqing Center for Disease Control and Prevention.

Consent to Participate All participants gave informed consent to be involved in this study and provided written informed consent.

Consent for Publication Not applicable.

Competing Interests The authors declare that they have no conflict of interest.

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