scientific reports

Check for updates

OPEN

Unveiling trends in late diagnosis among 22,504 people living with HIV in Hunan, China

Xinyi Su[1,7], Xueyuan Zhong[1,7], Xiangjun Zhang[2], Yanxiao Gao[3], Xiaobai Zou[4], Xi Chen[4], Wenru Wang[5], Honghong Wang[1], Jingjing Meng[6], Lu Yu[1], Jianmei He[4]✉ & Yaqin Zhou[1]✉

This study examined the prevalence of HIV late diagnosis (LD) and identified associated factors with LD among people living with HIV (PLWH). We extracted sociodemographic, epidemiological, and immunological information between 2018 and 2021 in Hunan, China from the HIV/AIDS Comprehensive Response Information Management System of China. The chi-squared test and multivariable logistic regression model were used to identify the factors associated with LD. Among 22,504 PLWH, 14,988 (66.6%) were diagnosed late. PLWH aged 50 and older had a higher proportion of LD (71.2%) than the younger group (60.0%). Older age, being male, Han ethnicity, being registered in Western Hunan, being transferred from health facilities, and being infected through heterosexual intercourse were associated with LD. Among PLWH younger than 50 years, apart from the factors mentioned above, individuals who had primary school or lower education, were non-student, and were divorced or widowed were more likely to be diagnosed late. Unlike younger PLWH, these factors were not associated with LD in the older group. But regional disparities in LD were more significant among them. LD in PLWH remains a severe issue, especially among older people. The study findings provided valuable insights into designing programs targeting groups at higher risk of LD to reduce its prevalence.

Keywords HIV, Acquired immunodeficiency syndrome, Late diagnosis, China, HIV testing, People living with HIV

By 2023, 39.9 million people were living with HIV globally[1]. Since 2010, new HIV infections have declined by 38%, and AIDS-related deaths have dropped by 51%, indicating we were getting closer to the end of the HIV/AIDS epidemic[2]. The Joint United Nations Programme on HIV/AIDS (UNAIDS) has proposed a goal known as 95-95-95 (95% detection, 95% treatment, 95% viral suppression) for HIV testing and treatment by 2025[3]. However, as of 2022, global data showed that testing and treatment had only reached levels of 86-89-93 worldwide[2]. This means we still have some way to go in achieving UNAIDS' goals, especially in reaching the first target of 95% of people knowing their infected status.

In 2018, UNAIDS launched the campaign "Know Your Status," which many counties have adopted, leading to expanded HIV testing[4]. However, many people living with HIV (PLWH) are still late in being diagnosed, defined as having a low CD4 cell count or showing symptoms of advanced stage (AIDS) at diagnosis[5]. As early as 2011, the European Late Presenter Consensus working group released a consensus definition of HIV late diagnosis (LD), which aroused researchers' interest in the severe impacts and prevalence of LD[6]. Compared with non-LD, PLWH with LD had a poor quality of life and higher morbidity and mortality rates, leading to higher costs of HIV care[7,8]. Additionally, the likelihood of HIV transmission might increase during the period of unknown HIV status[9]. Nevertheless, the proportion of LD in many countries remains high: about 50% in Europe[10], followed by 47–55% in Africa[11,12], and 34–72% in Asia[13]. Researchers have conducted studies to determine the reasons for and reduce the proportion of LD. Some factors associated with LD that have been identified are age, gender, educational level, transmission routes, and so on, but many of these remain controversial[10,13].

[1]Xiangya Nursing School, Central South University, 172, Tongzipo Road, Changsha 410013, Hunan, China. [2]Center for Community Research and Evaluation, University of Memphis, Memphis, TN, USA. [3]Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, Shenzhen, China. [4]Hunan Provincial Center for Disease Control and Prevention, Changsha, Hunan, China. [5]Alice Lee Centre for Nursing Studies, Yong Loo Lin School of Medicine, National University of Singapore, Singapore, Singapore. [6]School of Nursing, Anhui Medical University, Hefei, China. [7]Xinyi Su and Xueyuan Zhong contributed equally to this work. ✉email: jmhe69@126.com; yaqinzhou99@hotmail.com

As of 2022, China had 1.22 million PLWH; new HIV infections and AIDS-related deaths had decreased by nearly 30% between 2019 and 2022[14]. The completion of UNAIDS' goals had achieved 79-93-96 (79% detection, 93% treatment, 96% viral suppression) at the end of 2020 in China[15]. Despite the success in HIV prevention and care, more than 20% of PLWH are unaware of their infected status[15]. Many studies suggest that PLWH aged 50 and over, known as OPLWH, generally lack awareness of their HIV status, engages in riskier sexual behaviors, and are more likely to be diagnosed late[15,16]. As the proportion of OPLWH is gradually approaching that of younger PLWH in China, the Chinese Center for Disease Prevention and Control (CDC) has reported that there are many differences between OPLWH and the younger, such as demographic characteristics and transmission routes[16]. This situation may lead to differences in the factors affecting LD and also bring challenges to our management of HIV/AIDS. Currently, there are no studies that deeply explore the differences in risk factors between OPLWH and younger PLWH. Hunan Province, located in central China, is home to over 72 million permanent residents, including 53,030 PLWH by the end of October 2022[17,18]. By using the large real-world data from the Hunan CDC, we investigated the prevalence and factors associated with LD among PLWH, especially in two different age groups taking 50 as the boundary. The findings could provide valuable insights to guide the development of effective and targeted interventions aimed at reducing the prevalence of LD, and meeting this growing challenge of demographic changes among PLWH[19].

Materials and methods

Data source

We used data from the HIV/AIDS Comprehensive Response Information Management System (CRIMS), which is one of the largest HIV information systems in the world and is administered by the China CDC[20]. China CDC undertakes multiple important tasks including report and management of the HIV/AIDS epidemic, and their procedures are unified, rigorous and carried out in a timely manner. CRIMS stands as a national surveillance system in China, with real-time data collection and reporting from every level of the CDCs, thereby ensuring its unparalleled representativeness across the country[20]. Furthermore, Trained staff input information with cross-checking and verification to ensure data quality. The system provides easy access to both raw data and summary statistics and has provided scientific evidence for HIV-related policy decisions at all levels[20].

Study design and participants

Hunan Province comprises 13 cities and one autonomous prefecture, and it is divided into four geographic regions: central Hunan, southern Hunan, northern Hunan, and western Hunan. The provincial capital, Changsha City, is located in central Hunan, while the autonomous prefecture is located in western Hunan.

We conducted a consecutive cross-sectional study from 2018 to 2021 in Hunan to explore the prevalence of LD in PLWH and the factors associated with LD among two PLWH age groups. We collected participants' sociodemographic, epidemiological, and immunological information from CRIMS. Sociodemographic information included age, gender, employment status, marital status, ethnicity, education level, and registered region. Epidemiological information included the transmission route and sample sources. Immunological information consisted of baseline WHO clinical staging of HIV disease and baseline CD4 cell counts. This study included PLWH who met the following criteria: (1) were diagnosed as HIV-positive in Hunan province between 2018 and 2021, (2) were aged 16 years or older, and (3) had a record of baseline CD4 cell count or AIDS-defining events. PLWH with incorrect or missing information were excluded. Baseline CD4 cell count refers to a CD4 + T lymphocyte count detected before starting antiviral therapy but within three months following the diagnosis[21].

We divided all participants into two groups: PLWH with LD and PLWH without LD. LD was defined as either a baseline CD4 cell count of less than 350 cells/μL or the occurrence of an AIDS-defining event regardless of CD4 cell count at diagnosis, based on the European consensus definition (applies to patients aged 16 and over)[6]. An AIDS-defining event includes any HIV-related illness listed in the U.S. CDC's diagnostic criteria for AIDS, which primarily comprises opportunistic infections and cancers[22].

Statistical analysis

SPSS version 26.0 was used for data cleaning and analysis. We processed the data using the following steps: (1) Outliers with irrational values were removed. (2) For missing data ranging from 5 to 20%, we used mean imputations to handle them. (3) variables were deleted where over 20% of the data were missing.

Continuous variables were described using mean and standard deviation or median and interquartile range, while categorical variables were described using frequency and proportion. Proportions were expressed along with their 95% confidence intervals (CI), which were calculated using VassarStats, a website for statistical computation (http://vassarstats.net/index.html). All independent variables were categorical, the chi-square test was separately conducted among the total population of PLWH, PLWH aged below 50, and those aged 50 and above to determine differences in the proportion of LD among PLWH with different characteristics. A p-value of less than 0.05 was considered statistically significant. Multivariate analysis was conducted using logistic regression. The independent variables with p-values less than 0.1 in univariate analysis were included in the logistic regression model. The dependent variable was whether PLWH received LD (1 for LD, 0 for non-LD). If the independent variable had multiple categories, a dummy variable was set.

Ethics declarations

The study was approved by the Institutional Review Board of Xiangya Nursing School, Central South University (IRB Number: E2023109). Since we did not extract personal identifiable data from the database, written informed consent was waived by the Institutional Review Board of Xiangya Nursing School. But all participants received health counselling and verbal informed consent before data collection and related tests. We also

provided medical referrals for newly diagnosed patients. This study was conducted in strict accordance with the requirements of the Institutional Review Board of Xiangya Nursing School and the Declaration of Helsinki.

Results

Characteristics of the study population

Between 2018 and 2021, 24,820 new HIV cases were diagnosed in Hunan, of which 22,504 met our criteria. The process of screening participants is shown in Fig. 1. 491 PLWH were excluded because there was no record of their baseline CD4 cell count or AIDS-defining events. Based on the available data, 81.9% of the excluded PLWH were male, with a mean age of 53 (35–67) years, and 41.4% were married. No significant differences were found between the patients before and after exclusion (see Supplementary Table 1).

In our study, PLWH were predominantly male (77.4%) and Han ethnicity (91.0%), with a mean age of 54 (37–65) years. PLWH aged 50 and over accounted for 58.9%. Most PLWH were employed (72.9%), nearly half were married (44.5%), and only 16.1% of PLWH had a college degree or higher. Of the participants, 42.4% were diagnosed in Central Hunan, most were transferred from health facilities (61.1%), were mainly infected through sexual behavior (89.6%), and mostly through heterosexual contact (71.7%). PLWH had a mean baseline CD4 cell count of 278 (157–413) cells/μL, while 65.4% had a CD4 count of 350 cells/μL or lower. At the time of diagnosis, 24.7% of PLWH were classified as having clinical stage 3 HIV infection or above according to the WHO's guideline (see Table 1).

Late diagnosis of HIV infection

The proportion of LD among the participants was 66.6% (14,988 out of 22,504). We observed that the highest proportion of LD was found among those aged 50 and older (71.2%), with a primary school education or lower (71.3%), with a BMI of less than 18.5 (77.0%), who were transferred from health facilities (71.1%), and who were diagnosed in West Hunan (74.2%) (Table 1). A distribution map in Fig. 2 illustrates the proportion of LD in various cities in Hunan Province. Furthermore, a line graph in Fig. 3 illustrates the proportion of LD in different years.

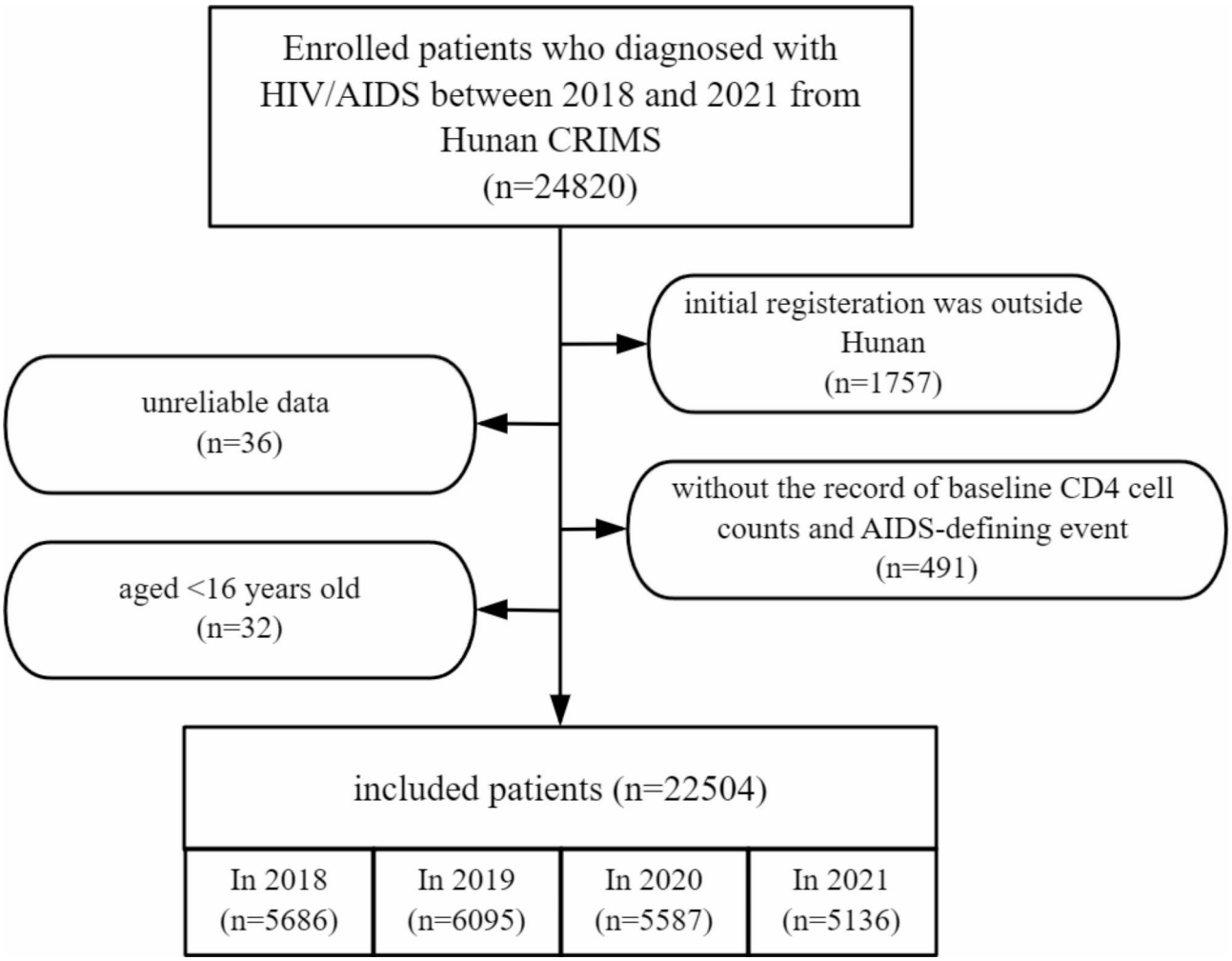

Fig. 1. Flow chart showing the screening of participants.

Characteristics	*N* (%)	LD	Proportion of LD (95% CI)	χ^2	*p*
Age (years)				638.415	**< 0.001**
16–25	1,738 (7.7)	800	46.0 (43.7–48.4)		
26–35	3,357 (14.9)	1880	56.0 (54.3–57.7)		
36–49	4,146 (18.5)	2862	69.0 (67.6–70.4)		
≥ 50	13,263 (58.9)	9446	71.2 (70.4–72.0)		
Gender				0.456	0.500
Male	17,417 (77.4)	11,580	66.5 (65.8–67.2)		
Female	5,087 (22.6)	3,408	67.0 (65.7–68.3)		
Ethnicity				7.475	**0.006**
Han	20,482 (91.0)	13,586	66.3 (65.7–67.0)		
Ethnic minorities	2,022 (9.0)	1,402	69.3 (67.3–71.3)		
Education level				319.997	**< 0.001**
Primary school or lower	7,942 (35.3)	5,665	71.3 (70.3–72.3)		
Junior high school	7,351 (32.7)	5,067	68.9 (67.9–70.0)		
Senior high school	3,577 (15.9)	2,232	62.4 (60.8–64.0)		
College or higher	3,630 (16.1)	2,022	55.7 (54.1–57.3)		
BMI				251.665	**< 0.001**
<18.5	3,306 (14.7)	2,546	77.0 (75.5–78.4)		
18.5–24.9	17,061 (75.8)	11,220	65.8 (65.0–66.5)		
≥ 25	2,137 (9.5)	1,222	57.2 (55.1–59.3)		
Employment status				245.180	**< 0.001**
Working	16,400 (72.9)	11,293	68.9 (68.1–69.6)		
Non-working	3,525 (15.7)	2,231	63.3 (61.7–64.9)		
Studying	776 (3.4)	343	44.2 (40.7–47.8)		
Other	1,800 (8.0)	1,121	62.3 (60.0–64.5)		
Marital status				333.779	**< 0.001**
Unmarried	6,270 (27.9)	3599	57.4 (56.2–58.6)		
Married	9,983 (44.5)	6,961	69.7 (68.8–70.6)		
Divorced or widowed	6,178 (27.6)	4,380	70.9 (69.8–72.0)		
Year of diagnosis				3.745	0.290
2018	5,686 (25.3)	3,797	66.8 (65.5–68.0)		
2019	6,095 (27.1)	4,019	65.9 (64.7–67.1)		
2020	5,587 (24.8)	3,772	67.5 (66.3–68.7)		
2021	5,136 (22.8)	3,400	66.2 (64.9–67.5)		
Registered region				178.991	**< 0.001**
Northern Hunan	3,458 (15.4)	2,290	66.2 (64.6–67.8)		
Central Hunan	9,539 (42.4)	5,954	62.4 (61.4–63.4)		
Southern Hunan	6,307 (28.0)	4,369	69.3 (68.1–70.4)		
Western Hunan	3,200 (14.2)	2,375	74.2 (72.6–75.7)		
Mode of HIV acquisition				343.879	**< 0.001**
Blood	190 (0.8)	113	59.5 (52.1–66.5)		
Heterosexual contact	16,111 (71.7)	11,195	69.5 (68.8–70.2)		
Homosexual contact	4,034 (17.9)	2,190	54.3 (52.7–55.8)		
Other	2,169 (9.6)	1,490	68.7 (66.7–70.6)		
Sample sources				329.008	**< 0.001**
Health facilities	13,745 (61.1)	9,769	71.1 (70.3–71.8)		
VCT	7,401 (32.9)	4,387	59.3 (58.2–60.4)		
Investigation	842 (3.7)	542	64.4 (61.0–67.6)		
Other	516 (2.3)	290	56.2 (51.8–60.5)		
Baseline CD4 counts					
≤ 200	7,363 (32.7)				
201–349	7,139 (31.7)				
≥ 350	8,002 (35.6)				
Baseline WHO clinical stage of HIV infection					
Stage 1	11,293 (50.2)				
Continued					

Characteristics	*N* (%)	LD	Proportion of LD (95% CI)	χ^2	*p*
Stage 2	5,645 (25.1)				
Stage 3	3,264 (14.5)				
Stage 4	2,302 (10.2)				

Table 1. Characteristics of participants and factors associated with HIV late diagnosis. CI, confidence interval; LD, late HIV diagnosis; VCT, HIV voluntary counseling and testing.

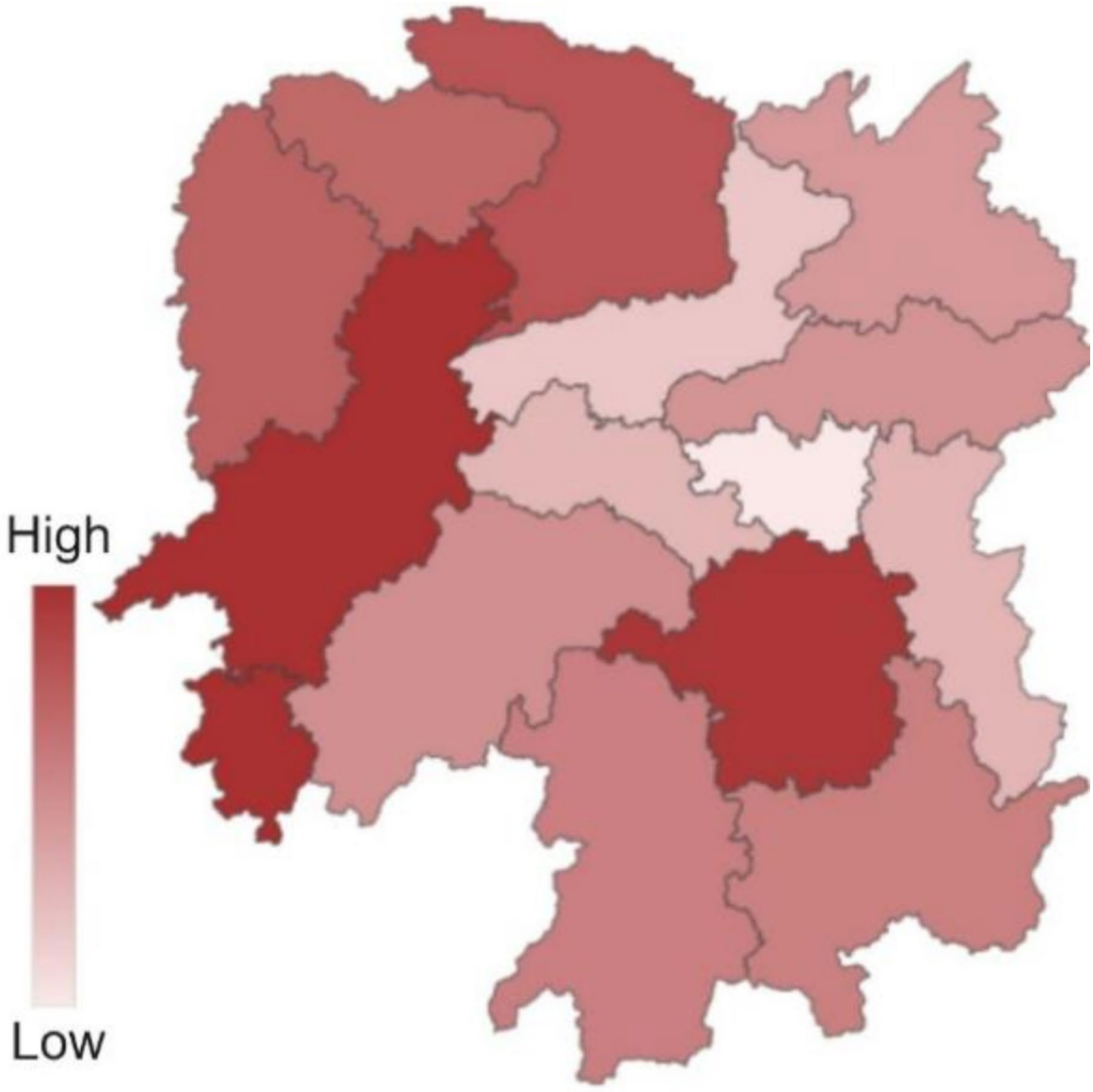

Fig. 2. The proportion of HIV late diagnoses in various cities of Hunan Province.

Factors associated with HIV late diagnosis

In the univariate analysis, we identified nine factors associated with LD, including age, ethnicity, education level, BMI, employment status, marital status, registered region, HIV transmission route, and sample sources.

All variables that showed significant differences in the univariate analysis were included in the multivariate analysis. The results indicated that participants with certain characteristics were more likely to have LD ($P < 0.05$). Male PLWH have a higher risk of LD compared to the female (OR = 1.178, 95% CI: 1.095–1.268).

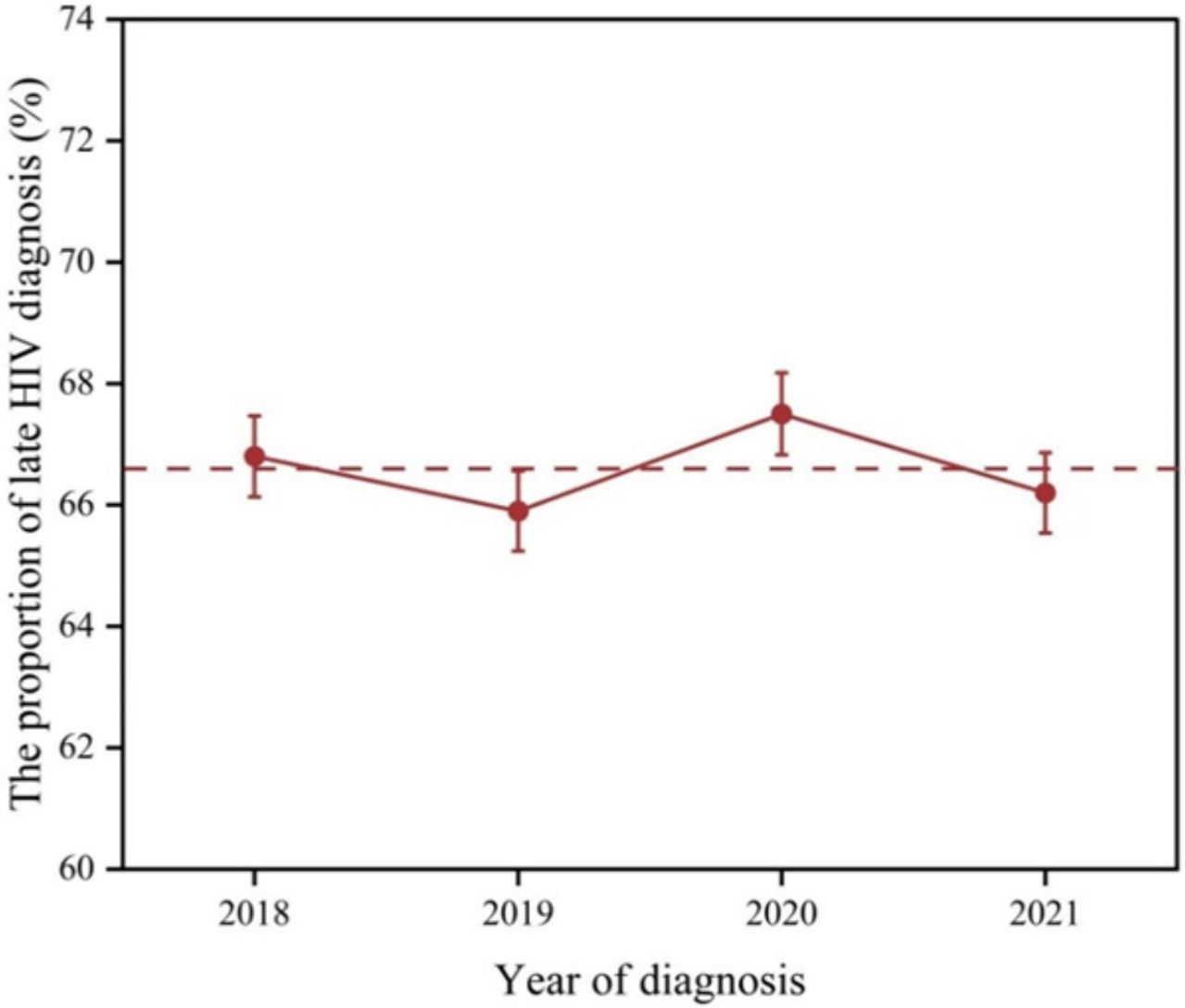

Fig. 3. The proportion of HIV late diagnoses between 2018 and 2021. The dotted line represents the overall proportion of late HIV diagnosis in 2018–2021; error bars show the 95% confidence intervals of every proportion.

PLWH belonging to ethnic minorities exhibit a reduced likelihood of LD compared to individuals of the Han ethnicity (OR = 0.887, 95% CI: 0.787–0.999). PLWH from Southern Hunan and Western Hunan exhibited an elevated risk of LD compared to those from Central Hunan (OR = 1.101, 95% CI: 1.022–1.186 and OR = 1.544, 95% CI: 1.386–1.720, respectively). PLWH infected through homosexual contact exhibited an elevated risk of LD compared to those infected through heterosexual contact (OR = 1.153, 95% CI: 1.049–1.266). PLWH who were transferred from health facilities exhibited an elevated risk of LD compared to those who were transferred from VCT (OR = 1.364, 95% CI: 1.278–1.455). Furthermore, this risk of LD demonstrates a positive correlation with increasing age. Compared to PLWH aged 16–25, those aged 26–35, 36–49 and ≥ 50 have a higher risk of LD (OR = 1.357, 95% CI: 1.188–1.551, OR = 2.159, 95% CI: 1.857–2.510, and OR = 2.225, 95% CI: 1.901–2.604, respectively).

Among the younger PLWH group, apart from the factors mentioned above, some other factors were also associated with LD. It showed that individuals who had primary school or lower education have a higher risk of LD compared to those with college or higher education (OR = 1.427, 95% CI: 1.174–1.736). In comparison to students, working people, non-working people and people in other employment status are more likely to be LD (OR = 1.592, 95% CI: 1.350–1.877, OR = 1.302, 95%CI: 1.090–1.556, and OR = 1.532, 95%CI: 1.272–1.846, respectively). Compared to unmarried PLWH, those who were married, and those who were divorced or widowed were more likely to be LD (OR = 1.252, 95%CI: 1.112–1.410, OR = 1.339, 95% CI: 1.161–1.544, respectively). Unlike younger PLWH, these above factors were not associated with LD among the older PLWH. But it's worth noting that regional disparities in LD were more significant among older individuals. Compared to patients from Central Hunan, those from Northern Hunan, Southern Hunan, and Western Hunan have a higher

risk of LD (OR = 1.214, CI: 1.082–1.364, OR = 1.162, 95%CI: 1.058–1.276, and OR = 1.717, 95%CI: 1.486–1.983, respectively). See Table 2.

Discussion

Using a large sample, this study investigated LD prevalence and factors associated with LD. This study found the proportion of LD between 2018 and 2021 was 66.6% and identified several factors associated with LD.

Compared to other regions, the prevalence of LD has been relatively high in China and across other Asian regions[10–13]. Previous studies have shown that HIV-related stigma was more serious in low- and middle-income countries, especially in sexually conservative countries, such as China[23]. This could be a reason for the relatively high proportion of LD in China. Sun et al. conducted a meta-analysis of 39 Chinese studies and found that the overall proportion of LD was 43.3%[24]. However, the definitions of LD in these studies were inconsistent as most studies considered LD as an HIV diagnosis with a baseline CD4 cell count of lower than 200 cells/μL, while

Characteristics	Total ($N = 22,504$)		< 50 yrs ($N = 9,241$)		≥ 50 yrs ($N = 13,263$)	
	OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*
Gender						
Female	Ref		Ref		Ref	
Male	1.178 (1.095–1.268)	**< 0.001**	1.291(1.124–1.483)	**< 0.001**	1.184(1.086–1.291)	**< 0.001**
Ethnicity						
Han	Ref		Ref		Ref	
Ethnic minorities	0.887 (0.787–0.999)	**0.049**	0.858 (0.724–1.018)	0.079	0.917 (0.775–1.085)	0.312
Education level						
College or higher	Ref		Ref		Ref	
Senior high school	0.976 (0.880–1.083)	0.646	0.932 (0.832–1.045)	0.231	0.987 (0.751–1.297)	0.925
Junior high school	1.022 (0.919–1.136)	0.688	1.129 (0.997–1.280)	0.056	0.898 (0.697–1.158)	0.407
Primary school or lower	1.033 (0.918–1.162)	0.590	1.427 (1.174–1.736)	**< 0.001**	0.911 (0.706–1.174)	0.470
Employment status						
Studying	Ref		Ref		/	/
Working	1.176 (0.981–1.409)	0.079	1.592 (1.350–1.877)	**< 0.001**	Ref	
Non-working	1.117 (0.929–1.344)	0.238	1.302 (1.090–1.556)	**0.004**	1.034 (0.922–1.160)	0.565
Other	1.218 (1.001–1.483)	**0.049**	1.532 (1.272–1.846)	**< 0.001**	1.152 (0.926–1.434)	0.205
Marital status						
Unmarried	Ref		Ref		Ref	
Married	0.971 (0.878–1.074)	0.566	1.252 (1.112–1.410)	**< 0.001**	0.935 (0.787–1.110)	0.442
Divorced or widowed	0.997 (0.896–1.111)	0.962	1.339 (1.161–1.544)	**< 0.001**	0.972 (0.815–1.158)	0.748
Registered region						
Central Hunan	Ref		Ref		Ref	
Northern Hunan	1.041 (0.956–1.134)	0.358	0.848 (0.745–0.964)	**0.012**	1.214 (1.082–1.364)	**0.001**
Southern Hunan	1.101 (1.022–1.186)	**0.012**	1.062 (0.936–1.205)	0.350	1.162 (1.058–1.276)	**0.002**
Western Hunan	1.544 (1.386–1.720)	**< 0.001**	1.335 (1.133–1.573)	**0.001**	1.717 (1.486–1.983)	**< 0.001**
Mode of HIV acquisition						
Homosexual contact	Ref		Ref		Ref	
Heterosexual contact	1.153 (1.049–1.266)	**0.003**	1.208 (1.082–1.349)	**0.001**	1.254 (1.025–1.534)	**0.028**
Blood contact	0.752 (0.553–1.023)	0.070	0.689 (0.451–1.052)	0.085	1.025 (0.636–1.652)	0.920
Other	1.314 (1.165–1.482)	**< 0.001**	1.197 (1.029–1.393)	**0.020**	1.567 (1.239–1.982)	**< 0.001**
Sample sources						
VCT	Ref		Ref		Ref	
Health facilities	1.364 (1.278–1.455)	**< 0.001**	1.542 (1.401–1.697)	**< 0.001**	1.239 (1.133–1.355)	**< 0.001**
Investigation	1.020 (0.873–1.192)	0.800	1.056 (0.786–1.419)	0.716	0.977 (0.811–1.177)	0.806
Other	0.917 (0.761–1.105)	0.363	0.970 (0.774–1.217)	0.794	0.906 (0.648–1.266)	0.563
Age (years)						
16–25	Ref					
26–35	1.357 (1.188–1.551)	**< 0.001**				
36–49	2.159 (1.857–2.510)	**< 0.001**				
≥ 50	2.225 (1.901–2.604)	**< 0.001**				

Table 2. Multivariate analysis of factors associated with HIV late diagnosis in all participants and in different age groups. OR, odds ratio, CI, confidence interval, VCT, HIV voluntary counseling and testing, ref, reference.

did not include PLWH presenting with AIDS-defining events[24]. Thus, the proportion of LD may have been underestimated in China based on these findings[24]. Other studies conducted in different regions of China used the same definition of LD as our study and also found a lower proportion of LD compared to our study: 55.1% in Jiangsu Province and 57.6% in Suzhou City[21,25]. We found the proportion of age groups was quite different between our and other studies in China, particularly in OPLWH. The proportion of OPLWH in other studies was low, and most of them are distributed between 15 ~ 40%.[21,25,26] Even this proportion in overall China is only 48.3%.[16] But this age group accounted for almost 60% of all PLWH in Hunan. Therefore, the higher proportion of LD in Hunan could be explained by the higher proportion of OPLWH.

Significantly, the proportion of LD increases with age, with the highest risk observed in the population over 50 years old. The risk of being LD among OPLWH was 2.2 times higher than for those aged 25 and younger. The proportion of LD is 71.2% among OPLWH in our study, which is higher than Chu's study in China[27]. Although a handful of studies have found that those aged 25–50 years were more likely to be LD[11,28], many other studies have found that those aged 50 and over were more likely to be LD[10,27,29]. This may be explained by inadequate knowledge, incorrect symptom attribution, inaccurate perception of risk, and severe stigma among OPLWH[30]. However, as this group was not considered a key group for HIV testing, limited interventions or strategies have been carried out targeting the older group with higher LD risk[15,31]. As the size of China's aging population increases, immediate actions are recommended, including expanding HIV testing and providing accessible HIV education for older people.

In our study, being male was also a risk factor for LD. This result is consistent with previous studies[11,25,27]. One possible reason is that they engaged in commercial sex without being aware of the risk of HIV infection[30]. Only one previous study found that being female was a risk factor for LD, as females encountered more severe HIV-related stigma and exhibited more delayed healthcare-seeking behaviors[28]. Among younger PLWH, students had a lower risk of LD, this might be because the acceptance proportion of HIV testing was high among Chinese college students, and they were relatively proactive in seeking HIV testing[32,33]. Among OPLWH, the proportion of LD was high, regardless of education level and employment status. This result confirms that age is an important factor in the occurrence of LD.

In our study, PLWH who acquired HIV through heterosexual contact had a higher risk of being LD than those who acquired HIV through homosexual contact. In recent years, HIV prevention and control efforts in China have prioritized men who have sex with men, leading to increased risk awareness and prompt HIV testing in this population[34]. However, 72% of sexual transmission is caused by heterosexual contact, which is the main HIV transmission route in China[14]. Therefore, it is important to include heterosexual individuals in HIV infection prevention campaigns. Additionally, our study found that regional disparities were apparent in Hunan. The prevalence of LD was alarmingly high in western Hunan (74.2%), a remote, rural area. Among OPLWH, the risk of LD is 1.7 times higher in western Hunan compared to central Hunan, where the capital of Hunan is located. HIV prevention and testing efforts specifically targeting the areas with higher LD should be proposed and conducted, especially focus on the elderly.

Since the "Know Your Status" campaign took place in 2018, the number of HIV tests conducted in China has significantly increased[15]. However, since then, the proportion of LD has not changed significantly in Hunan and has even risen in some regions of China[21,24]. It is possible that a significant number of previously undiagnosed HIV cases were identified during this campaign. Our study is among the few to cover the period of COVID-19 epidemic, which began in late 2019. A study revealed that COVID-19 was associated with delayed diagnosis of disease, with infectious diseases having the highest probability of delayed diagnosis (44%)[35]. However, we found the proportion of LD remained stable over this period. This may be associated with the implementation of timely changes in detection strategies. Although in the first quarter of 2020, the number of HIV tests decreased by 49%[36]. Between May and June of the same year, MSM community effectively utilized HIV self-testing as an alternative to facility-based testing, with no overall decline in HIV testing rates[37]. Consistent with the above studies, our findings show there was only a slight decline in the number of HIV diagnoses during 2020. Thus, the adaptability and resilience of HIV testing strategies proved crucial for early HIV diagnosis during a major pandemic like COVID-19.

In Hunan, 61.1% of PLWH were diagnosed at health facilities, and the risk of being LD among these PLWH was 1.4 times higher than those diagnosed through voluntary counseling and testing (VCT). This is because the former usually seek treatment only after the onset of some symptoms. What's worse, heuristics and the lack of HIV diagnosis experience among clinicians in non-HIV specialties may cause potential PLWH to miss opportunities for early diagnosis[35,38]. While provider-initiated HIV testing refers to the practice where healthcare providers offer or recommend HIV testing to patients during routine medical care or in specific healthcare settings without waiting for the patients to specifically request the test[39]. This approach aims to increase the detection rate of HIV infections, especially among those who might not be aware of their risk or might not voluntarily seek testing, such as the older[39]. After the implementation of the pilot practice of routine HIV screening in hospitals in Xishuangbanna, Yunnan, China, the estimated proportion of HIV-positive individuals who were aware of their status increased rapidly from 81.9% in 2019 to 90.8% in 2020, leading the way for us to gradually achieve the first 95% target[40]. Thus, improving provider-initiated HIV testing and counseling services could be a crucial step in preventing LD in healthcare facilities in the future.

This study has several limitations. First, despite the larger sample size, we only investigated PLWH in Hunan, China. Therefore, the study findings may not be generalized to PLWH in other regions. Second, this is a cross-sectional study, so it is not able to determine cause and effect. Finally, although CRIMS database have a comprehensiveness data, some certain relevant variables were not available for the analysis, such as the HIV/AIDS-related knowledge, HIV stigma, and so on. This omission may introduce potential biases to our findings. Despite these limitations, the study findings identified LD prevalence and associated factors, informing the

challenges that exist among OPLWH. Future studies could adopt a longitudinal study design and integrate data from health databases with surveys to further explore the causes of LD.

Conclusion

This study discovered a high proportion of LD in Hunan, China, particularly among OPLWH. We found that those who were older, male, registered in Western Hunan, transferred from health facilities, or were infected through heterosexual contact were more likely to be LD. Among younger PLWH, those who were non-student or had a lower level of education were at higher risk of LD. HIV testing should be specifically promoted among these groups. For HIV prevention and testing among OPLWH, it is necessary to raise their awareness of HIV infection and encourage them to seek HIV testing. More effective and targeted measures should be taken to reduce the prevalence of LD in the future.

Data availability

The data that support the findings of this study are not openly available due to reasons of sensitivity and are available from the corresponding author upon reasonable request. Data are located in controlled access data storage at Chinese Center for Disease Control and Prevention.

Received: 3 July 2024; Accepted: 19 September 2024
Published online: 05 October 2024

References

1. UNAIDS. *AIDS by the numbers, see the latest data on HIV*. https://www.unaids.org/en/Homepage
2. Joint United Nations Programme on HIV and AIDS & Global, H. I. V. & AIDS statistics. (2023). https://www.unaids.org/en/resources/fact-sheet
3. Joint United Nations Programme on HIV/AIDS. *New global pledge to end all inequalities faced by communities and people affected by HIV towards ending AIDS* https://www.unaids.org/en/resources/presscentre/pressreleaseandstatementarchive/2021/june/20210608_hlm-opens (2021).
4. Joint United Nations Programme on HIV/AIDS. Knowledge is Power: Know your Status, Know your Viral Load. https://www.unaids.org/en/resources/documents/2018/knowledge-is-power-report (2018).
5. Centers for Disease Control and Prevention. Monitoring Selected National HIV Prevention and Care Objectives by Using HIV Surveillance Data—United States and 6 Dependent Areas. : National Profile. (2021). https://www.cdc.gov/hiv/library/reports/hiv-surveillance/vol-28-no-4/content/national-profile.html (2023).
6. Antinori, A. *et al.* Late presentation of HIV infection: A consensus definition. *HIV Med.* **12**, 61–64 (2011).
7. Popping, S. et al. Characteristics and short- and long-term direct medical costs among adults with timely and delayed presentation for HIV care in the Netherlands. *PLoS One*. **18**, e0280877 (2023).
8. Chen, F. F. *et al.* Trends in suicide mortality among people with HIV after diagnosis during 2012–18: A retrospective, national cohort study in China. *Lancet HIV* **9**, e102–e111 (2022).
9. Malekinejad, M. *et al.* Change in condom use in populations newly aware of HIV diagnosis in the United States and Canada: A systematic review and meta-analysis. *AIDS Behav.* **25**, 1839–1855 (2021).
10. Miranda, M. N. S. et al. Determinants of HIV-1 late presentation in patients followed in Europe. *Pathogens*. **10**, 835 (2021).
11. Chone, J. S., Abecasis, A. B. & Varandas, L. Determinants of late HIV presentation at Ndlavela Health Center in Mozambique. *Int. J. Environ. Res. Public Health* **19**, 4568 (2022).
12. The Lancet, H. I. V. Time to tackle late diagnosis. *Lancet HIV*. **9**, e139 (2022).
13. Wong, C. S., Wei, L. & Kim, Y. S. HIV late presenters in Asia: Management and public health challenges. *AIDS Res. Treat.* **2023**, 1–8 (2023).
14. Han, M. J. Analysis of the HIV/AIDS epidemic and prospects for prevention and treatment in China. *Chin. J. AIDS STD*. **29**, 247–250 (2023).
15. He, N. Research Progress in the epidemiology of HIV/AIDS in China. *CCDCW*. **3**, 1022–1030 (2021).
16. Hou, Y. et al. Comparative Analysis of Epidemiological Features of HIV/AIDS cases aged over and under 50 years old — China, 2010–2022. *China CDC Wkly.* **5**, 1079–1083 (2023).
17. Survey Office of the National Bureau of Statistics in Hunan. Hunan statistical yearbook 2023. In *Hunan Provincial Bureau of Statistics* http://222.240.193.190/tjnj/indexeh.htm (2023).
18. Health Commission of Hunan Province. Fighting AIDS and sharing health together Hunan 35th World AIDS Day 2022. (2022). https://wjw.hunan.gov.cn/xxgk/gzdt/szdt/202212/t20221213_29159995.html [in Chinese].
19. Li, H., Gao, R. & Zhang, C. Evolution of HIV/AIDS prevention and control policies in China: A grounded theory approach. *CCDCW* **6**, 12–22 (2024).
20. Mao, Y. R., Xu, J. & Gu, D. The comprehensive response information management system. In *HIV/AIDS in China: Epidemiology, Prevention and Treatment* (eds Wu, Z. Y. et al.) 455–467 (Springer, Singapore, 2020). https://doi.org/10.1007/978-981-13-8518-6_24.
21. Xu, Z. H. *et al.* Real-world data in late presentation of HIV infection in Suzhou, China: Results from four consecutive cross-sectional surveys, 2017–2020. *Front. Public. Health* **11**, 1084840 (2023).
22. Centers for Disease Control and Prevention. AIDS-Defining conditions. (2008). https://www.cdc.gov/mmwr/preview/mmwrhtml/rr5710a2.htm
23. Gesesew, H. A. *et al.* Significant association between perceived HIV related stigma and late presentation for HIV/AIDS care in low and middle-income countries: A systematic review and meta-analysis. *PLoS One* **12**, e0173928 (2017).
24. Sun, C. Q. *et al.* HIV/AIDS late presentation and its associated factors in China from 2010 to 2020: A systematic review and meta-analysis. *AIDS Res. Ther.* **18**, 96 (2021).
25. Shi, L. G. *et al.* Trends of late HIV presentation and advance HIV disease among newly diagnosed HIV cases in Jiangsu, China: A serial cross-sectional study from 2008 to 2020. *Front. Public Health* **10**, 1054765 (2022).
26. Chen, J. F., Xu, J. F., Zhou, Y. Y. & Luo, Y. HIV detection and delayed diagnosis: A time series analysis in China. *Int. J. Environ. Res. Public. Health* **19**, 16917 (2022).
27. Chu, Q. S. et al. Prevalence and factors associated with late diagnosis among older adults living with HIV in Liuzhou, China: 2010–2020. *J. Med. Virol.* **95**, e28288 (2023).
28. Gesesew, H. A., Ward, P., Woldemichael, K. & Mwanri, L. Late presentation for HIV care in Southwest Ethiopia in 2003–2015: Prevalence, trend, outcomes and risk factors. *BMC Infect. Dis.* **18**, 59 (2018).
29. Justice, A. C. *et al.* Delayed presentation of HIV among older individuals: A growing problem. *Lancet HIV* **9**, e269–e280 (2022).

30. Youssef, E. *et al.* Factors associated with HIV testing in people aged ⩾50 years: An integrated qualitative analysis of patients and healthcare providers. *Ther. Adv. Infect. Dis.* **10**, 20499361231186870 (2023).
31. Wong, N. S., Tang, W., Miller, W. C., Ong, J. J. & Lee, S. S. Expanded HIV testing in non-key populations – the neglected strategy for minimising late diagnosis. *Int. J. Infect. Dis.* **138**, 38–40 (2024).
32. Han, J., Mao, Y. R., Tang, H. L., Li, J. & Wu, Z. Y. Initial follow-up and CD4^+T cell count test of newly reported students HIV cases in China,2013–2017. *Chin. J. Prev. Med.* **52**, 1254–1258 (2018).
33. Liao, S. et al. Acceptance and associated factors of HIV testing among college students in China: a systematic review and meta-analysis. *PLoS One*. **18**, e0284865 (2023).
34. Han, L. *et al.* HIV test uptake among MSM in China: Implications for enhanced HIV test promotion campaigns among key populations. *Glob Public. Health* **12**, 31–44 (2017).
35. O, F. et al. Diagnostic delays among COVID-19 patients with a second concurrent diagnosis. *J. Hosp. Med.* **18**, (2023).
36. Shi, L. G. et al. The impact of COVID-19 pandemic on HIV care continuum in Jiangsu, China. *BMC Infect. Dis.* **21**, 768 (2021).
37. Zhang, K. *et al.* Changes in HIV testing utilization among Chinese men who have sex with men during the COVID-19 pandemic in Shenzhen, China: An observational prospective cohort study. *Front. Med. (Lausanne)* **9**, 842121 (2022).
38. Tominski, D. *et al.* The late-presenting HIV-infected patient 30 years after the introduction of HIV testing: Spectrum of opportunistic diseases and missed opportunities for early diagnosis. *HIV Med.* **18**, 125–132 (2017).
39. World Health Organization & UNAIDS. Guidance on provider-initiated HIV testing and counselling in health facilities. (2007). https://iris.who.int/handle/10665/43688
40. Wang, *et al.* Implementing routine HIV screening in hospitals: An effective practice to expand HIV testing—Xishuangbanna Prefecture, Yunnan Province, China, 2019–2020. *CCDCW* **5**, 283–286 (2023).

Acknowledgements

We would like to thank all staff who recorded and managed the data in the Hunan Provincial Center for Disease Control and Prevention, China, as well as all participants whose health information was recorded and used anonymously in this study.

Author contributions

Xinyi Su and Xueyuan Zhong conceived of this study, cleansed and analysed the data, wrote the first draft, and revised the manuscript. Xiangjun Zhang and Yanxiao Gao reviewed the draft and provided critical suggestions, contributing greatly to the quality of our manuscript. Xiaobai Zou and Xi Chen provided clinical data input, output, and verification. Honghong Wang and Wenru Wang provided supervision and funding acquisition, and also reviewed and revised the manuscript. Jingjing Meng and Lu Yu contributed to the data review and analysis. Jianmei He and Yaqin Zhou contributed to the conception of this study, merged and first cleaned the data, communicated with each author, and reviewed and revised every crucial draft. All authors reviewed the manuscript and agreed on the final version of the manuscript to be submitted for publication.

Funding

This research was supported by the National Natural Science Foundation of China (No. 82273746). This research was also supported by the Hunan Provincial Innovation Foundation for Postgraduate, the Fundamental Research Funds for the Central Universities of Central South University and the Research Foundation of Anhui Medical University (No. 1053320213461, No. 2023ZZTS0604 and No. 2023xkj264).

Declarations

Competing interests

The authors declare no competing interests.

Additional information

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1038/s41598-024-73648-6.

Correspondence and requests for materials should be addressed to J.H. or Y.Z.