



The associations of population mobility in HIV disease severity and mortality rate in China

Wangting Li^{1#^}, Xiaoli Wang^{2#}, Yahan Yang^{1#}, Lanqin Zhao^{1#}, Duoru Lin^{1^}, Jinghui Wang^{1^}, Yi Zhu^{3^}, Chuan Chen^{3^}, Zhenzhen Liu^{1^}, Xiaohang Wu^{1^}, Xiayin Zhang^{1^}, Ruixin Wang^{1^}, Ruiyang Li¹, Daniel Shu Wei Ting⁵, Wenyong Huang^{1*}, Haotian Lin^{1,4*^}

¹State Key Laboratory of Ophthalmology, Zhongshan Ophthalmic Center, Sun Yat-sen University, Guangzhou, China; ²Guangzhou Eighth People's Hospital, Guangzhou Medical University, Guangzhou, China; ³Department of Molecular and Cellular Pharmacology, University of Miami Miller School of Medicine, Miami, Florida, USA; ⁴Center of Precision Medicine, Sun Yat-sen University, Guangzhou, China; ⁵Singapore National Eye Centre, Duke-NUS Medical School, Singapore, Singapore

Contributions: (I) Conception and design: H Lin, W Huang, W Li, X Wang, Y Yang, Q Zhao; (II) Administrative support: H Lin; (III) Provision of study materials or patients: H Lin, X Wang; (IV) Collection and assembly of data: X Wang, W Li, D Lin, Z Liu, X Wu, J Wang, X Zhang, Y Yang, R Wang, R Li; (V) Data analysis and interpretation: W Li, L Zhao; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

[#]These authors contributed equally to this work as co-first authors.

^{*}These authors contributed equally to this work as co-senior authors.

Correspondence to: Haotian Lin, MD, PhD. Zhongshan Ophthalmic Center, No. 54 Xian Lie South Road, Guangzhou 510000, China. Email: linht5@mail.sysu.edu.cn.

Background: Human immunodeficiency virus (HIV) infection has become a chronic disease and attracted public attention globally. Population migration was considered hindering the control and management of HIV infection, but limited studies have explored how population mobility could influence the development of HIV-related complications and overall prognosis.

Methods: We enrolled hospitalized HIV patients in this cross-sectional study between January 1, 2006, and December 31, 2016. We extracted demographic, hospitalization, and patient diagnosis data. Patients were divided into three groups according to the population type: (I) resident of Guangzhou City (local resident); (II) migrant outside of Guangzhou City but within Guangdong Province (migrant within the province); and (III) migrant outside of Guangdong Province (migrant outside the province). To represent the prognosis of HIV, in-hospital death was defined as the worst outcome, whereas vision-related events were considered moderate-to-severe complications. Logistic regression models were used to analyze factors influencing the prognosis of HIV.

Results: Eight thousand and six hundred thirty-one inpatients (14,954 cases) were enrolled. The overall mortality was 7.9%, decreasing from 21.5% in 2006 to 3.8% in 2016. The prevalence of vision-related events was 14.4% between 2015 and 2016. Compared to local patients, migrant patients (within and outside the province) were younger, had significantly less access to health insurance, fewer hospitalization admissions, longer hospital stays, and a higher proportion of physical work ($P < 0.01$). Furthermore, they had a higher prevalence of vision-related events (16.2% and 17.4% in migrant patients within the province and outside the province, respectively *vs.* 9.5%) and infectious diseases, but lower in-hospital mortality (5.9% and 7.0% *vs.* 12.3%) than local patients. Migrants correlated negatively with in-hospital death [odds ratio (OR) 95% CI, 0.37 (0.29–0.48) and 0.52 (0.40–0.68)] but correlated positively with vision-related events [OR (95% CI),

[^] ORCID: Wangting Li: 0000-0001-7070-5768; Duoru Lin: 0000-0002-7214-1801; Jinghui Wang: 0000-0002-6720-9170; Yi Zhu: 0000-0002-1778-8880; Chuan Chen: 0000-0001-5701-0857; Zhenzhen Liu: 0000-0002-4853-2474; Xiaohang Wu: 0000-0002-9398-4330; Xiayin Zhang: 0000-0003-0250-0247; Ruixin Wang: 0000-0003-4621-228X; Haotian Lin: 0000-0003-4672-9721.

2.08 (1.54–2.80) and 2.03 (1.47–2.80)].

Conclusions: Migrant patients have significantly poorer access to health insurance, with an increased risk of developing moderate-to-severe HIV infection but a decreased risk of in-hospital death, indicating a trend toward withdrawing treatment in migrant patients when they have advanced diseases. Managements such as optimizing access to health insurance and improving follow-up visits for HIV infection should be considered in the context of the population mobility of HIV patients.

Keywords: Human immunodeficiency virus infection (HIV infection); mortality; prognosis; population mobility; global health

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Introduction

Human immunodeficiency virus (HIV) infection has transitioned from an acute fatal disease to a chronic disease due to the application of highly active anti-retroviral therapy (HAART) (1-3). Mortality has decreased dramatically, while the number of patients has increased, which has aroused public attention globally. Previous studies have compared HIV prevalence in different populations and found that migrants have a higher risk of HIV (4-7). Moreover, migrant HIV patients are more likely to have a delayed diagnosis of HIV infection (8,9), a higher incidence of acquired immune deficiency syndrome (AIDS) (10,11), virologic failure (12-14), and higher mortality (11) than local patients. In the study by Saracino *et al.* in 2016, the incidence of virologic failure in migrants was 6.4 per 100 person-years in migrants and 2.7 in natives (12). The poor treatment outcome among migrants has led to obstacles in the prevention and treatment of HIV infection (15,16).

As a leading province following the reform and opening-up policy in China, Guangdong Province and its capital city, Guangzhou, have a large migrant population and a higher prevalence of HIV infection compared to other parts of China (17). To investigate the influence of the difference in population mobility on the prognosis of HIV patients, we conducted the Guangzhou HIV Infection Study and collected data from 8,631 patients hospitalized in Guangzhou. In-hospital death is the worst outcome among hospitalized HIV patients (18,19), whereas vision-related events are often considered moderate-to-severe and quality-of-life-related complications (20-23). Therefore, we selected hospital death and vision-related events as two main outcomes to represent the prognosis of HIV infection. We analyzed the association between population

mobility and the prognosis of HIV infection. The results provide evidence for the management of HIV infection and other chronic diseases in different populations. We present the following article in accordance with the STROBE reporting checklist (available at <http://dx.doi.org/10.21037/atm-20-4514>).

Methods

Study design and population

The Guangzhou HIV Infection Study enrolled HIV patients hospitalized in Guangzhou between January 1, 2006, and December 31, 2016. All inpatients met the HIV infection diagnostic criteria. According to *Guidelines for AIDS diagnosis and treatment in China* written by the China Center for Disease Control, the patients were referred to Guangzhou Eighth People's Hospital to receive HAART after receiving diagnosis in Guangzhou.

Patients were divided into three groups according to their registered permanent residence and population type: resident in Guangzhou City (local resident), migrant outside Guangzhou City but in Guangdong Province (migrant within the province) and migrant outside Guangdong Province (migrant outside the province). To compare the differences in the prognosis of HIV infection and characteristics regarding population mobility, the prevalence of systemic diseases was observed. To represent the prognosis of HIV, in-hospital death was defined as the worst outcome, whereas vision-related events were considered moderate-to-severe complications. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by institutional review board of Zhongshan Ophthalmic

Center of Sun Yat-sen University (2019KYPJ177), and individual consent for this retrospective analysis was waived.

Data extraction

We extracted demographic information, hospitalization, and patient diagnosis. All patient records and information were anonymized and de-identified before the analysis.

Demographic information consisted of patient age, sex, occupation, payment method (with or without insurance), marital status, relationship with the contact person, and place of registered permanent residence.

Hospitalization characteristics include hospital admissions, average hospitalization duration, and time (year) of the first hospitalization. To evaluate the impact of medical policies and management on the prognosis of HIV patients in different time periods, the patients were divided into three groups according to the changes in HIV mortality in three periods: 2006–2008, 2009–2014, and 2015–2016. In particular, in-hospital death between 2006 and 2016 and vision-related events between 2015 and 2016 were selected as the main outcomes representing the prognosis of HIV infection. Vision-related events between 2006 and 2014 were excluded since inpatients did not undergo routine ophthalmic examination until 2014. From 2014 on, patients were referred to an ophthalmologist routinely.

The diagnosis of the referral letter would compose part of the discharge diagnosis. In addition to in-hospital death and vision-related events, systemic diseases with high prevalence between 2006 and 2016 were also extracted to compare the prevalence in different populations.

Statistical analysis

All analyses were performed using STATA statistical software (Stata version 14.0, Stata Corp., College Station, TX, USA). Patient age, hospital admission, duration of the first hospitalization, and average duration of hospitalization were used as continuous variables. Patient sex, population type, occupation, payment method, marital status and contact person were used as categorical variables. Logistic regression was used to assess the association of potential related factors with in-hospital death and vision-related events. The odds ratio (OR) of these factors was identified without and with adjustment for all the selected systemic diseases. To compare distributions of characteristics between groups, Student's *t*-test and the Mann-Whitney U test were used for continuous variables, and the Chi-

square test was used for categorical variables. All tests were two sided, and P values less than 0.05 were considered statistically significant.

Results

Population composition and characteristics

A total of 8,631 inpatients with 14,954 hospitalization records were enrolled in this study, including 2,268 local residents, 4,263 migrants within the province, and 2,100 migrants outside the province. There were 736 patients between 2006 and 2008, 4,252 patients between 2009 and 2014, and 3,643 patients between 2015 and 2016. The number of inpatients increased with an annual rate of 23.2%, while the in-hospital mortality in general decreased rapidly, from 21.5% in 2006 to 3.8% in 2016 (*Figure 1*).

The hospitalization and demographic characteristics were significantly different between periods (*Figure 2*). Generally, patient was getting older, and approximately three-quarters of the inpatients were male. The mean number of hospital admissions increased (1.3 times in the period of 2006–2008, 1.5 times in the period of 2009–2014, 2.3 times in the period of 2015–2016), but the mean hospitalization duration decreased (31.2 days between 2006 and 2008, 20.7 days between 2009 and 2014, and 16.8 days between 2015 and 2016) over the three periods. The proportion of migrant patients within the province showed a downward trend (63.2% between 2006 and 2008, 54.8% between 2009 and 2014, 40.3% between 2015 and 2016), while the other two populations, local residents and migrants outside the province, increased significantly. A total of 83.4% of the inpatients paid without health insurance, but the proportions decreased. Of the married patients, 44.2% were accompanied by other relatives.

HIV infection among different migrant statuses

Because notable increases were observed in the numbers of local patients and migrant patients outside the province (*Figure 1*), we further identified and labelled the registered permanent residences of the patients on maps of China and Guangdong Province. The migrant population number increased sharply, and its scope surrounding Guangdong Province and Guangzhou City enlarged quickly (*Figure 3*).

To investigate the effect of migrant birthplace, we labelled the in-hospital mortality and the prevalence of vision-related events according to the registered permanent

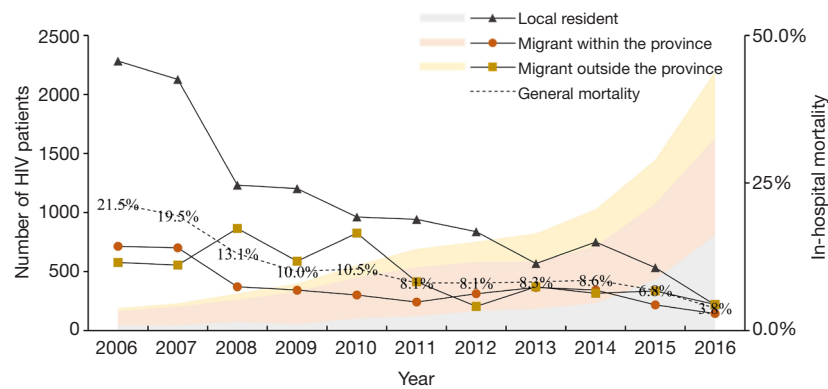


Figure 1 Number of hospitalized patients with HIV infection and in-hospital mortality. The in-hospital mortality decreased significantly from 21.47% in 2006 to 3.83% in 2016, while notable increases were observed in the numbers of local patients and migrant patients outside the province. HIV, human immunodeficiency virus.

residence of the patients on maps of China (Figure 4) and Guangdong (Figure 5). We found that although local inpatients had higher overall mortality, compared to migrant patients, the in-hospital mortality of local inpatients in the Guangdong population was lower than that in the surrounding provinces (such as Guangxi and Hunan) between 2015 and 2016 (Figure 4D). However, the local patients had higher in-hospital mortality than patients from surrounding cities (Figure 5), and the patients from the cities west of Guangdong Province had higher mortality than those from cities east of the province. Of note, the prevalence of vision-related events showed the opposite trend. The populations in Guangdong (Figure 4E) and Guangzhou (Figure 5E) had lower prevalence rates of vision-related events than those from the surrounding provinces and cities.

Figure 6 shows the summary of in-hospital mortality and the prevalence of vision-related events in different populations. Local residents had the highest in-hospital mortality (12.3% in general, 35.5% between 2006 and 2008, 16.2% between 2009 and 2014, and 6.5% between 2015 and 2016) compared to migrants outside the province (7.0% in general) and migrants within the province (5.9% in general, Figure 6). However, the local inpatients had the lowest prevalence of vision-related events (9.5% between 2015 and 2016) compared to the migrant patients outside the province (16.2%) and migrants within the province (17.4%). There was no significant difference between migrants within the province and migrants outside the province (in-hospital mortality: $P=0.09$, the prevalence of vision-related events: $P=0.46$).

Figure 7 shows characteristics in different populations. Local patients had an older age (42.4 vs. 40.7 vs. 38.1 years old, $P<0.01$), more hospitalization admissions (2.5 vs. 1.6 vs. 1.5 times, $P<0.001$), fewer average hospital stays (17.3 vs. 22.2 vs. 19.2 days, $P<0.01$), and lower proportions of physical work (24.2% vs. 34.5% vs. 30.7%, $P<0.01$) than migrants within the province and migrants outside the province. Moreover, the local patients were more likely to pay with health insurance (40.3%, $P<0.01$) than migrant patients within the province (5.5%) and outside the province (9.2%).

Figure 8 shows the prevalence of systemic diseases in different populations, demonstrating that the migrant patients had a significantly higher prevalence of vision-related events and numerous infectious diseases. The prevalence of infectious diseases was significantly higher in migrant patients within the province, whereas the prevalence of underlying diseases, including renal cysts, liver cysts, encephalatrophy, hypertension, fatty liver, diabetes, heart failure, and pulmonary emphysema, was significantly high in local patients.

Association of population mobility with the prognosis of HIV infection

The factors related to in-hospital death and vision-related events are shown in Tables 1,2. The population type was strongly related to both in-hospital death and vision-related events. After adjusting for systemic diseases, migrants within the province [OR, 0.37 (95% CI, 0.29–48), Table 1] and migrants outside the province [OR, 0.52 (95% CI, 0.40–

	2006-2008	2009-2014	2015-2016	Total	p value
Mean hospital admission (Std.)	1.3 (0.7)	1.5 (1.1)	2.3 (2.5)	1.8 (1.9)	<0.01
Mean hospitalization duration (days) (Std.)	31.2 (28.9)	20.7 (17.6)	16.8 (14.0)	20.0 (17.9)	<0.01
Mean age (Std.)	37.15 (12.0)	40.3 (13.6)	41.6 (13.7)	40.6 (13.5)	<0.01
Sex					<0.01
Male	547 (74.3%)	3004 (70.6%)	2844 (78.1%)	6395 (73.1%)	
Female	189 (25.7%)	1248 (29.4%)	799 (21.9%)	2236 (25.6%)	
Population type					<0.01
Local resident	166 (22.6%)	865 (20.3%)	1237 (34.0%)	2268 (25.9%)	
Migrant within the province	465 (63.2%)	2330 (54.8%)	1468 (40.3%)	4263 (48.8%)	
Migrant outside the province	105 (14.3%)	1057 (24.9%)	938 (25.7%)	2100 (24.0%)	
Occupation					<0.01
Clerical work	58 (7.9%)	189 (4.4%)	278 (7.6%)	525 (6.0%)	
In between jobs	121 (16.4%)	207 (4.9%)	21 (0.6%)	349 (4.0%)	
Physical work	201 (27.3%)	1290 (30.3%)	1175 (32.3%)	2666 (30.5%)	
Other or unspecified	356 (48.4%)	2566 (60.3%)	2169 (59.5%)	5091 (58.2%)	
Payment method					<0.01
With health insurance	32 (4.3%)	357 (8.4%)	954 (26.2%)	1343 (15.4%)	
Without health insurance	704 (95.7%)	3895 (91.6%)	2689 (73.8%)	7288 (83.4%)	
Marital status and companion (contact person)					<0.01
Married and accompanied by spouse	238 (32.3%)	1351 (31.8%)	978 (26.8%)	2567 (29.4%)	
Married but not accompanied by spouse	271 (36.8%)	1878 (44.2%)	1719 (47.2%)	3868 (44.2%)	
Unmarried, divorced or widowed	227 (30.8%)	1023 (24.1%)	946 (26.0%)	2196 (25.1%)	
Total	736	4252	3643	8631	

Figure 2 Characteristics of hospitalized HIV-infected patients in different periods. Darker colors represent higher proportions.

0.68)] correlated negatively with in-hospital death. Hospital admission, age, and unmarried, divorced, or widowed status correlated positively with in-hospital death.

In contrast, migrants within the province [OR, 2.08, (95% CI, 1.54–2.80), *Table 2*], migrants outside the province [OR, 2.03, (95% CI, 1.47–2.80)], hospital admission and age positively correlated with vision-related events. Payment without health insurance negatively correlated with vision-related events.

Discussion

In this study, we classified the patients according to population mobility and investigated the influences on hospitalization, demographic information, and the prognosis of HIV infection. There are three main findings in our study. First, the number of hospitalized HIV-infected migrant patients increased considerably during

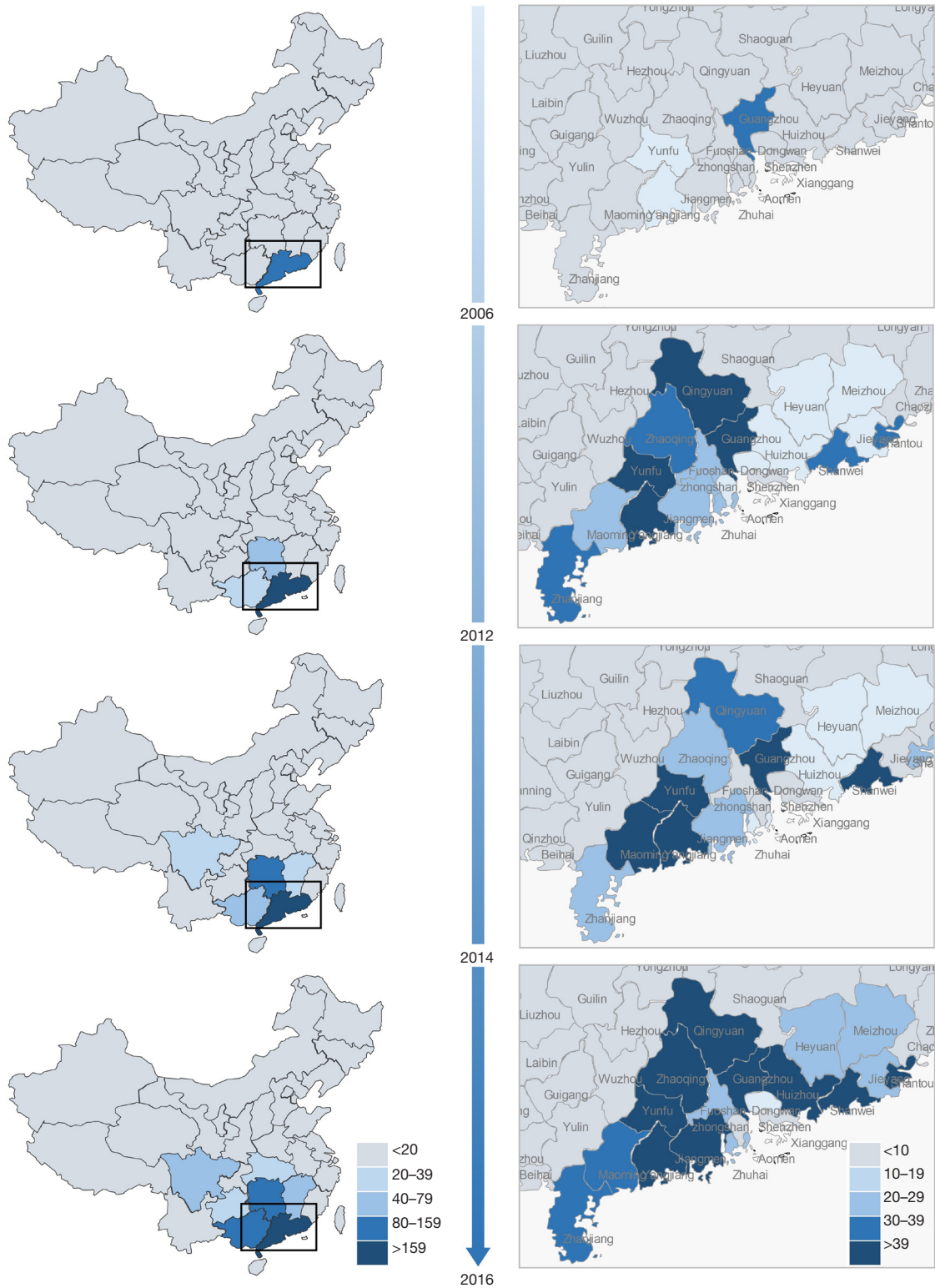
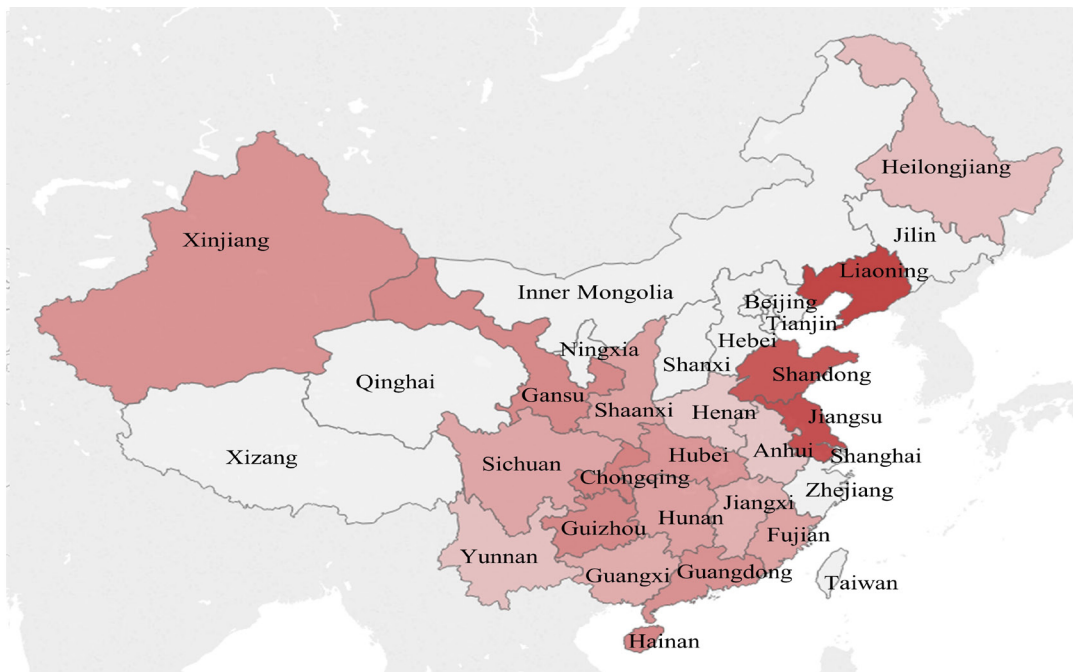


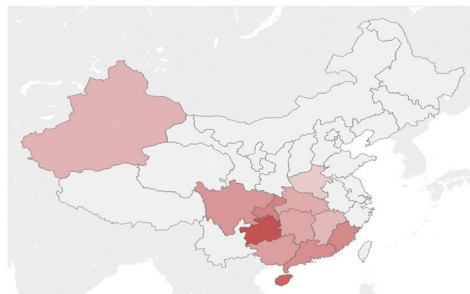
Figure 3 Numbers of hospitalized HIV patients from different provinces (left) and cities in Guangdong Province (right). The migrant population increased sharply, and its scope enlarged as Guangdong Province and Guangzhou City as the center. HIV, human immunodeficiency virus.



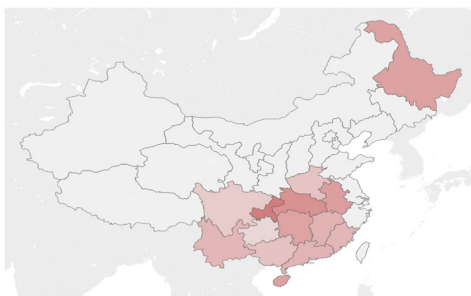
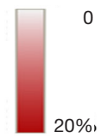
a . Overall mortality



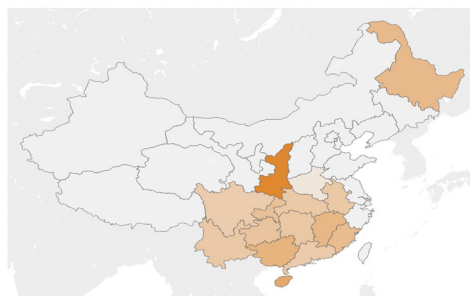
b. Mortality between 2006 and 2008



c. Mortality between 2009 and 2014



d. Mortality between 2015 and 2016



e. Prevalence of VRE between 2015 and 2016

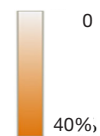


Figure 4 Mortality and prevalence of VREs in hospitalized HIV patients from different provinces in China. The patients from the surrounding provinces that are closer to Guangdong Province had higher mortality and a lower prevalence of vision-related events than the provinces further nearby in general. Footnote: Provinces with fewer than 10 patients were excluded. VRE, vision-related event; HIV, human immunodeficiency virus.

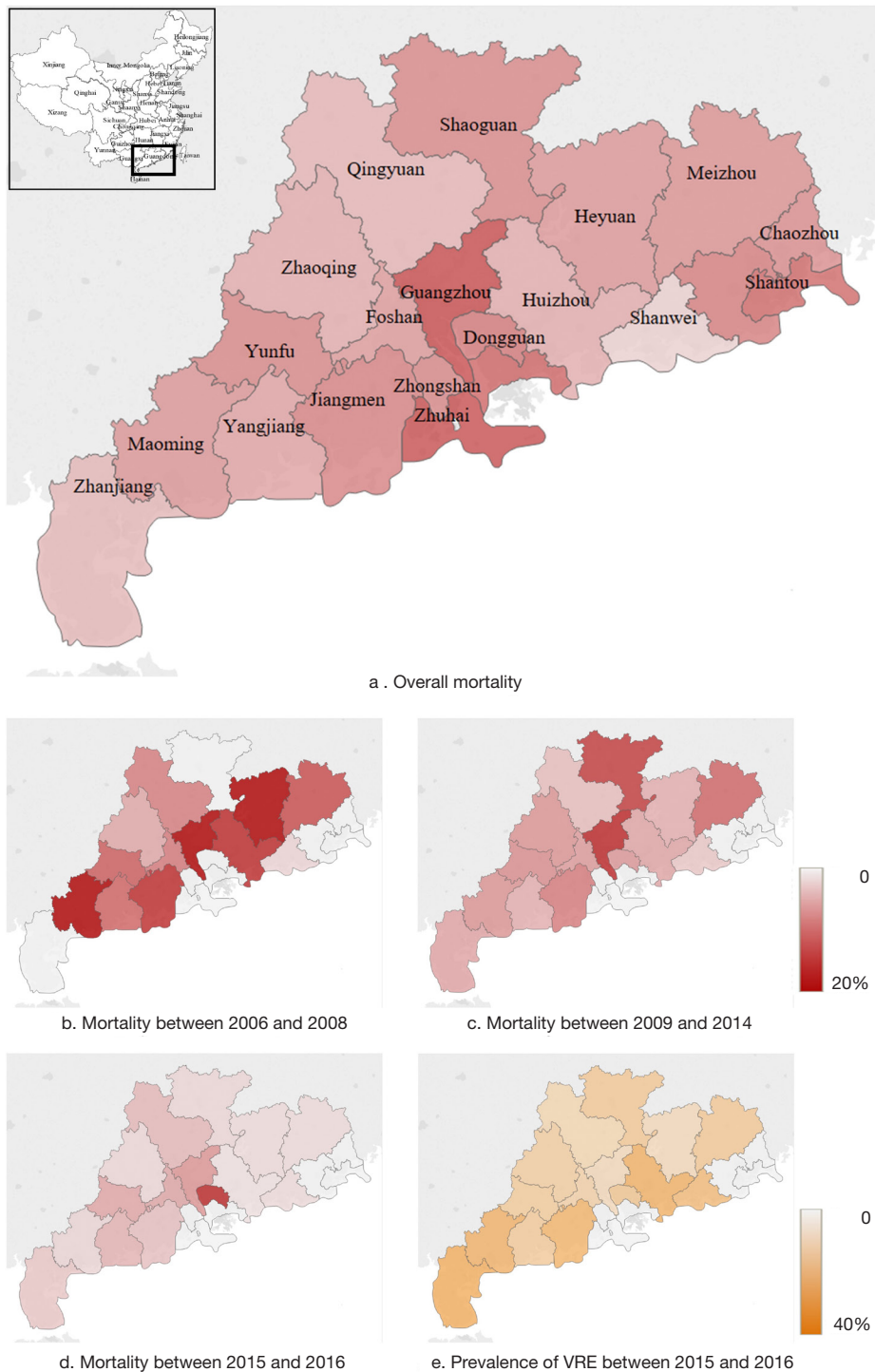


Figure 5 Mortality and prevalence of VREs in hospitalized HIV patients from different cities in the province. The patients from the surrounding cities that are closer to Guangzhou City had higher mortality and a lower prevalence of vision-related events than the provinces fewer nearby in general. Footnote: Cities with fewer than 10 patients were excluded. VRE, vision-related event; HIV, human immunodeficiency virus.

Population type	Mortality in general	Mortality in 2006–2008	Mortality in 2009–2014	Mortality in 2015–2016	Prevalence of VRE in 2015–2016
Local resident (A)	280 (12.3%)	59 (35.5%)	140 (16.2%)	81 (6.5%)	117 (9.5%)
Migrant within the province (B)	253 (5.9%)	53 (11.4%)	148 (6.4%)	52 (3.5%)	255 (17.4%)
Migrant outside the province (C)	148 (7.0%)	15 (14.3%)	83 (7.9%)	50 (5.3%)	152 (16.2%)
Total	681 (7.9%)	127 (17.3%)	371 (8.7%)	183 (5.0%)	524 (14.4%)
P					
Between A and B	<0.01	<0.01	<0.01	<0.01	<0.01
Between A and C	<0.01	<0.01	<0.01	0.24	<0.01
Between B and C	0.09	0.41	0.11	0.03	0.46
Full model	<0.01	<0.01	<0.01	<0.01	<0.01

Figure 6 Mortality and prevalence of vision-related event (VREs) in the different populations in the three periods. Darker colors represent higher prevalence.

the study period (*Figure 1*). Their residence enlarged with Guangdong Province and Guangzhou City as the center (*Figures 4,5*). Second, significant differences in hospitalization and demographic characteristics among different populations were revealed. Migrant patients had a younger age, fewer hospitalization admissions, longer hospital stays, and a higher proportion of physical work than local patients, indicating different hospitalization and demographic characteristics of local and migrant patients. Third, the migrant patients had much lower in-hospital mortality but a higher prevalence of vision-related events and infectious diseases compared to the local patients.

Vision-related events are moderate-to-severe complications that are highly related to the severity of HIV infection and seriously affect the quality of patient life (20,24-26). In our study, the migrant patients had a significantly higher prevalence of vision-related events and numerous infectious diseases (*Figure 5*) compared to the local patients, indicating that the migrant patients have a lower quality of life and worse health conditions than the local patients. Our results agree with studies from Kerani *et al.* and Demeke *et al.* that migrant patients were more likely to have delayed diagnoses of HIV infection and to develop severe conditions (4,27).

However, our results also show that migrant patients

would have a lower in-hospital mortality. We reviewed previous studies and found that many patients or their relatives would withdraw treatment due to severe complications, poor health insurance coverage, heavy financial burden, difficulties in transportation, and a sense of hopelessness (28-31). Moreover, most of the patients and their families would choose ‘at home’ as the most appropriate location of death (32). In our study, we found that migrant patients had less access to health insurance than local patients (*Figure 7*). According to the health policy in China, most migrant patients need to return home for better health insurance coverage, which results in reduced willingness to seek local medical help and increased intention to withdraw treatment. A high prevalence of vision-related events among migrant patients in our study also indicates the unavailability of medical insurance and poor economic conditions that may lead to delayed diagnosis (4,5,33).

Moreover, when we further investigated the correlations between the prognosis of HIV infection and the geographic characteristics of the patients’ permanent residences, we found that distance from the permanent residence to Guangzhou City contributed the most to the relationship, despite no significant difference in in-hospital mortality and prevalence of vision-related events between migrants

	Local resident	Migrant in province	Migrant outside province	Total	p value
Mean hospital admission (Std.)	2.5 (2.8)	1.6 (1.3)	1.5 (1.3)	1.8 (1.9)	<0.01
Mean hospitalization duration (days) (Std.)	17.3 (19.1)	22.2 (18.3)	19.2 (17.1)	20.2 (18.3)	<0.01
Mean age (Std.)	42.4 (13.9)	40.7 (13.8)	38.1 (12.0)	40.5 (13.5)	<0.01
Sex					<0.01
Male	1721 (75.9%)	3172 (74.4%)	1502 (71.5%)	6395 (74.1%)	
Female	547 (24.1%)	1091 (25.6%)	598 (28.5%)	2236 (25.9%)	
Occupation					<0.01
Clerical work	201 (8.9%)	199 (4.7%)	125 (6.0%)	525 (6.1%)	
In between jobs	58 (2.6%)	201 (4.7%)	90 (4.3%)	349 (4.0%)	
Physical work	548 (24.2%)	1473 (34.6%)	645 (30.7%)	2666 (30.9%)	
Other or unspecified	1461 (64.4%)	2390 (56.1%)	1240 (59.1%)	5091 (59.0%)	
Payment method					<0.01
With health insurance	914 (40.3%)	235 (5.5%)	194 (9.2%)	1343 (15.6%)	
Without health insurance	1354 (59.7%)	4028 (94.5%)	1906 (90.8%)	7288 (84.4%)	
Marital status and companion (contact person)					<0.01
Married and accompanied by spouse	615 (27.1%)	1337 (31.4%)	615 (29.3%)	2567 (29.7%)	
Married but not accompanied by spouse	951 (41.9%)	2030 (47.6%)	887 (42.2%)	3868 (44.8%)	
Unmarried, divorced or widowed	702 (31.0%)	896 (21.0%)	598 (28.5%)	2196 (25.4%)	
Total	2268	4263	2100	8631	

Figure 7 Characteristics of hospitalized HIV-infected patients with different population types. Darker colors represent higher proportions.

within the province and migrants outside the province. The surrounding provinces and cities that are closer to Guangzhou City had higher mortality and lower prevalence of vision-related events than the provinces that are farther away in general (Figures 4, 5). Therefore, we can conclude that migrant patients from farther places may have a worse condition and are more likely to withdraw treatment in the hospital and return to their city of origin.

Previous studies have indicated differences in occupation, income, and education level in different populations (5,7,33-36) and have demonstrated that migrant populations

lack awareness of HIV prevention and treatment (16,37). Therefore, migrant patients are at higher risk of having HIV infection and of spreading the disease. As a result, further management should be considered regarding the population mobility of HIV patients. For instance, the propagation of HIV prevention and management, such as education and condom dissemination, should also be promoted.

In addition to the positive relationship between vision-related events and immunity reported in previous studies (38,39), our results showed that vision-related

Disease (n, prevalence [%])	Local resident	Migrant within the province	Migrant outside the province	Total	P
Fungal infection	560 (24.7)	1930 (45.3)	823 (39.2)	3313 (38.4)	<0.01
Pulmonary infection	640 (28.2)	1677 (39.3)	824 (39.2)	3141 (36.4)	<0.01
Viral hepatitis	613 (27.0)	1217 (28.5)	427 (20.3)	2257 (26.1)	<0.01
Candida infection	338 (14.9)	1211 (28.4)	466 (22.2)	2015 (23.3)	<0.01
Oral candidiasis	319 (14.1)	1156 (27.1)	434 (20.7)	1909 (22.1)	<0.01
Tuberculosis infection	369 (16.3)	1000 (23.5)	504 (24.0)	1873 (21.7)	<0.01
Bacterial infection	333 (14.7)	855 (20.1)	477 (22.7)	1665 (19.3)	<0.01
Pulmonary tuberculosis	296 (13.1)	743 (17.4)	396 (18.9)	1435 (16.6)	<0.01
Pneumocystis carinii pneumonia	162 (7.1)	533 (12.5)	237 (11.3)	932 (10.8)	<0.01
Marasmus	176 (7.8)	569 (13.3)	172 (8.2)	917 (10.6)	<0.01
Toxic/drug hepatitis	176 (7.8)	474 (11.1)	238 (11.3)	888 (10.3)	<0.01
Cytomegalovirus infection	119 (5.2)	456 (10.7)	242 (11.5)	817 (9.5)	<0.01
Treponema pallidum infection	218 (9.6)	284 (6.7)	259 (12.3)	761 (8.8)	<0.01
Electrolyte disorder	161 (7.1)	372 (8.7)	194 (9.2)	727 (8.4)	0.02
Cholecystitis	175 (7.7)	331 (7.8)	139 (6.6)	645 (7.5)	0.23
Anemia	137 (6.0)	303 (7.1)	153 (7.3)	593 (6.9)	0.18
Kidney stone	108 (4.8)	246 (5.8)	127 (6.0)	481 (5.6)	0.13
Herpes virus infection	93 (4.1)	243 (5.7)	127 (6.0)	463 (5.4)	<0.01
Renal cyst	117 (5.2)	223 (5.2)	97 (4.6)	437 (5.1)	0.56
Liver cyst	115 (5.1)	213 (5.0)	100 (4.8)	428 (5.0)	0.88
Septicemia	73 (3.2)	210 (4.9)	89 (4.2)	372 (4.3)	<0.01
Renal failure	71 (3.1)	166 (3.9)	90 (4.3)	327 (3.8)	0.12
Encephalatrophy	92 (4.1)	168 (3.9)	60 (2.9)	320 (3.7)	0.06
Hypertension	128 (5.6)	123 (2.9)	57 (2.7)	308 (3.6)	<0.01
Severe pneumonia	74 (3.3)	149 (3.5)	68 (3.2)	291 (3.4)	0.82
Fatty liver	84 (3.7)	132 (3.1)	63 (3.0)	279 (3.2)	0.33
Septic shock	99 (4.4)	119 (2.8)	59 (2.8)	277 (3.2)	<0.01
Cryptococcus infection	29 (1.3)	159 (3.7)	77 (3.7)	265 (3.1)	<0.01
Diabetes	72 (3.2)	124 (2.9)	43 (2.0)	239 (2.8)	0.06
Bacterial pneumonia	45 (2.0)	116 (2.7)	73 (3.5)	234 (2.7)	<0.01
Heart failure	73 (3.2)	107 (2.5)	54 (2.6)	234 (2.7)	0.22
Pulmonary emphysema	89 (3.9)	98 (2.3)	39 (1.9)	226 (2.6)	<0.01
Meningitis	21 (0.9)	91 (2.1)	69 (3.3)	181 (2.1)	<0.01
Infectious diarrhea	28 (1.2)	107 (2.5)	31 (1.5)	166 (1.9)	<0.01
Central nervous system infection	28 (1.2)	71 (1.7)	46 (2.2)	145 (1.7)	<0.01
Favism	30 (1.3)	76 (1.8)	17 (0.8)	123 (1.4)	<0.01
Hypoproteinemia	20 (0.9)	63 (1.5)	32 (1.5)	115 (1.3)	0.09
Fungal pneumonia	16 (0.7)	54 (1.3)	28 (1.3)	98 (1.1)	0.08

Figure 8 Numbers of HIV-infected patients diagnosed with systemic diseases. The diseases are ranked according to their general prevalence. Darker colors represent higher prevalence.

Table 1 Association between in-hospital death and potential factors in HIV-infected patients

Factors	Model 1		Model 2	
	OR (95% CI)	P	OR (95% CI)	P
Time period				
2006–2008	Ref.		Ref.	
2009–2014	0.42 (0.31, 0.56)	<0.01	0.45 (0.35, 0.57)	<0.01
2015–2016	0.14 (0.10, 0.20)	<0.01	0.20 (0.15, 0.26)	<0.01
Hospital admission (per time)	1.11 (1.06, 1.15)	0.15	1.03 (0.99, 1.07)	<0.01
Duration of hospitalization (per day)	1.00 (1.00, 1.01)	0.06	1.00 (1.00, 1.01)	0.84
Sex (female)	0.81 (0.63, 1.04)	<0.01	0.65 (0.53, 0.80)	0.10
Age (per ten years)	1.01 (1.00, 1.02)	<0.01	1.02 (1.01, 1.03)	0.02
Population type				
Local resident	Ref.		Ref.	
Migrant within the province	0.36 (0.28, 0.46)	<0.01	0.45 (0.37, 0.55)	<0.01
Migrant outside the province	0.56 (0.42, 0.74)	<0.01	0.64 (0.51, 0.80)	<0.01
Occupation				
Clerical work	Ref.		Ref.	
Physical work	1.15 (0.63, 2.13)	0.07	1.63 (0.97, 2.75)	0.65
In between jobs	0.92 (0.56, 1.51)	0.39	1.20 (0.79, 1.81)	0.74
Other or unspecified	1.62 (1.02, 2.58)	0.01	1.65 (1.12, 2.44)	0.04
Payment method (without health insurance)	0.64 (0.48, 0.85)	0.04	0.78 (0.62, 0.99)	<0.01
Marital status and companion (contact person)				
Married and accompanied by spouse	Ref.		Ref.	
Married but not accompanied by spouse	0.86 (0.67, 1.10)	0.19	0.87 (0.71, 1.07)	0.22
Unmarried, divorced or widowed	1.42 (1.09, 1.85)	<0.01	1.55 (1.25, 1.93)	0.01

Model 1: logistic model that does not include diseases. Model 2: logistic model that additionally includes all the diseases in *Figure 8*. OR, odds ratio.

events correlated strongly with several systemic diseases, indicating the importance of immunity, systemic condition and nutritional status enhancement in the prevention of vision-related events. HIV infection can lead to a variety of ocular manifestations, such as vascular retinopathy, microaneurysms, and uveitis (40,41). Accordingly, we recommend that patients undergo regular examinations to monitor their ocular condition as well as their general condition, especially migrant patients. Regular examinations can not only promote the early diagnosis of ocular manifestation for better prognosis but also increase patient visits to the hospital and reduce complications

of HIV.

One limitation that should be noted is geographic bias. The permanent residency of patients was unevenly distributed in the early period, which may lead to fluctuations in prevalence in provinces with few migrants. For instance, only a few patients were from provinces far away from Guangdong Province; no patient was from Xizang Province or Taiwan Province. Second, because the participants were inpatients, they could not represent all HIV patients. Compared to the inpatients, the patients who went to the clinics but were not admitted to the hospital were less likely to have a severe condition (42,43).

Table 2 Association between vision-related events and potential factors in HIV-infected patients

Factors	Model 1		Model 2	
	OR (95% CI)	P	OR (95% CI)	P
Hospital admission (per time)	1.08 (1.05, 1.12)	<0.01	1.10 (1.06, 1.15)	<0.01
Duration of hospitalization (per day)	1.01 (1.01, 1.02)	<0.01	1.00 (0.99, 1.01)	0.92
Sex (female)	0.78 (0.60, 1.00)	0.05	0.81 (0.62, 1.07)	0.14
Age (per ten years)	1.02 (1.01, 1.03)	<0.01	1.02 (1.01, 1.03)	<0.01
Population type				
Local resident	Ref.		Ref.	
Migrant within the province	2.46 (1.87, 3.25)	<0.01	2.08 (1.54, 2.80)	<0.01
Migrant outside the province	2.42 (1.79, 3.26)	<0.01	2.03 (1.47, 2.80)	<0.01
Occupation				
Clerical work	Ref.		Ref.	
Physical work	0.91 (0.25, 3.29)	0.89	1.01 (0.21, 4.82)	0.99
In between jobs	1.00 (0.66, 1.51)	1.00	0.99 (0.64, 1.54)	0.98
Other or unspecified	0.83 (0.56, 1.23)	0.35	0.92 (0.60, 1.41)	0.71
Payment method (without health insurance)	0.78 (0.61, 1.00)	0.05	0.68 (0.52, 0.88)	<0.01
Marital status and companion (contact person)				
Married and accompanied by spouse	Ref.		Ref.	
Married but not accompanied by spouse	0.83 (0.66, 1.04)	0.11	0.86 (0.67, 1.09)	0.21
Unmarried, divorced or widowed	0.92 (0.69, 1.23)	0.58	0.91 (0.67, 1.23)	0.53

Model 1: logistic model that does not include diseases. Model 2: logistic model that additionally includes all the diseases in *Figure 8*. OR, odds ratio.

Third, because the patient diagnosis was extracted from the discharge diagnosis, the results could be potentially affected by missing data or failure to capture all the systemic information. Moreover, the study did not involve long-term visual and survival outcomes after the patients were discharged from the hospital.

In conclusion, migrant patients have significantly less access to health insurance and a higher risk of developing severe HIV-related complications conditions. As HIV infection can be effectively controlled by medicine, the coverage of health insurance is critical for the prevention and management of HIV infection. Therefore, although health policy varies in different countries, the government should advance access to health services to optimize the overall outcome of chronic diseases and infectious diseases, including HIV infection. Ophthalmic examination should also be considered as a routine examination, especially in migrant patients, to improve the rate of follow-up visits for

HIV infection.

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by institutional review board of Zhongshan Ophthalmic Center of Sun Yat-sen University (2019KYPJ177), and individual consent for this retrospective analysis was waived.

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