HIV care continuum among newly diagnosed student and non-student youths between 2012 and 2016 in Hangzhou, China

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Abstract

Background: Youths are disproportionally affected by the human immunodeficiency virus (HIV) infection. We aimed to assess anti-retroviral therapy (ART) initiation and viral suppression rates among student and non-student youths in Hangzhou, China.

Methods: Data were taken from the Chinese HIV/acquired immune deficiency syndrome Comprehensive Response Information Management System. Youths aged 15 to 24 years who were newly diagnosed with HIV between 2012 and 2016 and were living in Hangzhou were included in the study. Comparisons between student and non-student youths were made for ART initiation within 30 days, 90 days, and 12 months of HIV diagnosis, and the viral suppression rate at 12 months of HIV diagnosis and at 12 months of ART initiation.

Results: A total of 707 cases met inclusion criteria, 29.6% of which were students and 70.4% were non-student youths. The student group had a higher proportion of ART initiation compared with the non-student group within 30 days of diagnosis (45.5% *vs.* 37.0%, $P = 0.044$), and a slightly higher but not statistically significant proportion at 90 days (67.0% *vs.* 62.7%), and 12 months (83.7% *vs.* 78.5%) of HIV diagnosis. ART initiation within 30 days improved from <15% in 2012 to over 65% in 2016 in both groups, and ART initiation within 90 days improved from <30% in 2012 to >90% in 2016. A smaller proportion of students experienced viral suppression compared with the non-student group (9.6% *vs.* 17.1%, $P = 0.011$) at 12 months after HIV diagnosis, but the suppression rate was similar at 12 months of ART initiation (69.9% *vs.* 71.1%, $P = 0.743$).

Conclusions: ART initiation in both student and non-student youths has significantly improved between 2012 and 2016. However, the viral suppression rate remained unacceptably low at 12 months of HIV diagnosis in both student and non-student groups. Specific intervention strategies must be taken to address this challenge.

Keywords: Human immunodeficiency virus; Antiretroviral therapy; Viral suppression; Student; Non-student; Youths

Introduction

Global human immunodeficiency virus (HIV) infection has disproportionally affected youths aged 15 to 24 years, compared with other segments of the population, particularly in developing countries.[1-4] The World Health Organization estimated that globally, more than 30% of new HIV infections occur among youth.[5] This corresponds to approximately 5 million young people aged 15 to 24 years living with HIV.[5] More so, acquired immune deficiency syndrome (AIDS)-related mortality tripled amongst youth between 2000 and 2015[6] and is now the second leading cause of death among young people globally.[6] Despite innovative medical improvements and global prevention efforts, youth continue to be inordinately vulnerable to HIV. Limited access to comprehensive sexual education and subsequent lack of HIV awareness could influence adolescents' risk-taking behaviors and lead to an increase in new HIV infections.[1-4] Understanding current access to care and treatment from initial HIV diagnosis to viral suppression (the HIV care continuum) and identifying where gaps in coverage may exist is necessary if the global HIV epidemic within youth is to be controlled.

In China, the number of newly reported HIV cases among students has rapidly increased.[7] While the number of HIV infections in students aged less than 15 years has remained relatively stable, with around 210 to 250 cases since 2008,[7] the number of students aged 15 to 24 diagnosed with HIV has increased annually, from 527 cases in 2008 to 2695 in 2014.[7] More so, given that life-long anti-retroviral therapy (ART) and follow-up care are required for HIV infection, youth with HIV in school settings often face different challenges than their non-student counterparts. Despite

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these concerning issues and numbers, little efforts have been made towards designing interventions specifically targeting this group and youth specific policy in China is limited. The objective of this study is to compare the HIV continuum of care of newly diagnosed, HIV infections amongst 15- to 24-year-old from Hangzhou, China in order to highlight where improvements in linkage and retention in HIV care for both students and non-students is needed.

Methods

Ethical approval

This study utilized anonymous data and data from secondary sources which do not contain any personal identifiable information. Therefore, ethical approval was not needed.

Data source

Patients' date of birth, date of HIV diagnosis, occupation, education, gender, route of HIV transmission, $CD4^{+}T$ cell count at diagnosis, and year of diagnosis were downloaded from the Chinese National HIV/AIDS Comprehensive Response Information Management System (CRIMS).[8] The data is anonymous, de-linked, and de-identified from individual information. Only cases aged 15 to 24 years, residing in Hangzhou, China between the years 2012 and 2016 were included. Individual cases were matched to the CRIMS AIDS Follow-up Database[8] using case-card numbers in order to identify $CD4^{+}T$ cell counts at diagnosis. Lastly, selected cases were also matched to the CRIMS AIDS ART Database[8] in order to collect treatment information including length of time on treatment, viral load 1 year after diagnosis, and viral load 1 year after treatment.

Variable definition and statistical analysis

In this study, students were defined as individuals aged 15 to 24 years old who were currently enrolled in school, while non-students were considered those of the same age who were not currently enrolled in school. Continuous variables were transformed to categorical variables. Age was segmented into five brackets by 2-year-intervals. $CD4^{+}T$ cell counts at diagnosis were divided into four grades (<200, 200–349, ≥350 cells/mm^3, and unknown). Education was defined as secondary school or below, high school and college, or above. Gender was either male or female. All cases included in the analysis reported receiving their infection through sexual transmission, so transmission routes were coded as either homosexual or heterosexual only. Diagnosis setting included hospital settings, voluntary counseling and testing (VCT) sites, or other places. The proportion of those initiating ART within 30-days, 90-days, and 12-months after their diagnosis was calculated using the number of patients on ART during the proposed time period divided by the total number diagnosed. This variable was then compared between student and non-student groups. Virological suppression was assumed as a viral load <400 copies/mm^3. Two dimensions of indicators for virological suppression were considered. First, the proportion of virological suppression at 12 months after diagnosis was calculated using the number of patients who achieved virological suppression at 12 months after diagnosis regardless of their ART status divided by the number of diagnosed patients. This indicator measures the viral pool of HIV infected individuals 12 months after their diagnosis, or measures the transfer from infectiousness to non-infectiousness, thus having public health implications. Second, the proportion of virological suppression at 12 months of ART initiation was calculated using the number of patients who achieved virological suppression divided by the number of patients who initiated ART for 12 months. This indicator focuses more on clinical care. Both indicators were then compared between student and non-student groups.

Pearson Chi-square tests were used to compare the statistical difference between students and non-student youths. Fisher exact P-value was used to calculate the P-value for variable categories with less than five participants. SPSS 17.0 software (SPSS Inc., Released 2008, SPSS Statistics for Windows, Version 17.0, Chicago, IL, USA) was used for statistical analysis. A P-value <0.05 was considered as statistically significant.

Results

Basic characteristics at HIV diagnosis

A total of 707 eligible cases were included in our study [Table 1], of which 29.6% were students and 70.4% were non-students. The student group was relatively younger, with 83.3% of cases aged 17 to 22 years, while the non-student group was older, with 82.7% aged 21 to 24 years. Both samples were predominantly male (100% of students and 92.6% of non-students). More than three-fourths of students (89.0%) reported a college education or above, while almost half (49.8%) of non-students reported having the same level of education. The majority (40.2%) of students were diagnosed at VCT sites, while almost half of non-student cases were diagnosed in hospital settings (47.8%). Homosexual transmission was the predominant route of transmission in both groups, with 88.0% and 75.9% of students and non-students, respectively. The number of diagnosed cases in both students and non-students increased each year between 2012 and 2015, before declining in 2016. A third of students had $CD4^{+}T$ cell counts of greater than or equal to 350 cells/mm^3, though 32% of students had unknown $CD4^{+}T$ cell counts. Similar results were seen in the non-student youths, of which 30% had $CD4^{+}T$ cell counts of greater than or equal to 350 cells/mm^3 and 35% reported unknown $CD4^{+}T$ cell counts. To summarize, the majority of participants were older non-students. Homosexual transmission was the main route of HIV transmission amongst all participants, with the number of diagnosed cases increasing in both groups from 2012 to 2015, before falling in the last year.

ART initiation at 30 days, 90 days, and 12 months of diagnosis

As seen in Figure 1, the proportion of youth initiating ART at 30 days of diagnosis improved overall, from 10.6% in 2012 to 68.0% in 2016. This proportion also increased

Table 1: Characteristics of newly diagnosed human immunodeficiency virus cases between students and non-students aged 15 to 24 years in Hangzhou, China, 2012 to 2016.

Variables	Students, *n* (%)	Non-students, *n* (%)	Wald c^2	*P*
Total	209 (29.6)	498 (70.4)		
Age group (years)			135.592	<0.001
15–16	9 (4.3)	9 (1.8)		
17–18	56 (26.8)	42 (8.4)		
19–20	52 (24.9)	35 (7.0)		
21–22	67 (32.1)	155 (31.1)		
23–24	25 (12.0)	257 (51.6)		
Gender			16.386	<0.001
Male	209 (100.0)	461 (92.6)		
Female	0 (0.0)	37 (7.4)		
Education			96.887	<0.001
Secondary school or below	3 (1.4)	83 (16.7)		
High school	20 (9.6)	167 (33.5)		
College or above	186 (89.0)	248 (49.8)		
Settings of HIV diagnosis			6.376	0.041
Hospital settings	82 (39.2)	238 (47.8)		
VCT site	84 (40.2)	153 (30.7)		
Other places	43 (20.6)	107 (21.5)		
HIV transmission route			13.297	<0.001
Heterosexual	25 (12.0)	120 (24.1)		
Homosexual	184 (88.0)	378 (75.9)		
Year of Diagnosis			7.944	0.094
2012	17 (8.1)	58 (11.6)		
2013	29 (13.9)	91 (18.3)		
2014	48 (23.0)	121 (24.3)		
2015	59 (28.2)	134 (26.9)		
2016	56 (26.8)	94 (18.9)		
$CD4^+T$ cell counts at diagnosis				
<200 cells/mm^3	20 (9.6)	64 (12.9)	2.861	0.414
200–349 cells/mm^3	52 (24.9)	109 (21.9)		
≥350 cells/mm^3	70 (33.5)	150 (30.1)		
Unknown	67 (32.1)	175 (35.1)		

HIV: Human immunodeficiency virus; VCT: Voluntary counseling and testing.

from 2012 to 2016 for students and non-students, from 5.9% to 66.1% and 12.1% to 69.1%, respectively. As of 90-day of diagnosis, the proportion improved from 26.6% to 92.0%, 17.6% to 92.9%, and 29.3% to 91.5% for youth overall, students and non-students, respectively. As of 12-months of diagnosis, the proportion initiating ART improved from 45.3% to 97.3%, 41.2% to 98.2%, and 46.6% to 96.8% for youth overall, students and non-students, respectively, between 2012 and 2016. Generally, the number of youth initiating ART therapy within 30-days, 90-days, and 12-months of their HIV diagnosis has increased since 2012 in Hangzhou.

As seen in Table 2, the student group was more likely to initiate ART within 30 days of their HIV diagnosis compared with the non-student group (45.5% *vs*. 37.3%, $P = 0.04$), however these groups were relatively similar at 90 days after their HIV diagnosis (67.0% *vs*. 62.7%, $P = 0.27$) and within 12 months of their diagnosis (83.7% *vs*. 78.5%, $P = 0.11$). Of those initiating treatment within 30 days of diagnosis, more students had a $CD4^+T$ cell count of less than 200 cells/mm^3 (90.0% *vs*. 62.5%, $P < 0.02$). Additionally, more students aged 17 to 18 years or 21 to 22 years initiated ART within 30 days of their HIV diagnosis compared with non-students of the same age groups (48.0% *vs*. 14.3%, $P < 0.001$; 49.3% *vs*. 34.2%, $P = 0.03$, respectively). Lastly, students who initiated ART therapy within 30 days of their HIV diagnosis were more likely to have been diagnosed at a VCT site (50.0% *vs*. 36.6%, $P < 0.05$). To sum, younger students with a lower $CD4^+T$ cell count and diagnosed at a VCT site were more likely to initiate ART therapy within 30 days of their HIV diagnosis.

No statistically significant differences were found amongst the student and non-student participants in regards to initiation of ART therapy at 90 days after diagnosis [Table 2]. However, more students aged 17 to 18 initiated ART within 12 months of their HIV diagnosis (89.3% *vs*. 69.0%, $P < 0.01$) compared with non-students of the same age. Finally, a greater number of students diagnosed in hospital settings were found to have initiated ART within 12 months after their HIV diagnosis (91.5% *vs*. 81.1%, $P = 0.03$). Thus, younger students diagnosed in hospitals

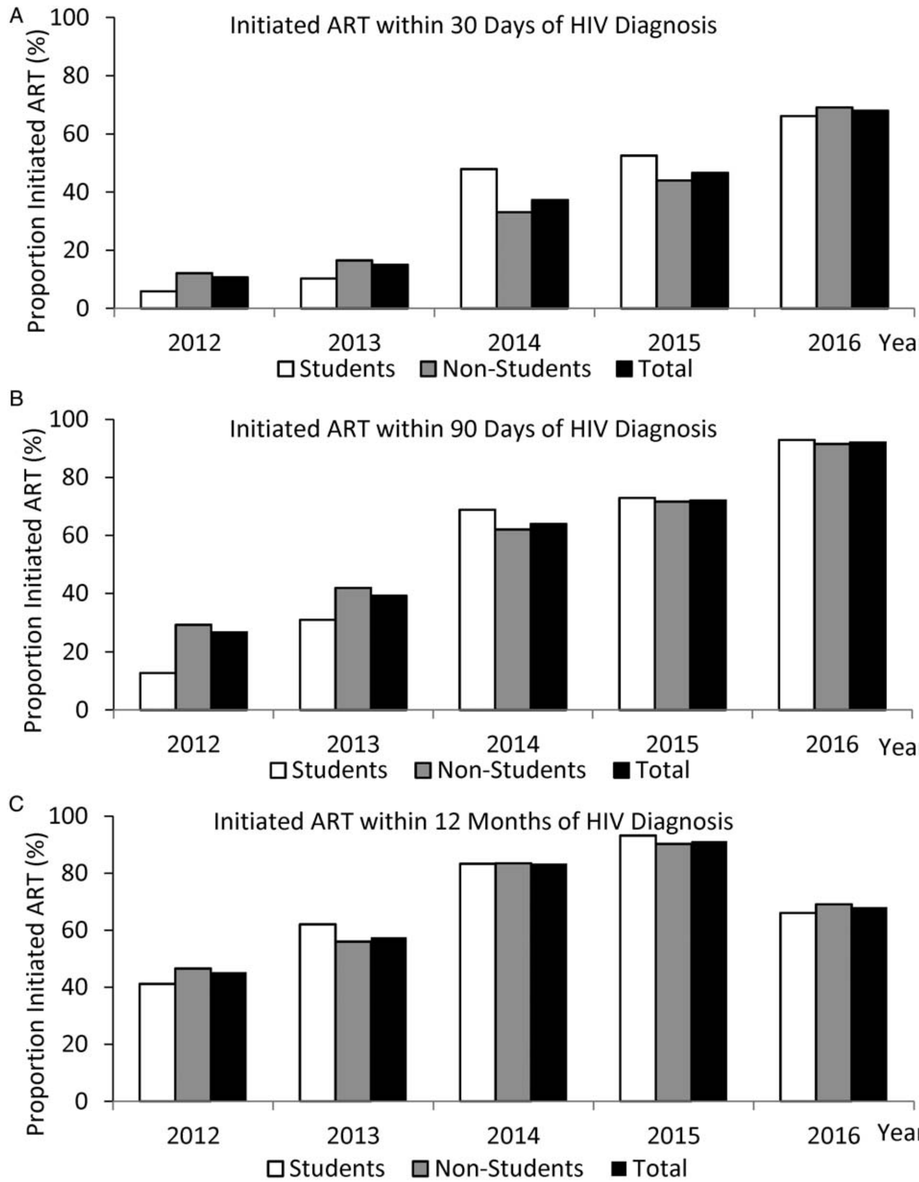

Figure 1: The proportion of students, non-students, and all youths living with HIV in Hangzhou initiating anti-retroviral therapy at 30 days, 90 days, and 12 months after their HIV diagnosis 2012 to 2016. (A) The proportion of students, non-students, and all youths initiating anti-retroviral therapy at 30 days after their HIV diagnosis, 2012 to 2016. In 2012, less than 20% of students, non-students, and all youths initiated ART within 30 days of their HIV diagnosis. However, by 2016, these rates have increased to more than 60% amongst all groups. (B) The proportion of students, non-students, and all youths initiating anti-retroviral therapy at 90 days after their HIV diagnosis, 2012 to 2016. The proportion of students, non-students, and all youths initiating ART within 90 days of their HIV diagnosis has been increasing over time, to more than 80% in 2016. (C) The proportion of students, non-students, and all youths initiating anti-retroviral therapy within 12 months of their HIV diagnosis, 2012 to 2016. The proportion of students, non-students, and all youths initiating ART increased from less than 50% in 2012 to over 90% in 2015. However, the proportion dropped to a little less than 70% in 2016. ART: Anti-retroviral therapy; HIV: Human immunodeficiency virus.

settings were more likely to initiate ART therapy within 12 months of their HIV diagnosis.

Virological suppression at 12-month diagnosis and 12 months of ART initiation

Virological suppression at 12-month diagnosis and at 12 months of ART initiation from 2012 to 2016 are presented in Figure 2. The virological suppression ratios at 12-months diagnosis from 2012 to 2016 fluctuated from 12.7% to 16.6%, 6.8% to 17.6%, and 12.1% to 20.9% for youth overall, students and non-students, respectively. No trend was observed. The virological suppression ratios at 12 months of ART initiation also oscillated between 2012 and 2016, from 64.8% to 73.5%, 55.6% to 85.0%, and 66.9% to 84.2% for youth overall, students and non-students, respectively. No trend was observed. Generally, virological suppression amongst youth in Hangzhou has wavered since 2012.

Table 3 highlights the factors related to viral load suppression amongst students and non-students achieving virological suppression at 12 months of their HIV diagnosis and at 12 months of ART therapy. Fewer students had virological suppression at 12 months after their HIV diagnosis compared with non-students (9.6% *vs.*

Table 2: Initiation of anti-retroviral therapy within 30 days, 90 days, and 12 months of human immunodeficiency virus diagnosis between student and non-student youths aged 15 to 24 years in Hangzhou, China, 2012 to 2016.

Variables	Initiated ART within 30 days of HIV diagnosis, *n*/*N* (%)				Initiated ART within 90 days of HIV diagnosis, *n*/*N* (%)				Initiated ART within 12 months of HIV diagnosis, *n*/*N* (%)			
	Students	Non-students	c^{2*}	*P* value	Students	Non-students	c^{2*}	*P* value	Students	Non-students	c^{2*}	*P* value
Overall	95/209 (45.5)	186/498 (37.3)	4.038	0.044	140/209 (67.0)	312/498 (62.7)	1.200	0.273	175/209 (83.7)	391/498 (78.5)	2.511	0.113
Age group (years)												
15–16	1/9 (11.1)	1/9 (11.1)		1.000	4/9 (44.4)	3/9 (33.3)		1.000	7/9 (77.8)	5/9 (55.6)		0.620
17–18	27/56 (48.2)	6/42 (14.3)	12.370	**<0.001**	38/56 (67.9)	22/42 (52.4)	2.421	0.120	50/56 (89.3)	29/42 (69.0)	6.290	0.012
19–20	21/52 (40.4)	12/35 (34.3)	0.331	0.565	36/52 (69.2)	20/35 (57.1)	1.333	0.248	44/52 (84.6)	27/35 (77.1)	0.778	0.378
21–22	33/67 (49.3)	53/155 (34.2)	4.471	0.034	45/67 (67.2)	95/155 (61.3)	0.693	0.405	56/67 (83.6)	118/155 (76.1)	1.533	0.216
23–24	13/25 (52.0)	114/257 (44.4)	0.538	0.463	17/25 (68.0)	172/257 (66.9)	0.012	0.913	18/25 (72.0)	212/257 (82.5)	1.667	0.197
Gender												
Male	95/209 (45.5)	170/461 (36.9)	4.426	0.035	140/209 (67.0)	290/461 (62.9)	1.041	0.308	175/209 (83.7)	363/461 (78.7)	2.264	0.132
Female	0/0 (0.0)	16/37 (43.2)	–	–	0/0 (0.0)	22/37 (59.5)	–	–	0/0 (0.0)	28/37 (75.7)	–	–
Education												
Secondary school or below	0/3 (0.0)	28/83 (33.7)		0.548	1/3 (33.3)	50/83 (60.2)		0.564	2/3 (66.7)	61/83 (73.5)		1.000
High school	7/20 (35.0)	49/167 (29.3)	0.273	0.602	11/20 (55.0)	96/167 (57.5)	0.045	0.832	16/20 (80.0)	125/167 (74.9)	0.255	0.613
College or above	88/186 (47.3)	109/248 (44.0)	0.484	0.487	128/186 (68.8)	166/248 (46.9)	0.172	0.678	157/186 (84.4)	205/248 (82.7)	0.235	0.628
Settings of HIV diagnosis												
Hospital settings	35/82 (42.7)	88/238 (37.0)	0.840	0.359	61/82 (74.4)	150/238 (63.0)	3.507	0.061	75/82 (91.5)	193/238 (81.1)	4.820	0.028
VCT site	42/84 (50.0)	56/153 (36.6)	4.014	0.046	55/84 (65.5)	100/153 (65.4)	0.000	0.986	68/84 (81.0)	120/153 (78.4)	0.210	0.849
Other places	18/43 (41.9)	42/107 (39.3)	0.087	0.768	24/43 (55.8)	62/107 (70.3)	0.057	0.811	32/43 (74.4)	78/107 (72.9)	0.036	0.647
HIV transmission route												
Heterosexual	7/25 (28.0)	38/120 (31.7)	0.130	0.718	10/25 (40.0)	66/120 (55.0)	1.866	0.172	19/25 (76.0)	91/120 (75.8)	0.000	0.986
Homosexual	88/184 (47.8)	148/378 (39.2)	3.821	0.051	130/184 (70.7)	246/378 (65.1)	1.736	0.188	156/184 (84.8)	300/378 (79.4)	2.373	0.123
Year of diagnosis												
2012	1/17 (5.9)	7/58 (12.1)		0.674	3/17 (17.6)	17/58 (29.3)		0.534	7/17 (41.2)	27/58 (46.6)	0.153	0.695
2013	3/29 (10.3)	15/91 (16.5)		0.557	9/29 (31.0)	38/91 (41.8)	1.061	0.303	18/29 (62.1)	51/91 (56.0)	0.327	0.568
2014	23/48 (47.9)	40/121 (33.1)	3.245	0.720	33/48 (68.8)	75/121 (62.0)	0.682	0.409	40/48 (83.3)	101/121 (83.5)	0.000	0.983
2015	31/59 (52.5)	59/134 (44.0)	1.193	0.275	43/59 (72.9)	96/134 (71.6)	0.031	0.860	55/59 (93.2)	121/134 (90.3)	0.435	0.509
2016	37/56 (66.1)	65/94 (69.1)	0.153	0.696	52/56 (92.9)	86/94 (91.5)	0.089	0.765	55/56 (98.2)	91/94 (96.8)	0.267	0.605
$CD4^+T$ cell counts at diagnosis												
< 200 cells/mm^3	18/20 (90.0)	40/64 (62.5)	5.392	0.020	18/20 (90.0)	57/64 (89.1)	0.014	0.906	20/20 (100.0)	64/64 (100.0)	–	–
200–349 cells/mm^3	33/52 (63.5)	56/109 (51.4)	2.080	0.149	47/52 (90.4)	96/109 (88.1)	0.189	0.663	52/52 (100.0)	109/109 (100.0)	–	–
≥350 cells/mm^3	39/70 (55.7)	75/150 (50.0)	0.624	0.429	62/70 (88.6)	131/150 (87.3)	0.068	0.794	70/70 (100.0)	150/150 (100.0)	–	–
Unknown	5/67 (7.5)	15/175 (8.6)	0.079	0.779	13/67 (19.4)	28/175 (16.0)	0.399	0.528	33/67 (49.3)	68/175 (61.1)	2.154	0.142

* Fisher exact *P* value is used for variable category with less than five participants. ART: Anti-retroviral therapy; HIV: Human immunodeficiency virus; VCT: Voluntary testing and counselling.

17.1%, $P = 0.01$). Students who were in the age group 21 to 22 years (6.0% *vs*. 16.8%, $P = 0.03$), were male (9.6% *vs*. 17.6%), reported at least a college education (9.7% *vs*. 18.5%, $P = 0.01$), reported their HIV infection through homosexual transmission (9.8% *vs*. 19.0%, $P < 0.01$), and a $CD4^+T$ cell count over 350 cells/mm^3 at diagnosis (8.6% *vs*. 24.7%, $P < 0.01$), had significantly lower virological suppression ratio at 12 months after their HIV diagnosis than non-students [Table 3]. The overall virological suppression ratio at 12 months after ART therapy; however, was 69.7% and 73.1% for students and non-students, respectively. There were no statistically significant differences between student and non-student groups who achieved virological suppression at 12 months after ART therapy in any variable categories [Table 3]. To sum, more students were likely to achieve virological suppression 12 months after their ART therapy, rather than at 12 months after their HIV diagnosis.

Discussion

This study highlights the general characteristics of student and non-student HIV infections in Hangzhou, China between 2012 and 2016. As reported in this study, the number of HIV/AIDS cases has steadily increased in the area, which may be due to the high-risk sexual behaviors that these groups tend to engage in. While these particular behaviors were not assessed in this study, other findings have shown that individuals aged between 15 and 24 years old lack sufficient knowledge regarding safe sexual practices and are more likely to engage in risk-taking sexual activity.[9] Additionally, research has found this group to be more vulnerable to HIV infection and transmission.[9] Supplementary to these particular risks, students and non-students in this study identified homosexual transmission as their main route of infection [Table 1]. Men who have sex with men (MSM) continue to be a key population for the spread of HIV in China,[10] with homosexual transmission of HIV increasing from 0.9% in 2003 to 8.0% in 2015.[11-12] A lack of youth appropriate resources coupled with stigma and discrimination often faced by high-risk groups such as MSM could be restricting youth in the region from seeking HIV testing and counseling. As such, though the number of diagnosed cases was found to be increasing since 2012, this may be an underrepresentation of the true number of HIV positive youth cases in Hangzhou. Thus, improved access to

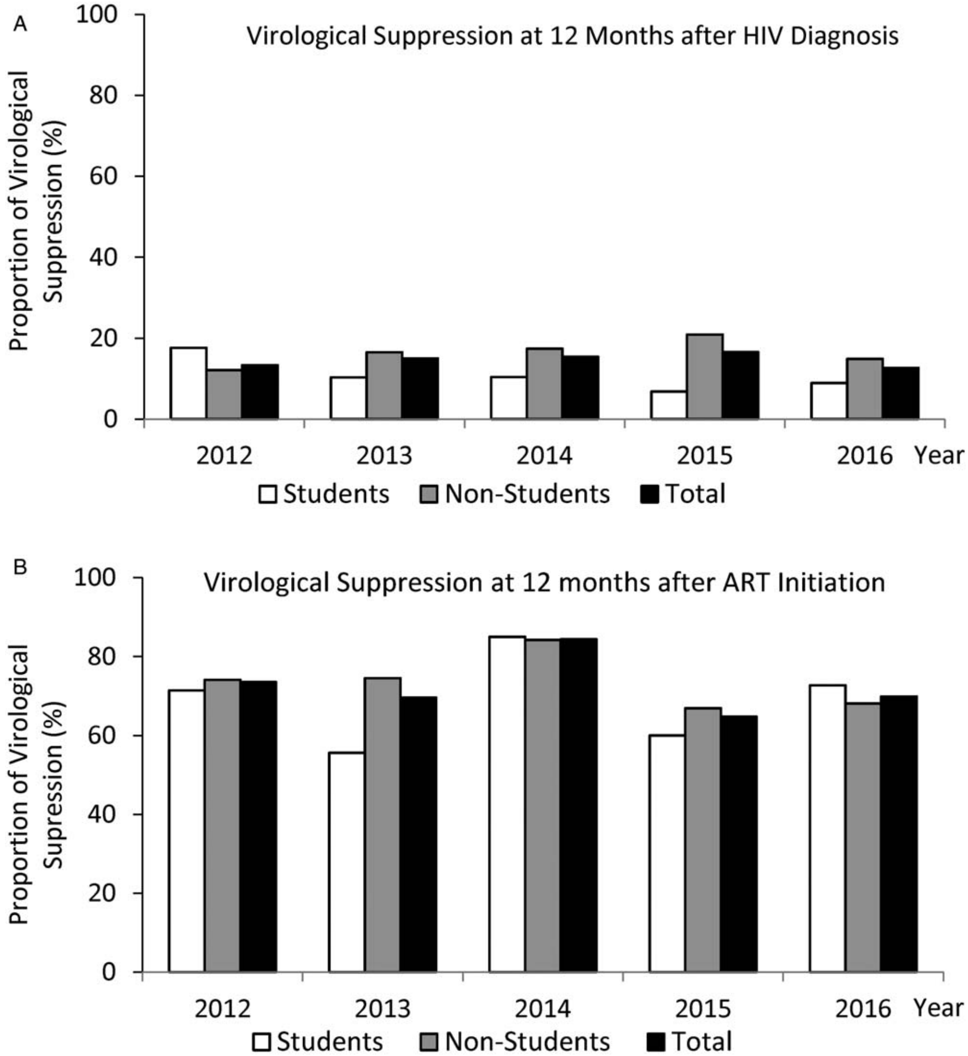

Figure 2: The proportion of students, non-students, and all youths living with HIV in Hangzhou, China who achieved virological suppression at 12 months after their HIV diagnosis and at 12 months after initiation of anti-retroviral therapy, 2012 to 2016. (A) The proportion of students, non-students, and all youths living with HIV who achieved virological suppression at 12 months after their HIV diagnosis, 2012 to 2016. Overall, both students and non-students achieving virological suppression at 12 months after HIV diagnosis were all less than 20% in 2012 to 2016 except non-students reached 20.9% in 2015; (B) The proportion of students, non-students, and all youths living with HIV who achieved virological suppression at 12 months of initiating antiretroviral therapy, 2012 to 2016. The proportions of virological suppression were below 80% in students, non-students, and all youths in 2012 to 2016 except in 2014. HIV: Human immunodeficiency virus.

comprehensive measures is urgently needed to reduce ongoing transmission in this group and contain the further spread of HIV among those aged 15 to 24 years old.

Linking newly diagnosed HIV infections to care is critical to achieving the control of HIV in youth, since earlier viral suppression improves an individual's HIV health outcomes and drastically reduces HIV transmission risk.[13] In our study, we found that the overall number of individuals initiating ART has been increasing since 2012 [Tables 1 and 2]. In particular, we found that more than two-thirds of individuals in the study were likely to initiate ART therapy within 90 days of their HIV diagnosis and approximately 80% were likely to initiate ART therapy within 12 months of their HIV diagnosis [Table 2]. Other observational studies have suggested that approximately 60% of adolescents and young adults link to care within the first year of diagnosis,[14] a rate less than what we reported. This is likely due to the implementation of China's national treatment policy, which since 2012 has supported free treatment for all patients with a $CD4^{+}$T cell count below 500 cells/uL.[15] However, the majority (90%) of students who initiated ART therapy within 30 days of their HIV diagnosis had a $CD4^{+}$T cell count of less than 200 cells/mm^3 [Table 2]. This suggests that while in recent years more youths are being placed on treatment, they may not be doing so until they have further progressed with their disease and have begun to show symptoms. Thus, identifying infected individuals sooner and placing them on ART therapy immediately following their HIV diagnosis should be a key focus in order to reduce the likelihood of negative HIV related outcomes amongst youth.

As seen in this study, less than three-fourths of youth initiate ART within the first 30 days of diagnosis [Figure 2 and Table 2]. Similarly, other studies have indicated that

Table 3: Viral load test and virological suppression at 12 months after human immunodeficiency virus diagnosis and viral load test and virological suppression at 12 months after initiating anti-retroviral therapy among student and non-students aged 15 to 24 years living with HIV in Hangzhou, China, 2012 to 2016.

Variables	Virological suppression at 12 months of HIV diagnosis, *n*/*N* (%)				Virological suppression at 12 months of ART initiation, *n*/*N* (%)			
	Students	Non-students	c^{2*}	*P* value	Students	Non-students	c^{2*}	*P* value
Overall	20/209 (9.6)	85/498 (17.1)	6.546	0.011	122/175 (69.7)	286/391 (73.1)	0.707	0.400
Age group (years)								
15–16	0/9 (0.0)	2/9 (22.2)		0.471	4/7 (57.1)	3/5 (60.0)		1.000
17–18	5/56 (8.9)	7/42 (16.7)	1.337	0.247	27/50 (54.0)	20/29 (69.0)	1.706	0.192
19–20	7/52 (13.5)	6/35 (17.1)	0.223	0.637	38/44 (86.4)	22/27 (81.5)	0.305	0.581
21–22	4/67 (6.0)	26/155 (16.8)	4.672	0.031	40/56 (71.3)	89/118 (75.4)	0.316	0.574
23–24	4/25 (16.0)	44/257 (17.1)	0.020	0.887	13/18 (72.2)	152/212 (71.7)	0.002	0.962
Gender								
Male	20/209 (9.6)	81/461 (17.6)	7.191	0.007	122/175 (69.7)	269/363 (74.1)	1.146	0.284
Female	0/0 (0.0)	4/37 (10.8)	–	–	0/0 (0.0)	17/28 (60.7)	–	–
Education								
Secondary school or below	0/3 (0.0)	11/83 (13.3)		1.000	2/2 (100.0)	40/61 (65.6)		1.000
High school	2/20 (10.0)	28/167 (16.8)	0.607	0.436	9/16 (56.2)	92/125 (73.6)	2.101	0.147
College or above	18/186 (9.7)	46/248 (18.5)	6.653	0.010	111/157 (70.7)	154/205 (75.1)	0.886	0.347
Settings of HIV diagnosis								
Hospital settings	8/82 (9.8)	37/238 (15.5)	1.692	0.193	51/75 (68.0)	137/193 (71.0)	0.230	0.632
VCT site	10/84 (11.9)	31/153 (20.3)	2.647	0.104	49/68 (72.1)	115/153 (75.2)	0.184	0.668
Other places	2/43 (4.7)	17/107 (15.9)		0.100	22/32 (68.8)	59/78 (75.6)	0.555	0.456
HIV transmission route								
Heterosexual	2/25 (8.0)	13/120 (10.8)		1.000	13/19 (68.4)	523/91 (58.2)	0.679	0.410
Homosexual	18/184 (9.8)	72/378 (19.0)	7.899	0.005	109/156 (69.9)	233/300 (77.7)	3.326	0.068
Year of diagnosis								
2012	3/17 (17.6)	7/58 (12.1)		0.686	5/7 (71.4)	20/27 (74.1)		1.000
2013	3/29 (10.3)	15/91 (16.5)		0.557	10/18 (55.6)	38/51 (74.5)	2.258	0.133
2014	5/48 (10.4)	21/121 (17.4)	1.271	0.260	34/40 (85.0)	85/101 (84.2)	0.015	0.901
2015	4/59 (6.8)	28/134 (20.9)	5.901	0.015	33/55 (60.0)	81/121 (66.9)	0.799	0.371
2016	5/56 (8.9)	14/94 (14.9)	1.129	0.283	40/55 (72.7)	62/91 (68.1)	0.344	0.558
$CD4^+T$ cell counts at diagnosis								
< 200 cells/mm^3	3/20 (15.0)	13/64 (20.3)		0.751	15/20 (75.0)	40/64 (62.5)	1.053	0.305
200–349 cells/mm^3	7/52 (13.5)	25/109 (22.9)	1.894	0.159	38/52 (73.1)	83/109 (76.1)	0.178	0.673
≥350 cells/mm^3	6/70 (8.6)	37/150 (24.7)	7.863	0.005	48/70 (68.6)	113/150 (75.3)	1.112	0.292
Unknown	4/67 (6.0)	10/175 (5.7)		1.000	21/33 (63.6)	50/68 (73.5)	1.041	0.307

* Fisher exact *P* value is used for variable category with less than five participants. ART: Anti-retroviral therapy; HIV: Human immunodeficiency virus; VCT: Voluntary testing and counselling.

adolescents and young adults are less likely to be linked to and remain in care compared with older adults with HIV.[16] This is likely due to adolescents still adjusting to their diagnosis, being overwhelmed by the amount of medical information and thus, unsure of how to proceed, or insecurities in engaging with medical providers.[14,17-18] The time between when an adolescent is newly diagnosed with HIV and his or her referral to care has concrete implications for long-term HIV-care engagement. Those that have shorter intervals between HIV test and referral, and then referral to initiation of treatment, are more likely to engage in care and experience a decrease in HIV-related morbidity and mortality.[16,19] Being able to expedite the referral process and improve linkage to care for adolescents requires supporting staff and providers with the appropriate skills and a network of clinics and community organizations that can assist them.[17] More effective and timely one-on-one referrals, as well as follow-up after diagnosis are essential for improving the HIV care continuum for 15- to 24-year-olds. Further steps are needed to reduce this lag time between diagnosis and initiation of therapy if treatment and care for adolescents are to be optimized.

Our study indicated that a large proportion of students and non-student youths were still infectious at 12 months after ART initiation and at 12 months after their HIV diagnosis. Considering that the efficiency of HIV transmission is directly proportional to the viral load in the transmitting individual,[20] this finding is of concern and indicates that on-going transmission in this population is likely. Several studies have documented similar findings, with poor viral suppression rates or poor ART therapy adherence among HIV-infected adolescents,[21] often due to medical, psychological, and logistical barriers.[22] In this study, a larger proportion of non-students achieved viral suppression compared with the student group. For students, barriers related to living in a collective environment such as student dorms, worries about privacy, lack of family care, and economic hardship may attribute to deteriorating adherence to ART therapy.[23] Additionally, medical barriers such as a difficult ART regimen, absence of symptoms, and side effects of medication; logistical barriers including travel and inconsistent routine; and psychological barriers including depression/anxiety, perceived stigma, and lack of support, all serve as potential barriers to adherence of ART therapy in youth.[24] While there is no simple solution to improve adherence among youth, simplifying treatment regimens, using directly observed therapy, and using mobile phones to send treatment reminders have shown promise in improving adherence amongst this group.[24] Additionally, providing targeted counseling and support to this vulnerable population, particularly youth identifying as MSM, can aid in the reduction of stigma and foster a healthier environment for these individuals.

A few limitations to the study exist. First, selection bias may exist as Hangzhou-specific cases were selected from a national record system. Additionally, no follow-up information of these cases was collected. Thus, the findings of this study may not be generalizable to other youth throughout China who experience different availability of services and testing uptake. Second, data on medical resistance to ART and its impact on adherence were not collected, and as such, differences between student cases and non-student cases could not be fully interpreted. Further, follow up studies should be conducted to identify what factors may be influencing these groups' decisions towards initiating and adhering to ART regimens. However, this study is important, as it is one of the first attempts to estimate the HIV cascade of care among young people in Hangzhou.

In conclusion, an increasing number of 15- to 24-year-olds were infected with HIV in Hangzhou between 2012 and 2016. While improvements in treatment access and viral suppression have been made, actions to improve diagnosis and linkage to care still need to be taken. The main differences in the continuum of care between student and non-students infected with HIV were found to be in their linkage to treatment and viral suppression at 12 months after diagnosis. In order to improve the continuum of care among 15 to 24 years old, expediting quicker linkage to care for non-students and providing quality retention in care for students is necessary.

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Conflicts of interest

None.

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