High Prevalence of Sexually Transmitted Infections and Risk Factors Among HIV-Positive Individuals in Yunnan, China

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Abstract

Background

Yunnan has the highest rates of HIV in the country. Other treatable sexually transmitted infections (STIs) are associated with accelerated HIV transmission and poor ART outcomes, but are only diagnosed by syndromic algorithms.

Methods

We recruited 406 HIV-positive participants for a cross-sectional study (204 ART-naive and 202 ART). Blood samples and first-voided urine samples were collected. Real-time polymerase chain reaction methods were used for *Chlamydia trachomatis* (CT), *Neisseria gonorrhoeae* (NG) and *Mycoplasma genitalium* (MG). Syphilis and HSV-2 tests were also performed.

Results

Among 406 participants, the overall prevalence of STI was 47.0% and 45.1% in ART-naive individuals and 49.0% in ART individuals, respectively. Testing frequency was 11.6% (11.8% vs 11.4%), 33.2% (29.4% vs 37.1%), 3.2% (3.4% vs 3.0%), 2.0% (3.4% vs 0.5%) and 4.7% (6.4% vs 3.0%) for active syphilis, HSV-2, *chlamydia*, *gonorrhoeae* and *genitalium*. Percentage of multiple infections in both groups was 10.8% (22/204) in ART-naive participants and 9.9% (20/202) in ART participants. Females, age between 18 to 35 years, ever injected drugs, homosexual or bisexual, HIV/HBV coinfection, and not receiving ART were identified as risk factors. Self-reported asymptom was not eliminating of having a laboratory-diagnosed STI.

Conclusions

STI prevalence was 47.0% (45.1% vs 49.0%), HSV-2, syphilis and MG were the most common STIs in HIV-infected individuals. We found high prevalence (6.4%) of Mycoplasma genitalium in ART-naive individuals. ART can reduce the diversity of STI-HIV coinfection but not the prevalence. HIV-positive individuals tend to neglect or maybe hide their genital tract discomfort, thus we suggest strengthening STI joint screening and treatment services among HIV-infected individuals whether they describe genital tract discomfort or not.

Introduction

Sexually transmitted infections (STI) present an ongoing and persistent global public health challenge. The latest World Health Organization (WHO) estimates that among people aged between 15 and 49 years there are 374.3 million new curable cases of STI every year of either *Chlamydia trachomatis* (CT), *Neisseria gonorrhoeae* (NG), *Trichomonas vaginalis* (TV), or syphilis [1]. This means STIs are responsible for more than one million new infections per day [1]. Evidence shows that genital ulcers caused by STI are an important clinical manifestation, which can increase the risk of human immunodeficiency virus type 1 (HIV-1) acquisition and replication [2].

The synergistic effect between STI and HIV can destroy the health of HIV-infected individuals in various ways. Firstly, some STIs generally destroy mucosal barriers, induce genital inflammation and ulceration, increase viral shedding of HIV in the genital tract, increase the scale of susceptible immune cells (e.g, $CD4^+$ T cells, and dendritic cells (DCs)) in the genital tract, which may facilitate HIV transmission to the sex partners by the increase of HIV target cells [3–5].

Secondly, STIs also can restrain the immune responses of the skin-resident DCs and create a microenvironment conducive to HIV infection in the host; STI not only helps itself but creates a "yellow brick road" for HIV-1, which transmit mostly through the sexual route [6, 7]. Thirdly, STI-HIV coinfection usually can reduce the $CD4^+$ T cell count and enhance HIV viral load in blood plasma and genital secretions, which might decrease the effectiveness of antiretroviral therapy (ART) [8, 9]. Finally, STI-HIV coinfection is significantly associated with persistent immune activation and poorer $CD4^+$ T cell recovery [10]. HIV can also accelerate the progression of other STIs. When the immune function is compromised, STI-HIV coinfection is more difficult to treat and may prolong the course of the disease [11].

Yunnan province is the earliest epidemic of AIDS in China and the most heavily affected area, there exists the largest number of HIV-Positive Individuals. Along with the rapid development of the economy, HIV has developed from high-risk groups to the general population, sexual transmission has now replaced unsafe intravenous drug use (IDU) as the dominant route of HIV transmission in China [12]. Epidemiological studies show that STIs are a public health problem in this area. Among miners in Yunnan province, the prevalence of CT, NG, syphilis and HSV-2 has been reported to be 4.8%, 0.8%, 1.8% and 9.6%, respectively [13]. Whereas among female sex workers involved in high-risk sexual behavior the prevalence of CT, NG, syphilis, HSV-2 and TV was 25.9%, 8.3%, 7.5%, 68.1% and 10.6%, respectively [14]. STIs such as CT, MG, syphilis and TV cause asymptomatic disease [15–18]. Hence, it is difficult to screening and treats asymptomatic STIs, which also can induce genital inflammation and facilitate HIV transmission. Since HIV and STIs own almost the same routes of transmission and risk behaviors, we should make a strategy to control the spread of these infections combining with HIV. However, limited researches have been managed to determine the prevalence and risk factors of STI-HIV coinfection among HIV-positive participants in Yunnan, China. This study aimed to evaluate the prevalence of coinfection of STIs (syphilis, herpes progenitalis, *chlamydia*, *gonorrhea* and *genitalium*) and the risk factors of coinfection among HIV-positive participants in Yunnan province. Our research results might be helpful to improve STIs screening and treatment services and reduce the risk of HIV acquisition and transmission.

Methods

Study population

The cross-sectional study was conducted from September 2020 to June 2021 and included ART-naive and ART HIV-Positive participants living in Yunnan, China. A total of 406 HIV-positive participants (204 cases of ART-naive group and 202 cases of ART group) were recruited. Demographic data including age, sex, nation, occupation, region, current marital status, education status, ever injected drugs, sexual orientation, number of sexual partners, condom use, HBV, HCV, blood routine, blood biochemistry, latest $CD4^+$ T cell count and ART were collected from the database of outpatient service system and questionnaire survey in Yunnan AIDS Care Center.

Data Collection and STI detection

Trained interviewers managed a face-to-face interview with each participant using a structured questionnaire. Measures included demographic characteristics, drugs use, sexual behaviors, and so on. Laboratory technicians collected approximately 5 ml of venous blood using an anticoagulant tube, which was centrifuged immediately for 15 minutes to separate the serum. Finally, participants provided a first-void urine specimen for the examination of *Chlamydia trachomatis* (CT), *Neisseria gonorrhoeae* (NG), and *Mycoplasma genitalium* (MG).

Serum samples were tested for syphilis using the Treponema pallidum particle agglutination (TPPA, FUJIREBIO Inc, Japan) and the toluidine red unheated serum test (TRUST, Shanghai Rongsheng Biotech Co. Ltd, China). Active syphilis-positive individuals were defined as those who were positive for both TPPA and TRUST. Serum samples were tested for herpes simplex virus type 2 (HSV-2) immunoglobulin (IgG) antibodies using the HSV-2 IgG enzyme-linked immunoassay

kit HerpesSelect 2 ELISA IgG (ACON Biotech Co. Ltd, China). First-void urine was collected from the participants for the detection of CT, NG and MG by polymerase chain reaction (PCR) using CT RNA PCR kit, NG RNA PCR kit, and MG RNA PCR kit (Shanghai Rendu Biotech Co. Ltd, China). If any test appeared positive, the participants would be notified and received treatment.

Statistical analyses

The chi-squared test or Fisher's exact test for categorical variables and *t* test for continuous variables were used to analyze differences of demographic characteristics and selected variables between the ART-naive group and ART group. Odds ratio (OR) and their 95% confidence intervals (CI) were calculated by using logistic regression analyses to evaluate the association between STI-HIV coinfection and its related factors with age, sex, nation, occupation, region, current marital status, education status, sexual orientation, ever injected drugs, number of sexual partners, condom use, HBV, HCV, CD4 latest and ART. All the statistics were performed by SPSS 19 software (IBM Company, New York, USA).

Results

Characteristics of participants

A total of 406 HIV-infected participants agreed to participate in the study, among which, 204 cases (50.25%) were ART-naive participants and 202 cases (49.75%) were ART participants. The characteristics between ART-naive participants and ART participants were summarized in Table 1. Compared to ART participants, ART-naive participants had a significantly higher unemployment rate (16.2% versus 4%) and were more likely to be unmarried or single (68.1% versus 51%). A higher proportion of ever-injected drugs in ART participants (14.9%) than ART-naive participants (5.9%). Regarding sexual behaviors, a total of 63 (30.9%) ART-naive participants with multiple sexual partners compared to 2 (1%) ART participants in the past year. The mean of sexual partners in the former were 3.2 (± 0.2) compared to the latter 1 (± 0.3). A higher proportion of never-used condoms in ART participants (12.7%) than ART-naive participants (0%).

The average count of $CD4^{+}T$ cells in ART-naive participants was significantly lower than ART participants (mean: 321 cells/μl versus 807 cells/μl). Similarly, the average count of Total T lymphocytes was lower on ART-naive participants compared with ART participants (mean: 1464 cells/μl versus 1890 cells/μl). Therefore, CD4/CD8 also became lower on ART-naive participants (0.4 versus 0.9). Compared with ART-naive participants, ART participants had a higher average count of white cells, percentage of lymphocytes, lymphocyte count, platelet and triglyceride, but a lower average count of erythrocyte and trioxypurine (Fig 1). In addition, the age, sex, nation, region, education, sexual orientation and other data between ART-naive and ART groups had no statistical difference ($p > 0.05$).

Coinfections and multiple infections in ART-naive and ART participants

The prevalence of syphilis, herpes progenitalis,*chlamydia*,*gonorrhea* and *genitalium* among the participants was 19.9% (ART-naive: 19.6% and ART: 20.3%), 33.2% (ART-naive: 29.4% and ART: 37.1%), 3.2% (ART-naive: 3.4% and ART: 3.0%), 2.0% (ART-naive: 3.4% and ART: 0.5%), 4.7% (ART-naive: 6.4% and ART: 3.0%) (Table 2). Percentage of coinfections and multiple infections in both groups was 10.8% (22/204) in ART-naive participants and 9.9% (20/202) in ART participants.

For the ART-naive participants, the coinfection rate by decreasing order of prevalence was 54.5% (12/22) for TP-HSV-2, 9.1% (2/22) for CT-HSV-2 and 9.1% (2/22) for TP-MG-HSV-2, and 4.5% (1/22) for MG-HSV-2, TP-NG, CT-NG, MG-NG, MG-TP, and for CT-NG-MG-HSV-2. The group of ART participants had a lower diversity of STIs. Coinfections by decreasing order of prevalence were 75.0% (15/20) for TP-HSV-2, 10.0% (2/20) for MG-HSV-2, 5% (1/20) for TP-NG, TP-NG-MG and TP-MG-HSV-2 (Fig 2).

Factors associated with STI-HIV coinfection

All of the items between STI-HIV coinfection groups were included in the logistic regression model (Table 3). For all participants, logistic regression analyses revealed that females were significantly associated with STI-HIV coinfection risk (OR = 3.46, 95%CI: 1.95-6.15, $p < 0.001$). In further stratification analysis of ART-naive and ART groups, Female also showed consistent significant associations with STI-HIV coinfection risk (OR = 3.89, 95% CI: 1.59-9.50, $p = 0.003$ versus OR = 4.21, 95% CI: 1.84-9.61, $p = 0.001$).

The identification of risk factors for each STI was determined by logistic regression model. In the logistic regression analysis, all variables were adjusted, the following variables remained in the model as risk factors: age > 36 years (OR = 0.33, 95% CI: 0.13-0.87, $p = 0.024$) reduced the risk of TP-HIV coinfection. Age > 36 years (OR = 2.24, 95%CI: 1.20-4.20, $P = 0.012$) and female (OR = 3.47, 95% CI: 1.95-6.16, $p < 0.001$) significantly increased the risk of HIV-HSV-2 coinfection. Ever injected drugs (OR = 171.00, 95%CI: 13.80-2133.40, $P < 0.001$) and female (OR = 9.60, 95%CI: 1.46-63.06, $P = 0.019$) were much associated with CT-HIV coinfection risk. Coinfection with HBV (OR = 100.50, 95% CI: 4.70-2168.70, $p = 0.003$) increased the risk of NG-HIV coinfection, however, received antiretroviral therapy (OR = 0.03, 95% CI: 0.001 - 0.75, $p = 0.032$) became a protective factor of NG-HIV coinfection. We also found Homosexual or Bisexual (OR = 5.12, 95% CI: 1.13-23.26, $p = 0.034$) was significantly associated with an increase of MG-HIV coinfection. The logistic regression analysis showed the following variables as risk factors for each STI coinfection among participants with ART-naive status: homosexual or bisexual (OR = 3.99, 95%CI:1.02-15.61, $p = 0.047$) for TP-HIV coinfection, female (OR = 3.03, 95% CI: 1.26-7.26, $p = 0.013$) for HIV-HSV-2 coinfection, ever-injected drugs (OR = 68.60, 95% CI: 1.60-2880.00, $p = 0.027$) and female (OR = 22.69, 95% CI: 1.10-448.20, $p = 0.040$) for CT-HIV coinfection, age > 36 years (OR = 0.05, 95% CI: 0.003-0.77, $p = 0.032$) and coinfection with HBV (OR = 81.84, 95% CI: 5.80-1159.50, $p = 0.001$) for NG-HIV (Fig 3).

Discussion

This is the first research of STI prevalence included large amounts of new HIV-infected people and detected by blood samples and first-voided urine samples in Yunnan, China. In the present study, a rather high STI prevalence among HIV-positive individuals was confirmed, namely, 47.0% (191/406) in total,45.1% (91/204) in ART-naive individuals and 49.0% (99/202) in ART individuals. This prevalence is much higher than the 5.3% observed in the HIV-positive individuals in Nepal [19], the 11.1% detected in the women living with HIV/AIDS (WLHA) in Uganda [20] and the 23.5% of HIV-infected MSM in China [21], but the prevalence was less than the 60.6% of female sex workers in Peru [22] and the 60.5% of HIV-infected Women in Zimbabwe [23]. The prevalence of genital tract discomfort was 0.5% (2/406),which was rather lower than the STI prevalence. It was interesting to find that HIV-positive individuals tend to neglect or maybe hide their genital tract discomfort. However, our health policy was that no symptom means no screening, those reason may contribute to the high prevalence of STIs. In this study, We found that the overall prevalence of STIs among ART individuals was slightly higher than among ART-naive individuals, although the difference was not statistically significant. This may be associated with the high prevalence of HSV-2/HIV coinfection, 29.4% (60/204) in the ART-naive group versus 37.1% (75/202) in the ART group. In HIV-positive individuals, genital herpes tends to recurrently attack, some individuals even show asymptomatic [24], without intervention, HSV-2 infection will be persisted, accumulated, and transmitted in the people living with HIV/AIDS. However, the ART-naive group had a higher diversity of STIs, coinfections and more sexual partners, and the prevalence of CT, NG and MG was also higher in this study, we believe that ART-naive individuals may face greater threats of STIs and keep in a more dangerous situation.

HSV-2 was the most common STI detected, with an overall prevalence of 33.2% (135/406) for HIV-positive individuals in this study. The prevalence of HSV-2/HIV coinfection was much higher than the 6%-13% observed in non-injecting drug users [25], but the prevalence was less than the 48.6% of HIV-positive men who have sex with men (MSM)

in Shenyang [26]. Active syphilis was also the familiar STI observed, with the prevalence of 11.8% (24/204) for the ART-naive group and 11.4% (23/202) for the ART group. The result is similar to the 11.3% detected in HIV-positive MSM in Zhejiang province [27], however, the prevalence of active syphilis detected in our study was lesser than the 34.3% of HIV-Positive MSM in Shenyang and 82.9% of HIV-Positive MSM in the United States [26, 28]. HSV-2 and TP can induce genital ulceration, which plays an important role in facilitating the acquisition and transmission of HIV and other STIs.Evidence shows that 60.7% of HSV-2, 3.9% of TP could be detected in ulcer specimens, and 68% of HSV-positive participants were coinfected with HIV in South Africa [29]. Moreover,among genital ulcer disease people, the positivity rate of HSV,TP and HIV was 38.5%,16.0% and 52.2% in Zimbabwe [30].

The prevalence of CT detected in the two groups of participants (3.4% vs 3.0%) was larger than the 0.9% identified in WLHA [20], while it was smaller than the 11.1% of MSM in Port-au-Prince [31]. The prevalence of NG identified in our study (3.4% vs 0.5%) was lower than the 5.4% observed in WLHA [20] and the 7.2% of HIV-positive MSM in Birmingham [32].

Very few researches of *M. genitalium* prevalence are assessed and generally associated with specific groups of women [33]. Our study provides the first report of MG prevalence among ART-naive individuals in Yunnan. We identified a prevalence of 6.4% (13/204) of MG infection in ART-naive participants. This prevalence was higher than the 2.4% detected in the HIV-infected women in Brazil [34], but the prevalence was lower than the 10.5% of HIV-Positive women in Zimbabwean [35]. However, more and more evidence shows an association between MG and HIV infection. The report shows that the prevalence of MG was comparable to that for CT, NG and HSV among HIV-positive men and MG infection may associate with HIV shedding in the genital tract [35]. MG infection was 21.4% among HIV-infected pregnant women and was associated with higher plasma HIV levels [36]. This finding was notable that the prevalence of MG infection in ART-naive participants was 6.4%, which was higher than CT or NG infection in the two groups. Therefore, we need further researches to understand MG infection in the HIV-positive population in Yunnan province.

We found that ART-naive individuals had a higher unemployment rate, unmarried rate, more sexual partners per year and less use of condoms compared to ART individuals. Unemployment and low income make marry become impractical in China and individuals are more likely to proceed with unprotected sexual behavior for economic gains. However, ART individuals had recognized their condition and more convenient to access STI preventative information. Our result shows that the proportion of ever-injected drugs in the ART-naive group was lower than in another group because the sexual transmission has become the dominant route of HIV transmission, with the government's strict control of drugs, intravenous drug users will be rare. The average count of $CD4^+$ T cells, total T lymphocytes, CD4/CD8, lymphocyte count and percentage of lymphocytes in ART-naive participants were significantly lower than ART participants. In China, the enrolment criteria for ART changed that individuals should receive ART once diagnosed as HIV-positive from 2015. ART can restrain the replication of HIV-1 and gradual recovery of $CD4^+$ T-cell counts [37]. We found the significant promotion of $CD4^+$ T cells and lymphocytes in the ART group. ART participants had a higher average count of white cell, platelet and triglyceride, but a lower average count of erythrocyte and trioxypurine. Lipid abnormalities and metabolic complications associated with ART maybe can explain it [38, 39].

Our findings revealed that females were more likely to have one of the curable STIs (CT, NG, MG, HSV-2 or active syphilis), no matter in the ART-naive group or ART group. Two variables of female and ever-injected drugs showed a significant association with CT-HIV coinfection. Similarly, females and ages >36 years showed association with HSV-2/HIV coinfection. Homosexual or bisexual was associated with a significantly increased MG-HIV coinfection risk. However, age between 18 to 35 years becomes a risk factor in TP-HIV or NG-HIV coinfection. Other risk factors of TP-HIV coinfection were Homosexual or bisexual and NG-HIV coinfection was HIV/HBV coinfection. Participants receiving ART were less likely to have NG-HIV coinfection compared with those not receiving ART. In conclusion, risk factors

associated with sexually transmitted infections among HIV-positive individuals were female, age between 18 to 35 years, ever-injected drugs, homosexual or bisexual, HIV/HBV coinfection, and not receiving ART.

Our results on STI-HIV coinfection have important implications for improving STIs screening and treatment services among HIV-positive individuals. Evidence shows that many STIs were asymptomatic.The prevalence of syphilis was 13.5%, among them, 91.3% were asymptomatic among women in China. Most of the anorectal (93.3%) and urethral (79.2%) MG infections were asymptomatic among MSM in western Sydney [15]. A Nigerian study shows that over 95% of STI cases were asymptomatic among MSM [40]. In Yunnan, we found that some hospitals and clinics may not screen other STIs when found a new HIV-positive case, especially in resource-poor settings and rural areas, unless having obvious symptoms. Therefore, strategies to screening all HIV-positive individuals for HSV-2, syphilis, and MG, and so on would be necessary. Untreated STIs may facilitate HIV acquisition and transmission and reduce the effectiveness of antiviral therapy.

There are several limitations to the research. This was a cross-sectional study and the participants were not random. Our collected information might have been compromised by recall bias and social desirability bias as sexual behavior is private information to participants.

Conclusions

In conclusion, we identified a high prevalence of STIs among ART-naive and ART HIV-positive individuals in Yunnan. HSV-2, syphilis and MG were the most common STIs in HIV-positive individuals.HSV-2 infection will be recurred, persisted and accumulated that cannot be stoped by ART. The prevalence of MG was high in ART-naive participant and the further researches are needed to understand this association. We suggest strengthening STIs joint screening and treatment services among every HIV-positive individual whether experienced ART or not, especially in resource-poor settings and rural areas. Females, age between 18 to 35 years, ever-injected drugs, homosexual or bisexual, HIV/HBV coinfection and not receiving ART were identified as risk factors. Younger patients, women, ever-injected drugs, homosexual or bisexual, coinfection with HBV and not receiving ART should be a focus for interventions to decrease STIs.

Declarations

Ethics approval and consent to participate

This study was approved by the review board of Yunnan Provincial Hospital of Infectious Diseases, and written informed consent was obtained from the study participants. All experiments were performed in accordance with the approved guidelines and regulations according to the principles expressed in the Declaration of Helsinki, and the experimental protocols were approved by the institutional review board.

Consent for publication

N/A

Availability of data and materials

The majority of datasets used and/or analyzed during the current study are available from the indicated published resources. The remaining data, including model code, are available from the corresponding author on reasonable request.

Competing interests

The authors declare no conflict of interest.

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Authors' contributions

L.L., Y.Y.L. and Y.Q.K. conceived and designed the study. W.T., R.H.X., X.Q.D. and D.Z. contributed to experiment conduction and data acquisition. W.T., Y.L.M., W.Y.Z. and Y.Q.K. analyzed and interpreted the data. W.T. and Y.Q.K. drafted the manuscript. L.L., Y.Y.L. and Y.Q.K. contributed to the critical revision of the manuscript for important intellectual content. Y.Y.L. and L.L. obtained funding. All authors read and approved the final version of the manuscript for publication.

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Tables

Table 1. Characteristics of ART-naive and ART HIV^{+} participants

Characteristics	ART-naive (n = 204)	ART (n = 202)	*p* value
	n (%)	n (%)	
General			
Age, years, median (range)	37 (18-86)	39.5 (23-69)	
18-35	93 (45.6)	74 (36.6)	
≥36	111 (54.4)	128 (63.4)	0.067
Sex			
Male	167 (81.9)	158 (78.2)	
Female	37 (18.1)	44 (21.8)	0.358
Nation			
Ethnic Han	171 (83.8)	179 (88.6)	
Other	33 (16.2)	23 (11.4)	0.162
Occupation			
Employee	121 (59.3)	115 (56.9)	
None	33 (16.2)	8 (4.0)	
Unknown	50 (24.5)	79 (39.1)	0.001
Region			
Yunnan	192 (94.1)	194 (96.0)	
Other province	12 (5.9)	8 (4.0)	0.371
Current marital status			
Married	65 (31.9)	99 (49.0)	
Unmarried or single	139 (68.1)	103 (51.0)	<0.001
Education			
Up to primary	120 (58.8)	114 (56.4)	
Above primary	84 (41.2)	88 (43.6)	0.626
Sexual orientation			
Heterosexual	125 (61.3)	135 (66.8)	
Homosexual/Bisexual	79 (38.7)	67 (33.2)	0.243
Ever injected drugs			
Yes	12 (5.9)	30 (14.9)	
No	192 (94.1)	172 (85.1)	0.003
No.of sexual partners			
Single	58 (28.4)	53 (26.2)	

Multiple	63 (30.9)	2 (1.0)	
Unknown	83 (40.7)	147 (72.8)	<0.001
Condom use			
Consistent/Casual	121 (59.3)	79 (39.1)	
Never	26 (12.7)	0 (0.0)	
Unknown	57 (28.0)	123 (60.9)	<0.001
Genital tract discomfort			
Yes	2 (1.0)	0 (0)	
No or unanswered	202 (99.0)	202 (100.0)	0.483
CD4, median (range)	273 (1-1148)	731 (551-2200)	
Normal	28 (13.7)	202 (100.0)	
Down	176 (86.3)	0 (0.0)	<0.001
CD4/CD8, median (range)	0.25 (0.02-3.19)	0.88 (0.30-6.75)	
Normal	16 (7.8)	135 (66.8)	
Down	160 (78.4)	65 (32.2)	<0.001
total T lymphocytes, median (range)	1314 (112-5416)	1815 (923-3840)	
Normal	111 (54.4)	180 (89.1)	
Down	39 (19.1)	1 (0.5)	<0.001

P values were based on the chi-square test (or Fisher exact test) for categorical variables.

The statistical significance was indicated as *p < 0.05, and **p < 0.001.

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Table 2. Prevalence of Sexually Transmitted Infections among HIV^+ Participants.

Variable	Total (n = 406)	ART-naïve (n = 204)	ART (n = 202)
	Case number (%)	Case number (%)	Case number (%)
Syphilis			
TPPA +	81 (19.9)	40 (19.6)	41 (20.3)
TPPA + TRUST +	47 (11.6)	24 (11.8)	23 (11.4)
HSV-2 IgG +	135 (33.2)	60 (29.4)	75 (37.1)
Neisseria gonorrhoeae	8 (2.0)	7 (3.4)	1 (0.5)
Chlamydia trachomatis	13 (3.2)	7 (3.4)	6 (3.0)
Mycoplasma genitalium	19 (4.7)	13 (6.4)	6 (3.0)
STI	191 (47.0)	92 (45.1)	99 (49.0)

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Table 3. Logistic regression analyses of related factors Associated with Curable STI-HIV coinfection among HIV^+ participants.

Variable	STI-HIV co-infection rate, (N = 406),n (%)			STI-HIV co-infection rate on ART-naive, (N = 204),n (%)			STI-HIV co-infection rate on ART,(N = 202),n (%)		
	n/N (%)	OR (95% CI)	*P value*	n/N (%)	OR (95% CI)	*P value*	n/N (%)	OR (95%CI)	*P value*
Age,years									
18-35	72/167 (43.1)	ref		37/93 (39.8)	ref		35/74 (47.3)	ref	
≥36	119/239 (49.8)	1.24 (0.70-2.19)	0.461	55/111 (49.5)	1.12 (0.48-2.60)	0.791	64/128 (50.0)	1.08 (0.45-2.62)	0.858
Sex									
Male	136/325 (41.8)	ref		66/167 (39.5)	ref		70/158 (44.3)	ref	
Female	55/81 (67.9)	3.46 (1.95-6.15)	<0.001	26/37 (70.3)	3.89 (1.59-9.50)	0.003	29/44 (65.9)	4.21 (1.84-9.61)	0.001
Nation									
Ethnic Han	168/350 (48.0)	ref		79/171 (46.2)	ref		89/179 (49.7)	ref	
Other	23/56 (41.1)	0.66 (0.36-1.22)	0.186	13/33 (39.4)	0.60 (0.25-1.42)	0.245	10/23 (43.5)	0.61 (0.23-1.62)	0.324
Occupation									
Employee	110/236 (46.6)	ref		52/121 (42.9)	ref		58/115 (50.4)	ref	
None	21/41 (51.2)	1.26 (0.61-2.59)	0.528	16/33 (48.5)	1.06 (0.44-2.54)	0.896	5/8 (62.5)	2.70 (0.56-13.05)	0.216
Others	60/129 (46.5)	0.89 (0.55-1.42)	0.614	24/50 (48.0)	0.94 (0.44-2.01)	0.880	36/79 (45.6)	1.01 (0.52-1.99)	0.966
Region									
Other province	10/20 (50.0)	ref		5/12 (41.7)	ref		5/8 (62.5)	ref	
Yunnan	181/386 (46.9)	1.08 (0.43-2.73)	0.864	87/192 (45.3)	1.13 (0.31-4.21)	0.853	94/194 (48.4)	0.92 (0.21-4.09)	0.916
Current marital status									
Married	75/164 (45.7)	ref		30/65 (46.2)	ref		45/99 (45.4)	ref	
Unmarried/single	116/242 (47.9)	1.31 (0.79-2.18)	0.304	62/139 (44.6)	1.06 (0.49-2.26)	0.884	54/103 (52.4)	1.52 (0.71-3.25)	0.278

Education									
Up to primary	113/234 (48.3)	ref		58/120 (48.3)	ref		55/114 (48.2)	ref	
Above primary	78/172 (45.3)	1.13 (0.69-1.87)	0.622	34/84 (40.5)	1.03 (0.49-2.18)	0.932	44/88 (50.0)	1.32 (0.64-2.73)	0.461
Sexual orientation									
Heterosexual	125/260 (48.1)	ref		61/125 (48.8)	ref		64/135 (47.4)	ref	
Homosexual/Bisexual	66/146 (45.2)	1.55 (0.88-2.72)	0.129	31/79 (39.2)	1.39 (0.62-3.15)	0.426	35/67 (52.2)	1.58 (0.67-3.76)	0.297
Ever injected drugs									
No	168/364 (46.1)	ref		85/192 (44.3)	ref		83/172 (48.3)	ref	
Yes	23/42 (54.8)	1.40 (0.64-3.08)	0.396	7/12 (58.3)	1.19 (0.22-6.59)	0.839	16/30 (53.3)	1.71 (0.67-4.38)	0.265
No.of sexual partners									
Single	53/111 (47.7)	ref		29/58 (50.0)	ref		24/53 (45.3)	ref	
Multiple	21/65 (32.3)	0.48 (0.23-1.00)	0.051	19/63 (30.2)	0.42 (0.18-0.98)	0.054	2/2 (100)		
Others	117/230 (50.9)	1.28 (0.66-2.46)	0.466	44/83 (53.0)	1.32 (0.51-3.41)	0.567	73/147 (49.7)	1.33 (0.48-3.72)	0.588
Condom use									
Consistent	55/118 (46.6)	ref		18/39 (46.2)	ref		37/79 (46.8)	ref	
Casual/Never	47/108 (43.5)	1.27 (0.63-2.58)	0.508	47/108 (43.5)	0.90 (0.37-2.17)	0.815	0		
Others	89/180 (49.4)	0.85 (0.45-1.60)	0.607	27/57 (47.4)	0.49 (0.16-1.44)	0.193	62/123 (50.4)	1.31(0.54-3.17)	0.545
CD4 count									
≥550	112/230 (48.7)	ref		13/28 (46.4)	ref		99/202 (49.0)	ref	
<550	79/176 (44.9)	0.90 (0.52-1.56)	0.714	79/176 (44.9)	0.93 (0.37-2.33)	0.872	0 (0.0)	NA	NA
HBV									
Negative	174/374 (46.5)	ref		77/182 (42.3)	ref		97/192 (50.5)	ref	

Positive	17/32 (53.1)	1.19 (0.55-2.57)	0.654	15/22 (68.2)	2.76 (1.00 - 7.67)	0.051	2/10 (20.0)	0.25 (0.05-1.18)	0.080
HCV									
Negative	177/381 (46.5)	ref		82/188 (43.6)	ref		95/193 (49.2)	ref	
Positive	14/25 (56.0)	1.04 (0.40-2.74)	0.934	10/16 (62.5)	1.50 (0.33-6.80)	0.598	4/9 (44.4)	0.58 (0.12-2.89)	0.501

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Figures

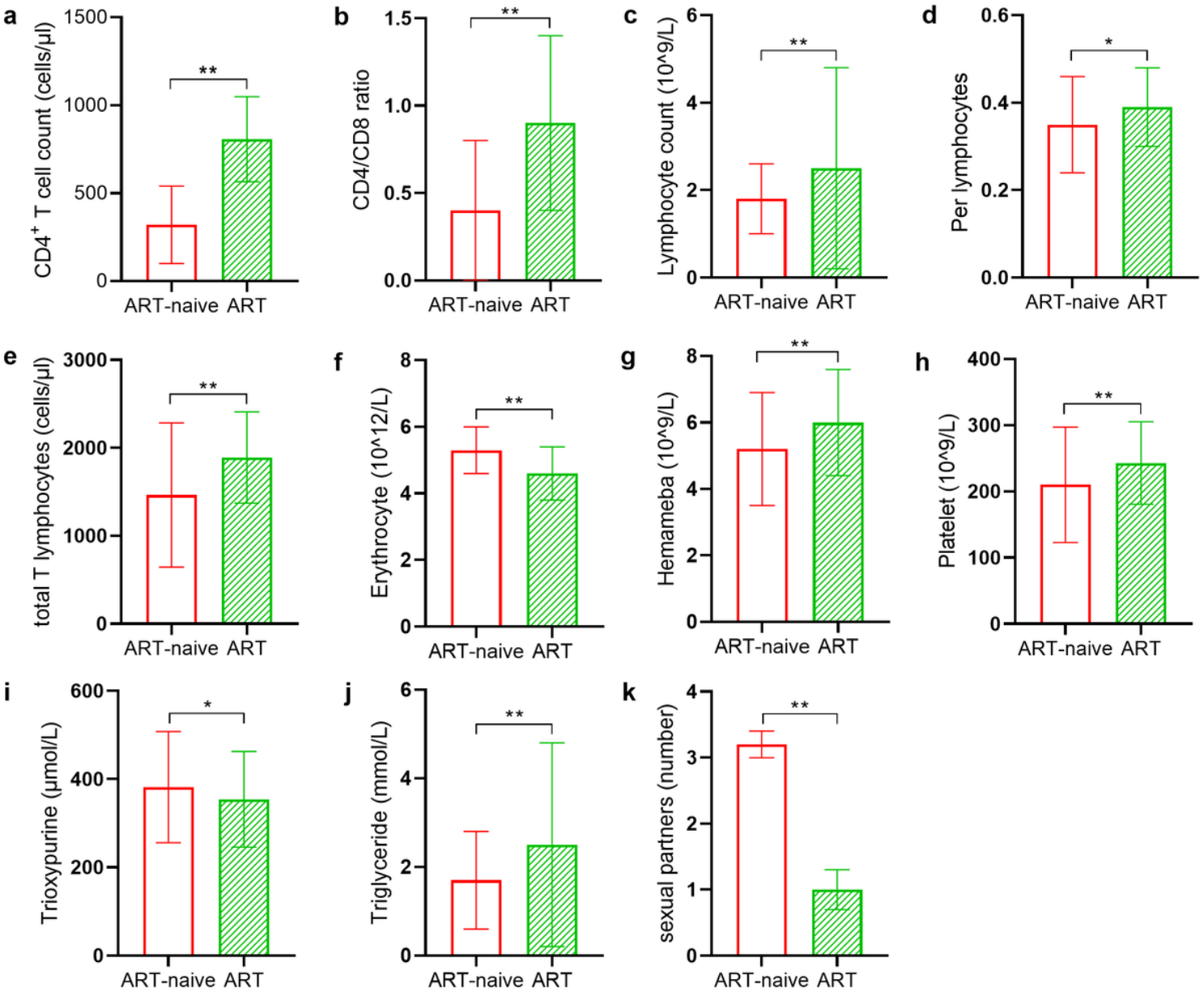

Figure 1

Comparison of laboratory data between ART-naive participants and ART participants. (a) CD4+ T cell count (cells/μl). (b) Ratio of CD4+T cell count/CD8+ T cell count. (c) Lymphocyte count (109/L). (d) The percentage of lymphocytes (%). (e) Total T lymphocyte count (cells/μl). (f) Erythrocyte count (1012/L). (g) Hemameba count (109/L). (h) Platelet count (109/L). (i) Trioxypurine level (μmol/L). (j) Triglyceride level (mmol/L). (k) Number of sexual partners. Red bar shows the ART-naive group (n = 204) and green bar shows ART group (n = 202). Data are presented as mean ± SEM. The statistical significance was indicated as *p < 0.05, and **p < 0.001. "Created by the authors"

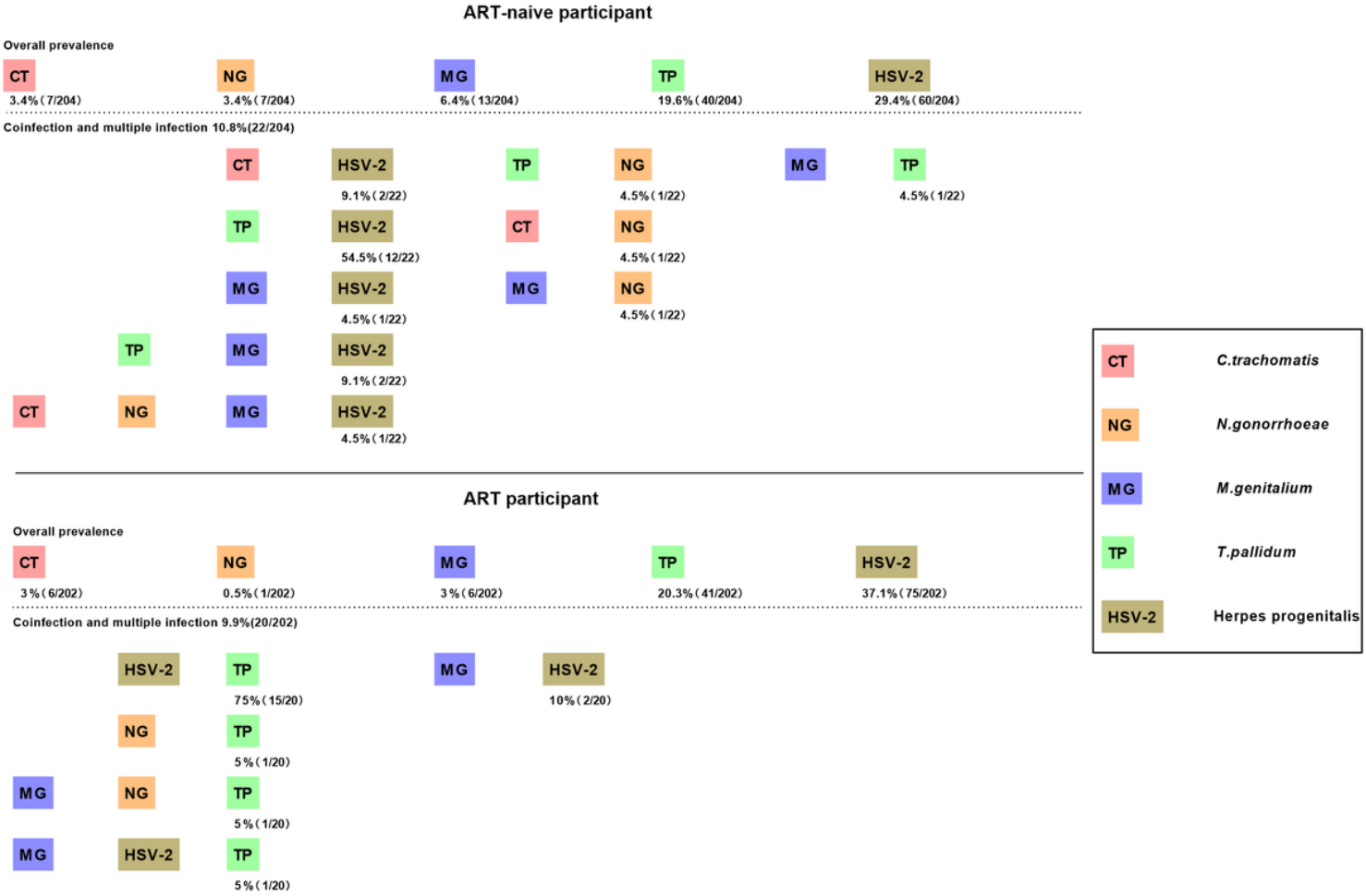

Figure 2

Prevalence of STIs among HIV-infected patients. Different-colored squares represent different STI. HSV-2, TP, CT, NG and MG indicate herpes progenitalis, T. pallidum, C. trachomatis, N. gonorrhoeae and M. genitalium, respectively. "Created by the authors"

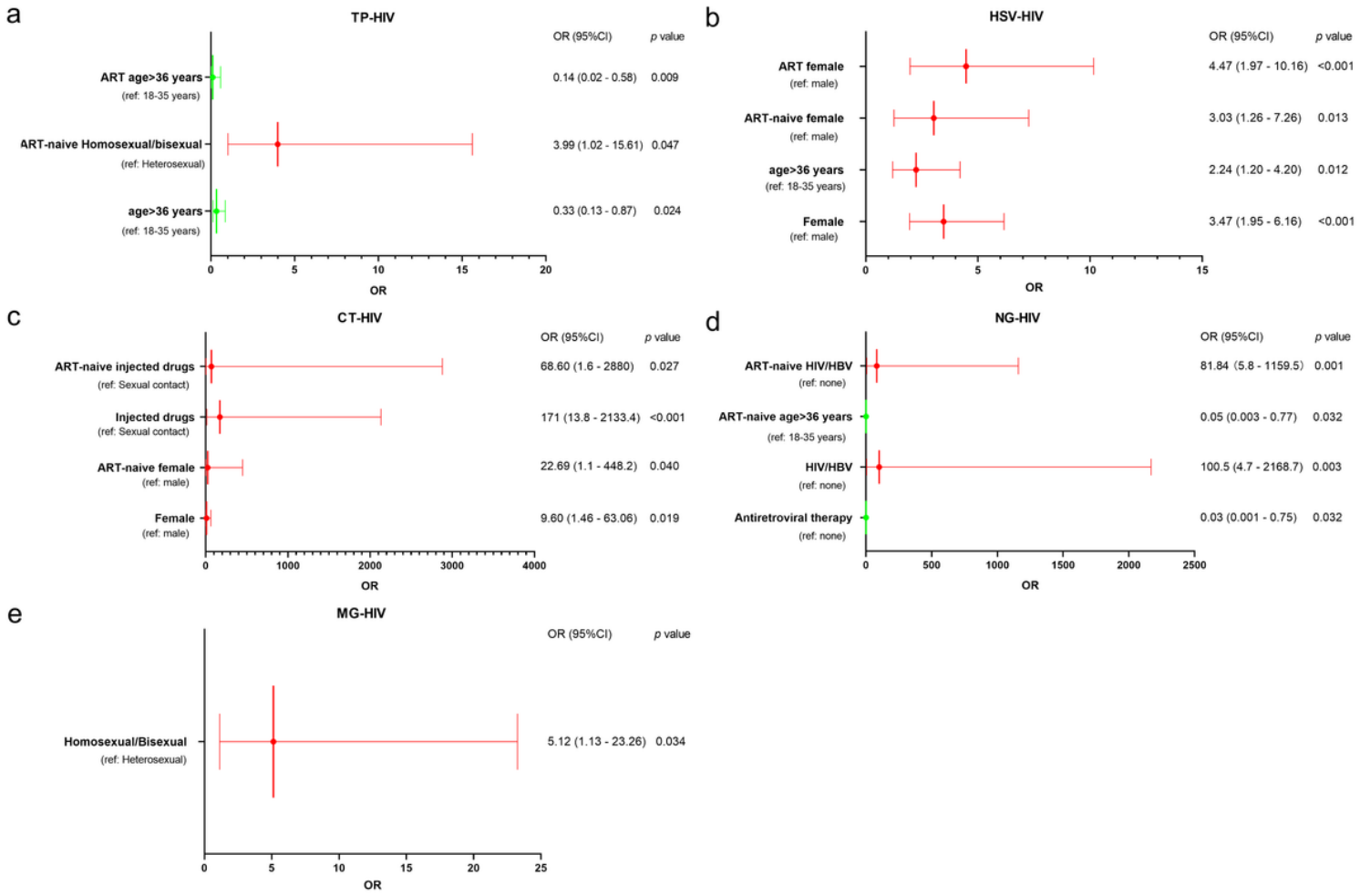

Figure 3

Factors associated with STIs among HIV-positive participants. (a) Factors associated with HIV and active syphilis coinfection. (b) Factors associated with HIV and HSV-2 coinfection. (c) Factors associated with HIV and C. trachomatis coinfection. (d) Factors associated with HIV and N. gonorrhoeae coinfection. (e) Factors associated with HIV and M. genitalium coinfection. The red line shows risk factors associated with each coinfection, green line shows protective factors and the ref are the risk factors in each coinfection. *p < 0.05 (Logistic regression). "Created by the authors"