Vital Surveillances

Epidemiological and Population Characteristics of Seroprevalence of TTIs Among Voluntary Blood Donors — Guangzhou City, Guangdong Province, China, 2014–2023

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ABSTRACT

Introduction: Transfusion-transmitted infections (TTIs) pose significant public health challenges. Screening potential blood donors for hepatitis B virus (HBV), hepatitis C virus (HCV), human immunodeficiency virus (HIV), and Treponema pallidum (TP), along with ongoing monitoring of epidemiological data on TTIs among donors, is essential to ensure blood safety.

Methods: This study conducted a retrospective analysis of the seroprevalence of HBsAg, anti-HCV, anti-HIV, and anti-TP among 3,111,265 blood donation events in Guangzhou from 2014 to 2023, investigating their relationships with demographic characteristics such as gender, age, and donation status.

Results: The findings indicated that the overall seroprevalence of TTIs among blood donations was 866.21 per 100,000, demonstrating a declining trend over the ten-year period. Seroprevalence rates of transfusion-transmissible infections also exhibited a downward trend across various demographic groups. Notably, male donors, first-time donors, and older donors demonstrated higher seroprevalence rates for TTIs.

Conclusions: While the overall seroprevalence rate of transfusion-transmissible infections among blood donors remains relatively low, significant disparities exist among different demographic groups. It is necessary of sustained TTIs monitoring among blood donors to guide public health interventions and donor screening practices.

Transfusion-transmitted infections (TTIs) caused by hepatitis B virus (HBV), hepatitis C virus (HCV), human immunodeficiency virus (HIV), and Treponema pallidum (TP) continue to pose a significant threat to global blood safety. The World Health Organization (WHO) recommends universal screening for these pathogens in blood donors to mitigate this risk. Although several studies have reported the prevalence of TTIs among blood donors in China (*1*–*3*), detailed epidemiological data remain limited. Guangzhou, a major city in southern China with a population of approximately 19 million, is one of the leading regions in terms of blood donation. Therefore, monitoring the epidemiology of TTIs among blood donors in Guangzhou is crucial for ensuring blood safety.

This study retrospectively analyzed the seroprevalence of HBV, HCV, HIV, and TP among voluntary blood donations in Guangzhou from 2014 to 2023 and examined their relationships to demographic factors, including gender, age, and donation status.

METHODS

Study Samples and Pre-donation Screening

This study retrospectively analyzed data from voluntary blood donations at the Guangzhou Blood Center between January 2014 and December 2023. Potential donors underwent a standardized pre-donation screening process that included a health history questionnaire, rapid testing, and a brief physical examination, as mandated by the National Health Commission of China. Donors were required to meet specific eligibility criteria, which excluded those with risk behaviors, abnormal test results, or failed physical examinations. Medical and sociodemographic information of eligible donors was recorded, and blood samples were collected in EDTA-K2 anticoagulant tubes. Donors with no prior donation records at our center were classified as first-time donors, while those with existing donation records were categorized as

repeat donors.

TTIs Detection

All donor samples were tested for TTIs, including hepatitis B surface antigen (HBsAg), anti-hepatitis C virus (anti-HCV), anti-human immunodeficiency virus (anti-HIV), and anti-Treponema pallidum (anti-TP), using two different enzyme-linked immunosorbent assay (EIA) kits from different manufacturers. All test reagents were approved by the China National Medical Products Administration. The specific manufacturers of the EIA kits are listed in Supplementary Table S1 (available at https://weekly.chinacdc.cn/). Donor blood samples that were reactive in both EIA tests were defined as TTI-positive. HIV antibody-reactive results were confirmed by the AIDS reference laboratory.

Seroprevalence Calculation and Statistical Analysis

To calculate the seroprevalence of TTIs, the number of donors who tested positive was divided by the overall number of donations, with the resulting value expressed as per 100,000 donations. Statistical analyses were conducted using SPSS software (version 25.0; IBM Corp., Armonk, NY, USA). Associations between categorical variables were assessed using the Chi-square test. Statistical significance was set at $P<0.05$.

RESULTS

Seroprevalence and Trends of TTIs Among Blood Donors

Between 2014 and 2023, 3,111,265 blood donor samples were collected in Guangzhou. Among these, 26,954 donors (866.34 per 100,000) tested seropositive for at least one TTI. The highest seroprevalence rate was observed for HBsAg, followed by anti-TP. The seroprevalence rates for HBsAg, anti-HCV, anti-HIV, anti-TP, and co-infections were 592.46 per 100,000, 67.01 per 100,000, 19.00 per 100,000, 202.62 per 100,000, and 14.62 per 100,000, respectively.

To investigate temporal trends, we conducted a year-by-year analysis of seroprevalence rates for each pathogen. Over the past decade, the seroprevalence rates of HBsAg, anti-HCV, anti-HIV, and anti-TP among blood donors in Guangzhou demonstrated a consistent downward trend. The HBsAg seroprevalence rate decreased from 842.26 per 100,000 in 2014 to 381.37 per 100,000 in 2023. Similarly, the anti-HCV seroprevalence rate declined from 147.44 per 100,000 in 2014 to 28.33 per 100,000 in 2023. The anti-HIV seroprevalence rate also decreased, falling from 26.1 per 100,000 in 2014 to 9.75 per 100,000 in 2023. Moreover, the anti-TP seroprevalence rate decreased from 353.51 per 100,000 in 2014 to 121.84 per 100,000 in 2023 (Figure 1, Supplementary Table S2, available at https://weekly.chinacdc.cn/).

Seroprevalence and Trends of TTIs Among Different Gender Blood Donors

Overall, the seroprevalence rates of HBsAg, anti-HCV, anti-HIV, and anti-TP were significantly higher in male donors compared to female donors (Supplementary Table S3, available at https://weekly.chinacdc.cn/). From 2014 to 2023, the seroprevalence rates of HBsAg, anti-HCV, anti-HIV, and anti-TP in male donors exhibited a marked downward trend, and the rates for HBsAg, anti-HCV, and anti-TP in female donors also decreased. In contrast, the seroprevalence rate of anti-HIV showed only a slight decrease over the decade in female donors. The disparity in seroprevalence rates of HBsAg, anti-HCV, anti-HIV, and anti-TP between male and female donors has progressively narrowed. However, as of 2023, male donors still exhibited significantly higher seroprevalence rates for both HBsAg and anti-HIV compared to female donors (Figure 2).

Seroprevalence and Trends of TTIs Among Different Age Group Donors

Compared to the 18–24 age group, the seroprevalence rates of HBsAg, anti-HCV, and anti-TP were significantly higher in the 25–34, 35–44, and ≥45 age groups. Additionally, the seroprevalence rate of anti-HIV was significantly higher in the 25–34 age group compared to the 18–24 age group (Supplementary Table S3). Over the decade from 2014 to 2023, the seroprevalence rates of HBsAg, anti-HCV, anti-HIV, and anti-TP showed a declining trend across all age groups. Specifically, the decline in HBsAg and anti-HCV seroprevalence rates was largely consistent across different age groups (Figure 3).

Seroprevalence and Trends of TTIs Among Different Donation Status Donors

The seroprevalence rates of HBsAg, anti-HCV, anti-

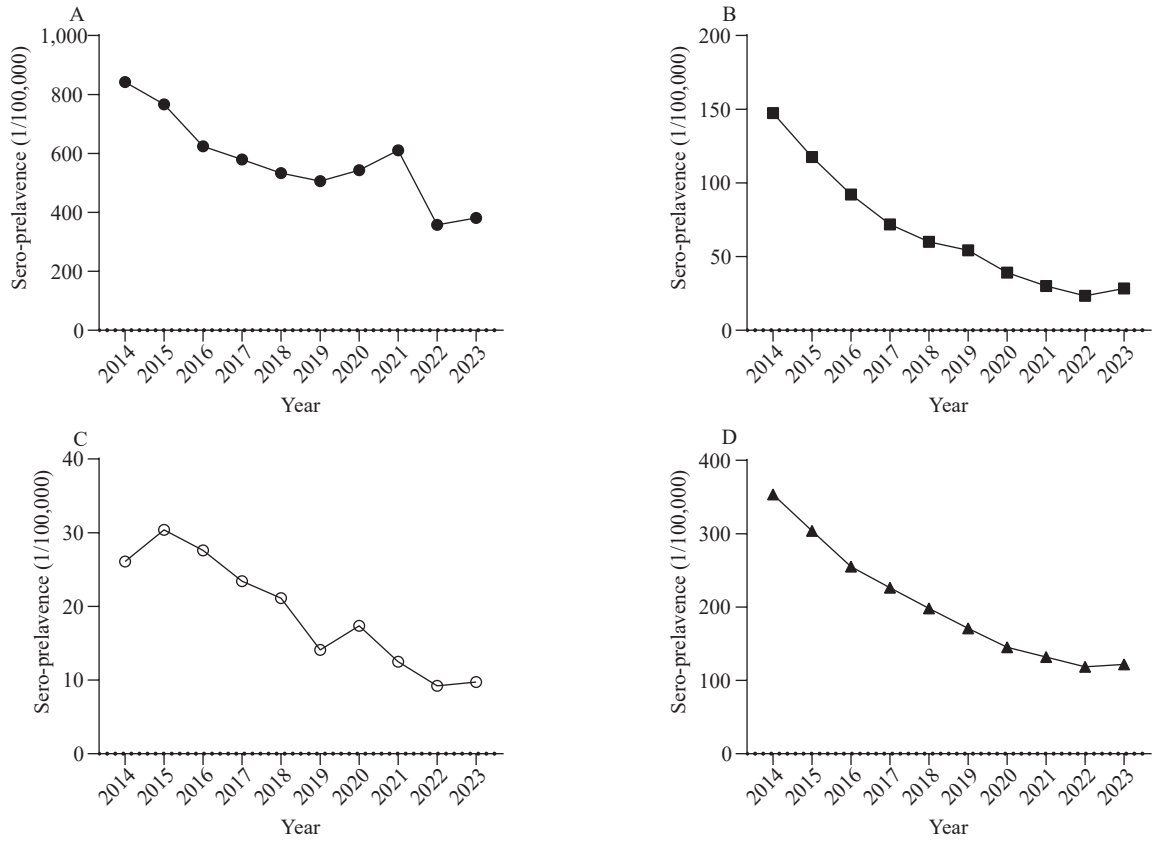

FIGURE 1. Seroprevalence rate of (A) HBsAg, (B) HCV, (C) HIV, and (D) TP among blood donors in Guangzhou from 2014 to 2023.
Abbreviation: HBsAg=Hepatitis B virus surface antigen; HCV=Hepatitis C virus; HIV=Human immunodeficiency virus; TP=*Treponema pallidum*; TTIs=Transfusion-transmitted infections.

HIV, and anti-TP were significantly higher in first-time donors compared to repeat donors (Supplementary Table S3). From 2014 to 2023, the seroprevalence rates of HBsAg, anti-HCV, anti-HIV, and anti-TP in first-time donors showed a downward trend, while the seroprevalence rates of HBsAg, anti-HCV, anti-HIV, and anti-TP in repeat donors remained consistently low (Figure 4).

DISCUSSION

China has implemented a voluntary blood donation system with routine screening for TTIs, including HBsAg, HCV, HIV, and TP, among all blood donors (*4*). The prevalence of TTIs directly impacts blood safety, making continuous monitoring essential for effective prevention and control strategies. This study reports the seroprevalence rates and trends of TTIs among 3,111,265 blood donations in Guangzhou from 2014 to 2023, while also investigating variations in seroprevalence across different demographic characteristics.

The overall seroprevalence of TTIs among blood donations in Guangzhou from 2014 to 2023 was 866.21 per 100,000. This differs from findings in other regions of China, such as western China, where the overall prevalence of TTIs among blood donors was 2.67% between 2005 and 2010 (*3*), and Zhejiang Province, where the prevalence was 1,916.31 per million between 2010 and 2019 (*5*). These regional variations likely stem from uneven population distributions across China and differences in study periods. Among the TTIs, HBsAg showed the highest seroprevalence (592.46 per 100,000), while anti-HIV had the lowest (19.00 per 100,000), consistent with findings from multiple studies (*2*–*3*,*5*–*7*). China has a high burden of hepatitis B, with an estimated prevalence of 3% between 2018 and 2022 (*8*), while the HIV infection rate in the general population is approximately 0.1% (*9*). The significantly lower seroprevalence of HBV and HIV among blood donors compared to the general population can be attributed to rapid pre-donation testing and the recruitment of

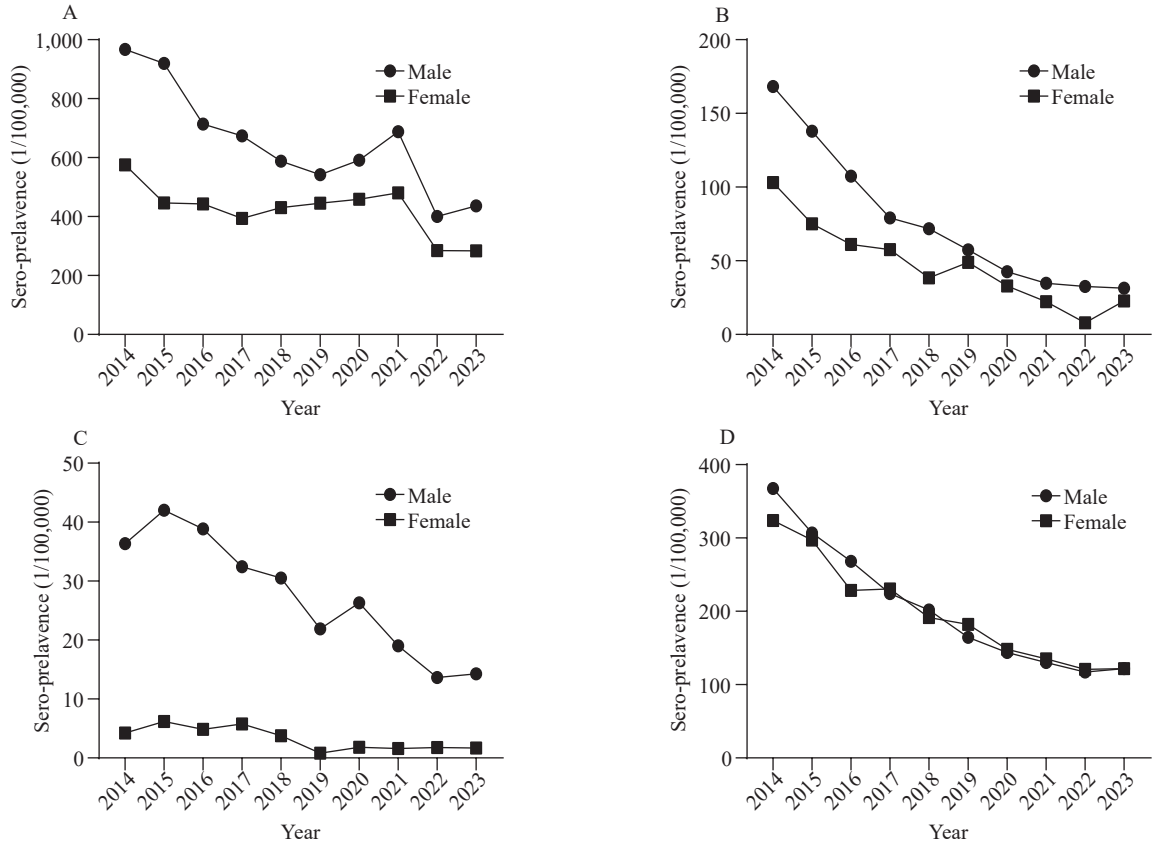

FIGURE 2. Seroprevalence rates of (A) HBsAg, (B) HCV, (C) HIV, and (D) TP among blood donors of different genders in Guangzhou from 2014 to 2023.
Abbreviation: HBsAg=Hepatitis B virus surface antigen; HCV=Hepatitis C virus; HIV=Human immunodeficiency virus; TP=*Treponema pallidum*; TTIs=Transfusion-transmitted infections.

donors primarily from low-risk populations. Year-by-year analysis revealed declining trends in the seroprevalence rates of HBsAg, anti-HCV, anti-HIV, and anti-TP from 2014 to 2023. This contrasts with earlier findings by Li et al. (2000–2010), which showed stable seroprevalence rates of HBsAg, anti-HCV, and anti-HIV among blood donors in Guangzhou, with increasing anti-TP rates. The recent decline highlights the effectiveness of the Chinese government initiatives in infectious disease prevention and control, including routine hepatitis B vaccination for newborns since 1992, free hepatitis B vaccines for all infants since 2002, and antiretroviral drugs for HIV treatment.

This study found that the seroprevalence rates of TTIs are higher among male donors, consistent with previous studies in China. Men exhibit a greater risk for HBV and HCV infections (*10*). According to research by Chang L et al., male sex is an independent predictor of HIV and syphilis infection among Chinese blood donors (*11*). Year-by-year analysis revealed that the discrepancy in seroprevalence rates of HBsAg, anti-HCV, anti-HIV, and anti-TP between male and female donors has narrowed. However, in 2023, the seroprevalence rates of HBsAg and anti-HIV remained significantly higher among male donors compared to female donors (Figure 2).

This study also found that among older blood donors, the seroprevalence rates of HBsAg, anti-HCV, and anti-TP were higher. In contrast, the seroprevalence of HIV was notably higher among donors in the 25–34 age group. Song Y et al. reported that higher TTIs prevalence in western China is associated with older age groups (*3*). It was found that from 2014 to 2017, the seroprevalence rate of anti-TP significantly increased with age among blood donors in Shenzhen (*12*). However, from 2010 to 2014, the proportion of HIV seroprevalence across different age groups among blood donors in Shiyan, was roughly similar (*6*). Further, our study showed that seropositive blood donors were predominantly first-time donors. Therefore, establishing a stable pool of regular repeat donors within the voluntary blood donation community enhances blood safety. Repeat donors test

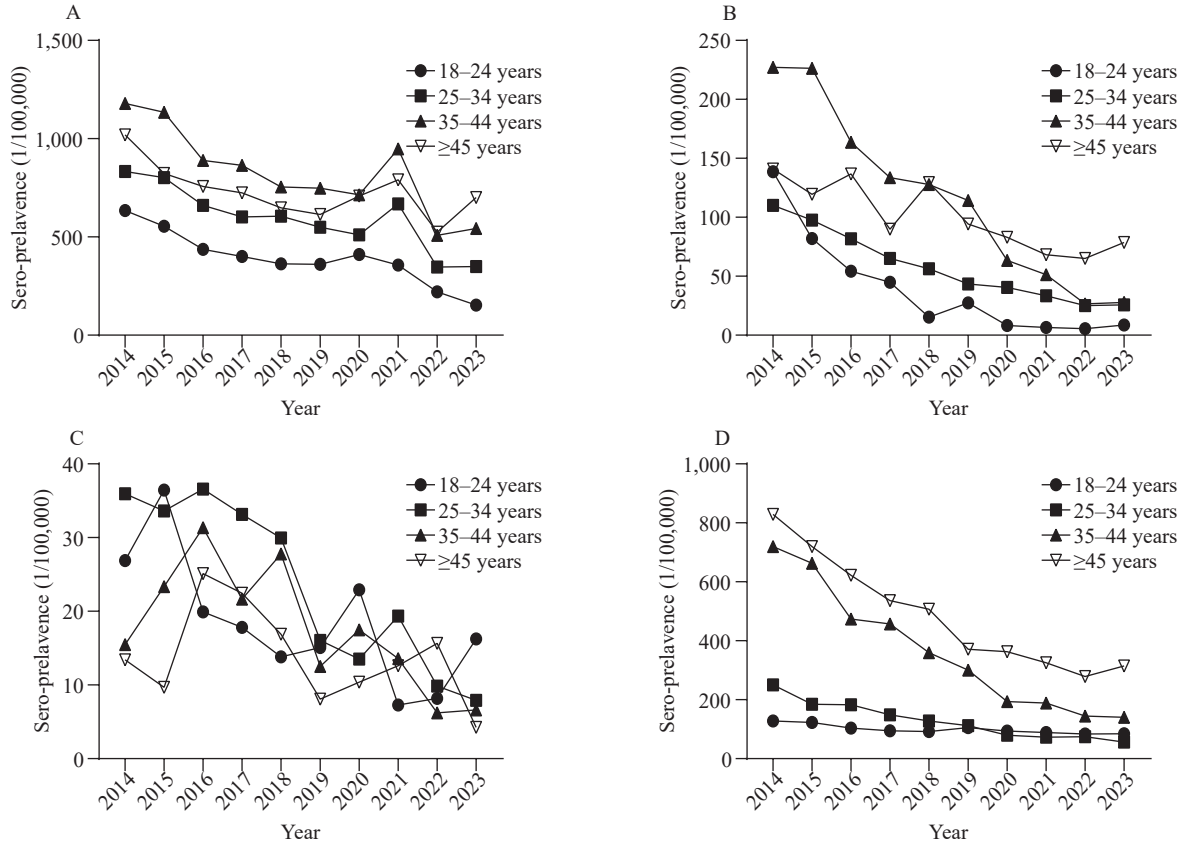

FIGURE 3. Seroprevalence rates of (A) HBsAg, (B) HCV, (C) HIV, and (D) TP among blood donors of different age groups in Guangzhou from 2014 to 2023.
Abbreviation: HBsAg=Hepatitis B virus surface antigen; HCV=Hepatitis C virus; HIV=Human immunodeficiency virus; TP=*Treponema pallidum*; TTIs=Transfusion-transmitted infections.

negative in previous donations, thus reducing the likelihood of window-period infections. The lower prevalence of repeat-time donors is also linked to blood deferral policies, where donors who test positive twice for TTIs are permanently deferred from future donations.

The key strength of this study is that it is a large-scale retrospective investigation of TTIs among blood donors in Guangzhou, China, and it also analyzes the annual trend of TTIs seroprevalence. However, this study had certain limitations. As a cross-sectional study, it did not include follow-up assessments of seropositive donors; therefore, we could not determine whether these donors had engaged in risk behaviors (such as men who have sex with men or multiple sexual partners). Furthermore, confirmatory tests for anti-HCV, HBsAg, and anti-TP were not performed.

In summary, this study found that the seroprevalence rates of hepatitis B, hepatitis C, HIV, and *Treponema pallidum* among blood donors were relatively low, and there has been a declining trend in the seroprevalence rate of TTIs over the decade. Upon stratification by demographic characteristics, significant variations in TTIs seroprevalence rates were noted among different donor groups: male donors, first-time donors, and older donors demonstrated higher seroprevalence rates for TTIs. The risk associated with different TTIs varied across genders and age groups. The findings from this study provide robust evidence to support ongoing surveillance of TTIs seroprevalence rates in China, and are instrumental in guiding blood donor screening strategies.

Conflicts of interest: No conflicts of interest.

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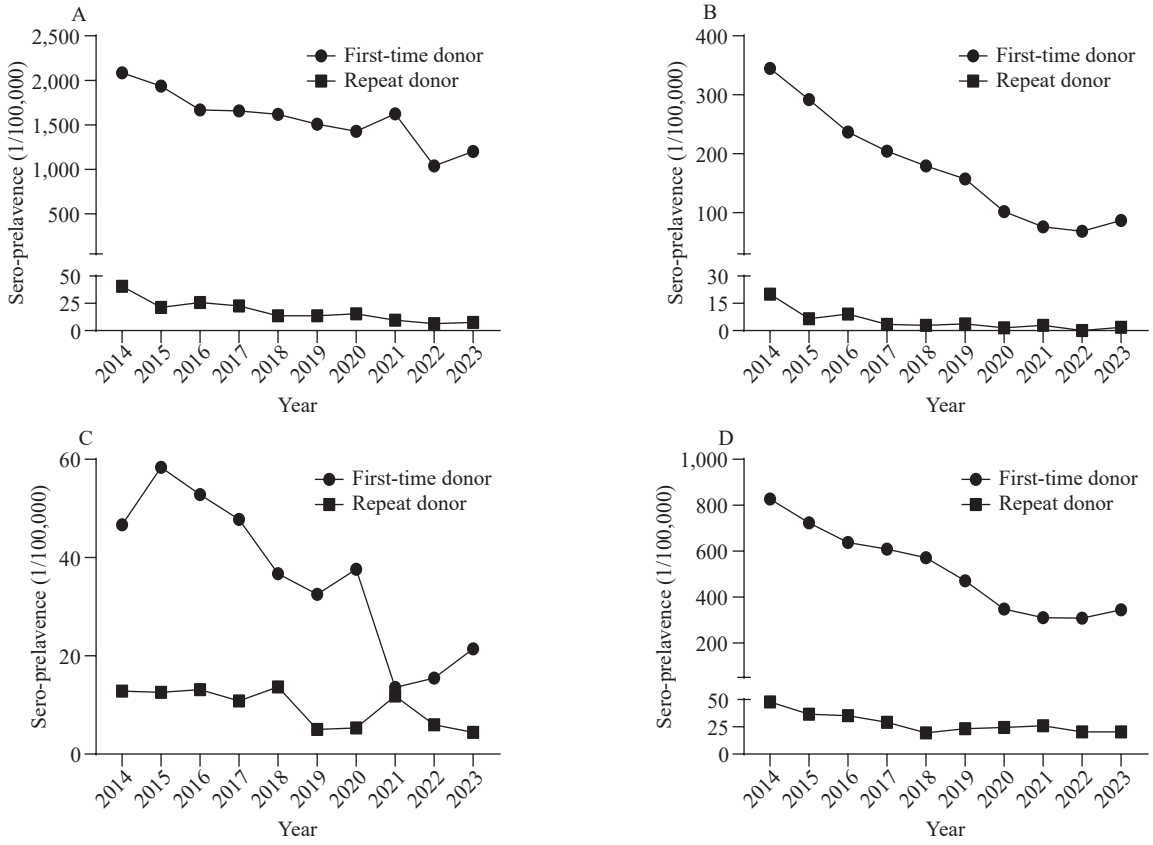

FIGURE 4. Seroprevalence rates of (A) HBsAg (B) HCV (C) HIV (D) TP among blood donors of different donation status in Guangzhou from 2014 to 2023.
Abbreviation: HBsAg=Hepatitis B virus surface antigen; HCV=Hepatitis C virus; HIV=Human immunodeficiency virus; TP=*Treponema pallidum*; TTIs=Transfusion-transmitted infections.

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SUPPLEMENTARY MATERIAL

SUPPLEMENTARY TABLE S1. HBsAg, anti-HCV, anti-HIV1/2, and anti-TP reagents used for screening donors.

Kit Name	Company
Diagnostic Kit for Antibodies to HBV Surface Antigen (ELISA)	Beijing WANTAI Biological Pharmacy Enterprise Co., Ltd; Shanghai Kehua BIO-ENGINEERING Co., Ltd; InTec Products, INC. (XIAMEN).
Diagnostic Kit for Antibodies to HCV (ELISA)	Beijing WANTAI Biological Pharmacy Enterprise Co., Ltd; Zhuhai Livzon Diagnostics INC; Shanghai Kehua BIO-ENGINEERING Co., Ltd.
Diagnostic kit for antibodies to HIV-1/2 (Sandwich ELISA)	BioMérieux Clinical Diagnostics (Shanghai, China); Zhuhai Livzon Diagnostics INC; Beijing WANTAI Biological Pharmacy Enterprise Co., Ltd.
Diagnostic kit for antibodies to Treponema pallidum (ELISA)	Beijing WANTAI Biological Pharmacy Enterprise Co., Ltd; Shanghai Kehua BIO-ENGINEERING Co., Ltd; InTec Products, INC. (XIAMEN).

Abbreviation: HBsAg=Hepatitis B virus surface antigen; HCV=Hepatitis C virus; HIV=Human immunodeficiency virus; TP=*Treponema pallidum*; HBV=Hepatitis B virus.

SUPPLEMENTARY TABLE S2. Seroprevalence rates of TTIs among blood donors in Guangzhou from 2014 to 2023.

Year	Total screened	Total sero-prevalence (/100,000)	HBsAg sero-prevalence (/100,000)	anti-HCV sero-prevalence (/100,000)	anti-HIV sero-prevalence (/100,000)	anti-TP sero-prevalence (/100,000)
2014	295,039	1353.04	842.26	147.44	26.10	353.51
2015	299,578	1204.03	766.41	117.50	30.38	303.76
2016	311,708	871.33	624.30	92.07	27.59	255.05
2017	307,480	890.14	579.55	71.87	23.42	226.36
2018	303,181	802.49	533.01	60.03	21.11	198.23
2019	326,400	741.42	506.43	54.23	14.09	170.96
2020	299,435	855.95	543.02	39.07	17.37	145.27
2021	336,333	759.96	610.41	30.03	12.49	132.01
2022	303,825	612.85	357.77	23.37	9.22	118.49
2023	328,286	629.94	381.37	28.33	9.75	121.84
Toatl	3,111,265	866.34	592.46	67.01	19.00	202.62

Abbreviation: HBsAg=Hepatitis B virus surface antigen; HCV=Hepatitis C virus; HIV=Human immunodeficiency virus; TP=*Treponema pallidum*; TTIs=Transfusion-transmitted infections.

SUPPLEMENTARY TABLE S3. Seroprevalence rates of TTIs among blood donors of different demographic characteristics.

Characteristics	HBsAg (1/100,000)	*P*	HCV (1/100,000)	*P*	HIV (1/100,000)	*P*	TP (1/100,000)	*P*
Gender								
Male	653.17	<0.0001	76.46	<0.0001	27.55	<0.0001	204.89	0.02
Female	421.28		45.10		3.11		192.75	
Age (years)								
18–24	391.37		38.93		18.24		99.92	
25–34	590.78	<0.0001	57.73	<0.0001	23.42	0.01	128.53	<0.0001
35–44	817.05	<0.0001	110.84	<0.0001	17.01	0.56	350.21	<0.0001
≥45	722.51	<0.0001	98.25	<0.0001	13.57	0.06	468.46	<0.0001
Donor status								
First-time donor	1587.23	<0.0001	176.19	<0.0001	36.40	<0.0001	517.00	<0.0001
Repeat donor	17.19		4.97		9.44		27.88	

Abbreviation: The *P* for the comparative analysis of TTIs seroprevalence rates across different age groups was obtained by comparing each age group with the 18–24 age group.
Abbreviation: HBsAg=Hepatitis B virus surface antigen; HCV=Hepatitis C virus; HIV=Human immunodeficiency virus; TP=*Treponema pallidumt*; TTIs=Transfusion-transmitted infections.