International Journal of General Medicine

Dovepress
open access to scientific and medical research

Open Access Full Text Article

ORIGINAL RESEARCH

Demographic Factors Among HIV Confirmed Blood Donors from 2013 to 2021 in Shenzhen

Song-Xing Wang*, Li-Yan Sun*, Qiong Yu, Tong Li, Ran Li, Yun-Ping Xu, Jin-Feng Zeng

Shenzhen Blood Center, Shenzhen, Guangdong, People's Republic of China

*These authors contributed equally to this work

Correspondence: Yun-Ping Xu; Jin-Feng Zeng, Email yunpingxu1982@qq.com; zzengjf@163.com

Background: New HIV (Human immune deficiency virus) infections are continuously increasing in China and it remains a huge challenge to blood donation. As access to health services has affected by COVID-19 (Corona virus disease 2019) pandemic, a drop in new diagnoses (especially HIV) was observed worldwide.

Methods: During 2013–2021, 735,247 specimens from unpaid blood donors collected by Shenzhen Blood Center underwent ELISA (Enzyme -linked immunosorbent assay) and NAT (Nucleic acid test). Samples with reactivity results were sent to the Shenzhen Center for Disease Control and Prevention for WB (Western blot). All data were statistically analyzed by the Chi-Square test.

Results: From 2013 to 2021, the prevalence of HIV among male blood donors was higher than in females ($P < 0.01$). During the COVID-19 pandemic, the prevalence of HIV among repeat blood donors decreased significantly compared to 2019 ($P < 0.05$), and the characteristics of blood donors changed in 2020 compared to 2019 and 2021.

Conclusion: The high proportion of female blood donors would help prevent HIV from getting into the blood supply. The COVID-19 pandemic affected the demographics of blood donors as well as the prevalence of HIV among repeat blood donors. An increased number of repeat blood donors can help decrease the risk of HIV transfusion transmission during the epidemic.

Keywords: COVID-19, Shenzhen, blood donors, HIV

Introduction

Blood transfusion medicine is an evolving discipline that is developed using a multidisciplinary approach. It focuses on the transfusion of blood from donors to patients for treatment and conducts research, development, and application. The most important of transfusion is to ensure the safety and efficacy of clinical blood transfusions. However, in 1981, after HIV was first reported in the world, it quickly became one of the most serious health challenges.[1] HIV can be spread via unprotected sex with an infected partner, sharing unsterilized injection tools used by an infected person with others, and transfusion of blood products from the infected person. Due to the characteristics of HIV transmission by blood transfusion, blood donors who test positive for HIV are more likely to infect recipients and become a threat to blood security. In addition, Donors who are more likely to cause HIV transmission are those with HIV but are in the window period (tested negative for HIV).

Before 1978 in China, blood for clinical use was mainly collected from paid individual donations, donating blood became an effective way to earn money for blood donors, which led to the widespread of HIV on the central plain of China. In 1998, the establishment and implementation of the Chinese national blood policy significantly reduced the spread of HIV,[2] as unpaid blood donors reduce the risk for HIV infection through transfusion.[3,4]

In 2020, COVID-19 spread around the world and severely impacted health systems.[5] In many countries, the COVID-19 pandemic had a serious impact on blood donation and led to changes in the prevalence of HIV.[6] This article aims to study the prevalence of HIV among blood donors in Shenzhen before the COVID-19 pandemic and the impact of COVID-19 on HIV prevalence, which provides scientific strategies for preventing HIV from getting into the blood supply chain, even during an epidemic.

Received: 11 November 2022
Accepted: 24 January 2023
Published: 3 February 2023

Methods

Shenzhen Blood Center is a public health institution, which carries out blood collection and supply. To provide blood consumption, testing services and medical blood service guidance for nearly 50 clinical medical institutions in Shenzhen.

From January 1, 2013, to December 31, 2021, samples from 735,247 blood donors at Shenzhen Blood Center were collected. Samples of blood donations screened reactive for HIV by ELISA or NAT were sent to Shenzhen Chronic Disease Prevention Center for confirmatory testing by WB. All blood donors in Shenzhen Blood Center are volunteers, and all tests were performed in strict accordance with the instructions regarding the reagents and equipment. Specimens with positive results in all tests were considered HIV-positive, and these blood donors were considered HIV-infected blood donors. The prevalence of HIV among blood donors was equal to the number of blood donors who tested positive for HIV divided by the total number of blood donors. All data were statistically analyzed by the Chi-square test.

Blood donors were grouped by different criteria. Blood donors with a higher education background were defined as those who were in the process of or have completed university studies. Blood donors with a lower education background were defined as those without a college education. Local blood donors were those whose household registration is in Shenzhen. Foreign blood donors were those whose household registration was not in Shenzhen, but who traveled, worked, or studied in Shenzhen during this study period. First-time blood donors were defined as those who made no blood donations prior to the study period. Repeat donors were defined as donors who had made at least one donation prior to the study period and one or more during the study period.

Results

As shown in Figure 1, during nine years, the prevalence of HIV among blood donors in Shenzhen showed a fluctuating trend. The highest prevalence of HIV was 0.073% in 2014 and the lowest prevalence of HIV was 0.027% in 2018.

In Table 1, from 2013 to 2021, the prevalence of HIV among males was higher than that of females (Figure 2), there were significant differences between males and females ($P < 0.01$). It indicated that in Shenzhen, the prevalence of HIV among blood donors was associated with gender. In 2019, the prevalence of HIV among repeat blood donors was higher than that of first-time blood donors ($P<0.05$), but in 2021, the prevalence of HIV among repeat blood donors was lower than that of first-time blood donors ($P < 0.001$). Only HIV prevalence among repeat blood donors in 2020 was statistically decreased compared to that in 2019 ($P < 0.05$) in Table 2. It may indicate that COVID-19 have an effect on HIV prevalence among blood donors with different history of blood donation.

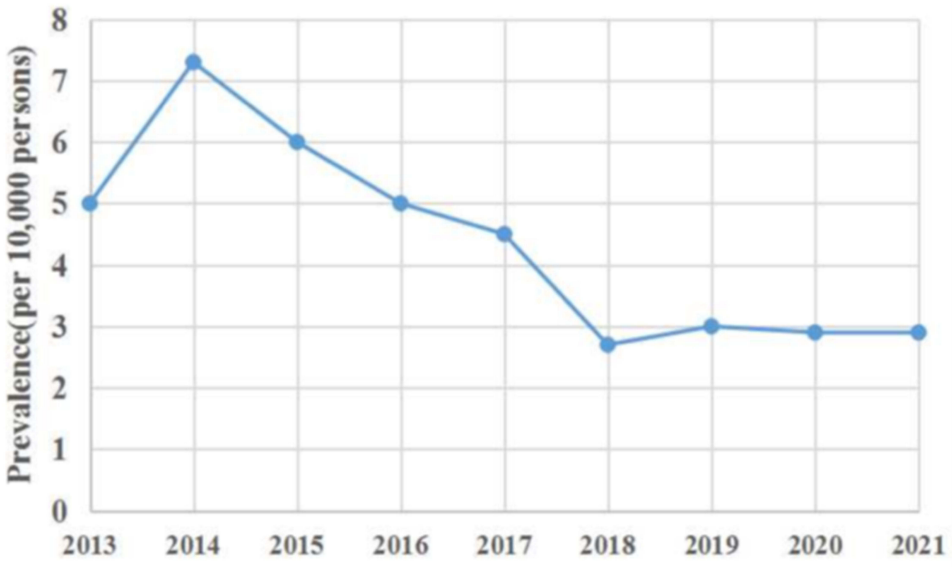

Figure 1 The prevalence of HIV among unpaid blood donors from 2013 to 2021.

Table 1 The Prevalence of HIV Among Unpaid Blood Donors from 2013 to 2021

Group	HIV-Positive	HIV-Negative	Prevalence (Per 10,000 Persons)	HIV-Positive	HIV-Negative	Prevalence (Per 10,000 Persons)	χ^2	P value	OR(95% CI)
Gender	**Male**			**Female**					
2013	31	40,353	7.7	1	23,677	0.4	15.732	<0.0001	18.189(2.483–133.248)
2014	49	42,314	11.6	1	25,966	0.4	25.527	<0.0001	30.069(4.152–217.764)
2015	40	45,984	8.7	4	26,879	1.5	14.599	<0.0001	5.845(2.091–16.339)
2016	38	48,266	7.9	1	29,296	0.3	20.560	<0.0001	23.065(3.167–167.997)
2017	35	54,287	6.4	2	28,647	0.6	13.888	<0.0001	9.235(2.221–38.397)
2018	22	53,947	4.1	1	30,823	0.3	10.185	0.001	12.570(1.694–93.257)
2019	26	58,009	4.5	2	34,058	0.6	10.702	0.001	7.633(1.811–32.159)
2020	25	59,067	4.2	2	33,978	0.6	9.868	0.002	7.191(1.703–30.359)
2021	34	63,422	5.3	5	35,950	1.4	9.212	0.002	3.854(1.507–9.856)
Age	**<30**			**≥30**					
2013	17	9107	18.6	15	54,923	2.7	36.630	<0.0001	6.835(3.412–13.691)
2014	28	14,180	19.7	22	54,100	4.1	37.658	<0.0001	4.856(2.777–8.490)
2015	33	19,309	17.1	11	53,598	2.1	53.122	<0.0001	8.327(4.208–16.480)
2016	27	22,404	12.0	12	55,158	2.2	30.876	<0.0001	5.539(2.806–10.936)
2017	19	25,156	7.5	18	57,779	3.1	7.731	0.005	2.424(1.272–4.620)
2018	19	30,655	6.2	4	28,225	1.4	21.484	<0.0001	4.373(1.488–12.857)
2019	15	36,726	4.1	13	55,341	2.3	2.185	0.139	1.739(0.827–3.654)
2020	15	36,366	4.1	12	56,648	2.1	3.070	0.080	1.947(0.911–4.160)
2021	22	41,753	5.3	17	57,636	2.9	3.318	0.069	1.786(0.949–3.364)
Region	**Local**			**Foreign**					
2013	6	17,067	3.5	26	46,834	5.5	1.035	0.309	1.539(0.261–0.633)
2014	5	16,202	3.1	45	51,989	8.6	5.224	0.022	0.357(0.142–0.898)
2015	7	17,410	4.0	37	55,359	6.7	1.553	0.213	0.602(0.268–1.350)
2016	4	17,965	2.2	35	59,453	5.9	3.668	0.055	1.064(0.134–0.378)
2017	3	20,664	1.5	34	62,159	5.5	5.603	0.018	0.265(0.082–0.864)
2018	2	21,391	0.9	21	63,356	3.3	3.336	0.068	0.282(0.066–1.203)
2019	5	22,754	2.2	23	69,239	3.3	0.711	0.399	0.662(0.251–1.740)
2020	5	26,962	1.9	22	66,088	3.3	1.434	0.231	0.557(0.211–1.471)
2021	3	26,160	1.1	36	73,212	4.9	6.980	0.008	0.233(0.072–0.757)

(*Continued*)

https://doi.org/10.2147/IJGM.S397236 DovePress

Table 1 (Continued).

Group	HIV-Positive	HIV-Negative	Prevalence (Per 10,000 Persons)	HIV-Positive	HIV-Negative	Prevalence (Per 10,000 Persons)	χ^2	P value	OR(95% CI)
Education background	**Lower**			**Higher**					
2013	21	35,040	6.0	11	28,961	3.8	1.527	0.217	1.578(0.761–3.273)
2014	35	38,948	9.0	15	29,322	5.1	3.420	0.064	1.757(0.959–3.217)
2015	28	42,103	6.6	16	30,756	5.2	0.617	0.432	1.278(0.692–2.363)
2016	21	43,649	4.8	18	33,895	5.3	0.095	0.758	0.906(0.483–1.701)
2017	25	44,767	5.6	12	38,152	3.1	2.745	0.098	1.775(0.892–3.534)
2018	17	45,086	3.8	6	39,679	1.5	3.966	0.046	2.494(0.983–6.325)
2019	18	47,906	3.8	10	44,150	2.3	1.682	0.195	1.659(0.766–3.594)
2020	16	43,431	3.7	11	45,649	2.4	1.192	0.275	1.529(0.709–3.295)
2021	17	47,009	3.6	22	52,363	4.2	0.216	0.642	0.861(0.457–1.621)
Donor State	**First-time**			**Repeat**					
2013	21	55,337	3.8	11	8693	12.6	11.784	0.001	0.300(0.145–0.622)
2014	41	59,658	6.8	9	8622	10.3	1.307	0.253	0.658 (0.320–1.355)
2015	35	63,823	5.5	9	9040	9.9	2.620	0.106	0.551 (0.265–1.146)
2016	33	66,932	4.9	6	10,630	5.6	0.093	0.760	0.873 (0.366–2.085)
2017	30	71,621	4.2	7	11,313	6.2	0.874	0.350	0.677 (0.297–1.542)
2018	20	72,751	2.7	3	12,019	2.5	0.024	0.876	1.101 (0.327–3.707)
2019	19	78,783	2.4	8	13,285	6.0	3.894	0.048	0.400(0.175–0.915)
2020	17	42,995	4.0	10	50,055	2.0	3.049	0.081	1.979(0.906–4.323)
2021	32	49,724	6.4	7	49,687	1.4	16.001	<0.001	4.568(2.016–10.350)

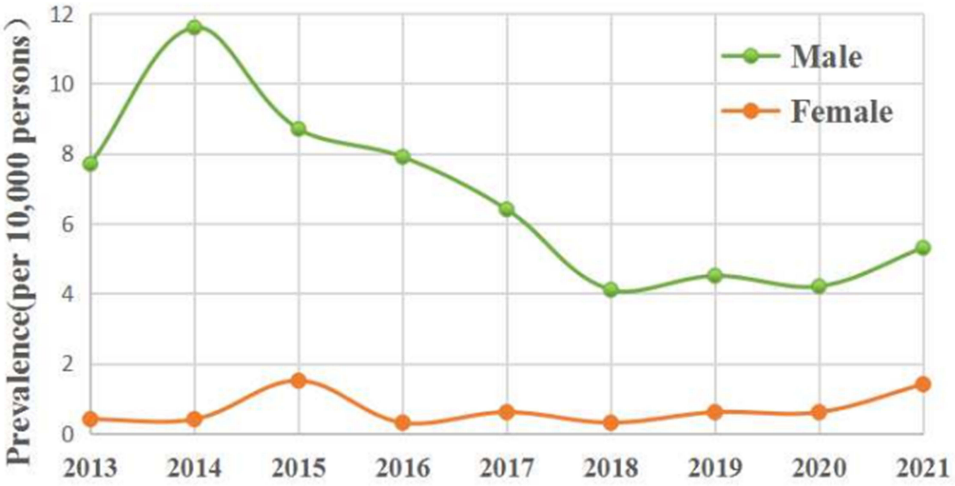

Figure 2 The prevalence of HIV among male and female blood donors from 2013 to 2021.

In Table 3, we found that the characteristics of blood donors changed in 2020 compared to 2019 and 2021. The percentage of males increased significantly from 2019 to 2020 ($P < 0.05$), although there was no significant difference between 2020 and 2021. From 2019 to 2021, there were more foreigners than locals, and the lowest percentage of

Table 2 The Impact of COVID-19 on the Prevalence of HIV Among Different Blood Donors

Group			2019	2020	2021
Gender	Male	Positive	26	25	34
		Negative	58,009	59,067	63,422
		χ^2	0.042	–	0.369
		P value	0.838	–	0.808
		OR	1.059 (0.612–1.834)		1.267 (0.756–2.123)
		95% CI			
	Female	Positive	2	2	5
		Negative	34,058	33,978	35,950
		χ^2	<0.001	–	0.464
		P value	1.000	–	0.496
		OR	0.998 (0.141–7.083)		2.363 (0.458–12.180)
		95% CI			
Region	Local	Positive	5	5	3
		Negative	22,754	26,962	26,160
		χ^2	<0.001	–	0.097
		P value	1.000	–	0.756
		OR	1.185 (0.343–4.094)		0.618 (0.148–2.588)
		95% CI			
	Foreign	Positive	23	22	36
		Negative	69,239	66,088	73,212
		χ^2	<0.001	–	2.104
		P value	0.994	–	0.147
		OR	0.998 (0.556–1.790)		1.477 (0.869–2.511)
		95% CI			

(*Continued*)

Table 2 (Continued).

Group			2019	2020	2021
Education background	Lower	Positive	18	16	17
		Negative	47,906	43,431	47,009
		χ^2	0.003	–	0.003
		P value	0.954	–	0.958
		OR	1.020 (0.520–2.000)		0.982 (0.496–1.943)
		95% CI			
	Higher	Positive	10	11	22
		Negative	44,150	45,649	52,363
		χ^2	0.020	–	2.325
		P value	0.887	–	0.127
		OR	0.940 (0.399–2.213)		1.744 (0.845–3.596)
		95% CI			
Donor status	First-time	Positive	19	17	32
		Negative	78,783	42,995	49,724
		χ^2	2.237	-	2.685
		P value	0.135	-	0.101
		OR	0.610 (0.317–1.174)		1.984 (1122–3.507)
		95% CI			
	Repeat	Positive	8	10	7
		Negative	13,285	50,055	49,687
		χ^2	4.647	-	0.507
		P value	0.031	-	0.476
		OR	3.014 (1.189–7.639)		0.705 (0.268–1.853)
		95% CI			
Age	18–29	Positive	15	15	22
		Negative	36,726	36,366	41,753
		χ^2	0.001	-	0.537
		P value	0.978	-	0.464
		OR	0.990 (0.484–2.026)		1.277 (0.663–2.463)
		95% CI			
	30–65	Positive	13	12	17
		Negative	55,341	56,648	57,636
		χ^2	0.067	-	0.778
		P value	0.796	-	0.378
		OR	1.109 (0.506–2.430)		1.392 (0.665–2.916)
		95% CI			

foreigners was observed in 2020 ($P < 0.001$). In 2019 and 2021, there were more first-time blood donors than repeat blood donors, but in 2020, it was the first time that there were more repeat blood donors than first-time blood donors and the percentage of repeat blood donors was the highest ($P < 0.001$). In 2019, there were more blood donors with a lower education background than those with a higher education background, but in 2020 and 2021, there were more blood donors with a higher education level than those with a lower education level, especially in 2020, the percentage of blood donors with a higher education level was the highest ($P < 0.05$). From 2019 to 2021, there were more blood donors aged 30–65 years old than those aged 18–29 years old, and compared to 2019, the percentage of blood donors aged 18–29 years old decreased significantly in 2020 ($P < 0.001$), but in 2021, it increased ($P < 0.001$). Overall, this may indicate that the character of blood donors, including education, age and so on, has been affected by COVID-19.

Table 3 The Impact of COVID-19 on the Structure of Blood Donors

Group		2019	2020	2021
Gender	Male	58,035 (63.02%)	59,092 (63.49%)	63,456 (63.83%)
	Female	34,060 (36.98%)	33,980 (36.51%)	35,955 (36.17%)
	χ^2	4.478	–	2.421
	P value	0.034	–	0.120
	OR	0.980 (0.961–0.998)		1.015 (0.996–1.034)
	95% CI			
Region	Locals	22,759 (24.73%)	26,967 (28.97%)	26,163 (26.32%)
	Foreigners	69,262 (75.27%)	66,110 (71.03%)	73,248 (73.68%)
	χ^2	423.477	–	169.537
	P value	<0.001	–	<0.0.001
	OR	0.806 (0.789–0.822)		0.876 (0.858–0.893)
	95% CI			
Education background	Lower	47,924 (52.04%)	43,447 (46.84%)	47,026 (47.30%)
	Higher	44,160 (47.96%)	49,304 (53.16%)	52,385 (52.70%)
	χ^2	500.075	–	4.111
	P value	<0.001	–	0.043
	OR	1.232 (1.209–1.254)		1.019 (1.001–1.037)
	95% CI			
Donor status	First-time	78,802 (85.57%)	43,012 (46.21%)	49,724 (50.02%)
	Repeat	13,293 (14.43%)	50,065 (53.79%)	49,687 (49.98%)
	χ^2	31,852.996	–	279.106
	P value	<0.001	–	<0.001
	OR	6.900 (6.747–7.057)		1.165 (1.144–1.186)
	95% CI			
Age	18–29	36,741 (39.89%)	36,381 (39.10%)	41,775 (42.02%)
	30–65	55,354 (60.11%)	56,660 (60.90%)	57,636 (57.98%)
	χ^2	12.166	–	169.950
	P value	<0.001	–	<0.001
	OR	1.034 (1.015–1.053)		1.129 (1.108–1.150)
	95% CI			

Discussion

HIV infections remain a global public health concern, especially for the safety of transfusion. According to one report, the national-level prevalence of HIV in China is 0.09%, and the prevalence of HIV among blood donors is different from that of general population. From 2010 to 2017, the HIV prevalence among blood donors is about 0.025% in Guangdong province,[7] which is lower than the national-level prevalence and the prevalence of blood donors in Shenzhen in our study. Demographic factors are shown to be associated with HIV prevalence.[8,9] In the past, there were many articles about the seroprevalence of HIV among blood donors.[10,11] But in recent years, many researchers have focused on the prevalence of HIV based on the positive result for NAT or WB.[12–14] Because the positive result of ELISA is not sufficient to indicate that the blood donor is HIV-infected, the positive result of WB can prove that the blood donor is infected with HIV. In this article, the prevalence of HIV among blood donors was determined based on the positive results of WB.

In many countries, the majority of blood donors are men.[15,16] In Shenzhen of China, from 2013 to 2021, there were more male blood donors than females. It may because of the existence of menstrual period, which limits women to donate blood. As for the prevalence of HIV among blood donors, we found that the prevalence of HIV among females was significantly lower than among males each year ($P < 0.01$), which was consistent with the results of many studies about the HIV prevalence of male and female blood donors,[17] and we also found that COVID-19 had no significant effect on HIV prevalence among male and female blood donors. An appropriate increase in the proportion of female blood donors in Shenzhen may reduce the HIV positive rate of blood donors, whether or not in times of other epidemics.

In Shenzhen of China, the year 2019 was considered pre-pandemic while 2020 was during the pandemic and 2021 was post-acute-pandemic. Shenzhen is a city with a large number of migrants, and there are more foreigners than locals donating blood. Population migration has been reported to be an obstacle to controlling and managing HIV infection.[18] Due to the COVID-19 pandemic, the Chinese government enforced a blockade policy. So there was a decline in the number of foreign blood donors in 2020 compared to 2019 and 2021. The pandemic led to changes in the percentage of foreign and local blood donors. The decrease of foreign blood donors may be conducive to controlling HIV infection among blood donors in Shenzhen. In addition, the proportion of blood donors with different ages was changed. The lowest percentage of blood donors aged 18–29 years old was observed in 2020. This may be due to the COVID-19 epidemic, the school's closure strategy banned students from going out. Students are the majority of blood donors younger than 30 years old. In our results, the HIV prevalence of blood donors aged younger than 30 years old was higher than those aged over 30 years old from 2013 to 2018 ($P < 0.05$). The increasing HIV risk among young people is posing potential threats to blood safety in China,[19,20,27,28] which may be closely related to the lack of sex education.[21,29] Some studies show that there is a certain correlation between the level of education and the incidence of HIV.[19,20,22,23] Some researchers' conclusions mean that HIV is related to lower education levels,[21,22,24,25] but others mean that the prevalence of HIV among blood donors with >8 years of education was higher than those with < 8 years of education.[23,26] However, in our results, we did not find significant differences in the HIV prevalence between higher-educated blood donors and lower-educated blood donors and the impact of COVID-19 on the HIV prevalence in these two groups. We only found that the percentage of blood donors with a higher educational background increased in 2020. It may due to that the highest educated people usually have better economic conditions, which can facilitate their access to services. Besides this affirmation causes constraints, the lowest educated people could be more affected by COVID-19 pandemic restrictions, impacting their access to services. So, during the COVID-19 pandemic, blood donors with a higher education background may be more willing to donate blood to help others than those with a lower education background.

Incidence in first-time and repeat blood donors is an important measure of transfusion-transmitted HIV infection risk.[24,27] First-time blood donors usually have different motivations for blood donation, some of which provoke the donors to hide risk factors of transfusion-transmissible infections (TTIs).[25,28] It has been reported that the HIV prevalence among first blood donors greatly exceeded that in repeat blood donors.[26,29] In this study, we observed the same trend in 2019, but in 2020, the prevalence of HIV among repeat blood donors decreased and the prevalence of HIV among first-time blood donors was higher than that among repeat blood donors in 2021. We also found that COVID-19 had a significant effect on the proportion of first-time and repeat blood donors, it was the first time in 2020 that there were more repeat blood donors than first-time blood donors from 2013 to 2021. During the COVID-19 epidemic, the main group of blood donors changed from first-time blood donors to repeat blood donors. An increased number of repeat blood donors can not only help ensure blood supply but also reduce the risk of HIV transmission through blood transfusion. It is well known that blood bank managers have the opportunity to receive more information about prevention and discuss repeat blood donors vulnerabilities and so, mitigate this group risks.

There are some limitations in this article. Many other factors associated with HIV infections among blood donors, including sexual behavior and injecting drugs, are not mentioned in our study. Instead of deriving information from all blood donors, we used some programming techniques to extract information, which also prevented us from further analyzing various factors related to HIV. In the future, we will consider further in-depth export data and analysis.

Conclusion

Overall, the data from this study showed that a higher prevalence of HIV among male blood donors than females, the prevalence of HIV decreased among repeat blood donors from 2019 to 2020, and the demographics of blood donors changed in 2020 compared to 2019 and 2021. We concluded that a higher proportion of female blood donors would help decrease HIV positive units in the blood supply, the COVID-19 pandemic affected the demographics of blood donors as well as the prevalence of HIV among repeat blood donors.

Data Sharing Statement

All data generated or analysed during this study were included in this published article.

Ethics Approval

This study complies with the Declaration of Helsinki and was approved by the Medical Ethics Committee of Shenzhen Blood Center. The informed consent was obtained from all subjects, and all methods were carried out in accordance with relevant guidelines and regulations.

Acknowledgments

We wish to acknowledge the Medical Ethics Committee of Shenzhen Blood Center for reviewing and approving all the procedures involved in this study. Special thanks to the staff of Tangshan Qiao Technology Co., Ltd. for helping us collect data. We also take this opportunity to thank all members of this project, for their commitment and contribution during the performance of this study. All authors thank the Shenzhen blood center for the permission to publish the finding.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

This study was financially supported by Shenzhen Key Discipline Project of Blood Transfusion Medicine (SZXK070), the Sanming Project of Medicine in Shenzhen (No. SZSM201811092).

Disclosure

The authors declare that they have no competing interests in this work.

References

1. Piot P, Plummer FA, Mhalu FS, et al. AIDS: an international perspective. *Science*. 1988;239(4840):573–579. doi:10.1126/science.3277271
2. Chen S, Lu X, Bai G, et al. Twenty-seven year surveillance of blood transfusion recipients infected with HIV-1 in Hebei Province, China. *PLoS One*. 2018;13(8):e0202265. doi:10.1371/journal.pone.0202265
3. Li L, Li KY, Yan K, et al. The history and challenges of blood donor screening in China. *Transfus Med Rev*. 2017;31(2):89–93. doi:10.1016/j.tmrv.2016.11.001
4. Yan J, Zheng X, Zhang X, et al. The survey of prevalence of HIV infection among paid blood donors in one county in China. *Chin J Epidemiol*. 2000;1:10–13.
5. Arsenault C, Gage A, Kim M, et al. COVID-19 and resilience of healthcare systems in ten countries. *Nat Med*. 2022;28(6):1314–1324. doi:10.1038/s41591-022-01750-1
6. Ghaznavi C, Tanoue Y, Kawashima T, et al. Recent changes in the reporting of STIs in Japan during the COVID-19 pandemic. *Sex Transm Infect*;2022. sextrans-2021–055378. doi:10.1136/sextrans-2021-055378
7. Yu Y, Xu J, Li M. Prevalence of HIV infection among Chinese voluntary blood donors during 2010–2017: an updated systematic review and meta-analysis. *Transfusion*. 2019;59(11):3431–3441. doi:10.1111/trf.15515
8. Siraj N, Achila O, Issac J, et al. Seroprevalence of transfusion-transmissible infections among blood donors at National Blood Transfusion Service, Eritrea: a seven-year retrospective study. *BMC Infect Dis*. 2018;18(1):264. doi:10.1186/s12879-018-3174-x
9. Guerrero-García J, Zúñiga-Magaña A, Barrera-De León J, et al. Retrospective Study of the Seroprevalence of HIV, HCV, and HBV in blood donors at a blood bank of Western Mexico. *Pathogens*. 2021;10(7). doi:10.3390/pathogens10070878
10. Karabaev BB, Beisheeva NJ, Satybaldieva AB, et al. Seroprevalence of hepatitis B, hepatitis C, human immunodeficiency virus, Treponema pallidum, and co-infections among blood donors in Kyrgyzstan: a retrospective analysis (2013–2015). *Infect Dis Poverty*. 2017;6(1):45. doi:10.1186/s40249-017-0255-9
11. Melku M, Ambachew S, Enawgaw B, et al. Sero-epidemiology and associated factors of HIV, HBV, HCV and syphilis among blood donors in Ethiopia: a systematic review and meta-analysis. *BMC Infect Dis*. 2021;21(1):778. doi:10.1186/s12879-021-06505-w
12. Mabunda N, Augusto O, Zicai AF, et al. Nucleic acid testing identifies high prevalence of blood borne viruses among approved blood donors in Mozambique. *PLoS One*. 2022;17(4):e0267472. doi:10.1371/journal.pone.0267472
13. Wu D, Feng F, Wang X, et al. The impact of nucleic acid testing to detect human immunodeficiency virus, hepatitis C virus, and hepatitis B virus yields from a single blood center in China with 10-years review. *BMC Infect Dis*. 2022;22(1):279. doi:10.1186/s12879-022-07279-5
14. Wu S, Gao M, Zheng J, et al. Prevalence of HIV indeterminate western blot tests and follow-up of HIV antibody sero-conversion in Southeastern China. *Virol Sin*. 2019;34(4):358–366. doi:10.1007/s12250-019-00130-3

15. M'Baya B. Seroprevalence and trends in transfusion transmissible infections among voluntary non-remunerated blood donors at the Malawi Blood Transfusion Service-a time trend study. *Malawi Med J*. 2019;31:118–125. doi:10.4314/mmj.v31i2.3
16. Peliganga L, Mello V, de Sousa P, et al. Transfusion transmissible infections in blood donors in the province of bié, Angola, during a 15-year follow-up, imply the need for pathogen reduction technologies. *Pathogens*. 2021;10(12):1633. doi:10.3390/pathogens10121633
17. Vučetić D, Jovičić M, Maslovarić I, et al. Transfusion-transmissible infections among Serbian blood donors: declining trends over the period 2005–2017. *Blood Transfus*. 2019;17(5):336–346. doi:10.2450/2019.0185-18
18. Li W, Wang X, Yang Y, et al. The associations of population mobility in HIV disease severity and mortality rate in China. *Ann Transl Med*. 2021;9:315. doi:10.21037/atm-20-4514
19. Shi L, Liu Y, Wang J, et al. HIV prevalence and incidence estimates among blood donors in five regions in China. *Transfusion*. 2020;60 (1):117–125. doi:10.1111/trf.15636
20. Zeng P, Liu J, Zhang C, et al. Current risk factors for HIV infection among blood donors in seven Chinese regions. *Transfusion*. 2020;60 (2):326–333. doi:10.1111/trf.15659
21. Griffifiths J, Fang N, Wang S. China's lack of sex education is putting millions of young people at risk. *CNN Health*. 2016. Available from: https://edition.cnn.com/2016/11/30/health/china-sex-educationworld-aids-day/.
22. Wang Y, Zhao C, Liu Z, et al. Spatiotemporal analysis of AIDS incidence and its influencing factors on the Chinese Mainland, 2005–2017. *Int J Environ Res Public Health*. 2021;18:1043. doi:10.3390/ijerph18031043
23. Chang L, Zhao J, Guo F, et al. Demographic characteristics of transfusion-transmitted infections among blood donors in China. *BMC Infect Dis*. 2019;19(1):514. doi:10.1186/s12879-019-4044-x
24. Slurink IA, Götz HM, van Aar F, et al. Educational level and risk of sexually transmitted infections among clients of Dutch sexual health centres. *Int J STD AIDS*. 2021;32:9564624211013670.
25. Jary A, Dienta S, Leducq V, et al. Seroprevalence and risk factors for HIV, HCV, HBV and syphilis among blood donors in Mali. *BMC Infect Dis*. 2019;19(1):1064. doi:10.1186/s12879-019-4699-3
26. Madeira H, da Silva C, Scapini N, et al. Correlation between serology and nucleic acid amplification test in blood donors who are reactive for hepatitis B virus, hepatitis C and human immunodeficiency virus and evaluation of the epidemiological profile of infected people in blood centers in the State of Paraná. *Saudi Pharm J*. 2021;29(6):586–596. doi:10.1016/j.jsps.2021.04.019
27. de Oliveira Garcia Mateos S, Preiss L, Gonçalez T, et al. 10-year analysis of human immunodeficiency virus incidence in first-time and repeat donors in Brazil. *Vox Sang*. 2021;116(2):207–216. doi:10.1111/vox.13002
28. Niazkar H, Dorgalaleh A, Rad F. First-time blood donors are double-edged swords for blood transfusion centers: a retrospective study in Southwest Iran. *Turkish J Haematol*. 2020;37(1):30–35. doi:10.4274/tjh.galenos.2019.2019.0166
29. Dodd RY, Crowder LA, Haynes JM, et al. Screening blood donors for HIV, HCV, and HBV at the American Red Cross: 10-year trends in prevalence, incidence, and residual risk, 2007 to 2016. *Transfus Med Rev*. 2020;34(2):81–93. doi:10.1016/j.tmrv.2020.02.001