International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Descriptive Epidemiology of Transfusion Transmissible Viral Infections and Syphilis among Asymptomatic Population at Nkwanta South Municipality in Oti Region of Ghana: A Six Years Single Centered Haemovigilance Study, 2015-2020

Abdul-Wahab Mawuko Hamid[1], Francis Kwaku Dusi[2], Emmanuel Agbasah Titiati [3], Kenneth Owusu Agyemang Jnr[4], Gideon Norvidzro[5], Emmanuel Senyo Kasu[6] Ahmed Tijani Bawah[7]

[1,2,5]Department of Medical Laboratory Sciences, School of Allied Health Sciences, University of Health and Allied Sciences, PMB 31, Ho, Volta Region, Ghana.
[3]St. Joseph's Catholic Hospital, P.O. Box 33 Nkwanta-South Municipal, Oti Region of Ghana.
[4]Akatsi Municipal Hospital, Agbalixorme on Tadzewu-Akatsi RD, Box Ak83.Akatsi, Volta Region, Ghana.
Ho Teaching Hospital, School of Public Health, University of Health and Allied Sciences, PMB31, Ho, Ghana.
[6]Faculty of Allied Health and Pharmaceutical Sciences Tamale Technical University, P.O. Box 3, Tamale, Ghana.

Abstract:
Background: As part of the ongoing Haemovigilance to tracks the changing epidemiology of Sexual Transmissible Infections (STIs) using population of Blood donors as proxy, this article presents the epidemiological features of Blood Donation and Transfusion Transmissible Viral Infections and Syphilis (TTIs) after the implementation of Global Health Strategy on STIs in 2016 to 2020 milestone, in line with the Sustainable Development Goals 3.3 for 2030 at the Nkwanta South Municipality in the Oti Region of Ghana.
Methods: This was a Laboratory-based Haemovigilance study. It was designed retrospectively to monitor and evaluate the dynamics of TTIs among Blood donors at St. Joseph Catholic Hospital in Nkwanta from 2015 to 2020. Data was managed electronically using Microsoft Visual Basics and analyzed using STATA. The descriptive features and associated trend metrics were determined using, frequentists, descriptive and Cochrane-Armitage statistics.
Results: Out of 2008 donors, 83.7% passed, and 16.1% failed the screening mechanism. Of 324 that failed, 61.7%, 30.6%, 7.7% were due to Clinical, Infections, and Clinical/Infection Comorbidity respectively. The Crude prevalence of TTIs was 6.0%. The point prevalence for HIV, HBV as well as HCV, and Syphilis was 4.4%, 5.0% 0.2% and 0.8% respectively.
Conclusion: Reference to validity metrics on Laboratory screening kits used, about 2.4% (48 of 2008) and 1.2% (24 of 2008) blood donated would be TTIs false negatives and false positives respectively. In addition to being the driver of TTIs in this study, HBV continues to trend positively (r=1.0) across the period. Although, HIV trended negatively across the period (r= -1.0), the prevalence of 4.4% HIV was significantly above the regional and national rates. These dynamics have 'programmatic' and 'research' implications. Transformation and Acceleration of Blood banking services to a regional status in Oti Region of Ghana are critical and urgently needed.

Keywords: Haemovigilance, Transfusion Transmissible Infections (TTIs), Human Immunodeficiency Virus (HIV), Hepatitis Viruses.

INTRODUCTION:

Blood transfusion remains a critical emergency intervention in clinical medicine. However, its association with Transfusion Transmissible Infections (TTIs) necessitates a constant monitoring and evaluation to track any changing epidemiology and optimize control and preventive strategies lead-in-time. In Sub-Saharan Africa, approximately 5-10% of Immunodeficiency Virus (HIV) infections and 12.5% of post-

transfusion Hepatitis cases are attributed to blood transfusion [1], [2], [3]. Furthermore, about 16 million of Hepatitis B Virus (HBV) and 5 million Hepatitis C virus (HCV) new infections are estimated to occur annually due to the transfusion of contaminated blood [4].

These trends pose a significant public health burden, particularly in low-income countries with limited financial resources and logistical constraints to procuring a cutting-edge technology in blood banking services. In response to these challenges, the global community implemented various strategies to mitigate the risks of Blood TTIs. These efforts are guided by centralized national policies and programs [5], in line with the United Nations' Sustainable Development Goals [6] and the Blood Safety Information System (BSIS) [7]. Following the implementation of the Global Health Strategy in 2016, and the launch of the BSIS in Ghana, which links HIV-infected donors to treatment mechanisms [8], it is essential to evaluate the impact of these interventions towards achieving the 2030 target for Sustainable Development Goal 3.3 [9]

However, conducting a scientific evaluation is challenging due to the scarcity of baseline information at some district levels in Ghana. To address this limitation, a Laboratory-Based Haemovigilance study was initiated to track the changing epidemiology of TTIs, including HIV and HBV, at the district levels before and after the introduction of the Global Health Strategies in Ghana. This article presents the Seroprevalence, Descriptive features, Dynamics and Trends of Transfusion Transmissible Viral Infections and Syphilis at St. Joseph's Catholic Hospital in Nkwanta, providing valuable insights into the epidemiology of these infections in Nkwanta Municipality in Oti Region of Ghana. The primary objective of this study was to track changes in the epidemiology of TTIs among blood donors in the study area, with a focus on the impact of the Global Health Sector Strategy on Sexual Transmissible Infections.

1 MATERIALS AND METHODS

1.1 Study Design and Setting:

This Laboratory-Based Haemovigilance study employed a retrospective design to investigate the dynamics of blood donation and trends in Transfusion-Transmissible Infections (TTIs) among blood donors at St. Joseph's Catholic Hospital in Nkwanta. The study period spanned six years, from 2015 to 2020, encompassing the pre-implementation (2015) and post-implementation (2016-2020) phases of the Global Health Sector Strategy on Sexual Transmissible Infections. Secondary data were extracted from laboratory records of blood donations collected between 2015 and 2020. The data focused on the prevalence of TTIs, specifically HIV, HBV, and Syphilis, among asymptomatic blood donors.

1.2 Study Site

The study was conducted in the Blood bank at St. Joseph's Catholic Hospital in Nkwanta. Nkwanta is the administrative capital of South Nkwanta Municipal. The Municipal is one of the eight municipalities and districts in Oti Region of Ghana [8]. It is in the northern part of the Oti Region at coordinates: 7 30°S, 8 45° N and 0 10°W, 0 45° East. The total land area is about 3,026km^2. The mean population within the study period was 117,878 with 58,482 males and 59,396 females [10] . The hospital is a 70-bed capacity facility, and provides a wider range of clinical services including surgical, reproductive child health and maternity [11]. It serves as a referral center for the surrounding primary health facilities including Four Health Centers, Twenty-nine CHPS compounds, and Four Private Health Facilities in the Municipality. During the period of study, the staff strength was over 200, including Six Biomedical Scientists and Three Laboratory Technicians who are technical handlers of Blood banking in the hospital [11] .

1.3 Study Participants

The blood donors constituted the study population. The blood donors were screened for HIV, HBV and HCV infections using Immunochromatographic Rapid Diagnostic Test kits of about 5 different brands listed in Table 1 within the study period. All tests were done according to the manufacturers' instructions outlined in the leaflets inserted in the test kits.

Table 1*: Brands and Validity values of RDT test devices used for screening of HBV, HCV and HIV among Blood donors in St. Joseph's Catholic Hospital Blood bank 2015 - 2020*

Manufacturer	***Year used***	***Device type***	***Sensitivity***	***Specificity***
ACON, San Diego, CA	2015	Strip	93%	100%
ACON, San Diego, CA	2016	Strip	99%	99%
OneStep HIGHTOP	2017-2020	Strip	99.3%	99.2%
Average			**97.6**	**98.8**

1.3.1 Data collection, Management and Analysis.

Data was collected using data extraction log and managed electronically using Microsoft Visual Basic. The computation was quality controlled using double data entry mechanism. The cleaned data was exported onto STATA software for statistical analyses. The socio-demographic, socio-economic, donation history and blood grouping parameters are categorized as independent variables, and serological test outcomes on named TTIs as dependent variables, a frequentists statistics and Cochrane-Armitage test were used to ascertain trends of TTIs. Clopper Pearson statistic was used to determine the 95% confidence intervals of the observations made in the study. The statistical outputs were presented in tables and Figures.

2 RESULTS

The frequentists in Table 2, showed that there was no single voluntary donor, as all the 2008 participants were Blood replacement donors. The highest number of 233 (11.7%) donors was recorded in the Month of May; followed by December: 229 (11.4%), August: 186 (9.3%), January: 183 (9.1%), February: 179 (8.9%), November: 176 (8.8%), July: 168 (8.4%) April: 158 (7.9%), September: 142 (7.1%), March: 133 (6·6%), October: 130 (6.5%) and June: 89 (4.4%). The Pearson's Chi-Square for proportions (p^{x2}), depicted a significant inter-variation in propositional distribution of donors across the Months (p^{x2}=326.7, p<0.01). However, the Cochrane-Armitage Chi-Square for trends (t^{x2}) depicted no significant intra-variation in propositional distribution of donors around the 167 mean donor population per month (t^{x2}=1.095, p=0.30). Nonetheless, the proportion of Blood donation in the months of May and December oscillate significantly at an average of 1.5% point above the mean rate of 8% [+/-2Standard Deviation (SD)]. Unlike May and December, the proportion of Blood donation in June oscillate significantly at -1.6% below the mean rate (+/-2SD). The proportional distribution of Blood donation in other months variate naturally around the Central Limit Theorem (+/-2 SD) (Table2). The frequentists on donation History in Table 2 showed a significant inter-variation (p^{x2}=35.1, p=0.01), and intra-variation (t^{x2} =4.7, p=0.05) in proportional distribution of 1994 (99.3%) first donors, and 14 (0.6) multiple donors across the period.

Also, the frequentists on periodicity of blood donation in Table 3 showed that out of 2008 donors recorded within the period, the highest proportion of 25.6% (n=515) was in 2018; followed by 24.7% (n=495) in 2019, 22.3% (n=447) in 2020, 14.8% (n=297) in 2017, 9.4% (n=189) in 2016, and 3.2% (n=65) in 2015. The number of Blood donors per annum was 335. The inter-variation (p^{x2}=595.9, p<0.01), as well as the intra-variation (t^{x2}=475.3, p<0.01) in proportional distribution of Blood donors within and across the period were statistically significant.

Periodicity	Population Screened For Blood Donation	BLOOD SOURCE		DONATION HISTORY		SCREENING OUTCOME		REASONS FOR FAILURE TO DONATE BLOOD		
		Voluntary Donors	*Replacement Donors*	*First time Doner*	*≥ Two Times Doner*	*Passed*	*Failed*	*Clinical Only*	*Infections Only*	*Both Clinical & Infections**
		n (%)	*n (%)*	*n (%)*	*n (%)*	*n (%)*	*n (%)*	*n (%)*	*n (%)*	*n (%)*
January	183	0(0.0)	183(9.1)	6(0.3)	2(0.1)	134(6.7)	49(2.4)	48(2.4)	0(0.0)	1(0.0)
February	179	0(0.0)	179(8.9)	0(0.0)	0(0.0)	159(7.9)	20(1.0)	6(0.3)	14(0.7)	0(0.0)
March	133	0(0.0)	133(6.6)	0(0.0)	0(0.0)	126(6.3)	7(0.3)	0(0.0)	7(0.3)	0(0.0)
April	158	0(0.0)	158(7.9)	0(0.0)	0(0.0)	153(7.6)	5(0.2)	0(0.0)	5(0.2)	0(0.0)
May	235	0(0.0)	235(11.7)	0(0.0)	0(0.0)	131(6.5)	104(5.2)	104(5.2)	0(0.0)	0(0.0)
June	89	0(0.0)	89(4.4)	1(0.0)	0(0.0)	88(4.4)	1(0.0)	0(0.0)	1(0.0)	0(0.0)
July	168	0(0.0)	168(8.4)	0(0.0)	0(0.0)	148(7.4)	20(1.0)	9(0.4)	11(0.5)	0(0.0)
August	186	0(0.0)	186(9.3)	1(0.0)	1(0.0)	129(6.4)	57(2.8)	2(0.1)	48(2.4)	7(0.3)
Sept	142	0(0.0)	142(7.1)	3(0.1)	0(0.0)	142(7.1)	0(0.0)	0(0.0)	0(0.0)	0(0.0)
October	130	0(0.0)	130(6.5)	0(0.0)	0(0.0)	129(6.4)	1(0.0)	0(0.0)	1(0.0)	0(0.0)
Nov	176	0(0.0)	176(8.8)	0(0.0)	0(0.0)	174(8.7)	2(0.1)	1(0.0)	1(0.0)	0(0.0)
Dec	229	0(0.0)	229(11.4)	0(0.0)	0(0.0)	171(8.5)	58(2.9)	30(1.5)	11(0.5)	17(0.8)
TOTAL	2008	0(0.0)	2008(100)	11(0.5)	3(0.1)	1684(83.9)	324(16.1)	200(10.0)	99(4.9)	25(1.2)
Mean	167(8.3)	0(0.0)	167(8.3)	1(0.0)	0(0.0)	140(6.7)	27(1.3)	17(0.8)	8(0.4)	2(0.1)
P^{X2} *(p-value)*	121.4 (<0.01)	-	50.30 (<0.01)	39.73 (<0.01)	15.24 (0.17)	326.7 (<0.01)		483.2 (<0.01)	221.9 (<0.01)	99.20 (<0.01)
T^{X2} *(p-value)*	1.095 (0.30)	-	6.903 (0.01)	4.581 (0.03)	2.468 (0.12)	6.545 (0.01)		35.28 (<0.01)	1.188 (0.28)	29.46 (<0.01)

Table 2: An Overview of Blood Banking Services In St. Joseph's Catholic Hospital: 2015-2020

Key; n= number; clinicals=Hb+weight+Blood pressure; TTIs= Transfusion Transmissible Infections; Clinical only means participants who failed to donate blood because they failed the physical examination, low Haemoglobin Concentration, and poor Body Mass Index; *clinical& Infections= participants which were excluded due to having both clinical infection and microbial infection at the same time %= Percentage; rc= Rate of Change; P^{X2}= Proportion Chi Square; T^{X2}= Trend Chi Square; r= Spearman's rank correlation coefficient

The Spearman's Coefficient depicted a strong negative correlation between trends in proportion of donors and period (r=-1.0). The frequentists on distribution of donors by socio-demographic parameters in Table 3, showed a significant inter - and intra-variations in proportional distribution of donors by host-gender parameters on one hand ($p<0.01$), and host-age parameters on another hand. Thus, of 2008 donors, 1462 (72.8%) and 546 (27.2%) of donors were Male and Female respectively ($p<0.01$), and 1505 (75%) and 503 (25%) were < 30years and ≥.30 years respectively ($p<0.01$).

Furthermore, the frequentists on screening outcomes in Table 2, showed that of 2008 potential donors screened, 1684 (83.9%) passed, and 324(16.1%) failed to donate. The inter- and intra-variations in propositional distribution of donors within ($p^{x2}=326.7$, $p<0.01$) and across ($t^{x2}=6.55$, $p=0.01$) those who passed versus failed the screening mechanism. Of the 324 that failed, 200 (10%) and 99 (4.9%) were due to clinical and microbial factors respectively.

YEAR	POPULATION SCREENED					PREVALENCE *Pathogens n(%)*					PREVALENCE *Pathogens (per 1,000 population)*				
	Frequency n (%)	Gender		Age Group											
		Male n (%)	*Female n (%)*	≤30yrs n (%)	>30yrs n (%)	*TTIs*	*HIV*	*HBV*	*HCV*	*T.p*	*TTIs*	*HIV*	*HBV*	*HCV*	*T.p*
2015	65 (3.2)	62 (3.1)	3 (0.1)	45 (2.2)	20 (1.0)	14 (21.5)	3 (4.6)	10 (15.4)	0 (0.0)	1 (1.5)	292	46	154	0	15
2016	189 (9.4)	118 (5.9)	71 (3.5)	161 (8.0)	28 (1.4)	22 (11.6)	9 (4.8)	11 (5.8)	0 (0.0)	2 (1.1)	524	48	58	0	11
2017	297 (14.8)	200 (10.0)	97 (4.8)	251 (12.5)	46 (2.2)	31 (10.4)	12 (4.0)	16 (5.5)	1 (0.3)	2 (0.7)	0	40	55	3	7
2018	515 (25.6)	338 (16.8)	177 (8.8)	492 (24.5)	23 (1.1)	48 (9.3)	23 (4.5)	20 (3.9)	1 (0.2)	4 (0.8)	10	45	39	2	8
2019	495 (24.7)	489 (24.4)	6 (0.3)	470 (23.4)	25 (1.2)	47 (9.5)	22 (4.4)	21 (4.2)	1 (0.2)	3 (0.6)	2	44	42	2	6
2020	447 (22.3)	416 (20.7)	31 (1.5)	86 (4.2)	361 (18.0)	50 (11.2)	20 (4.2)	2 4.9)	2 (0.4)	6 (1.3)	0	42	49	4	13
Total	2008 (100.0)	1462 (72.8)	546 (27.2)	1505 (75.0)	503 (25.0)	212 (73.5)	89 (26.5)	100 (39.7)	5 (1.1)	18 (6.0)	828	265	397	11	60
Mean (%)	335 (16.7)	244 (12.1)	91 4.5)	251 (12.5)	84 (4.2)	35 (12.3)	15 (4.4)	17 (6.5)	1 (0.2)	3 (1.0)	138	44	66	2	10
P^{X2} *(p-value)*	595.9 (<0.01)	677.4 (<0.01)	921.0 (<0.01)	837.4 (<0.01)	115.3 (<0.01)	10.15 (0.07)	0.165 (0.99)	17.14 (0.01)	1.541 (0.91)	2.077 (0.84)	2065 (<0.01)	0.967 (0.97)	154.1 (<0.01)	7.013 (0.22)	6.465 (0.26)
T^{X2} *(p-value)*	475.3 (<0.01)	545.8 (<0.01)	5.689 (0.02)	122.7 (<0.01)	497.7 (<0.01)	1.719 (0.19)	0.007 (0.99)	4.64 (0.03)	0.780 (0.38)	0.054 (0.82)	1092 (<0.01)	0.246 (0.62)	80.20 (<0.01)	4.879 (0.03)	0.8312 (0.36)
rs	0.6	0.6	0.5	0.5		0.83	1	0.77	0.68	0.81	-	-	-	-	-

Table 3: Epidemiologic Features of Venereal Infections Among Blood Donors In St. Joseph's Catholic Hospital: 2015-2020

Key: HBV = Hepatitis B Virus; TTIs= *Transfusion Transmissible Infections*; HIV= *Human Immunodeficiency Virus*; HCV= *Hepatitis C Virus*; T.p.= *Treponema pallidum;*n= number; %= Percentage; P-^{X2}= Proportion Chi Square; T-^{X2}= Trend Chi Square; rs= Spearman's rank correlation coefficient

Those who failed due to both clinical and microbial co-morbidity were 25 (1.2%). Although, the inter-variation in proportional distribution of those who failed due to Microbial factors was natural around the central limit theorem, the ANOVA depicted a significant intra-variation in proportional distribution of donors by failure to donate due to clinical, Microbial, and clinical/microbial co-morbidity parameter (F-stats= 268.1, p<0.01). The crude prevalence of TTI was 10.6% (212 of 2008). The highest crude prevalence of 5.0% (n=100) pathogen was HBV; followed HIV: 4.4% (n=89), Syphilis: 0.9% (n=18), and HVC: 0.2% (n=5).

The point prevalence of HBV was 15.4% (10 of 65) in 2015; 5.8% (11 of 189) in 2016; 5.5% (16 of 297) in 2017, 3.9% (20 of 515) in 2018; 4.2% (21 of 495) in 2019, and 4.9% (22 of 447). The inter-variation in proportional distribution of HBV across the period was statistically significant (p^{x2}=17.14, p=0.01). Also, the intra-variation in proportional distribution of HBV trended significantly around the central limit theorem (t^{x2}=4.64, p=0.03). Although, the distribution of HBV across the period was oscillatory dynamic, the Spearman's Coefficient depicted a moderate positive correlation between trends of HBV and periodicity (r= 0.8).

For HIV, the point prevalence was 4.6% (3 of 65) in 2015; 4.8% (9 of 189) in 2016; 4.0% (12 of 297) in 2017, 4.5% (23 of 515) in 2018; 4.4% (22 of 495) in 2019, and 4.2% (20 of 447) in 2020. The inter-variation in proportional distribution of HIV across the period was statistically significant (p^{x2}=0.165,

p=0.99). Also, the proportional distribution of HIV trended significantly around the central limit theorem by periodicity (t^{x2}=0.007, p=0.99). Although, the frequentists showed a reductive trend in distribution of HIV across the period, the Spearman's Coefficient depicted a moderate Negative correlation between trends of HIV and periodicity (r= -0.6). The point prevalence of HCV was 0.3% (1 of 297) in 2017, 0.2% (1 of 515) in 2018; 0.2% (1 of 495) in 2019, and 0.4% (2 of 447) in 2020. No case of HCV was recorded in 2015 and 2016. Unlike HIV and HBV, neither the inter-variation (p^{x2}=1.541, p=0.91), nor the intra-variation (t^{x2}=0.780, p=0. 38) in distribution of HCV within and across the period was statistically significant. Also, unlike HIV and HBV, the distribution of HCV plateaued across the period. Nonetheless, the Spearman's coefficient depicted a moderate positive correlation between trends of HCV and periodicity (r= 0.7).

For Syphilis, the point prevalence was 1.5% (1 of 65) in 2015; 1.1% (2 of 189) in 2016; 0.7% (2 of 297) in 2017, 0.8% (4 of 515) in 2018; 0.6% (3 of 495) in 2019, and 1.3% (6 of 447) in 2020. Similar to HIV and HBV, both the inter-variation (p^{x2}=2.077, p=0.84), and intra-variation in distribution of Syphilis within and across the period was statistically significant. Like HCV, the distribution of Syphilis plateaued across the period, and the Spearman's coefficient depicted a strong positive correlation between trends of HCV and periodicity (r= 0.8).

Moreover, the descriptive statistics Table 4 showed a broader Age range (15 - 90 years old) for non-infected donors. The Mean (*m*) age for non-infected host was 25.7, Standard Error (*SE*) for Mean: 0.2, Mode (*md*): 18, Median (*mn*): 23, 25% -75% Interquartile Range (IQR): 19.0 – 30.0 and Stand Deviation (SD) was 9.1. For infected Host, the Age ranges from 15 to 56 years, *m*: 22.7, S.E: 0.6, *md:* 17, *mn:* 20, 25% -75% *IQR*: 18-26 and *SD*: 7.1. The Mann-Whitney (U) test depicted a significant variation in mean ranks between infected and non-infected hosts (P<0.01). For HIV infected male-host, the age ranges from 16 - 46, *m:* 21.1, *SE*: 0.7, md: 17, *mn*: 19.0, *25%-75% IQR*: 17·0 - 23.0 and *SD:* 5.8. For infected female-host, the Age ranges from 15 - 56, *m:* 21.9, *SE:* 1.4, *md*: 16, *mn* = 20, *25% -75% IQR:* 17 - 24 and *SD:* 8.1. The Mann-Whitney depicted no significant variation in the mean ranks between HIV infected male and female host (p=0.86).

For HBV infected male-host, the age ranges from 16 – 46, *m*: 21.1, *SE:* 0.7, *md:* 17, *mn:* 19.0, *25% - 75% IQR*: 17 – 23, and *SD:* 5.4. For HBV infected female -host, the age ranges from ranges 15 - 56. *m:* 22.6, *SE*: 1.4, *md:* 16, *mn:* 20, 25%-75%, 1QR: 17 - 24 and *SD:* 8.2. Similar to HIV infection, Mann Whitney depicted no significant variations in Mean ranks between HBV infected male and female host (*U,p=0.66*). The Age for HCV infected male-host ranges from 19 -36, *m:* 29.7, SE: 5.4, *md:* 19, *mn:* 34, *25%-75% 1QR:*19 - 25 and *SD:* 9.3. For HCV infected female-host, the age ranges from 18 -40, *m*: 29.0, *SE:* 11, *md:* 18, *mn:* 29, *25%-75% IQR* 18 - 29, and *SD*: 15.6. Similar to HBV, there was no significant variation in mean ranks between HCV infected male and female hosts (*U,* p>0.99). The Age for Syphilis infected male, the age ranges from 18 - 44, *m:* 27; *SE:* 1.9, *md:* 26, *mn:* 26, *25% - 75% IQR:* 20 - 30, and *SD*: 7.5. For Syphilis infected female, the age ranges from 26 - 28, *m*: 26, *SE*: 0.3, *25% - 75% IQR*: 26 - 28. and *SD:*0.5. Unlike HIV, HBV and HCV, there was a significant variation in mean ranks between Syphilis infected Male and female hosts (*U, p<0.01*).

PARAMETERS	DESCRIPTIVE STATISTICS							MANN-WHITNEY TEST	
	Age Range	Mean	SE	Mode	Median	25% - 75% interquartile range	SD	U	P-value
1. Study Population Age									
a. Infections	15 - 56	22.7	0.6	17	20.0	18.0 - 26.0	7.1	91092	<0.01
b. No-Infection	15 – 90	25.7	0.2	18	23.0	19.0 - 30.0	9.1		
2.HIV Infections									
a. Male	16 - 46	21.1	0.7	17	19.0	17.0 – 23.0	5.8	891	0.86
b. Female	15 - 56	21.9	1.4	16	20.0	17.0 – 24.0	8.1		
2. HBV infection									
a. Male	16 – 46	21.1	0.7	17	19.0	17.0 - 23.0	5.4	1045	0.66
b. Female	15 – 56	22.6	1.4	16	20.0	17.0 - 24.0	8.2		
3. HCV Infection									
a. Male	19 – 36	29.7	5.4	19	34.0	19.0 – 25.0	9.3	3	>0.99
b. Female	18 – 40	29.0	11.0	18	29.0	18.0 - 29.0	15.6		
4. Syphilis Infection									
a. Male	18 – 44	27.0	1.9	26	26.0	20.0 - 30.0	7.5	2	>0.10
b. Female	26 – 28	26.0	0.3	26	26.0	26.0 - 26.0	0.5		

Table 4: Descriptive Features of Infectious Venereal Pathogens Among Population of Blood Donors in St. Joseph's Catholic Hospital, Nkwanta South Municipality From 2015 – 2020

Key; SE= Standard Error of Mean; SD= Standard Deviation, U = Mann-Whitney test

DISCUSSION

The findings of this study highlight the need for a comprehensive national assessment to determine the precise burden of TTIs in Ghana. In the context of the Nkwanta South Municipal in the Oti Region of Ghana, this study revealed trends in the Seroprevalence of HIV, HBV, and HCV infections among blood donors.

Trends of Blood Donation:

The study observed an increase in blood donation trends from 2015 to 2018, followed by a slight decline in 2019 and 2020. Notably, all blood donations were for family replacement, suggesting that this pattern may be driven by the need for replacement donors to save the lives of relatives and friends. The high percentage (99.3%) of first-time family replacement donors may be attributed to Ghana's reliance on replacement donors due to consistently low voluntary donor numbers. This phenomenon is consistent with the cultural context of Sub-Saharan Africa, where replacement donors remain the primary source of blood due to lower procurement costs and cultural acceptance. [12]

The demographic analysis of blood donors in this study revealed a significant gender disparity, with males comprising 72.8% of the total population. This finding is consistent with previous research in Ghana [13], [14], [15] and Africa [4], [16], [17], which have reported a higher proportion of male blood donors. The low participation rate of females in blood donation activities may be attributed to various clinical [18] and

sociocultural factors [19]. Clinical factors such as menstrual cycles [20] , anemia [18], pregnancy, nursing, or delivery [21] may contribute to the high deferral rate of female donors. Also, misconception about the effect of pre-pregnancy donation may deter women from engaging in blood donation [20]. Sociocultural views may also discourage female blood donation, perpetuating the gender disparity. [18], [22]

The study's findings also highlight the importance of engaging younger individuals in blood donation activities. Most blood donors (75.0%) were under the age of 30, demonstrating a higher level of engagement in blood donation among younger individuals. This finding is consistent with previous studies in Kenya [23] and Ethiopia [22], which reported similar age distributions among blood donors. The relatively high percentage of youth population in the Nkwanta South Municipal may contribute to the observed age distribution of donors [24].These findings have implications for blood donation policies and strategies, highlighting the need to target interventions towards increasing female participation and engaging younger individuals in blood donation activities.

Trends of Transfusion Transmissible Infections (TTIs):

The Seroprevalence rate of 10.6% for TTIs among blood donors at St. Joseph's Catholic Hospital in Ghana's Nkwanta South Municipality from 2015 to 2020 is notable. This rate is lower than that reported in Hohoe (18.6%) [4], Nigeria (19.3%) [16] and Burkina Faso (19.3%) [25], but higher than rates reported in Ho (3.6%) [26], Akatsi South (8.0%) [27], Eritrea (3.8%) [28], eastern Sudan (3%) [29] .Separate rates of TTIs among these regions may be attributed to variations in healthcare systems and associated risk factors. The high prevalence rate of TTIs in this study may be partly due to the fact that all blood donors were family replacements, which has been shown to be associated with higher infection rates compared to voluntary donors. [4], [29] . Voluntary donors, particularly repeat donors, may have received education on risk behaviors, making them less likely to have higher prevalence rates [30].

The age distribution of TTIs in this study showed that young people, particularly those between 15 and 56 years old, had the highest infection rates. Donors over 56 years old had generally lower infection rates. This finding is consistent with the typical distribution of TTIs among age groups. The slightly higher age range in this study compared to previous studies in Kintampo [14] and Hohoe [4] may be attributed to the increasing prevalence of risky sexual and social behaviors among younger generations [31], which exposes them to TTIs. Additionally, young people make up the bulk of blood donors, and those between the ages of 15 and 56 had the highest TTI rates, per the typical distribution of TTIs among age groups. Donors over 56 years old had generally reduced infection rates. The range was just a little bit higher than what was found in Kintampo [14] and Hohoe[4] , both of which had age ranges of 20 to 49 years. This may be explained by the rise in dangerous sexual and social behaviors among younger generations, which exposes them to TTIs, contrary to the older generations [31].

Transfusion Transmissible HIV infection:

The prevalence of HIV infection among blood donors in this study was 4.4%, which is slightly lower than rates reported in Ho (4.8%) [27] , Kintampo (4.9%)[14], Sokoto (4.6%) [32], and Calabar (4.2%) [2]. However, this rate is higher than those reported in Akatsi (3.8%)[27], Burkina Faso (2.2%) [26], and Ethiopia (0.1%) [17]. Notably, the prevalence rate in this study exceeds the national (2.0%) and regional (1.28%) HIV prevalence rates in Ghana [33]. The variation in HIV prevalence rates among different regions may be attributed to differences in risk behaviors, self-status knowledge, and donor recruitment strategies. The reliance on family replacement donors in this study, as opposed to voluntary unpaid donors in other regions, may have contributed to the higher prevalence rate. The persistent presence of HIV infection among blood donors over the study period highlights the need for intensified public health efforts to combat HIV/AIDS in the Nkwanta South Municipality. The age-specific analysis revealed a higher HIV

prevalence among donors under 30 years [31], which may be linked to risky social and sexual behaviors among younger individuals. The male-dominated prevalence of HIV infection in this study, with a higher rate among males than females, is consistent with previous findings. The possibility of males more likely to have [34] multiple sexual partners may contribute to this disparity.

Transfusion Transmissible HBV infection:

The Seroprevalence of HBV infection among blood donors in this study was 5.0%, which is comparable to the rate reported in Hohoe [4], but lower than rates reported in other regions of Ghana, including Ho municipal [15], Kintampo [14], Agogo [13], and Soboba District [35]. The prevalence rate in this study is also lower than those reported in Mozambique [36] and Equatorial Guinea [37], but higher than rates reported in Akatsi South [27] and Southeastern Nigeria [38]. The variations in HBV Seroprevalence rates among different studies may be attributed to differences in socioeconomic position, risk-taking behaviors, and the efficacy of donor selection techniques [38]. Notably, the HBV Seroprevalence rate in this study is lower than the national averages reported in Ghana's MDG [39] and SDG reports [40], suggesting the impact of global policy and national eradication programs [41].

The age-specific analysis revealed a higher HBV Seroprevalence rate among blood donors under 30 years, which may be linked to risk factors such as hazardous sexual behavior, bodily alteration, and youthful exuberance [42]. The higher prevalence of HBV infection among male donors compared to female donors in this study concurs with previous research [43], [44] and may be attributed to differences in behavioral risk factors between the sexes.

The high HBV Seroprevalence rate in this study highlights the need for strategic public health initiatives to address this issue, which should remain a top national priority. The WHO's management guidelines for HBV emphasize the importance of a streamlined public health strategy, including publicly-funded screening and treatment programs, universal access to hepatitis B prevention, care, and treatment, and scaled-up vaccination to reduce horizontal transmission [45].

Transfusion Transmissible HCV infection:

The Seroprevalence of HCV infection among blood donors in this study was 0.2%, which is significantly lower than rates reported in other regions, including Akatsi South (1.0%) [27], Koforidua (8.0%) [46], Kintampo (4.4%) [14], and Burkina Faso (8.6%) [25]. The variability in HCV Seroprevalence rates across studies may be attributed to differences in risk-taking behaviors [47], [48] and testing methodologies [49], which can have varying sensitivities and specificities [50]. The relatively low prevalence of HCV compared to HBV in this study may be due to the differences in transmission dynamics between the two viruses [51]. HCV is generally considered less contagious than HBV and is primarily spread through blood or blood product transfusions and intravenous drug misuse [51]. In contrast, HBV can be transmitted through multiple routes, including vertical transmission, sexual contact, and blood transfusions [52]. These differences in transmission dynamics may contribute to the observed disparity in Seroprevalence rates between HCV and HBV in this study.

Transfusion Transmissible Syphilis infection:

The Seroprevalence of Syphilis infection among blood donors in this study was 0.9%, which is lower than rates reported in Hohoe (5.2%)[4] and Nigeria (1.6%)[37], but significantly lower than the alarming rate of 21.5% reported in Equatorial Guinea[37]. In contrast, the Syphilis prevalence rate in this study is identical to the rate reported in Ethiopia (0.9%)[29].The relatively low prevalence rate of Syphilis in this study may be attributed to the effectiveness of intervention and treatment programs implemented over the years. However, the variability in Syphilis prevalence rates across different studies may also be influenced by factors such as the duration of the study and cultural and behavioral differences among the study

populations. These factors may contribute to the observed disparities in Syphilis prevalence rates across different regions.

LIMITATIONS

This study has several limitations that should be considered when interpreting the results. Firstly, the retrospective study design limited the evaluation of other risk factors that may affect the prevalence of TTIs, as certain information such as occupation, marital status, blood source, religion, education level, and location was missing from the blood donor registers. Additionally, the use of Rapid Diagnostic Testing (RDT) as a qualitative in vitro method may have impacted the results, as no additional sensitivity test methods were used to confirm positive RDT results as true positives. This may have led to potential false positives or false negatives, which could affect the accuracy of the results. Therefore, future research should consider addressing these limitations to provide a more comprehensive understanding of the prevalence of TTIs among blood donors.

CONCLUSION

In conclusion, this study has provided valuable insights into the Seroprevalence of TTIs among blood donors in the Nkwanta South Municipality of Ghana. The findings indicate a significant burden of TTIs, with HBV being the most prevalent, followed by HIV, Syphilis, and HCV. The study highlights the need for targeted interventions to reduce the transmission of TTIs, particularly among high-risk groups such as young people and family replacement donors. The study's findings also emphasize the importance of addressing the social and behavioral factors that contribute to the transmission of TTIs. Furthermore, the study underscores the need for improved blood donor selection and screening practices, including the use of more sensitive and specific diagnostic tests.

The results of this study have implications for blood transfusion services, public health policy, and future research directions. Specifically, the findings suggest the need for:

1. Enhanced public awareness and education campaigns to promote safe blood donation practices and reduce the risk of TTI transmission.
2. Improved blood donor selection and screening practices, including the use of more sensitive and specific diagnostic tests.
3. Targeted interventions to reduce the transmission of TTIs among high-risk groups, such as young people and family replacement donors
4. Continued monitoring and evaluation of TTI prevalence among blood donors to inform public health policy and practice.

Overall, this study contributes to the understanding of the epidemiology of TTIs among blood donors in Ghana and highlights the need for sustained efforts to reduce the transmission of TTIs and ensure the safety of the blood supply.

RECOMMENDATIONS

Short-term Recommendations:

1. Improved Blood Donor Selection and Screening Practices by using more sensitive and specific diagnostic tests to screen for TTIs, particularly among high-risk groups.
2. Enhanced Public Awareness and Education Campaigns by conducting public awareness and education campaigns to promote safe blood donation practices and reduce the risk of TTI transmission.

3. Implement targeted interventions to reduce the transmission of TTIs among high-risk groups, such as young people and family replacement donors.

Long-term Recommendations:

1. Implementation of national guidelines for blood donor selection and screening practices to ensure consistency and standardization across the districts in Oti Region of Ghana.
2. Establishment of a Regional Blood Transfusion Service to oversee and coordinate blood donation and transfusion activities across the districts in Oti Region of Ghana.
3. Source for funding for blood safety initiatives, including the procurement of diagnostic tests and equipment, and the training of healthcare personnel.
4. Research and Surveillance: Conduct regular research and surveillance to monitor the prevalence of TTIs among blood donors and to evaluate the effectiveness of interventions across the districts in Oti Region of Ghana
5. Implement the national regulatory framework to oversee and regulate blood donation and transfusion activities, including the licensing and accreditation of blood banks and transfusion services across the districts in Oti Region of Ghana.

DECLARATIONS

Funding

State funding information or write: 'This research received no specific grant from any funding agency.'

Conflict of Interest

The authors declare no conflict of interest.

Ethical Approval (if applicable)

Ethical clearance was sought from the University of Health and Allied Sciences, Research Ethics Committee (REC) to carry out this study. The ethical certification number is UHAS-REC A.6 [102] 19-20. Permission was also obtained from the management of the St. Joseph's Catholic Hospital before the commencement of the study.

Author Contributions

1. **Conceptualization:** Abdul-Wahab Mawuko Hamid.
2. **Methodology:** Emmanuel Senyo Kasu (Study design), Francis Dusi Kwaku (Data collection), Gideon Norvidzro (Data Collection),
3. **Analysis:** Kenneth Owusu Agyemang Jnr (Laboratory analysis), Emmanuel Agbasah Titiati (Laboratory analysis and statistical analysis).
4. **Writing:** Abdul-Wahab Mawuko Hamid and Ahmed Tijani Bawah (internal editor),

Data Availability Statement

Data available upon reasonable request.

AI Usage Statement

Writefull software used for language editing only.

Acknowledgement

We would like to extend our sincere gratitude to the management of hospital, particularly Dr. Raymond Amoah, Medical Superintendent, and Rev. SR. Anastasia A. Okyere, Administrator, for granting us permission to conduct this study in their facility. We appreciate the support shown to us, and we are grateful for the opportunity to collaborate with the hospital.We also acknowledge the contribution of Mr. Adea Abada, Biostatistician, for his valuable input and guidance throughout the study.The cooperation and assistance provided by the hospital's administration, medical staff, and other personnel have been invaluable to our research, and we acknowledge their contributions to the success of this study. We look forward to sharing our findings with the hospital and the broader medical community.

REFERENCES:

[1] B. Biadgo, S. E, W. B, A. Ka, and M. M, "Transfusion-transmissible viral infections among blood donors at the North Gondar district blood bank, northwest Ethiopia: A three year retrospective study," *PloS One*, vol. 12, no. 7, Jul. 2017, doi: 10.1371/journal.pone.0180416.

[2] H. U. Okoroiwu, I. M. Okafor, E. A. Asemota, and D. C. Okpokam, "Seroprevalence of transfusion-transmissible infections (HBV, HCV, syphilis and HIV) among prospective blood donors in a tertiary health care facility in Calabar, Nigeria; an eleven years evaluation," *BMC Public Health*, vol. 18, no. 1, p. 645, May 2018, doi: 10.1186/s12889-018-5555-x.

[3] E. Shiferaw, W. Tadilo, I. Melkie, and M. Shiferaw, "Sero-prevalence and trends of transfusion-transmissible infections among blood donors at Bahir Dar district blood bank, northwest Ethiopia: A four year retrospective study," *PloS One*, vol. 14, no. 4, p. e0214755, 2019, doi: 10.1371/journal.pone.0214755.

[4] F. Adu-poku, and E. Agboli, "Seroprevalence of Transfusion Transmissible Infections among Blood Donors in the Hohoe Municipality Hospital, Ghana 2015-2016 A Retrospective Hospital-Based Cross-Sectional Study. PAMJ— Clinical Medicine, 2, Article No. 12. - References - Scientific Research Publishing." Accessed: Feb. 12, 2026. [Online]. Available: https://www.scirp.org/reference/referencespapers?referenceid=3478517

[5] L. Riva and C. Petrini, "Blood safety policy: should cautionary policies be adopted with caution?," *Blood Transfus. Trasfus. Sangue*, vol. 16, no. 5, pp. 405–407, Sep. 2018, doi: 10.2450/2018.0135-18.

[6] Promoting Safe and Sustainable National Blood Systems, "IFRC Blood Policy: Promoting Safe and Sustainable National Blood Systems – Blood Donation Community Based Health and First Aid (CBHFA) | Resilience Library." Accessed: Feb. 12, 2026. [Online]. Available: https://www.rcrc-resilience-southeastasia.org/document/ifrc-blood-policy-promoting-safe-and-sustainable-national-blood-systems-blood-donation-community-based-health-and-first-aid-cbhfa/

[7] Centers for Disease Control and Prevention (CDC), "Prevalence and awareness of HIV infection among men who have sex with men --- 21 cities, United States, 2008," *MMWR Morb. Mortal. Wkly. Rep.*, vol. 59, no. 37, pp. 1201–1207, Sep. 2010.

[8] S. Ampomah, "Hon. Kwaku Agyeman-Manu launches the revised National Blood Policy," Ministry Of Health. Accessed: Feb. 12, 2026. [Online]. Available: https://www.moh.gov.gh/hon-kwaku-agyeman-manu-launches-the-revised-national-blood-policy/

[9] J. B. Tapko, B. Toure, and L. G. Sambo, "STATUS OF BLOOD SAFETY IN THE WHO AFRICAN REGION".

[10] Ghana Districts, "Ghana Districts: A repository of all Local Assemblies in Ghana." Accessed: Feb. 12, 2026. [Online]. Available: https://ghanadistricts.com/

[11] GNA, "Health infrastructural decay-the state of Akatsi Municipal Hospital," Ghana News Agency. Accessed: Feb. 12, 2026. [Online]. Available: https://gna.org.gh/2021/06/health-infrastructural-decay-the-state-of-akatsi-municipal-hospital/

[12] E. Osaro and A. T. Charles, "The challenges of meeting the blood transfusion requirements in Sub-Saharan Africa: the need for the development of alternatives to allogenic blood," *J. Blood Med.*, vol. 2, pp. 7–21, 2011, doi: 10.2147/JBM.S17194.

[13] B. Nkrumah, M. Owusu, H. O. Frempong, and P. Averu, "Hepatitis B and C viral infections among blood donors from rural Ghana," *Ghana Med. J.*, vol. 45, no. 3, pp. 97–100, Sep. 2011.

[14] W. Walana *et al.*, "Sero-prevalence of HIV, HBV and HCV among Blood Donors in the Kintampo Municipal Hospital, Ghana," *Br. Microbiol. Res. J.*, vol. 4, no. 12, pp. 1491–1499, 2014, doi: 10.9734/bmrj/2014/12160.

[15] S. Y. Lokpo *et al.*, "Viral Hepatitis Endemicity and Trends among an Asymptomatic Adult Population in Ho: A 5-Year Retrospective Study at the Ho Municipal Hospital, Ghana," *Hepat. Res. Treat.*, vol. 2017, p. 6174743, 2017, doi: 10.1155/2017/6174743.
[16] E. Nwankwo, M. Imoru, I. Umar, M. Babashani, and S. Adeleke, "Seroprevalence of major blood-borne infections among blood donors in Kano, Nigeria," *Turk J Med Sci*, vol. 42, Apr. 2012, doi: 10.3906/sag-1009-1176.
[17] Y. Mohammed and A. Bekele, "Seroprevalence of transfusion transmitted infection among blood donors at Jijiga blood bank, Eastern Ethiopia: retrospective 4 years study," *BMC Res. Notes*, vol. 9, p. 129, Feb. 2016, doi: 10.1186/s13104-016-1925-6.
[18] L. Kasraian, S. Ashkani-Esfahani, and H. Foruozandeh, "Reasons of under-representation of Iranian women in blood donation," *Hematol. Transfus. Cell Ther.*, vol. 43, no. 3, pp. 256–262, 2021, doi: 10.1016/j.htct.2020.03.009.
[19] N. Saqlain, "Blood Donation; Knowledge, Attitude and Beliefs Of The Female Attendants," *Prof. Med. J.*, vol. 24, pp. 1806–1811, Dec. 2017, doi: 10.17957/TPMJ/17.4003.
[20] M. Germain, G. Delage, P. Robillard, L. M. Katz, and Y. Grégoire, "The association between frequency of blood donation and the occurrence of low birthweight, preterm delivery, and stillbirth: a retrospective cohort study," *Transfusion (Paris)*, vol. 56, no. 11, pp. 2760–2767, Nov. 2016, doi: 10.1111/trf.13762.
[21] B. E. Feleke and T. E. Feleke, "The Effect of Pregnancy in the Hemoglobin Concentration of Pregnant Women: A Longitudinal Study," *J. Pregnancy*, vol. 2020, p. 2789536, 2020, doi: 10.1155/2020/2789536.
[22] A. Mremi, J. J. Yahaya, M. Nyindo, and E. Mollel, "Transfusion-Transmitted Infections and associated risk factors at the Northern Zone Blood Transfusion Center in Tanzania: A study of blood donors between 2017 and 2019," *PloS One*, vol. 16, no. 3, p. e0249061, 2021, doi: 10.1371/journal.pone.0249061.
[23] N. Njuguna, "Factors influencing blood donation at selected sites in Nairobi, Kenya." Accessed: Feb. 12, 2026. [Online]. Available: https://scholar.google.com/citations?view_op=view_citation&hl=en&user=jEt6QzoAAAAJ&citation_for_view=jEt6QzoAAAAJ:UeHWp8X0CEIC
[24] Population and Housing Census, "2021 Population and Housing Census." Accessed: Feb. 12, 2026. [Online]. Available: https://census2021.statsghana.gov.gh/subreport.php?readreport=MjYzOTE0MjAuMzc2NQ==&Ghana-2021-Population-and-Housing-Census-General-Report-Volume-3B
[25] M. B. Nagalo *et al.*, "Seroprevalence of human immunodeficiency virus, hepatitis B and C viruses and syphilis among blood donors in Koudougou (Burkina Faso) in 2009," *Blood Transfus. Trasfus. Sangue*, vol. 9, no. 4, pp. 419–424, Oct. 2011, doi: 10.2450/2011.0112-10.
[26] E. Osei, S. Y. Lokpo, and E. Agboli, "Sero-prevalence of hepatitis B infection among blood donors in a secondary care hospital, Ghana (2014): a retrospective analysis," *BMC Res. Notes*, vol. 10, no. 1, p. 391, Aug. 2017, doi: 10.1186/s13104-017-2733-3.
[27] A.-W. Hamid *et al.*, "Haemovigilance and Trends of Transfusion Transmissible Viral Infections among Asymptomatic Population at Akatsi South Municipal in Volta Region of Ghana from," *Isr. J. Health Policy Res.*, vol. 2, pp. 94–102, Jun. 2023.
[28] N. Fessehaye, D. Naik, and T. Fessehaye, "Transfusion transmitted infections - a retrospective analysis from the National Blood Transfusion Service in Eritrea," *Pan Afr. Med. J.*, vol. 9, p. 40, 2011, doi: 10.4314/pamj.v9i1.71219.
[29] T. Abdallah, A. Aziem, and A. Ali, "Sero-prevalence of transfusion-transmissible infectious diseases among blood donors in Kassala, eastern Sudan," Jan. 2012.

[30] D. O. Damulak *et al.*, "The pattern of blood donation and transfusion transmissible infections in the National Blood Transfusion Service in north central Nigeria," *Highl. Med. Res. J.*, vol. 14, no. 2, pp. 80–84, Nov. 2014.
[31] M. Popov, S. Vojinov, I. Levakov, D. Grbić, D. Jeremić, and I. Popov, "Risky sexual behavior and knowledge about sexually transmitted infections among the young people," *Med. Pregl.*, vol. 72, no. 9–10, pp. 265–271, 2019.
[32] O. Erhabor *et al.*, "Prevalence of transfusion- transmissible HIV infection among blood donors in Sokoto, North Western Nigeria," *Am. J. Microbiol. Biotechnol.*, Sep. 2014.
[33] National AIDS Control Programme, "CCM Ghana - National AIDS Control Programme." Accessed: Feb. 12, 2026. [Online]. Available: https://ccmghana.net/index.php/2018-2020/hiv-aids/national-aids-control-program
[34] W. N. Chialepeh and A. Sathiyasusuman, "Associated Risk Factors of STIs and Multiple Sexual Relationships among Youths in Malawi," *PloS One*, vol. 10, no. 8, p. e0134286, 2015, doi: 10.1371/journal.pone.0134286.
[35] A. M. Nlankpe, P. K. Kwadzokpui, D. Adedia, J. N. Nignan, and P. K. Owiafe, "Seroepidemiology of Hepatitis B and C Virus Infections: A Five-Year Retrospective Study among Blood Donors in Saboba District in the Northern Region of Ghana," *BioMed Res. Int.*, vol. 2021, p. 5599705, 2021, doi: 10.1155/2021/5599705.
[36] J. Stokx *et al.*, "Seroprevalence of transfusion-transmissible infections and evaluation of the pre-donation screening performance at the Provincial Hospital of Tete, Mozambique," *BMC Infect. Dis.*, vol. 11, p. 141, May 2011, doi: 10.1186/1471-2334-11-141.
[37] D.-D. Xie *et al.*, "Seroprevalence of Human Immunodeficiency Virus, Hepatitis B Virus, Hepatitis C Virus, and Treponema pallidum Infections among Blood Donors on Bioko Island, Equatorial Guinea," *PloS One*, vol. 10, no. 10, p. e0139947, 2015, doi: 10.1371/journal.pone.0139947.
[38] T. Deressa *et al.*, "Proportion and predictors of transfusion-transmissible infections among blood donors in North Shewa Zone, Central North Ethiopia," *PLOS ONE*, vol. 13, no. 3, p. e0194083, Mar. 2018, doi: 10.1371/journal.pone.0194083.
[39] R. Ofori-Asenso and A. A. Agyeman, "Hepatitis B in Ghana: a systematic review & meta-analysis of prevalence studies (1995-2015)," *BMC Infect. Dis.*, vol. 16, p. 130, Mar. 2016, doi: 10.1186/s12879-016-1467-5.
[40] J. Abesig, Y. Chen, H. Wang, F. M. Sompo, and I. X. Y. Wu, "Prevalence of viral hepatitis B in Ghana between 2015 and 2019: A systematic review and meta-analysis," *PloS One*, vol. 15, no. 6, p. e0234348, 2020, doi: 10.1371/journal.pone.0234348.
[41] CGHE, "Ghana National Hepatitis Elimination Profile: Key Takeaways," CGHE. Accessed: Feb. 12, 2026. [Online]. Available: https://www.globalhep.org/news-blogs/ghana-national-hepatitis-elimination-profile-key-takeaways
[42] S. Yang *et al.*, "Transmission of Hepatitis B and C Virus Infection Through Body Piercing: A Systematic Review and Meta-Analysis," *Medicine (Baltimore)*, vol. 94, no. 47, p. e1893, Nov. 2015, doi: 10.1097/MD.0000000000001893.
[43] R. T. Mavenyengwa, M. Mukesi, I. Chipare, and E. Shoombe, "Prevalence of human immunodeficiency virus, syphilis, hepatitis B and C in blood donations in Namibia," *BMC Public Health*, vol. 14, p. 424, May 2014, doi: 10.1186/1471-2458-14-424.
[44] F. Farshadpour *et al.*, "Prevalence and Trends of Transfusion-Transmissible Viral Infections among Blood Donors in South of Iran: An Eleven-Year Retrospective Study," *PloS One*, vol. 11, no. 6, p. e0157615, 2016, doi: 10.1371/journal.pone.0157615.
[45] G. L.-H. Wong and M. Lemoine, "The 2024 updated WHO guidelines for the prevention and management of chronic hepatitis B: Main changes and potential implications for the next major

liver society clinical practice guidelines," *J. Hepatol.*, vol. 82, no. 5, pp. 918–925, May 2025, doi: 10.1016/j.jhep.2024.12.004.
[46] A. Holy *et al.*, "HIV, HBV, HCV and syphilis infections among blood donors in Koforidua, 2016," *Pan Afr. Med. J. Conf. Proc.*, vol. 1, Jan. 2018, doi: 10.11604/pamj.cp.2017.3.34.153.
[47] A. Dantas-Duarte *et al.*, "Risk-taking behavior and impulsivity among HCV-infected patients," *Psychiatry Res.*, vol. 243, pp. 75–80, Sep. 2016, doi: 10.1016/j.psychres.2016.04.114.
[48] R. Henrique-Araújo *et al.*, "Comparative study of impulsiveness and risk behaviors among infected individuals with hepatitis C virus and human T-cell lymphotropic virus type 1," *Ann. Hepatol.*, vol. 19, no. 2, pp. 166–171, 2020, doi: 10.1016/j.aohep.2019.09.005.
[49] S. V. Thoke and A. K. Yadav, "Prevalence and Genotype Distribution of Hepatitis C Virus Infection at Zonal hospital in Northern India," *NaN*, no. NaN, p. NaN-NaN, 2023, doi: 10.4103/jmms.jmms_147_23.
[50] G. Jargalsaikhan *et al.*, "Sensitivity and specificity of commercially available rapid diagnostic tests for viral hepatitis B and C screening in serum samples," *PLOS ONE*, vol. 15, no. 7, p. e0235036, Jul. 2020, doi: 10.1371/journal.pone.0235036.
[51] F. Saillour *et al.*, "Prevalence and determinants of antibodies to hepatitis C virus and markers for hepatitis B virus infection in patients with HIV infection in Aquitaine. Groupe d'Epidémiologie Clinique du SIDA en Aquitaine," *BMJ*, vol. 313, no. 7055, pp. 461–464, Aug. 1996, doi: 10.1136/bmj.313.7055.461.
[52] J. Hou, Z. Liu, and F. Gu, "Epidemiology and Prevention of Hepatitis B Virus Infection," *Int. J. Med. Sci.*, vol. 2, no. 1, pp. 50–57, 2005, doi: 10.7150/ijms.2.50.