

# Seroprevalence, trends, and risk factors of hepatitis B and C among family replacement blood donors; a 7-year retrospective study at Sunyani Municipal Hospital, Ghana

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# Abstract Background

Hepatitis B and C cause chronic infections which develop into liver-related sequelae, like cirrhosis and liver carcinoma. This study determined the prevalence, trends, and risk factors of HBV and HCV among family replacement blood donors.

# Methods

A retrospective review of primary data on blood donors screened between January 2015 and December 2021 was conducted at the Sunyani Municipal Hospital. The data were assessed for seroprevalence, trends, and odds ratios using SPSS.

# Results

Of 6847 donors, the majority were males (88.1% [6033]),  $\leq$  24 years (27.4% [1874]), of the O blood type (69.8% [4776]), and Rh-positive (89.9% [6154]). Seroprevalences of HBV and HCV were 3.2% and 1.9%, respectively, with more males infected with both HBV and HCV (3.4% vs 2.0%). Male donors were 2.842 times (CI: 1.500-5.385, p = 0.001) and 2.399 times (CI: 1.116-5.157, p = 0.025) more susceptible than females to HBV and HCV, respectively. In the rainy season, donors were 1.489 times (CI: 1.017-2.180, p = 0.041) more susceptible to HCV. HBV and HCV showed declining trends over the period (slope: -0.5464,  $p \leq$  0.001 vs slope: -0.6179,  $p \leq$  0.001).

# Conclusion

Gender was significantly associated with both HBV and HCV, while season was significantly associated with HCV. The male gender and rainy season were significant determinants of both infections. The seroprevalence of HBV was higher than HCV despite the significant decline in both HBV and HCV seroprevalences. We, recommend health authorities intensify health education among males and during the rainy season. Also, local variations in the seroprevalence of these infections call for upgrade and standardisation in serological testing for blood donors across Ghanaian blood centres.

# Introduction

Worldwide, whole blood and its fractionated products are transfused to save the lives of patients suffering from anaemia due to either sudden or insidious blood shortages [1]. Patients with a high risk of transfusion include haemorrhaging pregnant women, patients with anaemia due to plasmodial infections [2][3], sickle cell disease and other haemoglobin disorders [3]. Although blood transfusion plays a significant therapeutic role in patient care, healthcare providers still rely on the benevolence of human

donors for blood, since there is currently no alternative to blood [4]. Consequently, there is the propensity to disseminate diseases through the donation and transfusion of infected blood units.

Blood transfusion is a notable source of spread for transfusion-associated infectious agents like hepatitis B virus (HBV) and hepatitis C virus (HCV), which have similar routes of spread including sexual intercourse and or contact with infected blood [5]. Although effective prophylaxis against HBV exist for several decades [6][7], about 2 billion infected individuals have been recorded globally, of which approximately 350 million are persistently infected [8][7]. Hepatitis B virus causes chronic infections in over 50 million individuals in Africa, whereas, in Sub-Saharan Africa alone up to 20% of HBV-infected people are chronic carriers [8]. Such persistent infections result in hepatitis-associated sequelae like cirrhosis and carcinoma of the liver [7]. For instance, approximately 59% of liver carcinomas detected in underdeveloped countries are attributed to HBV infection [6]. Conversely, the burden of HCV infection is estimated at 200 million cases globally, of which 85% are long-term carriers who are likely to develop cirrhosis and carcinoma of the liver [9]. Consequently, infections resulting from both HBV and HCV account for over 1 million deaths annually [10].

In Ghana, blood donors undergo screening to exclude infected donors, however, the screening may be insufficiently done due to limited resources [11] and this may pose a significant health risk to blood recipients. The burden of HBV and HCV in Ghana is fragmented and varies from one place to the other, with some [12][13] showing local variations. Although several studies [11][12][14] conducted in Ghana reported on the prevalence, and trends of HBV and HCV, they failed to determine the risk factors of these infections. Furthermore, a similar study conducted by Walana *et al.*, [8] in the Bono Region focused only on the prevalence of HBV while no attention was accorded to HCV despite its association with severe liver-related diseases.

This study, therefore, determined the prevalence, trends, and risk factors of HBV and HCV among apparently healthy family replacement blood donors. This aims to document the epidemiology of HBV and HCV in the Sunyani Municipality since there is currently a paucity of data on the burden of hepatitis infections in this setting.

# **Materials And Methods**

## Study design and setting

This was a single-centre hospital-based retrospective study conducted between January and May 2022, at the Sunyani Municipal Hospital, Ghana. The Sunyani Municipal Hospital is a 105-bed capacity healthcare facility located within an urban and central business district of the Sunyani Municipality. The hospital is one of several- and the second largest public hospital in Sunyani, after the Regional Hospital. The hospital manages both in-patient and out-patients, with services ranging from public health, pharmacy, trauma and surgery, internal medicine, clinical diagnostic laboratory, chest clinic, ear-nose-and-throat (ENT) clinic, antiretroviral therapy (ART) clinic, dental clinic, eye clinic, medical imaging (including ultrasonography and x-ray), antenatal and post-natal clinic, and a morgue. The

hospital has separate in-patient wards for obstetric, post-surgery recovery, paediatrics, and adult female and adult male patients. Sunyani is the administrative capital of the Sunyani Municipality and is located within the western section of the Bono Region. The municipality is inhabited by approximately 123,224 people, with 6,933 of them being females [15].

## Study population

In this study, we retrospectively reviewed primary laboratory data of prospective family replacement blood donors who visited the blood bank of Sunyani Municipal Hospital in the Bono Region between January 2015 and December 2021. Information on 6847 family replacement blood donors screened within this seven years (2015-2021) and had their data entered in the blood bank's archived records were retrieved using convenient sampling.

### **Data collection**

Primary laboratory data on prospective family replacement blood donors which were completely entered in the blood bank registers and legible for data extraction were included in the study. Conversely, records with incomplete and/or illegible donor information were excluded. The eligibility of each donor record was determined by the completeness and correctness of the information. Some of the donor information retrieved included year and month of screening, age of donors in years, gender, ABO and Rh blood types, and results of serological screening for HBV and HCV.

### Screening of blood donors

The prospective blood donors were healthy individuals between 17 and 60 years of age. All the donors were assisted to complete a self-exclusion pre-donation questionnaire to help exclude unsuitable donors with high-risk behaviour and morbidities. Anthropometric data including weight and blood pressure were measured. Furthermore, serological screening of infectious agents which included HCV and HBV was performed on serum from each blood donor using rapid lateral-flow immunoassays. The assay qualitatively detects the presence of HCV antibodies and surface antigens of HBV (HBsAg). The algorithms used for routinely testing HBV and HCV in blood banks in Ghana have been described by Nkansah *et al.,* [11].

The spreadsheet containing the data was checked for entry errors and imported into IBM SPSS Statistics for Windows, Version 23 (Armonk, NY: IBM Corp.) for binning, recoding, and analyses. Microsoft Excel 2016 for Windows (Microsoft Corporation, USA) was used to visualise the data. The only scale variable, age, was presented as median and interquartile range. Also, it was transformed into four categories, using "visual binning". The months in which donors were screened were recoded into rainy- and dry seasons, the two major seasons observed in Ghana. This was done as described by Logal *et al.*, [16]: the rainy season included April-July and September-November, whereas the dry season included December-March and August. All the categorical data were presented as frequencies and proportions, while Chi-square and Fisher's exact tests were used to determine associations between different categories. The determination of age as a risk factor for the viral markers was done using multinomial logistic regression, whereas for gender and donor type binary logistic regression was used. P-value  $\leq 0.05$  was considered significant for all statistical analyses.

## Results

## Sociodemographic and blood group characteristics of the blood donors

Table 1 presents the sociodemographic and blood group characteristics of the prospective family replacement blood donors. The median age of the blood donors was 29 years (with  $25^{\text{th}}$ - $75^{\text{th}}$  percentiles being 24-35 years). Of the 6847 family replacement blood donors screened, the majority (88.1% [6033]) were males,  $\leq$ 24 years of age (27.4% [1874]), screened in the rainy season (62.1% [4251]), had the O blood type (69.8% [4776]), and were Rh-positive (89.9% [6154]) (Table 1).

Table 1. Sociodemographic characteristics of blood donors at the Sunyani Municipal Hospital, Ghana (2018-2021).

Variable	Frequency (n)	Proportion (%)	
Gender			
Male	6033	88.1	
Female	814	11.9	
Age (years)			
≤24	1874	27.4	
25-29	1706	24.9	
30-35	1611	23.5	
≥36	1656	24.2	
Median (IQR)	29 (24, 35)		
Season			
Rainy season	4251	62.1	
Dry season	2596	37.9	
ABO blood group			
0	4776	69.8	
А	914	13.3	
В	1124	16.4	
AB	33	0.5	
Rh blood group			
Positive	6154	89.9	
Negative	693	10.1	
Total	6847	100.0	

Data are presented as frequencies and proportions. Age is presented as median with interquartile range (IQR) in parenthesis; n: Sample size.

## Seroprevalence of hepatitis B and C stratified by sociodemographic characteristics of the blood donors

Table 2 shows the seroprevalence of hepatitis B and C stratified by sociodemographic characteristics of the blood donors. The overall seroprevalences of HBV and HCV were 3.2% (216/6847) and 1.9% (130/6847), respectively. The seroprevalence of HBV was increased in male donors (3.4% [206/6033]), 3.7% (60/1611) in 30-35 years, and 3.3% (86/2596) in the dry season. Hepatitis B infection among the donors was significantly associated with gender, but not age and season ( $p \le 0.001$ , vs p=0.411, vs p=0.569, respectively). The seroprevalence of HCV was increased in male donors (2.0% [123/6033]), 2.3% (38/1656) in the  $\ge$  36-year group, and 2.2% (92/4259) in the rainy season. Hepatitis C was significantly associated with gender and season, but not age (p=0.019, vs p=0.044, vs p=0.341, respectively) (Table 2).

# Table 2. Seroprevalence of hepatitis B and C stratified by sociodemographic characteristics of blood donors at the Sunyani Municipal Hospital, Ghana (2015-2021).

		HBV		H	ICV	
	Total screened	R	NR	R	NR	
Variable		n (%)	n (%)	n (%)	n (%)	
Gender		<i>p</i> ≤0.001		<i>p</i> =	<i>p</i> =0.019	
Male	6033	206 (3.4)	5827 (96.6)	123 (2.0)	5910 (98.0)	
Female	814	10 (1.2)	804 (98.8)	7 (0.9)	807 (99.1)	
Age (years)		<i>p</i> =0.411		<i>p</i> =	<i>p</i> =0.341	
≤24	1874	51 (2.7)	1823 (97.3)	39 (2.1)	1835 (97.9)	
25-29	1706	53 (3.1)	1653 (96.9)	27 (1.6)	1679 (98.4)	
30-35	1611	60 (3.7)	1551 (96.3)	26 (1.6)	1585 (98.4)	
≥36	1656	52 (3.1)	1604 (96.9)	38 (2.3)	1618 (97.7)	
Season		<i>p</i> =0.569		<i>p</i> =	$p\!=\!0.044$	
Rainy season	4251	130 (3.1)	4121 (96.9)	92 (2.2)	4159 (97.8)	
Dry season	2596	86 (3.3)	2510 (96.7)	38 (1.5)	2558 (98.5)	
Total	6847	216 (3.2)	6631 (96.8)	130 (1.9)	6717 (98.1)	

Data are presented as frequencies, with corresponding proportions in parentheses; Pearson Chi-Square and Fisher's exact tests were used to compare differences in proportions of reactive vs non-reactive tests for HBV and HCV; HBV: Hepatitis B virus; HCV: Hepatitis C virus; R: Reactive; NR: Non-Reactive; *n*: Sample size; *p*: P-value;  $p \leq 0.05$  was considered significant.

## Seroprevalence of hepatitis B and C stratified by ABO and Rh blood groups of blood donors

Table 3 shows the seroprevalence of hepatitis B and C, stratified by ABO and Rh blood groups of blood donors. An increased percentage (3.6% [40/1124]) of the blood donors with blood group B tested reactive for HBV, followed by 3.4% (31/914) in blood group A, and 3.0% each in blood groups O and AB. An increased percentage of blood donors in the Rh-negative blood group tested reactive for HBV compared to 3.1% (191/6154) in the Rh-positive group. Hepatitis B infection had no significant association with either ABO or Rh blood groups (p=0.783 and p=0.491, respectively). Unlike HBV, an increased percentage (2.8% [31/1124]) of blood group B donors tested reactive to HCV, followed by 1.8% (86/4776) in blood group O, and 1.4% (13/914) in blood group A. With regards to the Rh blood group, an increased percentage of the Rh-positive than Rh-negative blood donors tested reactive to HCV (1.9% [118/6154] vs 1.7% [12/693]). Hepatitis C infection among the blood donors had no significant associations with ABO and Rh blood groups (p=0.091 and p=0.883, respectively) (Table 3).

# Table 3. Seroprevalence of hepatitis B and C stratified by ABO and Rh blood groups of blood donors at the Sunyani Municipal Hospital, Ghana (2015-2021).

		HBV		H	CV	
Variable	Total screened	R	NR	R	NR	
		11 (70)	11 (70)	11 (70)	11 (70)	
ABO blood group		p=0.783		p=0	<i>p</i> =0.091	
0	4776	144 (3.0)	4632 (97.0)	86 (1.8)	4690 (98.2)	
А	914	31 (3.4)	883 (96.6)	13 (1.4)	901 (98.6)	
В	1124	40 (3.6)	1084 (96.4)	31 (2.8)	1093 (97.2)	
AB	33	1 (3.0)	32 (97.0)	0 (0.0)	33 (100.0)	
Rh blood group		<i>p</i> =0.491		<i>p</i> =0	<i>p</i> =0.883	
Positive	6154	191 (3.1)	5963 (96.9)	118 (1.9)	5963 (98.1)	
Negative	693	25 (3.6)	668 (96.4)	12 (1.7)	681 (98.3)	

Data are presented as frequencies, with corresponding proportions in parentheses; Pearson Chi-Square and Fisher's exact tests were used to compare differences in proportions of reactive vs non-reactive tests for HBV and HCV; HBV: Hepatitis B virus; HCV: Hepatitis C virus; R: Reactive; NR: Non-Reactive; *n*: Sample size; *p*: P-value;  $p \le 0.05$  was considered significant.

## Sociodemographic risk factors of hepatitis B and C among the blood donors

Table 4 shows the sociodemographic risk factors of HBV and HCV among the blood donors. Male blood donors were 2.842 times (CI: 1.500-5.385, *p*=0.001) and 2.399 times (CI: 1.116-5.157, *p*=0.025) more likely than females to be infected with HBV and HCV, respectively. The risk of the blood donors being infected with either HBV or HCV did not significantly differ across different age groups. Blood donors screened during the rainy season were 1.489 times (CI: 1.017-2.180, *p*=0.041) more likely to be infected with HCV. The risks of the donors being infected with HBV, and HCV were significantly different between gender, whereas for season the risks of being infected with HCV was significant. The age of blood donors, however, was not a significant risk factor for HBV and HCV in this study (Table 4).

# Table 4. Sociodemographic risk factors of hepatitis B and C among blood donors at the Sunyani Municipal Hospital, Ghana (2015-2021).

	HBV		HCV		
Variable	OR (95% CI)	р	OR (95% CI)	р	
Gender					
Male	2.842 (1.500-5.385)	0.001	2.399 (1.116-5.157)	0.025	
Female	1.000	-	1.000	-	
Age (years)					
≤24	0.981 (0.667-1.443)	0.922	1.026 (0.657-1.604)	0.909	
25-29	1.019 (0.695-1.494)	0.922	0.711 (0.434-1.164)	0.175	
30-35	1.154 (0.796-1.673)	0.450	0.684 (0.415-1.127)	0.136	
≥36	1.000	-	1.000	-	
Season					
Rainy season	0.921 (0.698-1.214)	0.559	1.489 (1.017-2.180)	0.041	
Dry season	1.000	-	1.000	-	

Data are presented as odds ratio and 95% confidence interval in parentheses; Binary logistic regression was used to determine the risk of HBV and HCV between gender and season; Multinomial logistic regression was used to determine the risk of HBV and HCV across age groups; HBV: Hepatitis B virus; HCV: Hepatitis C virus; OR: Odds ratio; CI: Confidence interval; *p*: P-value;  $p \leq 0.05$  was considered significant.

## Year-on-year trends of hepatitis b and c among the blood donors

Figure 1 shows a year-on-year trend of HBV and HCV among the blood donors. The seroprevalence of HBV declined moderately from 2015 to 2016, followed by a sharp rise from 2016 to 2017, and further to 2018. It then declined sharply in 2019, followed by a moderate and transient increase in seroprevalence in 2020 and a further decline in 2021, with a slope of -0.5464. However, the seroprevalence of HCV showed a steep decline from 2015 to 2016, followed by a sharp increase in 2017. The seroprevalence of HCV then declined in 2018, and further showed a steady decline to 2021, yielding a slope of -0.6179. The declining trends in seroprevalence of HBV and HCV over the seven years were statistically significant ( $p \le 0.001$  and  $p \le 0.001$ , respectively) (Figure 1).

## **INSERT FIGURE 1**

## Discussion

Presently, human blood donors remain the only source of blood for transfusion. There is, therefore, the propensity for infectious agents like viral hepatitis B and C from infected blood donors to threaten the blood supply chain. This retrospective study reviewed records of 6847 family replacement donors at the Sunyani Municipal Hospital, to determine the seroprevalence, risk factors, and trends of HBV and HCV

among family replacement donors. The blood donors in this study were predominantly males (88.1%), with a male to female ratio of 7:1. This was consistent with findings of other studies in Ghana [11] and Mali [17]. Nkansah *et al.*, [11] inferred that the high turnout of male donors is attributed to the fact that a lot of males meet the standards for blood donor selection, and further used this to justify the increased population of younger donors. However, the basis for the reduced level of female participation in blood donation is suggested to be the result of peculiarities associated with the female gender; according to some studies, obstetric factors like menstruation [18][19][20], childbearing [18][19][20][21], and lactation [18][20][21] lead to increased deferral of females, making males more suitable candidates [19]. Conversely, a study by Degefa *et al.*, [22] in Ethiopia showed more female than male donors, and although this contrasting finding was not justified, the probable cause may be due to the recruitment of more voluntary donors in their study.

The seroprevalences of HBV and HCV among the family replacement donors in this study (3.2% vs 1.9%) were lower compared to the findings of other studies conducted in other parts of Ghana [14][12][11]. Also, the observation of an increased HBV seroprevalence than HCV in the current study corroborates similar patterns (9.6% vs 4.4%) reported by Walana et al., [14] in the Bono Region, Ghana; (6.94% vs 1.84%) in the Volta Region [12]; and (4.7% vs 0.7%) in Ethiopia [23]. The comparison of the lower seroprevalences of the infectious markers observed in this study to the findings reported in other parts of Ghana [14][12] suggests the existence of local variations in the burden of hepatitis. This corroborates data from other West African states, including Burkina Faso [24][25]. The probable cause of such variations in the burden of infectious agents has been attributed to differences in the geographical distribution of the disease, immigration of the population [26][27], the accuracy of the assays employed, and the donor recruitment methods used [26]. Furthermore, Attaullah et al., [28], posit that although blood donors are used as a proxy to extrapolate the burden of infectious agents to the general population, they may not give a true reflection of the burden in the general population since the seroprevalence may be miscalculated owing to varied population traits. This may have accounted for the comparably low seroprevalences reported in our study. Conversely, in the study by Nkansah et al., [11], the burden of HCV was rather increased compared to HBV (11.7% vs 10.3%). This is because the frequency of HCV is much affected by the geographical settings of inhabitants [5]; whereas Nkansah and colleagues conducted their study in a rural district, ours was in the city. Therefore, the exposures, population risks, and other determinants that influence the transmission of these infectious agents may be different.

The seroprevalences of HBV and HCV were significantly associated with gender, with more male than female donors infected with both infections. This corroborates the findings of another study conducted in the middle belt of Ghana [11]. Furthermore, male blood donors were nearly 3 times (OR: 2.842, p = 0.001) more susceptible to HBV, and 2 times (OR: 2.399, p = 0.025) more susceptible to HCV. This is because females are less vulnerable to viruses, and can produce adequate, acute, and long-lasting first-line and adaptive immunity [29]. This is further linked to the increased synthesis and differentiation of innate cells like macrophages, dendritic- and monocytic cells which enable females to produce acute inflammatory reactions [29] in response to the viral infection. Furthermore, the increased estrogen levels in females

enable them to produce increased CD4 + immune cells that stimulate a pronounced activation of immune T cells [29].

In this study, HCV seroprevalence was significantly associated with season, with increased prevalence in the rainy season (p = 0.044). The donors were significantly more susceptible to HCV (OR: 1.489, p = 0.041) in the rainy season than in the dry season, whereas, HBV was rather increased in the dry season, although not significant. Since both infections have a similar mode of spread [30], it is unclear why there exist varied patterns for both infections in different seasons. However, according to Hernández-Alvarez *et al.*, [31] there exist an association between vitamin D deficiency and the persistence of HCV and HCV-related sequelae. Therefore, the increased susceptibility of the donors to HCV could be attributed to the relatively reduced access to sunlight during the rainy season, a situation that could result in inadequate vitamin D synthesis, which may have further led to compromised immunity [31] in the donors.

The burden of both HBV and HCV was increased in blood type B donors, while HBV was increased among the Rh-negative blood donors and HCV was rather increased among Rh-positive donors. Although the significance of the ABO blood group system has been reported widely, and its association with several disease states have been highlighted in several studies [32][33][34][35], there were no significant associations between hepatitis and the blood group systems in this study. This corroborates the conclusions of a similar study conducted in India [35].

Although the yearly burden of HBV and HCV was inconsistently decreasing, general declining trends were observed for both infections over the 7 years using the seroprevalences obtained in 2015 as the baseline. This corroborates the findings of similar studies conducted in China [36] and the Ashanti Region, Ghana [11]. This observation suggests a paradigm shift towards either improved lifestyle choices, responsible sexual behaviour, and increased health education, or in the case of HBV it may be the cause of increased awareness and vaccinations over the years.

This study had a few limitations: firstly, due to the retrospective nature of the study, we were unable to ascertain donors' HBV vaccination status and its effect on the overall declining trend of the infections. Secondly, the donor records did not indicate whether the donors were first-time or repeat donors; Ji *et al.*, [36] suggest that there exists an increased prevalence of infectious markers among first-time than repeat donors. Therefore, this information would have better explained the cause of the declining trends of the infections.

## Conclusion

The seroprevalences of HBV and HCV were comparably low. Gender was significantly associated with both HBV and HCV, while season was significantly associated with only HCV. Whereas the male gender was a significant determinant of both infections, the rainy season was a determinant of HCV. Furthermore, the seroprevalence of HBV was higher than HCV, despite the declining trends of both infections recorded over the years. We recommend that health authorities intensify health education, especially during the rainy season and among males. Local variations in the seroprevalence of these

infections in Ghana calls for upgrade and standardisation in the serological testing for blood donors across Ghanaian blood centres.

## Declarations

## Ethical considerations

Ethical approval was sought from the Committee on Human Research, Publication and Ethics (CHRPE) at the School of Medicine and Dentistry, Kwame Nkrumah University of Science and Technology (Reference: CHRPE/AP/342/22). Also, permission was sought from the Administration of the Sunyani Municipal Hospital before conducting the study. However, due to the retrospective design of the study, consent from the donors was not required.

## Conflict of interest

The authors declare that no conflict of interest exists regarding the publication of this manuscript.

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## Author contribution

Authors FO-B and CN conceived the study. FO-B, CAD, KM, SKA, AAA, VAB, OGN, and DK-N collected the data. FO-B analysed, interpreted and visualised the data. FO-B, CN, KM, SKA, and CAD wrote the first draft of the manuscript. All authors critically reviewed, revised, and approved the manuscript.

## Data availability

The dataset supporting the current study has been deposited in the Havard dataverse repository and available at https://doi.org/10.7910/DVN/JTGVCP.

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## **Figures**



## Figure 1

# Shows the year-on-year trend of hepatitis B and C among blood donors at the Sunyani Municipal Hospital (2015-2021).

The data are presented as a line graph showing trends of HBV and HCV prevalence; Chi-Square test for trend was used to compare changes in prevalence over the seven years; HBV: Hepatitis B virus; HCV: Hepatitis C virus;  $p \le 0.05$  was considered significant.