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Sero-Epidemiology of Transfusion Transmissible Hepatitis B, C and E among Blood Donors in Ekiti, Southwestern Nigeria: A Cross-sectional Study

K. A. Fasakin [a,b*], M. A. Muhibi [c], A. A. Ibijola [a,d], O. D. Ajayi [e], M. I. Onyema [f], Y. Obazee [g], A. A. Adeniyi [h], W. A. Ajetunmobi [i], I. O. Adebara [h], A. Adebayo [d], A. I. Okunlola [j], M. Yusuf [k], B. S. Awoyinka [h], O. A. Ajetunmobi [l], A. Bakare [h], O. T. Adeyemo [h], O. E. Adewara [h], N. Anyahara [m], C. E. Onyema [i], O. B. Bolaji [i], O. M. Ayankunle [h], O. P. Aduloju [n], E. O. Ogundare [o], A. O. Babatola [o], A. S. Adefisan [n], B. A. Olofinbiyi [n] and Z. A. Jeremiah [p]

[a] Department of Haematology and Blood Transfusion, Federal Teaching Hospital, Ido Ekiti, Nigeria.
[b] Department of Medical Laboratory Science, ELIZADE University, Ilaramokin, Nigeria.
[c] Department of Medical Laboratory Science, Edo State University, Uzairue, Nigeria.
[d] Department of Haematology and Blood Transfusion, Afe Babalola University, Ado Ekiti, Nigeria.
[e] Department of Medical Laboratory Science, Afe Babalola University, Ado Ekiti, Nigeria.
[f] Department of Medical Microbiology & Parasitology, Federal Teaching Hospital, Ido Ekiti, Nigeria.
[g] Asokoro District Hospital, Abuja, Nigeria.
[h] Department of Obstetrics and Gynaecology, Federal, Teaching Hospital, Ido Ekiti/Afe Babalola University, Ado Ekiti, Nigeria.
[i] Department of Paediatrics, Federal, Teaching Hospital, Ido Ekiti/Afe Babalola University, Ado Ekiti, Nigeria.
[j] Department of Surgery, Federal, Teaching Hospital, Ido Ekiti/Afe Babalola University, Ado Ekiti, Nigeria.
[k] Department of Medicine, Federal, Teaching Hospital, Ido Ekiti/Afe Babalola University, Ado Ekiti, Nigeria.
[l] Department of Family Medicine, Federal, Teaching Hospital, Ido Ekiti/Afe Babalola University, Ado Ekiti, Nigeria.
[m] Vedic Lifecare Hospital LFTZ Annex/Lagoon Hospitals, Ibeju Lekki, Lagos, Nigeria.
[n] Department of Obstetrics and Gynaecology, Ekiti State University/ Ekiti State University Teaching Hospital, Ado Ekiti, Nigeria.
[o] Department of Paediatrics, Ekiti State University /Ekiti State University Teaching Hospital, Ado Ekiti, Nigeria.
[p] Department of Medical Laboratory Science, Rivers State University, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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**Corresponding author: E-mail: fasakin_kolawole@yahoo.co.uk, fasakin.kolawole@elizadeuniversity.edu.ng;*

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ABSTRACT

Background: Transfusion transmissible hepatitis (TTH) is a global health problem and the incriminating agents such as hepatitis B virus (HBV), hepatitis C virus (HCV) and hepatitis E virus (HEV) continue to pose serious threats to blood safety. The aim of this study was to determine the seroprevalence of HBV, HCV and HEV and relate the outcomes with blood donation type, age and gender and confirm any significant associations.
Materials and Methods: In this cross-sectional study, Hepatitis B surface antigen (HBsAg) and antibody to HCV were determined with Diaspot and Lab Acon immunochromatographic ELISA-based test devices. Antibodies to HEV were first determined with Biopanda lateral flow device followed by ELISA assay for sero-reactive HEV immunoglobulins M and immunoglobulin G (IgM and IgG) antibodies.
Results: A total of 370 prospective blood donors between 18 and 55 years old (mean 31.2 ± 7.6 years) who presented for blood donation at FETHI Blood Bank were screened. Overall male: female ratio was 7:1. Cummulative hepatitis seroprevalence of 8.1% was found mainly among the replacement blood donors (RBD) and consist of 4.3%, 1.6%, 1.1%, 0.8% and 0.3% serologic evidence of HBsAg, anti-HCV, HEV IgM, both HEV IgM & HEV IgG, and HEV IgG antibodies. Blood donors aged 18 – 45 years were most affected with evident significant association between the age group of donors and TTH seroprevalence. Cummulative hepatitis seroprevalence was 0% among voluntary blood donors, and 9.1% and 0.3% among the male and female RBD respectively. There was significant association between the pathogens and RBD, though the association with male gender was clinically but not statistically significant.
Conclusion: The high transfusion transmissible hepatitis seroprevalence among RBD called for promoting voluntary donations. Comparable prevalence of HEV antibodies with that of HCV called for its inclusion in the TTIs screening algorithm to ascertain optimal blood safety in Nigeria.

Keywords: Hepatitis; blood donors; transfusion; Sero-epidemiology; southwestern; Ekiti.

1. INTRODUCTION

Blood transfusion can save millions of lives yet compromise of blood safety quality can expose recipients to danger due to life threatening blood borne infections otherwise referred to as transfusion transmissible infections (TTIs) [1-2]. Transfusion transmissible hepatitis (TTH) is a major public health problem that poses threats not only to the recipients of blood transfusion but also their friends and families [3]. Hepatitis B virus (HBV) and hepatitis C virus (HCV) are blood borne infections that are more endemic in Sub-Saharan Africa and Asia when compared to other parts of the world and the roles of stringent screening for these viruses to ensure optimal blood safety cannot be overemphasized [4]. Of recent, hepatitis E virus (HEV) infection has been reported by Traoré et al (2017)5 and Yazbek et al (2016) [6] to pose increasing threats to blood safety. Hepatitis E virus is the most common cause of acute hepatitis worldwide [7-8]. Immunocompromised patients transfused inadvertently with hepatitis E virus-infected unit have greater risk of developing chronic hepatitis E virus infection9-10 while fatal cases of fulminant hepatitis can result when such units are transfused to pregnant women especially in their third trimester [11-12]. Varying HBV and HCV mono-infection and HBV-HCV dual infection prevalence among blood donors have been reported by authors in Nigeria [13-14] while few authors reported HEV mono-infection among blood donors [15-18]. While the compulsory screening for TTIs has been a constant practice in nearly all health facilities in Nigeria, HEV has not been part of the testing protocol especially in Ekiti state and there is a great possibility of inadvertent transfusion of HEV-infected blood into recipients. We posit that inclusion of HEV in the testing protocol in addition to hepatitis B surface antigen (HBsAg) and anti-HCV screening requires scientific approach that ensures availability of baseline data on HEV at the only serving federal tertiary

health institution in Ekiti state to assess its blood safety contributions and its possible inclusion in the national database.

Most apparently healthy individuals especially blood donors with hepatitis are in their asymptomatic phases and the challenges of poor health facilities in sub-Saharan Africa make transfusion of blood a risk [19]. Transfusion of infected blood is very costly from all points of view. From social and psychological points of view, the grave consequences of transfusion associated hepatitis in asymptomatic recipients include high risk to, and high dependency on relative and friends; behavioural changes due to the psychological trauma; marginalization and stigmatization of infected individuals due to fear or cultural reasons, and possible restrictions of access to care or discrimination in some countries of residence [20-22].

Post-transfusion clinical impacts of HBV [23], HCV [4] and HEV [7,10] are too challenging for recipients to cope with. These impacts may range from progression to chronicity, high risk of cirrhosis and hepatocellular carcinoma (HCC) and antiviral drug insufficiency [20, 23] thus contributing to high morbidity and mortality rate [23]. Buseri et al (2009) [3] listed increased need for medical care, more demand for support, and low service delivery by personnel as the economic costs of failure to control the transmission of TTH and other blood borne infections. That is actually a great burden on already Nigeria-low ranked health and social services and the national economy based on global and country-based findings [3, 24].

Enhancing optimal blood safety is one of the primary objectives of the World Health Organization [24]. However, achievement of optimal blood safety in sub-Saharan Africa may be more challenging and requires multiple approaches due to factors contributing to transfusion-related transmissions such as poor donor selection, high endemicity of TTH in this region, multiple transfusions, inadequate screening facilities, lack of capacity to ensure sustainable operations and other associated risk factors of hepatitis [3]. With the National Blood Service Commission Act 2021 in Nigeria, there is a need to ensure current data availability that will enhance blood transfusion related policy formulations and ease of implementations of same. This study was conducted to determine the prevalence of TTH and possible co-infections among blood donor populations in Ekiti state and provide the baseline data for hepatitis E research and the implementation of National Blood Transfusion Services (NBTS) strategies in the long run.

2. MATERIALS AND METHODS

2.1 Study Population

A total of 370 apparently healthy prospective blood donors aged between 18 and 55 years (mean age: 31.2 ± 7.6 years) who presented at the Blood Transfusion Laboratory, Federal Teaching Hospital, Ido Ekiti between June, 2020 and January, 2021 and gave written informed consent were selected by consecutive sampling technique. This sampling technique was used due to difficulty in recruiting blood donors during the severe acute respiratory syndrome corona virus-2 (SARSCOV-2) pandemic to enable all eligible blood donors to be included until the required sample size was reached and for issues that related to constraints of time and blood donors' conveniences. Ido Ekiti is the headquarters of Ido/Osi local government with an estimated population of 106, 792 people. It is located 25km from Ado Ekiti, the state capital, and nearly 376.5km to Abuja. The tertiary hospital serves Ekiti state and the four neighbouring states (Osun, Ondo, Kwara and Kogi states). As at 2015 male and female median age in Ido Ekiti were 18.6 years and 19.7 years respectively and over 17,000 met the age criterion for blood donation [25]. Structured questionnaires were used to obtain the demographic data of study participants. Age bracket of 18 – 65 years, weight > 50 kg, and haemoglobin values of 12.5g/dL and 13.5g/dL for female and male donors respectively were used as inclusion criteria while history or evidence of chronic illness, haemolytic diseases, current experience of fever, recent blood transfusion, recent donation and known HBV, HCV and HEV infection were used as the exclusion criteria for this study.

2.2 Sample Collection

Five millilitres of whole blood samples were collected by venipuncture from 370 blood donors and dispensed into EDTA blood collection tubes following informed consent. Plasma was harvested and aliquot into a separate plain container following centrifugation at 2,500 rpm for 5 minutes. Initial screening for hepatitis B surface antigen (HBsAg), antibody to HCV (ant-HCV) and HEV Immunoglobulin M/immunoglobulin G (HEV IgM/IgG) antibodies was done immediately using sterile transfer pipettes. For seropositive HEV IgM/IgG cases,

plasma samples were transferred into – 40^{O}C deep freezer until analysis by enzyme linked immunosorbent assay (ELISA) assay.

2.3 Serological Assays

The anti-HCV and HBsAg were detected using Diaspot (Diaspot Diagnostics, USA) and LabAcon (Acon Diagnostics, USA) rapid test devices. Two reactive cases from the two test devices were interpreted as positive results while two non-reactive results were interpreted as negative. Use of known positive and negative controls served as part of quality control measures to optimize quality data. The HEV IgM/IgG rapid test device (Biopanda Diagnostic Limited, UK) was used for the initial detection of HEV antibodies. Those reactive by HEV IgM/IgG rapid test device were further screened with HEV-IgM and HEV-IgG ELISA kits (Melsin Medical Co. Limited, China) to support the initial results. The probable tendency of cross-reactivity reactions of the rapid screening tests with antibodies for Lupus and Rheumatoid arthritis among other diseases formed the basis for using more specific HEV IgM and HEV IgG ELISA kits for further screening in this study. The analyses were carried out according to the manufacturers' instructions.

2.4 Statistical Analyses

Research code was assigned to each questionnaire containing the sociodemographic and analytical data generated for ease of data entry and validation. The Statistical Package for Social Sciences version 21 was used to analyze data and results were presented tables. P-value < 0.05 is statistically significant and that was used to interpret results. Data were saved into storage devices as back-ups to prevent data loss.

3. RESULTS

A total of 370 prospective blood donors aged 18 – 55 years (mean age = 31.2 ± 7.6 years) were screened for hepatitis B, C and E within the study period. Table I showed that the blood donors were predominantly family replacement blood donors (n=353; 95.4%) and 326 (88.1%) were male donors while 44 (11.9%) were female donors thus giving an approximate male: female ratio of 7:1. Male: female ratio among the voluntary, non-remunerated blood donors (VNBD) and replacement blood donors (RBD) were 1:1 and 9:1 respectively. Highest number of blood donors (n=156; 42.2%) fell within 26-35 years age group. The enrolled blood donors were predominantly Yoruba (n=334; 90.3%); at least 315 (85.0%) had secondary education; and 181 (48.9%) and 183 (49.5%) were singles and married respectively. Nearly two-third (n=245; 66.2%) were self-employed.

Table 2 revealed a cummulative hepatitis markers seroprevalence of 8.1% as mono-infections while no dual infection was found. According to the serological markers screened, HBsAg, anti-HCV, HEV IgM, HEV IgM & IgG, and HEV IgG seroprevalence were 4.3%, 1.6%, 1.1%, 0.8% and 0.3% respectively. In the cummulative viral hepatitis seroprevalence, HBsAg, anti-HCV, HEV IgM, HEV IgM & IgG, and HEV IgG constituted 53.3%, 20.0%, 13.3% 10.0% and 3.3% respectively

Table 3 showed that all the seropositive TTH markers occurred among the replacement blood donors (n=30; 8.1%).

Table 4 showed that male blood donors had cumulative hepatitis seroprevalence of 9.1% while the female counterparts had only 0.3%. Within the male gender, 16 (5.2%), 6 (1.8%), 4 (1.2%), 2 (0.6%) and 1 (0.3%) were seropositive for HBsAg, anti-HCV, HEV IgM, HEV IgM & IgG (HEV antibody total), and HEV IgG markers respectively. Highest number of male blood donors fell within age group 26-35 years (n=138; 42.6%) followed by 18-25 years (n=96; 29.4%) and 36-45 years (n= 82; 25.2%) respectively. Cummulative hepatitis markers seroprevalence were 3.7%, 2.8% and 2.1% among the 26-35 years, 18-25years and 36-45 years age-group male donors respectively. The only female RBD age grouped 36 – 45 years was seropositive for both HEV IgM and IgG antibodies.

4. DISCUSSION

This study showed that RBD were the predominant group of blood donors (n=353; 95.4%) that participated in the study. Less than 5.0% (n=17; 4.6%) of the donor populations were VNBD. That was a marked reduction of 94.0% from the previous 77.2% voluntary, non-remunerated donations reported in the same facility by Amilo et al [26] in 2017 and over 500% increase in replacement donations. Marked switch in donation experience reported might not be unconnected with the gross effects of economic meltdown on the country which in turn negatively impacted on the donor drive activities

of the facility and the NBTS in the state with which Federal Teaching Hospital had strong collaboration. In essence, funding by the government is a major key factor in the achievement of 100% voluntary, non-remunerated, anonymous donations advocated for by the World Health Organization [24].

Table1. Social Demographic Characteristics of Research Participants

Demographic Variables	Mean Age (± Standard Deviation)	Number (Percentage)
Overall Number of Prospective Blood Donors Screened	31.2 ± 7.6	370 (100.0)
Voluntary Blood Donors		17 (4.6)
Replacement Blood Donors		353 (95.4)
Sex		
Male		326 (88.1)
Female		44 (11.9)
Male: Female Ratio: 7:1		
Sex Based on Donor Category:		
Voluntary Blood Donors:		17 (4.6)
Male		8 (2.2)
Female		9 (2.4)
Male: Female Ratio: 1:1		
Replacement Blood Donors:		353 (95.4)
Male		318 (89.8)
Female		35 (5.6)
Male: Female Ratio: 9:1		
Age Groups:		
18 – 25	22.6 ± 2.3	107 (28.9)
26 – 35	30.9 ± 2.9	156 (42.2)
36 – 45	40.1 ± 3.2	97 (26.2)
46 - 55	48.1 ± 3.0	10(2.7)
Tribe:		
Yoruba		334 (90.3)
Igbo		17 (4.6)
Hausa		2 (0.5)
Ebira		7 (1.9)
Others		10 (2.7)
Religion:		
Christianity		343 (92.7)
Islam		27 (7.3)
Educational Status:		
None		15 (4.1)
Primary		40 (10.8)
Secondary		117 (31.5)
Tertiary		198 (53.5)
Marital Status:		
Single		181 (48.9)
Married		183 (49.5)
Divorced		02 (0.5)
Separated		04 (1.0)
Occupation:		
Students		17 (4.6)
Civil Servants		103 (27.8)
Self-employed		245 (66.2)
Poultry Farming		3 (0.8)
Livestock farming		2 (0.6)

Table 2. Seroprevalence of transfusion transmissible hepatitis markers in the Study population

Viral Hepatitis Marker	Mono-infection Number (%)	Dual Infection Viral Hepatitis Markers	Number (%)
HBsAg	16 (4.3)	HBsAg – Anti-HCV	0 (0)
Anti-HCV	06 (1.6)	HBsAg – HEV IgM	0 (0)
HEV IgM	04 (1.1)	HBsAg – HEV IgG	0 (0)
HEV IgM & IgG	03 (0.8)	Anti-HCV – HEV IgM	0 (0)
HEV IgM & IgG	01 (0.3)	Anti-HCV – HEV IgG	0 (0)
TOTAL	30 (8.1)	TOTAL	0 (0)

Key: %=Percentage HBsAg = Hepatitis B surface antigen; HCV= Hepatitis C Virus; HEV = Hepatitis E Virus; IgG = Immunoglobulin G; IgM= Immunoglobulin M; HEV IgM & IgG = HEV antibody total

Again, it could also be attributed to the unquantifiable havocs wrecked by severe acute respiratory syndrome corona virus-2 (SARSCOV-02, otherwise known as COVID-19) pandemic on Ekiti state and Nigeria's already overwhelmed blood transfusion services during the ongoing lockdown at the study period [27]. The lockdown was accompanied with restricted movements and skeletal activities of NBTS facility in Ekiti state. The United Nations estimated 206,139,589 as the Nigeria's population in 2020 [28] and Nigeria's National Blood Service Commission collected 21,780 voluntary blood donations in 2020 according to Oreh et al (2022) [29]. That translated to 0.01% voluntary donations for that year and it was 100-fold less than 1% of Nigeria population recommended as voluntary blood donors for Nigeria's blood need [30]. Replacement donations thus remained the only feasible solution to severe blood shortages being faced by the country and the need to meet the increased demand for blood due to haemolytic episodes, road traffic accidents, surgical interventions, maternal comorbidities, severe anaemia, haemorrhagic shocks, cancer related issues and other medical conditions. Study showed the need to address the protracted issue of COVID-19 pandemic holistically with considerations to its negative impacts on blood and blood products availability and supply [27,29]. Another study by Okoroiwu et al (2018) on voluntary donations during COVID-19 pandemic in Nigeria showed similar trend of negative impacts [31]. Moreover, comparison of male: female ratio among the study participants showed there was no gender disparity among VNBD as was found among the RBD with high male: female ratio (9:1). Oreh et al (2018) [29] and the World Health Organization [30] reported 33% voluntary non-remunerated donations by women. With more efforts on public enlightenment programmes that break the female gender phobia for blood donation, availability of blood from the safest category of blood donors is a great possibility. The blood donors were predominantly Yoruba and Christian dominated and 85.0% of them had at least secondary education. Amilo and her co-authors reported same findings in 2017 [26].

From this study, a cummulative transfusion transmissible hepatitis seroprevalence of 8.1% and 0% dual-infections were found. Hepatitis B virus was the leading cause of TTH in this study as evidenced by 4.3% HBsAg seropositivity. It constituted 53.3% of the cummulative hepatitis markers seroprevalence. All the blood donors were asymptomatic and were unaware of their status until tested. That lent credence to the submission of the Hepatitis B Foundation which stated that more than 90% of infected individuals with hepatitis B virus infection are not diagnosed [32]. Detection of HBsAg in serum or plasma of blood donors over six months is an evidence of chronic carrier or chronic immune active hepatitis B infection [26] and the seropositive blood donors ran the risk of developing consequent cirrhosis and in advanced cases, hepatocellular carcinoma [26]. HBsAg seroprevalence in this study was lower than 6.2% and 12.0% hepatitis B surface antigenaemia published in 2015 and 2020 by Adekoya-Benson et al and Daramola et al respectively at the State-owned tertiary health facility [33-34]. The wide difference between HBsAg seroprevalence reported in this study and that of Daramola et al (2020) [34] could probably be due to differences in the categories of blood donors used and the study design. Retrospective data of replacement and commercial blood donors were used in the latter study while prospective data of voluntary and replacement blood donors were used in this study. According to the World Health Organization, paid blood donors do present as RBD to blood bank staff thereby posing more threats to blood safety [35].

Table 3. Seroprevalence of transfusion transmissible hepatitis markers in the Study Population According to Blood Donor Type

Voluntary Blood Donors		Replacement Blood Donors			P value
Hepatitis Markers	**Number (%)**	**Hepatitis Markers**	**Number (%)**	**Number Seropositive/30**	
HBsAg	0 (0)	HBsAg	16 (4.3)	16 (53.3)	
Anti-HCV	0 (0)	Anti-HCV	6 (1.6)	6 (20.0)	
HEV IgM	0 (0)	HEV IgM	4 (1.1)	4 (13.3)	0.012
HEV IgM & IgG	0 (0)	HEV IgM & IgG	3 (0.8)	(10.0)	
HEV IgG	0 (0)	HEV IgG	1 (0.3)	1 (3.3)	
TOTAL	0 (0)	TOTAL	30 (8.1)	30(100.0)†	

Keys: HBV = Hepatitis B Virus; HCV= Hepatitis C Virus; HEV = Hepatitis E Virus; IgG = Immunoglobulin G; IgM= Immunoglobulin M; † = Approximated percentage

Table 4. Distribution of Blood Donors and Prevalence of Viral Hepatitis B, C and E Based on Gender with in Different Age Groups

Age (Years)	†† Male Number	†Percent	HBsAg	Anti-HCV	HEV IgM	HEV IgM & IgG	HEV IgG	Cummulative Hepatitis Prevalence	P Value
					Prevalence				
18 - 25	96	29.4	3 (0.9)	3(0.9)	2 (0.6)	0 (0.0)	1 (0.3)	9 (2.8)	
26 – 35	139	42.2	9 (2.8)	2 (0.6)	1 (0.3)	0 (0.0)	0 (0.0)	12 (3.7)	0.06†
36 – 45	82	25.2	4 (1.2)	1 (0.3)	1 (0.3)	2 (0.6)	0 (0.0)	7 (2.1)	0.000††
46 – 55	9	2.8	1 (0.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.3)	
Total	**326**	**(100.0)**	**16 (5.2)**	**6 (1.8)**	**4 (1.2)**	**2 (0.6)**	**1 (0.3)**	**29 (9.1)**	
Age (Years)	**Female Number**	**Percent**	**HBsAg**	**Anti-HCV**	**HEV IgM**	**HEV IgM &IgG**	**HEV IgG**	**Cummulative Hepatitis Seroprevalence**	
					Prevalence				
18 - 25	11	25.0	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	**0(0)**	
26 – 35	17	38.6	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)		
36 – 45	15	34.1	0 (0)	0 (0)	0 (0)	1 (0.3)	0 (0)	**1 (0.3)**	
46 – 55	1	2.3	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	
Total	**44**	**(100.0)**	**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**	**1 (0.3)**	

Keys: HBV = Hepatitis B Virus, HCV= Hepatitis C Virus, HEV = Hepatitis E Virus, IgG = Immunoglobulin G; IgM= Immunoglobulin M; HEV IgM & IgG = HEV antibody total; † = Clinically but non-statistically significant association of Cummulative Hepatitis Seroprevalence with male gender); †† = Significant association of Cummulative Hepatitis seroprevalence with age

Without strict measures in place to checkmate that possibility; it was not unlikely that many of the blood donors were paid donors as revealed by high prevalence of TTIs and consequent high discard rate. Besides, it can cause a sharp difference in WHO viral hepatitis endemicity classification owning to non-conformity with the voluntary donations advocacy. In essence, high endemicity of TTIs in Nigeria and many African countries could be traced to very low level of voluntary donations practice.

Moreover, anti-HCV antibody seropositivity found in this study was 1.6%. The anti-HCV seroprevalence in this study was similar to 1.7% reported by Adekoya-Benson et al (2015) [33] in Ekiti state tertiary health facility in 2015. It was lower than 6.7% recently reported by Daramola et al (2020) [34] in the same facility in Ekiti, 3.6% reported by Okoroiwu et al (2018) [31] in Calabar and 6.0% reported by Buseri et al (2009) [3] in Osogbo respectively. However, it was higher than pooled seroprevalence of 0.8% reported by Lake et al (2021) [36] in a systematic and meta-analysis review among blood donors in Ethiopia and 0.39% reported by Macroo et al (2013) [37] in India. Anti-HCV seroprevalence of 0.5% have been reported by Erhabor et al (2006) [38] in Port-Harcourt. The differences in the anti-HCV seroprevalence in this study and others confirm the variations in HCV endemicity in different parts of Nigeria.

Based on Hepatitis E viral markers seropositivity, overall HEV seroprevalence in this study was 2.4%. In different parts of the globe, authors [39-40] have shown in surveillance studies that seropositivity of HEV among blood donors ranged from 2% to 49% [41]. The HEV IgM antibody seroprevalence of 1.1% reported in this study is lower than 5.0%, 5.9% and 1.3% seroprevalence reported by Al-Kasaby et al (2019) [39] in Egypt, Meldal et al (2012) [42] in Ghana and John-Olabode et al (2017) [16] in Nigeria respectively. It was approximately two-to-five-fold higher than 0.5, 0.4% and 0.2% seroprevalence reported by Spada et al (2018) [43] in Italy, Ibrahim et al (2011) [44] in Egypt and Ma et al (2015) [45] in China respectively. HEV IgM antibody detection is the hallmark of acute hepatitis infection. [46] There is a virtual lack of published data on simultaneous sero-detection of HEV IgM and HEV IgG in Ekiti state and Nigeria. This study therefore provides a baseline seroprevalence with which multicenter studies among blood donors can be compared and used for national policy formulations. A seroprevalence and incidence study carried out in Upper Austria among blood donors on follow up showed both HEV IgM and HEV IgG antibodies were detected in 6 of 7 (85.7%) blood donors tested 2-11 weeks post-donation [47]. All were previously seronegative for both HEV antibody markers at donation period and had detectable molecular marker (HEV RNA). That agreed with a recent study by Traore et al (2017) [6] that emphasized HEV increasing threat to blood safety and other studies that reported post-transfusion hepatitis E infection in transfusion recipients [9,17]. The HEV IgG antibody seroprevalence in this study is 0.3%, translating to 3 per 1000 blood donors. This is lower than 3.14% seroprevalence reported by Al Dossary et al (2021) [41] among male donors in Saudi Arabia. HEV IgG is the evidence of past infection. Variations in HEV IgG antibody seroprevalence worldwide have been attributed to differences in sensitivities, specificities and limit of detection of assay kits, geographical locations, poor quality control measures and population tested [16,46]. The enzyme-linked immunosorbent assay kit used for this study demonstrated high sensitivity and specificity (data not shown) which shows truly low HEV IgG antibody seroprevalence in this study. A previous vaccine study showed that HEV IgG antibody confers immune protection to once exposed and immune patients and an anti-HEV IgG titre of 2.5 IU/mL is protective [48].

Evidence from this study showed that viral hepatitis seroprevalence is somewhat male gender and blood donor type associated. Distribution of blood donors based on gender, age group and viral hepatitis seroprevalence showed that the numbers of both male and female blood donors peaked at age group 26 – 35 years with 139 (42.6%) and 17 (38.6%) enrolled in the study. More than 99% of the HBsAg seropositive (4.9%) male donors and 100.0% of seropositive anti-HCV (1.8%) and HEV IgM (1.2%) male blood donors ranged from 18 – 45 years old. This agrees with anti-HCV seroprevalence by Egah et al (2004) [49] where all the blood donors were males. There should more risk assessment evaluations among males within this age range to prevent post-transfusion hepatitis in transfusion recipients. Transfusion transmissible hepatitis was predominantly noted among male replacement blood donors with cummulative hepatitis seroprevalence of 9.1%. This is consistent with high transfusion transmissible infections among male donors compared to the female counterparts reported in Calabar [31] Broadly speaking, the highest rate

of TTH occurs among male donors within 18-45 years old. This correlate with previous report by the Centre for Disease Control and Prevention [50] and Buseri et al (2009) [3] that found highest rate of TTIs among blood donors of age groups 20-49 years old and 18-47 years old respectively. The highest HBsAg seroprevalence was found among male donors 26-35 years, followed by 36-45 years and 18-25 years respectively. The trend was different for HCV antibody seroprevalence. The anti-HCV antibody seroprevalence declined with increasing age specifics. Younger male blood donors with highest HCV antibody seroprevalence (0.9%) belonged to age group 18-25 years and the oldest male donors within 46-55 years had the least (0.0%). This trend was also observed in a north Indian study by Makroo et al (2013) [37].

Seroprevalence of TTH was 0.3% among female blood donors in this study. The only female blood donor with HEV antibody total (both HEV IgM & HEV IgG antibodies) seroprevalence of 0.3% was a RBD. In other words, irrespective of age group and blood donor type, 99.7% of female blood donors were free from TTH. A number of reasons have been attributed to this near zero seroprevalence. First was optimal blood donor selection. A large percentage of the female blood donors were known VNBD and college students on practical posting who on compassionate ground donated for patients having difficulties in replacing loaned units during the COVID-19 pandemic era. That again agreed with the well-established fact that voluntary donation is the ethical and international best practice to achieve optimal blood safety [24]. Secondly administration of questionnaires for clinical assessments prior donation helped more in excluding female volunteers who had the potential risk of TTH. This study revealed the contribution of quality pre-donation counselling in achieving optimal blood safety.

5. CONCLUSION

Transfusion transmissible hepatitis is still a global health problem and demands increasing attention for more stringent screening of blood and blood products. Blood and blood products availability and supply from the safest category of blood donors is an important step to ending paid donation system characterized with high TTH seroprevalence and government's commitment to funding voluntary donations and related research will enhance the achievement of this goal. There should be a paradigm shift from the old blood donor recruitment strategy involving post-donation testing after acceptable haemoglobin value to include emergency screening for TTIs using validated high sensitive and specific rapid ELISA-based kits during exercise prior more advanced procedure. There is an increasing evidence to inculcate HEV antibodies screening into blood donation screening protocol and more elaborate researches that utilize more robust probability/randomization sampling criteria to confirm the findings among the age-marched general populace as the sexually active blood donors in Nigeria are still required. It is important to point out that study outcomes and others on TTIs in Nigeria and across the globe show there is need for more quality controls of blood banking practices in Nigeria and Africa by extension in order to standardize quality of blood and minimize, if not totally eradicate, post-transfusion TTHs in recipients.

DISCLAIMER

The articles and other online materials used for this study were used under strict international guidelines prescribed for manuscript preparation globally and in our country. There is absolutely no conflict of interest declared by the authors and this research is not intended to create avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by any governmental or non-governmental organization; rather it was funded by personal efforts of the authors.

CONSENT

As per international standard or university standard, patients' written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

Ethical approval was sought and obtained for the study, with assigned number ERC/2020/06/378A from the Human Research and Ethics Committee of the Federal Teaching Hospital, Ido Ekiti.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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