Characteristics of first-time blood donors with unsatisfactory hemoglobin level and positive hepatitis B test in Binh Dinh Province

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Abstract

Introduction: Blood transfusion is essential in the treatment of a various diseases. In order to guarantee a safe and sufficient volume of blood supply, it is crucial to select appropriate donors based on stringent eligibility criteria. The objective of this study was to furnish robust epidemiological information and identify the risk factors linked to hepatitis B virus (HBV) infection and low hemoglobin levels in first-time blood donors in Binh Dinh. Understanding the causes for donor deferrals can assist better plan and establish an efficient recruiting strategies as well as evaluate donor selection criteria.

Methods: A cross-sectional study was undertaken in Binh Dinh Provincial General Hospital from November 2022 to February 2023 to examine individuals in their first-time blood donation. Data were sourced directly from voluntary blood donation registration forms. HBsAg results were assessed using rapid immunochromatographic tests and chemiluminescent immunoassays.

Results: The rate of unsatisfactory hemoglobin levels was 2.56% tested on 1,638 participants. This rate was significantly associated with female sex (18 times greater odds than males), and lower weight. The results revealed that the rate of HBV infection was 3.13% when detected by the rapid test, but increased by 0.58% when measured by chemiluminescent microparticle immunoassay. The positive hepatitis B deferral correlated with sex ($p<0.05$), age group ($p<0.05$) and occupation ($p<0.05$).

Conclusions: HBV was found the leading cause of deferral in the study area and associated with males, age groups (25–35 and 36–44), officer, worker-farmer, and self-employed people. The prevalence of low hemoglobin donor deferral obtained was 2.56%. Low hemoglobin deferral is associated with female gender, lower body weight, worker-farmer, and self-employed - others. This finding underscores a significant public health concerns, highlighting the need for strategies to lower the infection rates. Understanding the factors leading to defered donation can contribute to development of proactive strategies for recruiting and retaining donors.

Keywords: blood donors, HBsAg, hemoglobins

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1. INTRODUCTION

Blood serves numerous vital functions in the human body as a circulating fluid. Despite advancements in medicine, no artificial blood components can completely replace human blood; emergency cases and blood treatments continue to depend on donors. According to the estimation of World Health Organization (WHO), Vietnam requires approximately 2 million units of blood to cater to emergency aid and medical treatments, including accidents, disasters, and epidemics. Ensuring the safety of blood transfusion is essential for its efficacy. Screening blood donors is imperative alongside promoting blood donation. According to the Circular No. 26/2013/TT-BYT providing guidance on the blood transfusion of the Vietnamese Ministry of Health, voluntary blood donors are required to undergo clinical screening and rapid pre-donation tests, such as hemoglobin level measurement and HBsAg detection [1]. Conditions for donating blood require satisfactory health examination results, negative hepatitis B virus (HBV) test results and Hb concentration≥120 g/L. Pre-donation screening tests mitigate blood bag rejection from immunological and hematological issues, reducing screening costs. Additionally, donors can identify potential diseases for early treatment, promoting repeat donations. In a study conducted by Biswas T, and Kumar Biswas S in 2016, the HBsAg positivity rate in Bangladesh was 1.5% [2]. The research conducted at the Hue Regional Blood Transfusion Center showed that 8.41% of voluntary blood donors were positive for HBsAg during the initial rapid screening process [3]. In 2017, in research conducted by Truong et al. at the Hematology Blood Transfusion Hospital, the percentage of blood donors with unsatisfactory Hb levels was 1.7% in men and 15.7% in women [4]. Binh Dinh consistently leads in promoting voluntary blood donation, receiving approximately 18,000 blood units annually from voluntary donors. The principal goal of this study was to identify the reasons for blood donor deferral among more than 1,600 donors from Binh Dinh Province. These data offer valuable insights for managing blood donors to minimize instances of low Hb deferrals and aid in making informed policy decisions, such as adjusting the Hb threshold or allowable donation frequency.

Additionally, these data are essential for strategic decisions regarding the revision of the HBV screening algorithm for blood donations in Binh Dinh Province.

2. MATERIALS AND METHODS

2.1. Study design and participants

The cross-sectional study was carried out during the period of November 2022 to February 2023 at the Hematology and Blood Transfusion Center of Binh Dinh Provincial General Hospital. Our study's eligible participants were first-time blood donors age from 18 to 60 years, weighed minimum of 42 kg for females, 45 kg for males, the systolic pressure is measured between 100 mmHg and less than 160 mmHg, while the diastolic pressure is measured between 60 mmHg and less than 100 mmHg. The heart rate is considered regular with a frequency ranging from 60 to 90 beats per minute and who were recurrent blood donors were excluded from the list.

2.2. Data collection

The data was obtained from registration forms for first-time voluntary blood donation at the Hematology - Blood Transfusion Center of Binh Dinh Provincial General Hospital between November 2022 and February 2023. Patients' characteristics data, namely age, gender, ethnicity, weight, occupation, screening tests, were collected. Blood donor selection involved hemoglobin screening test (Hb), the rapid test for Medicon IHBsAg-301 (specificity 99.4%; sensitivity 99.7%), and chemiluminescent microparticle immunoassays (CMIA) were used for HBsAg detection, which included ARCHITECT HBsAg Qualitative II (specificity 99.93%; sensitivity 100%).

2.3. Data analysis

Data were analyzed on STATA v17 (Stata, Lakeway, TX, USA). We used frequency and percentage to describe almost general characteristics (exclude age, which was analyzed using median and interquartile range [IQR]). In the univariate analysis, logistic regression was employed to evaluate the influence of these attributes on seroprevalence. The findings are reported in terms of odds ratios (OR) and 95% confidence intervals. Statistical significance was determined for

p-values<0.05 (Fig. 1).

3. RESULTS

3.1. General characteristics of the study population

From November 2022 to February 2023, 1,638 first-time blood donors participated in the study at the Hematology and Blood Transfusion Center of Binh Dinh Provincial General Hospital, 52.63% were females and 47.37% were males. The majority of participants belonged to the Kinh ethnic group (94.38%). Most first-time blood donors (46.95%) were in the age group 18–24 years. The median age of all first-time blood donors was 28 years (IQR: 18–58). The weight group of 51–60 kg was the most represented (41.64%), and the majority of participants were students (31.20%). Blood group
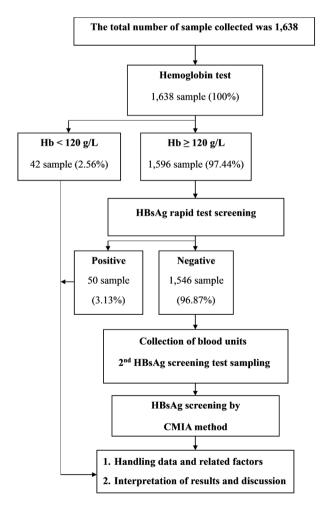
testing was not conducted for 28 cases due to Hb levels below 120 g/L, which were still recorded. Blood group O was the most prevalent (44.41%), while blood group AB was the least represented (5.53%) among the study group (Table 1).

3.2. Seroprevalence of HBsAg among first-time blood donors according to their socio-demographic characteristics

Of the 1,638 participants, 42 individuals were excluded from the HBsAg rapid test due to a Hb concentration of less than 120 g/L. Among 1,596 individuals who received the HBsAg rapid test, 50 were HBsAg positive, representing

Fig. 1. Flowchart of the research process.

Table 1. General characteristics of the first-time blood donors

Characteristics	n	(%)
Gender (n=1,638)		
Male	776	47.37
Female	862	52.63
Ethnic group (n=1,638)		
The Kinh	1,546	94.38
Other	92	5.62
Age, *median (IQR)*	28 (18–58)	
Age group (years) (n=1,638)		
18−24	769	46.95
25−35	536	32.72
36−44	218	13.31
45−60	115	7.02
Weight (kg) (n=1,638)		
42–50	382	23.32
51–60	682	41.64
>60	574	35.04
Occupation (n=1,638)		
Student	511	31.20
Officer	331	20.21
Police – Military	75	4.58
Worker – Farmer	386	23.56
Self-employed – others	335	20.45
Blood group (n=1,610)		
A	320	19.88
B	486	30.19
O	715	44.41
AB	89	5.53

3.13% of the total sample (Table 2). In the univariate analysis, a higher prevalence of HBsAg seropositivity was noted among male blood donors (OR=2.31 [95% CI: 1.27–4.23], p=0.006), the age groups 25–35 years (OR=3.53 [95% CI: 1.67–7.44], p=0.001) and 36–44 years (OR=4.34 [95% CI: 1.85–10.20], p=0.001), officer (OR=3.49 [95% CI: 1.07–11.44], p=0.039), worker - farmer (OR=7.11 [95% CI: 2.42–20.88], p<0.001), self-employed – others (OR=5.79 [95% CI: 1.90–17.59], p=0.002) were shown to be associated with HBsAg seroprevalence.

3.3. Proportions (ratios) of donor deferral due to low hemoglobin among first-time blood donors according to their socio-demographic characteristics

Out of the 1,638 participants, 42 individuals were found to have abnormal hemoglobin levels, constituting 2.56% of the total registered blood donors (Table 3). Females were more likely to be deferred for low hemoglobin compared to the males (OR=18.83 [95% CI: 4.54–78.19], p<0.001). First-time donors aged above 24 years of age were less likely to be deferred for low hemoglobin. An inverse correlation was observed between body weight and hemoglobin deferral. First-time donors over 60 kg had only 0.28 times the odds of having a low hemoglobin deferral as first-time donors 42–50 kg (OR=0.28 [95% CI: 0.12–0.69], p=0.006), worker-farmer (OR=0.37 [95% CI: 0.15–0.92], p=0.033), self-employed – others (OR=0.35 [95% CI: 0.13–0.95], p=0.039) were associated with a lower proportion of donor deferrals due to low hemoglobin (Tables 4 and 5).

3.4. Evaluation of the specificity of HBsAg rapid test compared to chemiluminescent microparticle immunoassay

The current study reveals a positivity rate of 3.13% for HBsAg detected through rapid testing. Upon retesting the initially negative samples using CMIA, the positivity rate

Table 2. Prevalence of donor deferral due to positive hepatitis B test among first-time blood donors

HBsAg rapid test result (n=1,596)	Frequency	Percentage (%)
Negative	1,546	96.87
Positive	50	3.13

Table 3. Seroprevalence of HBsAg among first-time blood donors according to their socio-demographic characteristics

Independent variables	N	HBsAg (+)	Univariate COR (95% CI)	p-value[1]
Sex				
Females	862	16 (1.95)	Reference	0.006
Males	776	34 (4.39)	2.31 (1.27–4.23)	
Ethnic group				
The Kinh	1,546	49 (3.25)	Reference	
Other	92	1 (1.15)	0.35 (0.05–2.54)	0.297
Age group				
18–24	769	10 (1.34)	Reference	
25–35	536	24 (4.58)	3.53 (1.67–7.44)	0.001
36–44	218	12 (5.58)	4.34 (1.85–10.20)	0.001
45–60	115	4 (3.57)	2.72 (0.84–8.83)	0.095
Occupation				
Student	511	4 (0.82)	Reference	
Officer	331	9 (2.80)	3.49 (1.07–11.44)	0.039
Police – Military	75	1 (1.35)	1.66 (0.18–15.10)	0.651
Worker – Farmer	386	21 (5.53)	7.11 (2.42–20.88)	<0.001
Self-employed – others	335	15 (4.55)	5.79 (1.90–17.59)	0.002

[1] Logistic regression.
COR, crude odds ratio.

Table 4. Prevalence of donor deferral due to low hemoglobin among first-time blood donors

Hemoglobin concentration (g/L) (n=1,638)	Frequency	Percentage (%)
≥120	1,596	97.44
<120	42	2.56

Table 5. Proportions (ratios) of donor deferral due to low hemoglobin among first-time blood donors according to their socio-demographic characteristics

Independent variables	N	Low hemoglobin deferral	Univariate COR (95% CI)	p-value[1]
Sex				
Males	776	2 (0.26)	Reference	<0.001
Females	862	40 (4.64)	18.83 (4.54–78.19)	
Ethnic group				
The Kinh	1,546	37 (2.39)	Reference	
Other	92	5 (5.43)	2.34 (0.90–6.11)	0.082
Age group				
18–24	769	24 (3.12)	Reference	
25–35	536	12 (2.24)	0.71 (0.35–1.43)	0.341
36–44	218	3 (1.38)	0.43 (0.13–1.45)	0.175
45–60	115	3 (2.61)	0.83 (0.25–2.81)	0.766
Weight				
42–50	382	16 (4.19)	Reference	
51–60	682	19 (2.79)	0.66 (0.33–1.29)	0.222
>60	574	7 (1.22)	0.28 (0.12–0.69)	0.006
Occupation				
Student	511	21 (4.11)	Reference	
Officer	331	9 (2.72)	0.65 (0.29–1.44)	0.291
Police – Military	75	1 (1.33)	0.32 (0.04–2.38)	0.263
Worker – Farmer	386	6 (1.55)	0.37 (0.15–0.92)	0.033
Self-employed – others	335	5 (1.49)	0.35 (0.13–0.95)	0.039

[1] Logistic regression.
COR, crude odds ratio.

increased by 0.58%. Notably, nine samples that tested negative through rapid testing were found to be positive through CMIA (OR=0.18), indicating that the CMIA method shows an 18% higher positivity rate compared to the rapid test method.

4. DISCUSSION

This study investigated on 1,638 first-time blood donors, nearly 80% of them aged between 18 and 35 years. The older the study group, the less likely they are to participate in blood donation. Results indicated that the rate of unsatisfactory Hb concentration was 2.56% among all first-time blood donors, with a higher rate observed in women than in men. This could be attributed to factors such as inadequate nutrition, as many women tend to fast for weight loss purposes. Additionally, women of reproductive ages, including those with menstrual cycles, may experience fluctuations in blood quality. These findings are consistent wit those reported by Mast et al. (2010) in the United States, based on over 2.5 million donations between January 2006 and December 2007 [5]. The study revealed a strong inverse association between

higher body weight and reduced probability of hemoglobin deferral in first-time blood donors. This discrepancy can be ascribed to the relatively lesser overall blood volume in individuals with lower body weight, resulting in a greater extraction of total blood volume and total body iron stores with each donation. Therefore, weight criteria should be given more consideration in the donor selection process, especially for lightweight individuals. Socio-professional categories of blood donors were associated with proportionas of donor deferral due to low hemoglobin. Factors such as being a worker/farmer (OR=0.37 [95% CI: 0.15–0.92], p=0.033), or self-employed/other profesisons (OR=0.35 [95% CI: 0.13–0.95], p=0.039) were associated with rates of donor deferral due to low hemoglobin.

The results of HBsAg screening by rapid test showed that there were 50 positive samples, accounting for only 3.13% of the total number of first-time blood donors in Binh Dinh Provincial General Hospital. This rate is relatively lower compared to the HBsAg positive rate in Vietnam of 8.1%, according to WHO data in 2018 [6]. The research results are different and low due to the voluntary nature of the blood donors who must satisfy the eligibility criteria for blood donation. Furthermore, the age range of 18–60 may not be representative of the entire Vietnamese population, particularly those who are hepatitis B positive and do not participate in blood donation. Our results show lower rates compared to the studies of Nguyen et al. at Hue Blood Transfusion Center in 2018 (8.41%) [3], Tu et al. (4.26%) in the Mekong Delta in 2020 [6] but higher rates compared to studies by Nguyen et al. at the Hematology Center of Viet Tiep Hai Phong Hospital in 2022 (3.00%) [7], Nguyen et al. (2.7%) at the 108 Military Central Hospital in 2018 [8]. This variation is likely due to differences in the prevalence of hepatitis B in each locality, region, and time. In the activities of the Center for Hematology and Blood Transfusion of Binh Dinh province, the rate of hepatitis B infection is currenlty somewhat lower than before, possibly due to the increased vaccination rates and the growing awareness of disease prevention. Strict control measures for hepatitis B screening during the blood donor selection examination have also contributed to this decrease.

The positive HBsAg rapid test result was higher in men (4.39%) than in women (1.95%) with a statistically significant difference (p<0.05). These findings are consistent with several previous studies in Gabon, South of Iran, Burkina Faso [9–11]. A study by Tu et al. (2020) also showed that the infection rates were higher in men than in women (male 5.15%, female 2.64%) [12]. In another study by Doan Hoang Anh and Vo Thi Linh Tien on the situation of HBV infection in volunteer blood donors in Dong in 2015, the rate of males with positive HBsAg was also higher than that of females [13]. Men may have a higher rate of HBV infection than women due to their likelihood of engaging in behaviors that lead to rapid liver damage, such as frequent use of alcohol, and tobacco, unsafe sex, and not being as careful as women who share objects.

The correlation between the seroprevalence of HBsAg and the age of first-time blood donors revealed a more significant reactivity among donors aged 25–34 years. Specifically, the age group of 25–34 years had a 3.53 times higher likelihood of infection compared to the 18–24 years age group. As the age of blood donors increased, the seroprevalence of HBsAg also increased until around 45 years, after which it gradually declined. Previous studies have similarly reported an upward trend in HBV seroprevalence with advancing age, particularly in the 31–50 and 51–60 years age groups within the Mekong Delta provinces [12]. This shows that the cases eligible to participate in blood donation are mainly young people located in agencies and schools; they have been educated, propagated, and mobilized to be able to capture information and ways to prevent infectious diseases harmful to health. Part of the reason is that Vietnam's Expanded Program on Immunization started to implement hepatitis B vaccination in 1997, and by 2003, children under 1-year-old had been vaccinated nationwide [14]. Therefore, the majority of 18–24-year-olds have been vaccinated.

The prevalence of HBsAg was linked to the socio-professional classifications of individuals who donated blood. Workers – farmers (5.53%), self-employed – others (4.55%), and officers (2.80%) were the most infected with HBV. Our results are consistent with those of Nguyen Thi Tuyet Tram and colleagues at Hue Center for Hematology and Blood Transfusion in 2018, showing a low positive rate in the

group of students (3.87%) and highest among other workers (15.12%) [3]. This pattern may be attributed to the fact that most of these subjects have been vaccinated and have better awareness of disease prevention.

When more precise techniques were employed, it was discovered that of the samples testing negative through the rapid test, only 9 were positive, a rate of just 0.58%. This result is also consistent with a number of domestic and foreign studies. For example, the study of Nga Quynh Nguyen et al. showed that the positivity rate of HBV (HBsAg) by using CMIA techniques was 0.63% [15]. Another study by Pham et al. reported a 0.4% increase in HBV infection rate compared to that detected by rapid testing [16]. Similarly, a study by Allain JP also showed that the positive rate for HBsAg was 0.61% [17].

Nine samples tested negative in rapid tests but positive in the CMIA (OR 0.18, 95% CI: 0.08–0.37), indicating means that the CMIA method has a positive result difference of 18% (versus negative) compared to the rapid test method. This significant difference in HBsAg test results between the two methods is quite significant. White rapid test provides quick evaluation of the patient samples, CMIA method is more reliable. Therefore, blood screening should be repeated using techniques such as CMIA and molecular nucleic acid testing to ensure blood transfusion safety.

5. CONCLUSION

The Hematology and Blood Transfusion Center of Binh Dinh Provincial General Hospital has utilized a large database of individuals who donated blood for the first time. This database was used to develop a logistic regression model, with the aims of identifying and measuring the demographic factors associated with low hemoglobin deferral and positive HBsAg seroprevalence. These data offer valuable insights that can be employed to effectively manage blood donors, thereby reducing the number of low hemoglobin deferrals and instances of HBV infection. By understanding the factors that lead to deferral, blood donation centers can implement measures to address these issues. This research highlights the importance of identifying and addressing deferral reasons, as it can help increase the pool of eligible donors and enhance the sustainability of blood donation programs.

Conflict of interest

No potential conflict of interest relevant to this article was reported.

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Availability of data and material

Upon reasonable request, the datasets of this study can be available from the corresponding author.

Ethics Approval

The Council of Ethics in Biomedical Research at the University of Medicine and Pharmacy at Ho Chi Minh City approved this study on October 24th, 2022, No. 777 – ĐHYD.

REFERENCES

1. Xuyen NT, Circular guiding the blood transfusion: No. 26/2013/TT-BYT [Internet]. 2013 [cited 2023 Jan 20]. https://thuvienphapluat.vn/van-ban/EN/The-thao-Y-te/Circular-No-26-2013-TT-BYT-guidance-on-the-blood-transfusion/271388/tieng-anh.aspx

2. Biswas T, Biswas SK. Seroprevalence of hepatitis B infection among first-time blood donors in Faridpur, Bangladesh: a cross-sectional ctudy. Int J Med Stu. 2016;4(1):9-13.

3. Nguyen TTT, Dong SB, Tran VL, Hoang DQ, Phan QHM. Survey on the results of HBsAg rapid test used to test the first–time voluntary blood donors at the Hue Regional Blood Transfusion Center in 2018. Ho Chi Minh City J Med. 2019;23(6):473-6.

4. Truong TKD, Chau TMN, Nguyen TH, Nguyen PL, Le VT, Tran TH, et al. Surveying blood count of the blood donor at The Hematology and Blood Transfusion Hospital in 2017. Ho Chi Minh City J Med. 2019;23(6):449-54.

5. Mast AE, Schlumpf KS, Wright DJ, Custer B, Spencer B, Murphy EL, et al. Demographic correlates of low hemoglobin deferral among prospective whole blood donors. Transfusion. 2010;50(8):1794-802.

6. Nguyen TTV, Tran DQ, Nguyen TA, Masaya Kato L, Polin Chan HR, Le QT, et al. Estimates and projection of disease burden and economic analysis for hepatitis B in Viet Nam. In: Proceedings of the Global Hepatitis Summit; 2018 Nov 22; Toronto, ON.

7. Nguyen HY, Hoang VP, Le TC. Status of carrying HBsAg of first-time voluntary blood donors at Hematology Center of Viet Tiep Hospital in Hai Phong in 2022. J Control Vaccine Biol. 2022;2(2):27-32.

8. Nguyen XT, Le HK, Ngo QV, Ngo TN, Pham TTH. HBV test results in blood donors for the first time in 108 Military Central Hospital 2020. Viet Nam Med J. 2021;499(1-2).

9. Eko Mba JM, Bisseye C, Ntsame Ndong JM, Mombo LE, Bengone C, Mouelet Migolet G, et al. Prevalent hepatitis B surface antigen among first-time blood donors in Gabon. PLOS ONE. 2018;13(4):e0194285.

10. Farshadpour F, Taherkhani R, Tajbakhsh S, Gholizadeh Tangestani M, Hajiani G, Sharifi N, et al. Prevalence and trends of transfusion-transmissible viral infections among blood donors in south of Iran: an eleven-year retrospective study. PLOS ONE. 2016;11(6):e0157615.

11. Nagalo BM, Bisseye C, Sanou M, Kienou K, Nebié YK, Kiba A, et al. Seroprevalence and incidence of transfusion-transmitted infectious diseases among blood donors from regional blood transfusion centres in Burkina Faso, West Africa. Tro Med Int Health. 2012;17(2):247-53.

12. Tu M, Nguyen XK, Bui TTX, Nguyen AT, Nguyen XV. Survey on the rate of HBsAg rapid test for the first-time voluntary donors in The Mekong Delta Provinces in 2020. Viet Nam Med J. 2022;520.

13. Doan HA, Vo TLT. The rate of HBV was detected by voluntary blood donors at Lam Dong Hospital in 2015. J Clin Me - JoCM. 2017;46.

14. Keja K, Chan C, Hayden G, Henderson RH. Expanded programme on immunization. World Health Stat Q. 1988;41(2):59-63.

15. Nguyen QN, Nguyen TH, Vo AN. Survey of HBV, HCV, HIV infection and related factor in blood donors at Hematology Blood Transfusion Center of Binh Dinh Hospital. In: Proceedings of the 5th ASEAN Association Schools of

Medical Technology (AASMT) Congress 2020; 2020 Nov 5-6; Ho Chi Minh City, VietNam.

16. Pham VH, Tran HT, Nguyen HB. The Hepatitis B Status of Volunteers at Hanoi Medical University 2021. Viet Nam Med J. 2022;516(2).

17. Allain JP, Candotti D. Diagnostic algorithm for HBV safe transfusion. Blood Transfus. 2009;7(3):174-82.