

# Sociodemographic and clinical features related to hepatitis B virus infection among rejected blood donors in Luanda, Angola

Cruz Sebastião<sup>1</sup>, Victor Pimentel<sup>2</sup>, Domingos Jandondo<sup>3</sup>, António Vigário<sup>4</sup>, Pedro Vienga<sup>3</sup>, Joana Sebastião<sup>3</sup>, Anabela Mateus<sup>3</sup>, Felícia Comandante<sup>4</sup>, Euclides N.M. Sacomboio<sup>3</sup>, Eunice Manico<sup>4</sup>, Deodete Machado<sup>4</sup>, Zinga David<sup>3</sup>, Jocelyne Vasconcelos<sup>1</sup>, and Joana Morais<sup>3</sup>

<sup>1</sup>Centro de Investigação em Saúde de Angola (CISA)

<sup>2</sup>Instituto de Higiene e Medicina Tropical (IHMT) Universidade Nova de Lisboa (UNL)

<sup>3</sup>Instituto Nacional de Investigação em Saúde (INIS)

<sup>4</sup>Instituto Nacional de Sangue (INS)

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## Abstract

HBV remains a public health concern. Blood donors screened for HBsAg along with AST/ALT could play a key in providing safe blood products. We investigated the features related to HBV infection among rejected blood donors in Luanda, Angola. This was a cross-sectional study conducted with 164 rejected donors. Donors were screened for HBsAg from March to May 2022. Overall, 63.4% tested positive for HBV. Mean age of the HBV-positive ( $29.2 \pm 8.02$ ) was lower than the HBV-negative ( $33.9 \pm 10.0$ ) ( $p < 0.001$ ). Donors between 20–40 years (OR:2.34,  $p=0.045$ ), females (OR:1.40,  $p=0.516$ ), residents in urbanized areas (OR:1.23,  $p=0.530$ ), low educational (OR:1.54,  $p=0.458$ ), unemployed (OR:1.65,  $p=0.271$ ), and unmarried (OR:1.41,  $p=0.616$ ), might be likely to contract HBV. AST/ALT ratio was higher in HBV-infected ( $2.07 \pm 1.42$ ) than in HBV-uninfected ( $1.90 \pm 1.14$ ). About 20% of HBV-positive were classified as having acute liver disease, while 80% with chronic liver disease, based on AST/ALT ratio. Age ranged from 20-40 years (OR:1.97,  $p=0.305$ ), females (OR:1.61,  $p=0.557$ ), donors from non-urbanized (OR:1.69,  $p=0.557$ ), a low educational (OR:1.64,  $p=0.571$ ), and unemployed donors (OR:1.81,  $p=0.289$ ) were likely to develop chronic liver disease. Our findings indicated the failure of viral hepatitis control measures. Authorities should consider including HBV nucleic acid testing to ensure early identification of HBV in Angola.

## Sociodemographic and clinical features related to hepatitis B virus infection among rejected blood donors in Luanda, Angola

Running title: **HBV infection among blood donors from Angola**

Author's list

Cruz S. Sebastião<sup>1,2,3\*</sup>, Victor Pimentel<sup>3</sup>, Domingos Jandondo<sup>2</sup>, António Vigário<sup>4</sup>, Pedro Vienga<sup>2</sup>, Joana Sebastião<sup>2</sup>, Anabela Mateus<sup>2</sup>, Felícia Comandante<sup>4</sup>, Euclides Sacomboio<sup>2</sup>, Eunice Manico<sup>4</sup>, Deodete Machado<sup>4</sup>, Zinga David<sup>2</sup>, Jocelyne Neto de Vasconcelos<sup>1</sup>, and Joana Morais<sup>2</sup>

Author's details

<sup>1</sup> Centro de Investigação em Saúde de Angola (CISA), Caxito, Angola;

<sup>2</sup> Instituto Nacional de Investigação em Saúde (INIS), Luanda, Angola;

<sup>3</sup> Global Health and Tropical Medicine (GHTM), Instituto de Higiene e Medicina Tropical (IHMT), Universidade Nova de Lisboa (UNL), Lisboa, Portugal;

<sup>4</sup> Instituto Nacional de Sangue (INS), Ministério da Saúde, Luanda, Angola

\*Correspondence:

Cruz S. Sebastião, Ph.D. Centro de Investigação em Saúde de Angola (CISA), Caxito, Angola. Email: cruzdossantos10@gmail.com

## ABSTRACT

HBV remains a public health concern. Blood donors screened for HBsAg along with AST/ALT could play a key in providing safe blood products. We investigated the features related to HBV infection among rejected blood donors in Luanda, Angola. This was a cross-sectional study conducted with 164 rejected donors. Donors were screened for HBsAg from March to May 2022. Overall, 63.4% tested positive for HBV. Mean age of the HBV-positive ( $29.2 \pm 8.02$ ) was lower than the HBV-negative ( $33.9 \pm 10.0$ ) ( $p < 0.001$ ). Donors between 20–40 years (OR:2.34,  $p=0.045$ ), females (OR:1.40,  $p=0.516$ ), residents in urbanized areas (OR:1.23,  $p=0.530$ ), low educational (OR:1.54,  $p=0.458$ ), unemployed (OR:1.65,  $p=0.271$ ), and unmarried (OR:1.41,  $p=0.616$ ), might be likely to contract HBV. AST/ALT ratio was higher in HBV-infected ( $2.07 \pm 1.42$ ) than in HBV-uninfected ( $1.90 \pm 1.14$ ). About 20% of HBV-positive were classified as having acute liver disease, while 80% with chronic liver disease, based on AST/ALT ratio. Age ranged from 20-40 years (OR:1.97,  $p=0.305$ ), females (OR:1.61,  $p=0.557$ ), donors from non-urbanized (OR:1.69,  $p=0.557$ ), a low educational (OR:1.64,  $p=0.571$ ), and unemployed donors (OR:1.81,  $p=0.289$ ) were likely to develop chronic liver disease. Our findings indicated the failure of viral hepatitis control measures. Authorities should consider including HBV nucleic acid testing to ensure early identification of HBV in Angola.

## KEYWORDS

HBV infection; HBsAg; Liver damage; Blood donors; Angola.

## 1 INTRODUCTION

Blood components are used by health services around the world for the treatment of numerous clinical conditions. Therefore, the safety of blood products remains a major concern for blood collection centers, mainly due to transfusion-transmitted viruses (TTVs), such as hepatitis B virus (HBV). HBV is prevalent in blood donors worldwide and constitutes a serious global public health problem, especially in low- and middle-income countries (LMICs). Globally, more than 2 billion people, equivalent to about a third of the world population, have already been infected with HBV, of which 350 million people have developed chronic hepatitis infection. Geographic regions are classified as highly endemic (8%), intermediate (2 to 7%), and low endemic (<2%). The African continent is an area of high HBV endemicity compared to the other geographical regions.

Due to improvements in the criteria for selecting eligible donors for blood donation, the risk of transmitting viruses such as HBV has decreased significantly in recent years, even so, surveillance to estimate the risk of HBV transfusion in blood donors remains essential to monitor the safety of the blood supply as well as the impact of new screening tests, especially in areas of high HBV endemicity. HBV surface antigen (HBsAg) along with HCV, HIV, and syphilis screening remains the keys biological marker used for screening blood donors for sexual transmission infections. However, studies have shown that HBV mutations associated with structural changes in HBsAg and circulating immune complexes could negatively affect the performance of HBsAg detection, suggesting the inclusion of other biomarkers along with HBsAg although the cost and equipment requirements of these assays might limit their use in LMICs.

The biological markers aspartate transaminase (AST) and alanine aminotransferase (ALT) as well as the ratio of the AST/ALT have always been used in clinical practice to reflect liver injury and have been associated with some human diseases, including chronic diseases and mortality. Previous studies showed that serum determination of AST and ALT enzymes as well as their proportion is a clinically valuable procedure for

differentiating viral hepatitis from other icteric diseases along with markers of infection, antibodies, and antigens. Despite the high endemicity of HBV in Angola, few studies have been carried out, for the screening of HBV infection in the asymptomatic or healthy population. To the best of our knowledge, there is no study published assessing the determinants of HBV infections along with the clinical profile of liver function in HBV-infected individuals in Angola. In this study, we combine sociodemographic and clinical features related to HBV infection as well as the clinical progression to chronic liver disease among HBV-positive blood donors rejected for blood donation in Luanda, the capital city of Angola, in order to (i) avoid the TTVs, (ii) improve the safe blood products, and (iii) control the spread of HBV infection in Angola. Furthermore, this study presents the epidemiological picture of HBV and could serve to reflect the status of HBV prevention and vaccination programs in Angola.

## 2 MATERIAL AND METHODS

### 2.1 Study design and setting

This was a cross-sectional study that included 164 individuals who were rejected for blood donation at the Instituto Nacional de Sangue (INS), a reference health unit, located in Luanda, the capital city of Angola, between March to May 2022. The study was carried out at Centro de Investigação em Saúde de Angola (CISA), a research institution supported by the Instituto Nacional de Investigação em Saúde (INIS), also located in Luanda. The INIS is a public institution of the Angolan Ministry of Health (MoH), which develops research in the most diverse areas of health and its determinants, to contribute to the strengthening of public health policies in Angola. This study was approved by the National Ethics Committee of the Angolan MoH (nr. 39/2021) and the direction board of the INS (nr.128/GDG/INS/2022). Participants were informed about the objectives of the study and verbal consent was obtained from all enrolled even before they were considered part of the study.

### 2.2 Data/sample collection and laboratory procedure

A structured questionnaire was used to collect demographic data such as age, gender, place of residence, level of education completed, occupation, and marital status. An estimated volume of 5 mL of blood sample was collected from all participants and placed in tubes containing ethylenediamine tetraacetic acid (EDTA) for serological (HBsAg) and biochemical (AST and ALT) screening. Additional screening for other sexually transmitted diseases was performed, to rule out HCV, HIV, and syphilis infections. For this study, donors with a negative result for HBsAg were considered the control group, while the group with a positive result for HBsAg was considered the test group. All the serological screening was performed with the ARCHITECT PLUS i2000SR immunoassay analyzer (ARCHITECT, Abbott Laboratories) using the HBsAg QUAL II detection kit (Abbott Laboratories, Ltd.) to screen for the current presence of HBsAg, while the biochemical screening was performed with the automatic biochemical analyzer Cobas C111 (Roche), using the AST (Roche, Germany) and ALT (Roche, Germany) detection kits, for evaluation of possible liver damage resulting from HBV infection. Positive and negative controls were added during all laboratory procedures following the manufacturer's instructions. All laboratory processing as well as the interpretation of the results were carried out according to the manufacturer's instructions. Patients reactive to the HBsAg biomarker were classified as positive for HBV infection. For purposes of this study, the reference range for AST was considered to be 8-48 U/L while for ALT it was 7-55 U/L. Furthermore, AST/ALT ratios less than one were assigned to donors with acute or non-alcoholic liver disease, while an AST/ALT ratio greater than or equal to 1, was assigned to donors with suspected chronic liver disease, viral hepatitis, or liver toxicity.

### 2.3 Statistical analysis

The analysis was conducted in SPSS version 29 (IBM SPSS Statistics, USA). The descriptive analysis was presented as frequencies and percentages. The normal data distribution was presented as mean and standard deviation (SD). Parametric tests such as independent-sample T-tests and One-way analysis of variance (ANOVA), were used to compare the mean values. Whenever possible, the variables were dichotomized and analyzed with the Chi-square ( $X^2$ ) test and univariate logistic regression with a corresponding 95% confidence interval (CI) to predict features with a relation or an independent chance to present HBV infection or chronic

liver disease. The reported p-value is two-tailed and was deemed statistically significant when  $p < 0.05$ .

### 3 RESULTS

#### 3.1 Features related to HBV infection among rejected blood donors from Luanda, Angola

The putative features related to the hepatitis B virus infection among rejected blood donors from Luanda are shown in Table 1. A total of 164 rejected blood donors fulfilled the inclusion criteria and formed part of the analyses. The mean age of rejected blood donors was  $30.9 \pm 9.04$  years, which varies from 18 to 58 years, of which the age group between 20 - 40 years was predominant with about 79% (130/164). The predominant sociodemographic features in the studied population were male donors (87.8%, 144/164), residents in urbanized areas (54.9%, 90/164), with a low educational level (92.1%, 151/164), employees (82.3%, 135/164), and unmarried (94.5%, 155/164).

Overall, the HBV positivity rate among these rejected blood donors was 63.4% (104/164). Mean age was statistically related to HBV infection with a difference of 4.67 years old ( $p < 0.001$ ), being the mean age of the HBV-infected donors ( $29.2 \pm 8.02$  years) lower compared to the HBV-uninfected donors ( $33.9 \pm 10.0$  years). None of the demographic characteristics studied was related to HBV infection ( $p > 0.05$ ). Despite that, we observed that blood donors aged between 20–40 years (83.7%, 87/104), male gender (86.5%, 90/104), donors from urbanized areas (56.7%, 59/104), donors with low education (93.3%, 97/104), donors employed in the public and/or private sector (79.8%, 83/104), and unmarried donors (95.2%, 99/104), were the most affected by HBV infection. Univariate logistic analyses showed that donors between 20–40 years [OR: 2.34 (95% CI: 1.02 - 5.34),  $p = 0.045$ ], the male gender [OR: 1.40 (95% CI: 0.51 - 3.86),  $p = 0.516$ ], residents in urbanized areas [OR: 1.23 (95% CI: 0.65 - 2.32),  $p = 0.530$ ], with a low educational level [OR: 1.54 (95% CI: 0.49 - 4.82),  $p = 0.458$ ], unemployed [OR: 1.65 (95% CI: 0.68 - 3.99),  $p = 0.271$ ], and unmarried [OR: 1.41 (95% CI: 0.37 - 5.48),  $p = 0.616$ ], were more likely to contract HBV infection, compared to the other groups.

The clinical features showed that the mean AST, a marker of liver function in the generally rejected blood donors enrolled in this study, was  $58.9 \pm 53.6$  U/L, higher than the maximum expected value established for this study, which ranged from 8 to 48 U/L. Mean AST values were higher in HBV-infected donors ( $59.7 \pm 56.6$  U/L) compared to mean values from HBV-uninfected donors ( $57.6 \pm 48.6$  U/L), with a mean difference of 2.04 U/L, although no significance was observed ( $p = 0.816$ ). On the other hand, ALT values, another biological marker used to monitor liver function, in the generally rejected blood donors were  $34.0 \pm 30.2$  U/L and were within the range established as the standard for this study. No difference in mean ALT values was observed between HBV negative ( $33.9 \pm 20.4$ ) or positive ( $34.0 \pm 34.7$ ) donors ( $p = 0.972$ ). Also, no relationship between AST and ALT status and HBV infection was observed. Despite that, the mean AST/ALT ratio was higher in HBV-positive donors ( $2.07 \pm 1.42$ ) compared to the mean in uninfected donors ( $1.90 \pm 1.14$ ), although not significant ( $p = 0.430$ ). Donors with AST/ALT ratio  $< 1$  presented 1.92 times (95% CI: 0.76 - 4.82) more chances of HBV infection compared to donors with an AST/ALT ratio  $\geq 1$ .

#### 3.2 Features related to acute or chronic liver disease in HBV-infected blood donors

Overall, of the 104 HBV-positive donors, 21 (20.2%) had acute liver disease and 83 (79.8%) had chronic liver disease based on AST/ALT ratio, with a mean AST of  $59.7 \pm 56.6$  U/L and ALT of  $34.0 \pm 34.7$  U/L. The mean age of donors indicative of chronic liver disease ( $28.6 \pm 7.51$  years old) was lower compared to donors with suspicion of acute liver disease ( $31.8 \pm 9.53$  years old), although no statistical significance was observed ( $p = 0.097$ ). Mean values of AST (41.7 to 68.2 U/L,  $p = 0.706$ ) and ALT (27.7 to 49.1 U/L,  $p = 0.240$ ) increased with age from under 20 to over 40 years, respectively. The chronic liver infection rate was highest in the 20-40 age group (85.5%, 71/83), being the same group that presented 1.97 times (95% CI: 0.54 - 7.21,  $p = 0.305$ ) more likely to develop chronic liver disease, compared to the other groups. Suspected liver disease in the acute (90.5%, 19/21) or chronic (85.5%, 71/83) phase was higher in males. In addition, the highest average values of AST ( $60.1 \pm 58.9$ ) and ALT ( $35.0 \pm 36.6$ ), were also seen in male donors. Despite that, the female gender presents 1.61 times (95% CI: 0.33 - 7.80,  $p = 0.557$ ), more likely to develop chronic liver disease. Even so, no significant difference in men's or women's AST and ALT means was observed ( $p > 0.05$ ). Suspicion of liver disease in the acute (66.7%, 14/21) or chronic (54.2%, 45/83) phase was higher in donors

residing in urbanized areas. However, the highest mean values of AST (67.3 +- 77.0), ALT (37.0+-49.1), as well as more chances [OR: 1.69 (95% CI: 0.62 - 4.61),  $p=0.557$ ] to develop chronic liver disease were observed in donors from non-urbanized areas. Suspected acute (90.5%, 19/21) or chronic (94.0%, 78/83) liver injury was more observed in donors with a low educational level, as well as 1.64 times (95% CI: 0.30 - 9.12,  $p=0.571$ ) more likely to progress to chronic liver disease, although higher AST (111+-162) and ALT (38.5+-15.8) values, observed in donors with a high educational level. A statistically significant difference was observed between educational level and AST values, with the AST values of donors with high education twice as high compared to donors with low education ( $p=0.013$ ). The employed donors were those who most had suspected acute (71.4%, 15/21) or chronic liver (81.9%, 68/83) disease and also to be the ones with the highest AST (61.8+-60.6) and ALT (34.4+-37.5) values. Despite that, unemployed donors were 1.81 times (95% CI: 0.60 - 5.45,  $p=0.289$ ) more likely to develop chronic liver disease than employed donors. Married and unmarried donors had the same chances of developing chronic liver disease, despite unmarried donors predominating with suspected acute (95.2%, 20/21) or chronic (95.2%, 79/83) liver injury, as well as presenting the highest values of AST (60.0+-57.7) and ALT (34.4+-35.4).

#### 4 DISCUSSION

HBV infections remain a major public health problem worldwide and the main factor for the development of liver cirrhosis. To the best of our knowledge, this was the first study that combined HBV seroprevalence with an evaluation of the clinical evolution and insights regarding the liver disease based on AST/ALT ratio, in a young population rejected for blood donation in Luanda, the capital city of Angola.

The peak prevalence of HBV infection in Africa has been estimated to be around 20% while the seroprevalence of HBV in the general population of Angola has been estimated to be around 26%, higher than the average of the eight countries in Africa. The HBV seroprevalence observed in this study (63.4%) (Table 1), indicating to be the main cause of the rejection of blood donors in Luanda. A previous study carried out by our research team in 2018 observed an HBV positivity rate of 7.5% among HIV-positive pregnant women, which was below the infection rate in Africa, however, in the present study, we observed an HBV positivity rate of 63.4% among rejected candidates to blood donation, which is equivalent to 3 times more than the global rate observed in Africa. Previous studies carried out by Nebenzahl et al (9.3%), Vueba et al (25.7%), Peliganga et al (22.7%), and Almeida et al (15.1%) have also reported a high rate of HBV positivity for HBV in Angola using the same HBsAg biomarker used in the present study. This increase in the seroprevalence of HBV among rejected blood donors in the capital of Angola might be explained due the increase of people with high unsafe sexual activity and a low vaccination coverage rate against HBV among the young population. The result could also reflect the increase in socioeconomic inequalities, which is a crucial determinant for the increase of risk groups in the population. Indeed, the main risk groups for HBV identified in this study were young people aged 20 - 40 years (OR: 2.34,  $p=0.045$ ), females (OR: 1.40,  $p=0.516$ ), urbanized areas (OR: 1.23,  $p=0.530$ ), low level of education (OR: 1.54,  $p=0.458$ ), unemployed (OR: 1.65,  $p=0.271$ ), and unmarried (OR: 1.41,  $p=0.616$ ) (Table 1). These findings suggest that measures such as awareness-raising and mass vaccination campaigns to control the spread of HBV in Angola should be centered on these vulnerable groups, although little statistical power was observed.

We observed a statistically significant relationship between age and HBV infection ( $p<0.001$ ), with those infected (29.2+-8.02 years old) at a lower mean age than the uninfected (33.9+-10.0 years old), which could be attributed to the early onset of sexual activity, ineffective HBV vaccination programs, as well as, a little awareness about practices to avoid contracting HBV infection in the young population. Previous studies have also reported a high rate of HBV infection in the young population up to 30 years old in different populations from Angola. The females in our study were 1.4 times more likely to contract HBV (Table 1), which corresponds to the findings of Nebenzahl et al, but differs from the report of Valente et al, which showed that men have twice the rate of HBV infection compared to females in Angola. It is worth mentioning that the high number of individuals with low education, unemployed and unmarried, might contribute to young people adopting risky behaviors, including the practice of sex workers, which enhances the dissemination of HBV as well as other infectious agents that share the same transmission routes. Therefore, it is crucial to

carry out more studies to understand the sociodemographic and behavioral determinants that enhance the spread of HBV and other viral infectious diseases in Angola.

Curiously, no significant difference was observed in the mean values of AST, ALT, or AST/ALT ratio, among infected and uninfected donors with HBV ( $p>0.05$ ), although the infected individuals had a higher AST/ALT ratio (2.07) than the uninfected (1.90) (Table 1), suggesting that AST, ALT, and the AST/ALT ratio could not be a suitable marker to be used as clinical markers of liver disease among individuals with HBV infection, as previously reported in the previous studies. We observed that the AST (from 42 to 68) and ALT (from 28 to 49) levels increased with increasing age among HBV-positive donors.

Based on AST/ALT ratio, about 20% and 80% of those infected with HBV had a clinical indication of acute or non-alcoholic liver disease and chronic disease or viral hepatitis, respectively (Table 2). Previous studies have shown that the AST/ALT ratio is a potential biomarker to assess health conditions and long-term mortality, especially high values of the AST/ALT ratio indicating a diagnosis of more severe liver damage or prediction of future cancer development due to viral hepatitis. Anderson et al. showed that an AST/ALT ratio of more than one is highly suggestive of the presence of liver cirrhosis. Based on these observations from previous studies, our findings showed that around 80% of rejected candidates due to HBV infection could be at an advanced stage of liver disease with a high chance of developing liver cirrhosis in the future, suggesting the need for an urgent review of control measures, to rejected donors receive a specialized assistant in case they test positive for viral hepatitis.

It is worth highlighting that some studies have reported that the AST/ALT ratio seems to have clinical value as an insight into the diagnosis of cirrhosis but does not define the diagnosis of cirrhosis and does not effectively predict the degree of fibrosis in patients with chronic viral hepatitis. The literature disagreement regarding the clinical utility of the AST/ALT ratio in individuals with HBV infection is an indication of the need for further studies, especially in terms of the population with occult HBV infection, such as blood donors. Despite this, our findings show that the evaluation of enzymes AST and ALT, as well as the AST/ALT ratio, could be useful in Angola for the timely identification of candidates with suspected advanced liver damage and with a high likelihood of developing liver cirrhosis. Furthermore, our results show that candidates infected with HBV who presented a high odd of developing liver cirrhosis or clinical progression of liver damage are donors between 20 - 40 years old (1.97 times), females (1.61 times), residents in non-urbanized areas (1.69 times), and unemployed candidates (1.81 times), although no statistical significance was observed ( $p>0.05$ ). Sociodemographic, clinical, and behavioral determinants related to the progression to liver cirrhosis among blood donors rejected due to viral hepatitis, such as HBV infection, are still little explored and deserve further investigation. Previous studies have shown that laboratory algorithms based on HBsAg detection leave a gap for infected HBsAg negative donors donating blood during the window period and could potentiate the spread of HBV infection through blood transfusion. Therefore, due to the high endemicity of HBV in Angola, new screening strategies including HBV nucleic acid testing (NAT) capable of detecting HBsAg-negative and anti-HBc-negative blood units donated during the initial acute HBV infection, should be quickly included in the testing algorithm for blood donors in Angola. This strategy aims to strengthen current diagnostic strategies and to prevent or reduce the transmission of viruses due to blood transfusion, although we recognize that the Angolan Ministry of Health should consider the need to evaluate the cost-effectiveness of incorporating the NAT in the algorithms of the health units responsible for the treatment and blood transfusion.

There are important limitations to be considered when interpreting the results of this study. Firstly, the small sample size and the regional limitation of the study among rejected blood donors screened by HBsAg in Luanda, the capital city of Angola, could have contributed to the low statistical power of the study as well as not representing a current epidemiological picture of the HBV infection in the general population. Secondly, the rate of HBV infection could be underestimated, as other markers such as NAT, anti-HBc, and anti-HBe, able to define the time of infection and infectiousness were not screened among HBsAg positive or negative donors. Finally, the clinical profile of liver damage among HBV-positive donors was defined only with the biomarkers AST, ALT, and the AST/ALT ratio, although we recognize the existence of other

serum markers and important clinical procedures that define liver damage or liver cirrhosis. Furthermore, we know that other conditions including metabolic disorders, alcohol intake, and physical exercise could affect AST and ALT values to change capable of inducing a misinterpretation of liver damage, which reinforces the need for further studies including behavioral determinants as well as the screening of additional markers of liver function to help define earlier the stage of liver damage in blood donors rejected due to HBV infection. Despite the observed weaknesses, our findings provide an important contribution to a more comprehensive knowledge of HBV epidemiology and vaccination status in Angola. However, further studies should be performed to allow a better characterization of the HBV epidemiology, risk groups, and clinical profile of the HBV-infected population to reinforce ongoing strategies to control HBV infection in Angola.

In summary, HBV infection is a burden among young individuals in Luanda, the capital city of Angola. The high HBV positivity rate could indicate the failure of viral hepatitis control measures in Angola. HBV screening, awareness, and control strategies must be urgently reviewed to prevent the unprecedented spread of HBV infection in the young population. Angolan health authorities should consider including HBV nucleic acid testing along with markers of liver function to ensure early identification of donors with occult HBV infection to improve the safe blood products and control the spread of chronic HBV infection in Angola. Further studies must be carried out to better understand the key determinants associated with HBV infection and progression to chronic liver disease among the HBV-infected population in Angola.

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### DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author.

### CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

### AUTHOR CONTRIBUTION STATEMENT

Conceptualisation: CSS. Data curation: CSS. Formal analysis: CSS and VP. Investigation: CSS, DJ, PV, JS, AM, FC, ES, and AV. Project administration: CSS, JNV, ZD, EM, DM, and JM. Supervision: CSS. Validation: CSS. Writing – original draft: CSS. Writing – review & editing: CSS, VP, ES, JNV, and JM. All authors have seen and approved the submitted version of this manuscript.

### ORCID

Cruz S. Sebastiao: <https://orcid.org/0000-0003-1232-0119>

Victor Pimentel: <https://orcid.org/0000-0001-6390-4128>

Euclides Sacomboio: <https://orcid.org/0000-0002-2341-9133>

Jocelyne Neto de Vasconcelos: <https://orcid.org/0000-0002-7318-693X>

Joana Morais: <https://orcid.org/0000-0002-4524-4055>

### REFERENCES

**TABLE 1** Sociodemographic and clinical features related to HBV infection among rejected blood donors from Luanda, Angola

Independent variables	N (%)	N (%)	Hepatitis B Virus Neg (%)
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Independent variables	N (%)	N (%)	Hepatitis B Virus
Overall	164 (100)	164 (100)	60 (36.6)
<b>DEMOGRAPHIC CHARACTERISTICS</b>	<b>DEMOGRAPHIC CHARACTERISTICS</b>		
Age (years), mean ± SD	30.9 ± 9.04	30.9 ± 9.04	33.9 ± 10.0
<20yrs	6 (3.70)	6 (3.70)	2 (3.30)
20-40yrs	130 (79.3)	130 (79.3)	43 (71.7)
>40yrs	28 (17.1)	28 (17.1)	15 (25.0)
Gender			
Female	20 (12.2)	20 (12.2)	6 (10.0)
Male	144 (87.8)	144 (87.8)	54 (90.0)
Residence area			
Non-urban	74 (45.1)	74 (45.1)	29 (48.3)
Urban	90 (54.9)	90 (54.9)	31 (51.7)
Educational level			
Low	151 (92.1)	151 (92.1)	54 (90.0)
High	13 (7.90)	13 (7.90)	6 (10.0)
Occupation			
Unemployed	29 (17.7)	29 (17.7)	8 (13.3)
Employed	135 (82.3)	135 (82.3)	52 (86.7)
Marital status			
Unmarried	155 (94.5)	155 (94.5)	56 (93.3)
Married	9 (5.50)	9 (5.50)	4 (6.70)
<b>CLINICAL CHARACTERISTICS</b>	<b>CLINICAL CHARACTERISTICS</b>		
AST (UL), mean ± SD	58.9 ± 53.6	58.9 ± 53.6	57.6 ± 48.6
Normal (8 – 48)	91 (55.5)	91 (55.5)	33 (55.0)
Abnormal	73 (44.5)	73 (44.5)	27 (45.0)
ALT (UL), mean ± SD	34.0 ± 30.2	34.0 ± 30.2	33.9 ± 20.4
Normal (7 – 55)	148 (90.2)	148 (90.2)	53 (88.3)
Abnormal	16 (9.80)	16 (9.80)	7 (11.7)
AST/ALT Ratio, mean ± SD	2.01 ± 1.33	2.01 ± 1.33	1.90 ± 1.14
<1 (acute or non-alcoholic liver disease)	28 (17.1)	28 (17.1)	7 (11.7)
1 (chronic disease, viral hepatitis, or toxicity)	136 (82.9)	136 (82.9)	53 (88.3)

Note: Bold numbers mean that the results were statistically significant for Chi-square or univariate analysis (p<0.05). Abbreviation: AST, aspartate transaminase; ALT, alanine aminotransferase.

**TABLE 2** Sociodemographic and clinical features related to acute or chronic liver disease in HBV-infected blood donors in Luanda, Angola

Independent variables	N (%)	AST (UL) mean ± SD	ALT (UL) mean ± SD	Liver damage status	Liver damage status	p-value	Univariate analysis	Univariate analysis
							(Chronic liver disease)	(Chronic liver disease)
				<b>Acute disease (AST/ALT Ratio &lt;1) (%)</b>	<b>Chronic disease (AST/ALT Ratio [?]1) (%)</b>		<b>OR (95% CI)</b>	<b>p-value</b>

Independent variables	N (%)	AST (UL) mean ± SD	ALT (UL) mean ± SD	Liver damage status	Liver damage status		Univariate analysis (Chronic liver disease)	Univariate analysis (Chronic liver disease)
Overall	104 (100)	59.7 ± 56.6	34.0 ± 34.7	21 (20.2)	83 (79.8)			
Age (years), mean ± SD	29.2 ± 8.02	-	-	31.8 ± 9.53	28.6 ± 7.51	0.097		
<20yrs	4 (3.80)	41.7 ± 13.3	27.7 ± 9.67	1 (4.80)	3 (3.60)	0.567	1.33 (0.10 – 17.1)	0.8
20-40yrs	87 (83.7)	59.2 ± 58.5	32.1 ± 28.8	16 (76.2)	71 (85.5)		1.97 (0.54 – 7.21)	0.3
>40yrs	13 (12.5)	68.2 ± 51.8	49.1 ± 64.0	4 (19.0)	9 (10.8)		1.00	
p-value		0.706	0.240					
Gender								
Female	14 (13.5)	56.7 ± 39.3	27.7 ± 18.3	2 (9.50)	12 (14.5)	0.554	1.61 (0.33 – 7.80)	0.5
Male	90 (86.5)	60.1 ± 58.9	35.0 ± 36.6	19 (90.5)	71 (85.5)		1.00	
p-value		0.837	0.468					
Residence area								
Non-urban	45 (43.3)	67.3 ± 77.0	37.0 ± 49.1	7 (33.3)	38 (45.8)	0.304	1.69 (0.62 – 4.61)	0.3
Urban	59 (56.7)	53.8 ± 33.2	31.8 ± 17.3	14 (66.7)	45 (54.2)		1.00	
p-value		0.278	0.453					
Educational level								
Low	97 (93.3)	56.0 ± 39.8	33.7 ± 35.7	19 (90.5)	78 (94.0)	0.567	1.64 (0.30 – 9.12)	0.5
High	7 (6.70)	111 ± 162	38.5 ± 15.8	2 (9.50)	5 (6.00)		1.00	
p-value		<b>0.013</b>	0.728					
Occupation								
Unemployed	21 (20.2)	51.0 ± 36.0	32.6 ± 21.2	6 (28.6)	15 (18.1)	0.284	1.81 (0.60 – 5.45)	0.2
Employed	83 (79.8)	61.8 ± 60.6	34.4 ± 37.5	15 (71.4)	68 (81.9)		1.00	
p-value		0.435	0.834					

Independent variables	N (%)	AST (UL) mean ± SD	ALT (UL) mean ± SD	Liver damage status	Liver damage status		Univariate analysis (Chronic liver disease)	Univariate analysis (Chronic liver disease)
Marital status								
Unmarried	99 (95.2)	60.0 ± 57.7	34.4 ± 35.4	20 (95.2)	79 (95.2)	0.991	1.00	
Married	5 (4.80)	52.3 ± 24.7	27.5 ± 15.3	1 (4.80)	4 (4.80)		1.01 (0.11 – 9.57)	0.9
p-value		0.767	0.671					

Note: Bold number means that the result was statistically significant for independent-sample T-tests (p<0.05).

Abbreviation: AST, aspartate transaminase; ALT, alanine aminotransferase.