Original Research Article

Seroprevalence of Viral Markers among Tattooed and Non-Tattooed Prospective Blood Donors at Lagos University Teaching Hospital (LUTH)

ABSTRACT

Introduction: Blood transfusion is vital but carries risks of transfusion-transmissible diseases (TTDs), especially in regions with inadequate practices. While tattoos may pose infection risks, evidence linking them to TTDs is inconclusive.

Aim/Objectives: This study aimed to evaluate the seroprevalence of viral markers among tattooed and non-tattooed prospective blood donors at Lagos University Teaching Hospital (LUTH).

Method: A cross-sectional study was conducted at LUTH, Lagos, Nigeria, from June to July 2024. A total of 158 adult blood donors, comprising 79 tattooed and 79 non-tattooed individuals, were recruited. Blood samples were tested for Hepatitis B virus (HBV), Hepatitis C virus (HCV), and Human Immunodeficiency virus (HIV) antibodies using rapid diagnostic kits. Statistical analysis included multivariate and odds ratio calculations.

Results: Among 79 tattooed participants, 26.6% tested positive for a TTI, with higher rates in those with older tattoos. Among non-tattooed donors, 21.5% had TTIs. Hepatitis B virus prevalence was slightly higher in tattooed individuals (11.4%) than in non-tattooed (10.1%). Co-infections (HIV/HBV and HBV/HCV) were more common in tattooed donors, though none of these differences were statistically significant. No TTIs were found in tattooed females, and participants with multiple tattoos or sexual partners had higher odds of testing positive.

Conclusion: The study suggests that tattoos may contribute to an increased risk of TTIs, particularly for older tattoos. However, other factors like gender, age, and sexual behaviour are also significant contributors. The findings imply that recent tattoos and improved practices may reduce risks, challenging the need for strict deferral policies for all tattooed donors.

Keywords: Blood donor, Hepatitis B virus (HBV), Hepatitis C virus (HCV), Human Immunodeficiency virus (HIV), Tattoo, Transfusion-transmissible infections (TTIs).

1.0 INTRODUCTION

Blood transfusion plays a crucial role in modern medical services, saving millions of lives globally. However, the safety and efficacy of transfusions are paramount, particularly with the risk of transfusion-transmissible infections (TTIs) such as HIV, hepatitis B (HBV), hepatitis C (HCV), and syphilis. These infections, if transmitted through blood transfusions, can cause significant morbidity and mortality [1]. The hepatitis C virus (HCV) is a parentally transmitted hepatotropic virus that causes chronic infection in 55%–85% of cases. Due to its chronic nature, HCV infection usually progresses to serious end-stage complications, such as cirrhosis and hepatocellular carcinoma. Globally, about 150 million individuals are infected with HCV [2,3]. Therefore, stringent donor screening procedures, including medical history evaluations and blood testing, are implemented to minimise the risk of such transmissions [4].

Tattooing, a growing trend worldwide, is considered a potential risk factor for blood-borne infections due to the invasive nature of the procedure and the possible use of non-sterile equipment or contaminated ink [5,6]. In many countries, individuals with tattoos face temporary deferral from blood donation to prevent the spread of transfusion-transmitted infections (TTIs). However, these deferral policies may also lead to missed donation opportunities, especially as tattoos become more common among young adults, a key demographic of blood donors [5]. In regions such as sub-Saharan Africa, where there is already a significant shortage of blood donations, such deferrals can have a profound impact on the availability of safe blood [6].

Lagos State, Nigeria, has witnessed an increasing prevalence of tattoos among its young adult population, coinciding with a rise in demand for blood due to medical emergencies and other blood-demanding conditions [7]. Currently, tattooed individuals are subject to permanent or extended deferrals from blood donation, resulting in reduced donation rates [8]. Given the shortage of blood supplies and the rising prevalence of tattoos, there is a need

to reassess whether tattooed individuals pose a higher risk for TTIs compared to their non-tattooed counterparts.

The primary aim of this research is to evaluate the seroprevalence of viral markers, including HBV, HCV, and HIV, among tattooed and non-tattooed prospective blood donors in Lagos University Teaching Hospital. The study seeks to provide evidence-based insights into the validity of current deferral policies for tattooed individuals, with the ultimate goal of optimizing donor eligibility criteria while ensuring the safety of blood transfusions.

2.0 MATERIALS AND METHODS

2.1 Study Design and Area

A cross-sectional study was conducted at Lagos University Teaching Hospital (LUTH), an 800-bed facility in Lagos, Nigeria, from June to July 2024. The hospital's blood bank accommodates about 1,200 prospective donors monthly. Lagos, created on May 27, 1967 [9], is Africa's most urbanized city and one of the world's fastest-growing urban centers [10]. Geographically, Lagos is located in southwestern Nigeria along the West African coast, stretching over 180 km along the Gulf of Guinea. It occupies approximately 3,577 km², with 220.6 km² composed of water bodies [11].

2.2 Sample Size Determination

The sample size was determined using a formula for comparing two proportions. The proportion of tattooed and non-tattooed with a serologic marker for at least one of the viral markers (HIV, HBV, HCV) was obtained from a study [12]. Proportion of tattooed participants with at least one marker was (59/182=0.324) and non-tattooed was (17/163=0.104).

Using the formula below:

$$\frac{\{u\sqrt{[\pi_0(1-\pi_0)+\ \pi_1(1-\pi_1)]}+v\sqrt{[2\pi(1-\pi)]}\}}{(\pi_1-\pi_0)^2}$$

Where $\pi = \frac{\pi_0+\pi_1}{2}$

Setting the power at 90%, u=1.28 and significance level at 5%, v=1.96

The minimum calculated sample size was 71each for the test and control groups. After sample size adjustment to account for attrition, 79 donors were enrolled in each group to participate in this study.

2.3 Recruitment Process and Study Participants

One hundred and fifty-eight blood donors comprising 79 tattooed (test group) and 79 non-tattooed (control group) attending LUTH, Lagos State, Nigeria, were recruited for this study. The study subjects were adults 18 years of age and above who volunteered to donate blood. Data from each study participant were collected after taking written informed consent. Structured questionnaire-based interviews of the study participants were used to collect necessary socio-demographic information on blood donors, gender, age, residence, types of donors, occupation, and marital status. The interviewer was trained on how to take history of exposure to know the risk factors for the viral Transfusion Transmissible Infection (TTI) and other potential confounders. Information on the presence of tattoos, their number, design, and conditions under which they were made was noted.

2.3.1 Inclusion criteria

i. Eighteen years or more (younger than sixty-five years)
ii. Thirteen grams per deciliter (13 g/dL) or 12 g/dL or more of hemoglobin concentration for men and women, respectively.
iii. A body mass of 50 kg and above
iv. A blood donation gap of three months and above

2.3.2 Exclusion criteria

Exclusion criteria complement inclusion criteria by identifying individuals who possess specific characteristics yet should be excluded from the study due to potential confounding factors, risks, or safety concerns.

2.4 Exposure and outcome of interest

The exposure of interest was at least one permanent tattoo, defined as an imprint of pigments in the skin made for reasons other than medical. The outcome of interest was the presence of serological markers of one or more transfusion-transmitted viral infections caused by HIV, HBV, and HCV.

2.5 Clinical Laboratory Investigation

2.5.1 Sample collection and analysis

Three millilitres (3 ml) of venous blood were collected from each donor, with 1 ml placed in a plain container and 2 ml in an EDTA tube. The samples in the EDTA containers were mixed to ensure anticoagulation, and labeled, and the 1 ml sample was clotted, centrifuged, and the serum stored at -20°C. Serological tests for hepatitis B, hepatitis C, and HIV were performed using rapid diagnostic test kits in the Blood Bank Transfusion Transmissible Infection Laboratory.

2.5.2 HBV and HCV serodiagnosis

Each participant's serum was tested for hepatitis B surface antigen (HBsAg) and anti-HCV using Bioline™ HBV and HCV Kits by Abbott Diagnostics Korea. This is a colloidal gold-enhanced immunoassay for detecting HBsAg and HCV in human whole blood, serum, or plasma. In the test area, goat anti-HBsAg antibody is immobilized on a nitrocellulose membrane and allowed to react with the specimen during the assay. The resulting mixture, as a result of capillary action, moved on the membrane chromatographically. An HBsAg- or

HCV-positive specimen produced a distinct colour band in the test region, formed by the particular antibody–HBsAg-coloured conjugate complex. A negative outcome was suggested by the absence of this coloured band in the test area. A coloured band in the control region served as procedural control regardless of the test result. For each run of the test internal quality controls were performed.

2.5.3 HIV 1/2 testing

A micropipette was used to add 50µl of the already separated test serum onto the end of the Determine™ HIV 1/2 Kit (Abbott Diagnostic Medical Co. Ltd, Japan) that is designed for the test sample. The test was left for at least 15 minutes (results are produced within 15-30 minutes). After the specified period of time, the result was read. Negative samples are indicated by reaction at the control window only while positive samples are indicated by double reaction at both test and control windows. Any reaction outside these is invalid.

2.5.4 Packed Cell Volume (PCV) Determination

The PCV of each of the participants was determined using standard haematological procedure. In brief, the EDTA Blood-filled capillary tubes were loaded into a microhaematocrit centrifuge which was set to 12,000 rpm and operated for 5 minutes to separate the blood components. After centrifugation, the tubes were carefully removed, and the PCV was measured using a microhaematocrit reader.

2.6 Statistical Analysis

Data were entered into an Excel sheet and cleaned. Analysis was done using SPSS version 22, International Business Machines Corporation (IBM). The association between infections and tattoos and other variables was measured by adjusted odds ratios (OR). Categorical data were presented as frequencies (Numbers and percentages) and inferential analysis was done with Fisher's exact test or Chi-square test. Continuous variables e.g., age were

presented as mean ± Standard deviation, and an ANOVA test was conducted where possible. Statistical significance was set as $P < 0{\cdot}05$, with a two-tailed analysis.

3.0 RESULTS

Table 1: Demographic Characteristics of Prospective Blood Donors (Tattooed vs. Non-Tattooed)

Variable	Non-tattooed (Control Group) Frequency (%)	Tattooed (Test Group) Frequency (%)
Gender		
Male	70 (88.6)	69 (87.3)
Female	9 (11.4)	10 (12.7)
Age (years)		
18-22	27 (34.2)	32 (40.5)
23-27	40 (50.6)	35 (44.3)
28-32	5 (6.3)	5 (6.3)
33-37	7 (8.9)	6 (7.6)
38-42	0 (0.0)	1 (1.3)
Marital Status		
Single	66 (83.5)	72 (91.1)
Married	13 (16.5)	7 (8.9)
Number of Partners		
One	66 (83.5)	65 (82.3)
Two	13 (16.5)	14 (17.7)
Level of Education		
Primary	4 (5.0)	12 (15.2)
Secondary	27 (34.2)	39 (49.4)
Tertiary	48 (60.8)	28 (35.4)

Socio-Demographic Data of the Participants

Table 1 shows the frequency distribution of socio-demographic factors of the prospective blood donors. Approximately 89% (non-tattooed) and 87% (tattooed) of the prospective blood donor were male. About 34% (non-tattooed) and 40% (tattooed) were between 18 and 22 years. Similarly, 50.6% and 44.3% of the non-tattooed and tattooed prospective blood donors were between 23 and 27 years. The majority of the participants were single 83.5% (non-tattooed) and 91.1% (tattooed). Also, subjects with only one partner were 83.3% (non-tattooed) and 82.3% (tattooed). Only a few of the participants had Primary as their highest level of education 5% (non-tattooed) and 15.2% (tattooed).

The Prevalence of TTIs and Duration Since the Tattoo was Done

Out of 79 prospective blood donors with tattoos, 1 (1.3%) and 21 (26.6%) among those who had had their tattoo done ≤ 1 year and 2-6 years respectively, tested positive for at least one TTI. In comparison, 17 of 79 prospective blood donors without tattoos (21.5%) also had at least one TTI (Figure 1).

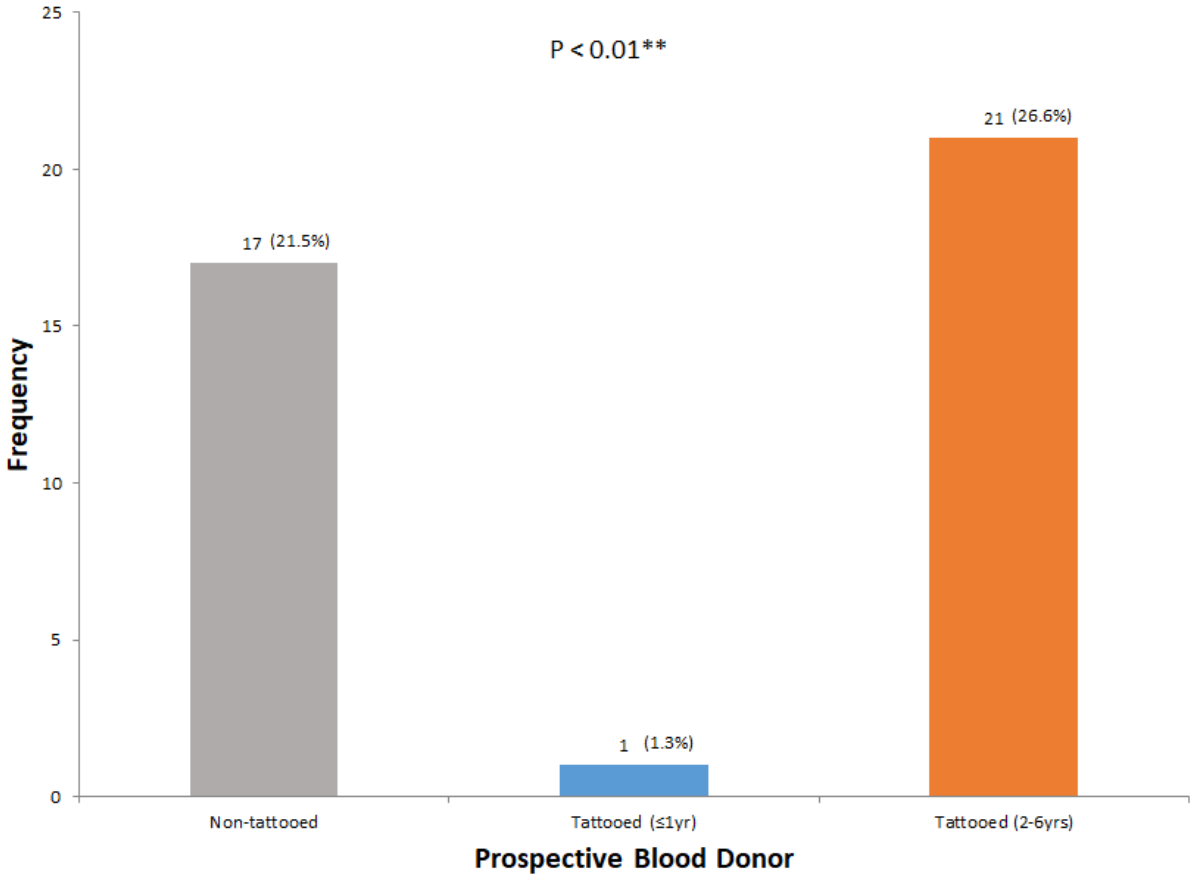

Figure 1. Non-tattooed and tattooed prospective blood donors (who have had their tattoo done between a year and below and 2 to 6 years) with at least one TTI.

Prevalence of TTIs between Tattooed and Non-tattooed Prospective Blood Donors

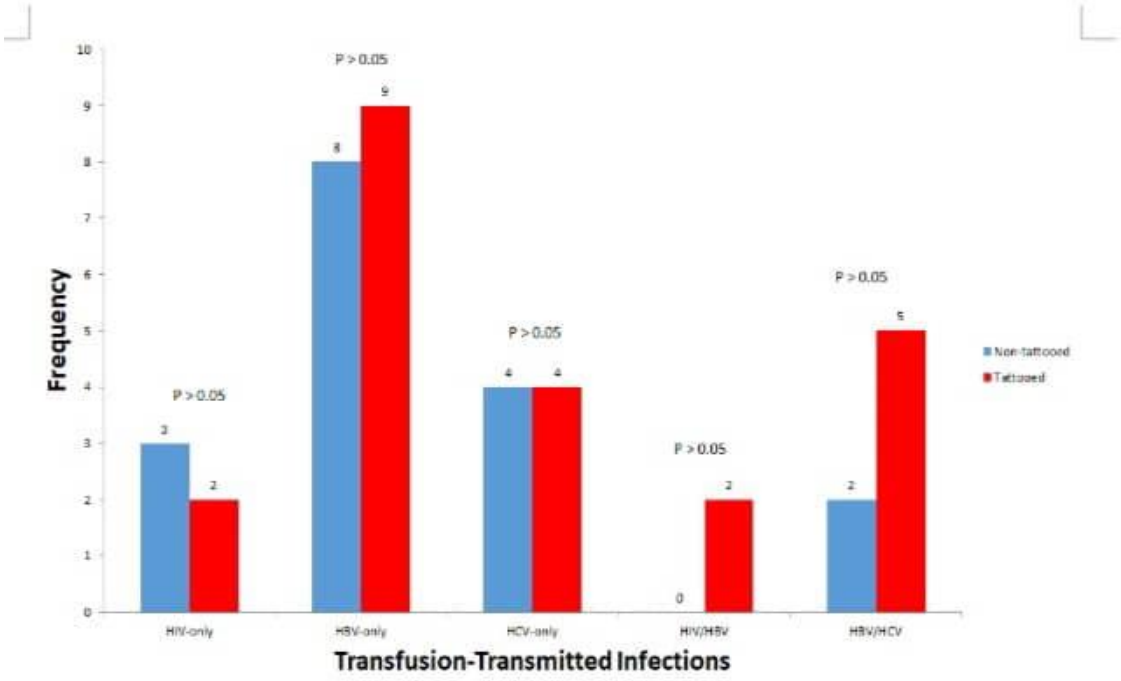

Figure 2. Prevalence of different TTIs among tattooed and non-tattooed prospective blood donors in LUTH.

Figure 2 shows the comparison of different TTIs between the tattooed and non-tattooed prospective blood donors. Hepatitis B Virus infection was higher among tattooed prospective blood donors 9 (11.4%) than those without tattoos 8 (10.1%). Likewise, HIV/HBV (2.5%) and HBV/HCV (6.3%) co-infections were more among these individuals. However, none of these comparisons were found to be statistically significant.

Prevalence of TTIs as Related to the Demographic Distribution of the Participants

Table 2. Distribution of TTIs among tattooed prospective blood donor in relation to gender of the participants.

Gender	No Tested	HIV (%)	HBV (%)	HCV (%)	HIV/HBV (%)	HBV/HCV (%)
Male	69 (87.3)	2 (2.5)	9 (11.4)	4 (5.0)	2 (2.5)	5 (6.3)
Female	10 (12.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Total	79 (100.0)	2 (2.5)	9 (11.4)	4 (5.0)	2 (2.5)	5 (6.3)

Table 2 shows the prevalence of different Transfusion-Transmitted Infections in relation to the gender distribution of the participants. None of the tattooed female subjects had TTIs. However, the prevalence of HIV, HBV, and HCV among the male were 2.5%, 11.4%, and 5.0% respectively. Similarly, HIV/HBV and HBV/HCV co-infections prevalence were 2.5% and 6.3%, respectively.

Table 3. Distribution of TTIs among tattooed prospective blood donor in relation to age of the participants.

Age (years)	No Tested	HIV (%)	HBV (%)	HCV (%)	HIV/HBV (%)	HBV/HCV (%)
18-22	32 (40.5)	0 (0.0)2 (2.5)1 (1.3)0 (0.0)1 (1.3)				
23-27	35 (44.3)	2 (2.5)	5 (6.3)	3 (3.8)	1 (1.3)	3 (3.8)
28-32	5 (6.3)	0 (0.0)	1 (1.3)	0 (0.0)	0 (0.0)	0 (0.0)
33-37	6 (7.6)	0 (0.0)	1 (1.3)	0 (0.0)	1 (1.3)	0 (0.0)
38-42	1 (1.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.3)
Total	79 (100.0)	2 (2.5)9 (11.4)4 (5.0)2 (2.5)5 (6.3)				

The age distribution of various TTI among participants is shown in Table 3. Among the age groups, the participants between ages 23 – 27 years had the highest prevalence of all the TTIs tested for in the study. Additionally, Table 3 indicates that this group had the highest rate of HBV/HCV co-infection at 3.8%.

Table 4. Distribution of TTIs among tattooed prospective blood donor in relation to level of education of the participants.

Education level	No Tested	HIV (%)	HBV (%)	HCV (%)	HIV/HBV (%)	HBV/HCV (%)
Primary	12 (15.2)	1 (1.3)	1 (5.1)	0 (0.0)	0 (0.0)	0 (0.0)
Secondary	39 (49.4)	0 (0.0)	6 (7.6)	2 (2.5)	2 (2.5)	5 (6.3)
Tertiary	28 (35.4)	1 (1.3)	2 (2.5)	2 (2.5)	0 (0.0)	0 (0.0)
Total	79 (100.0)	2 (2.5)	9 (11.4)	4 (5.0)	2 (2.5)	5 (6.3)

The distribution of TTIs in relation to the level of education of the individuals is shown in Table 4. Subjects whose level of education was secondary had the highest prevalence of HBV (7.6%). Similarly, HIV/HBV (2.5%) and HBV/HCV (6.3) co-infections were only recorded among this group.

Association between Tattoo Characteristics and TTIs in Prospective Blood Donors

Table 5. Odd Ratio for tattoo and Transfusion-Transmitted Infection.

Variable	Adjusted Odd Ratio	95% CI	P-value
Tattoo			
Yes vs No	1.41	0.68 – 2.91	> 0.05
Number of Tattoo			
2 vs 1	6.14	2.02 – 18.64	< 0.05*
Type of Tattoo			
Non-professional vs Professional	1.68	0.57 – 4.93	> 0.05
Marital Status			
Single vs Married	0.96	0.17 – 5.36	> 0.05
Number of Partner			
2 vs 1	18.00	4.30 – 75.35	< 0.01**
Level of Education			
Primary vs Secondary	0.32	0.06 – 1.66	> 0.05
Primary vs Tertiary	0.92	0.15 – 5.57	> 0.05
Time Done			
2-6 years vs ≤ 1 year	15.27	1.92 – 121.50	< 0.05*

CI – Confidence Interval. *Significant at P < 0.05.

The adjusted odds ratio for testing positive for at least one serological test for a TTI among those with tattoos was 1.41 (95% CI: 0.68 – 2.91). Participants with up to two (2) tattoos are associated with having at least one TTI (OR: 6.14, 95% CI: 2.02 – 18.64). Tattooed prospective blood donor who had more than one partner are linked to having at least one TTI (OR: 18.00, 95% CI: 4.30 – 75.35). Similarly, those who have had their tattoo done more than a year are associated with at least one TTI (OR: 15.27, 95% CI: 1.92 – 121.50) (Table 5).

4.0 DISCUSSIONS

World Health Day 2000 was themed "Safe Blood Starts with Me, Safe Blood Saves Lives," highlighting a crucial and timely public health issue [13]. Ensuring the availability of safe blood for transfusion is vital for an effective healthcare system [14], and blood donors are essential for this [13]. Testing all donors for transfusion-transmitted infections (TTIs) with sensitive and reliable serological tests is necessary [15] [16], still, efficient algorithms should be implemented to minimize loss of donation due to positive serology results [17]. This study provides insight into the seroprevalence of TTIs among tattooed and non-tattooed prospective blood donors at Lagos University Teaching Hospital. Risky health behaviour such as tattooing especially when it is not done under aseptic conditions predisposes individuals to certain infections which can eventually be transmitted through blood products[4] [18]. The demographic data showed a predominance of male donors (87.3%) which is consistent with global trends [19] [20] [21] [22]. The lower rate of female donors may be due to traditional beliefs about menstruation or lack of support from spouses in some African cultures [17] [20].

A greater percentage of tattooed donors (40.5%) were aged 18-22 compared to non-tattooed donors (34.2%), indicating a higher likelihood of tattoos among younger individuals. Most tattooed (91.1%) and non-tattooed donors (83.5%) were single, aligning with global trends of younger, single individuals being more involved in tattooing [23] [24]. Educational levels among tattooed donors varied, suggesting that education might not strongly predict tattoo prevalence; this is comparable with findings from India [8].

The overall TTI prevalence was slightly higher among tattooed donors (27.8%) than non-tattooed donors (21.5%). This is in tandem with a report elsewhere [25]. This suggests a potential association between tattooing and an increased risk of TTIs. However, this was in contrast to the results of a study conducted in India [8]. This disparity may be due to differences in geographical area and variations in tattooing practices. The prevalence of TTI

among tattooed prospective donors who had had their tattoo done less than a year was greatly lower (1.3%) compared to those who had theirs between two to six years (26.6%) and non-tattooed donors (21.5%). This is in agreement with previous studies conducted elsewhere [5] [26]. This could be due to improved technology, awareness, and compliance [27] [28]. In the same vein, tattooed individuals who recently had their tattoos done may be more likely to follow post-tattoo care instructions and avoid risky behaviours, which could lower the risk of TTIs. In addition, the shorter duration of exposure to potential risk factors associated with recent tattoos might contribute to lower TTI prevalence. Over time, risk factors might accumulate, explaining higher TTI rates in older tattoos. The HBV infection rate was not statistically different among tattooed and non-tattooed donors. This is in agreement with a study in Pondicherry, India [8]. The prevalence of HIV/HBV and HBV/HCV co-infections was higher among tattooed individuals. Despite these findings, the lack of statistical significance suggests that while there is a trend, it does not robustly establish a causal link.

The multivariate analysis conducted in this study revealed no significant difference in the packed cell volume (PCV) between tattooed and non-tattooed prospective blood donors, regardless of the presence or absence of transfusion-transmissible infections (TTIs). This finding suggests that, within our study population, the act of having a tattoo does not significantly impact PCV levels. Factors such as overall health, hydration status, and diet could play a significant role in PCV levels [29]. Additionally, the absence of a significant difference may indicate that the process of getting a tattoo, when conducted under standard hygienic conditions, does not adversely affect haematological parameters such as PCV. This aligns with the broader understanding that well-managed tattoo practices do not significantly impact blood health.

Gender analysis revealed that none of the tattooed female donors tested positive for TTIs, whereas male donors showed varied prevalence rates. This suggests potential differences in risk behaviours or exposure between genders. The absence of TTIs in tattooed females may

indicate either lower exposure risk or other confounding factors that were not assessed in this study. These findings in this study are consistent with the reports of previous studies [23] [30]. However, this is in disagreement with the outcome of the study conducted in Port Harcourt, Nigeria [31]. This disparity may be due to differences in the sample population. Donors aged 23-27 had the highest TTI prevalence, possibly due to higher exposure risks or behaviours prevalent in this age group. This is in tandem with the reports of a similar study carried out in Plateau State, Nigeria [32]. This age group includes active young people, who may engage in risky behaviours such as using intravenous drugs and having multiple sexual partners. Increased HBV/HCV co-infection rates (3.8%) could be because certain TTIs, like HBV, require a relatively small infectious dose compared to other sexually transmitted and blood-borne infections, increasing the likelihood of infection among these high-risk individuals. This suggests that targeted preventive measures may benefit this demography. The association between being single and higher TTI rates, along with the increased TTI prevalence among individuals with multiple partners, underscores the importance of sexual risk behaviours in TTI transmission. This aligns with known epidemiological trends where an increased number of sexual partners correlates with a higher risk of TTIs. This is in comparison with the reports of a study conducted elsewhere [33]. Furthermore, the highest HBV prevalence among those with secondary education may indicate that educational level influences risk behaviours or socio-economic status rather than TTI prevalence directly.

Findings from the present study revealed that tattooing, especially with multiple tattoos or tattoos done more than a year ago, is associated with a higher risk of TTIs. This aligns with studies suggesting that non-sterile tattooing practices or inadequate aftercare may increase infection risk [25].

5.0 Conclusion

This study found that while the prevalence of certain infections, particularly Hepatitis B and co-infections, was slightly higher among tattooed blood donors, the differences were not statistically significant. Demographic factors like age, number of partners, and the duration since the tattoo was made were more strongly associated with infection rates. The findings suggest that tattoos may be a potential risk factor for TTIs, but blanket deferral policies for tattooed individuals may not be necessary. A more refined approach to donor eligibility could help address blood shortages without compromising safety.

6.0 Recommendation

Further research is needed to conduct studies with larger sample sizes across different regions to further validate the association between tattoos and TTIs in prospective blood donors. Also, further research into other behavioural risk factors, such as sexual activity and drug use, in conjunction with tattoo status, could help identify more accurate risk predictors for TTIs in blood donors.

Ethical Approval

Ethical approval was obtained from the Health Research and Ethics Committee of Lagos University Teaching Hospital (LUTH), Lagos State, Nigeria with number ADM/DCST/HREC/APP/6740.

Consent

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

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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