Transfusion transmitted infections among male blood donors of White Nile State, Sudan: Screening of the current seroprevalence and distribution

Elnaim Bushra Ahmed1,2*, Areej Ahmed Essa1, Babiker Saad Almugadam1,3*, Qawaeid Mohamed Ahmed1 and Mofeeda Mohammed Hussein1

Abstract

Objective: Our study planned to investigate the current positivity rate and distribution of the serologic markers of TTIs among male blood donors of the White Nile state, Sudan.

Results: The overall reported seropositive cases of TTIs was 15.91%, and percentages of anti-Human immunodeficiency virus 1/2 (anti-HIV1/2), Hepatitis B virus surface antigen (HBVsAg), anti-Hepatitis C virus (anti-HCV), and anti-Treponema palladium (anti-T. palladium) were 2.61%, 5.57%, 1.40%, and 5.72%, respectively. Out of 10897 donors examined, 0.59% had a serological sign of multiple infections. Furthermore, the odds of testing positive for TTIs were higher in the 28–37 age group (OR: 2.620, 95% CI: 2.324–2.955) and lower in the 38–47 age group (OR: 0.671, 95% CI: 0.567–0.794) compared to individuals of 18–27 years old. Likewise, it is more in individuals of Kosti (OR: 1.122, 95% CI: 0.987–1.277) and Rabak (OR: 1.354, 95% CI: 1.188-1.543) localities compared to Al Douiem locality. Anti-HIV/anti-T. palladium (27.70%) and anti-HIV/HBVsAg (23.07%) were the most frequently detected serologic markers of co-infections, $P = 0.002$.

Keywords: HIV, Blood donors, HBV, HCV, T. palladium, TTIs

Introduction

Transfusion-transmitted infections (TTIs) are a heterogeneous group of infectious diseases, which constitute major health challenges. Collectively, the Human immunodeficiency virus (HIV), Hepatitis B virus (HBV), Hepatitis C virus (HCV), and T. palladium infections represent the most common TTIs globally [1–5]. Moreover, HIV, HBV, and T. palladium are not only acquired through the infected blood but also can transmit by sexual contact, which make them easily and rapidly spread [6]. Formerly, to evade the probability of moving ailments from non-diagnosed cases to blood receivers, the World Health Organization (WHO) issued a statement of testing the blood donors before transfusion at least to HIV, HBV, HCV, and T. palladium, which are causes of AIDS, Hepatitis B, Hepatitis C, and Syphilis, respectively [7, 8].

Regardless of the availability of the advanced and rapid diagnostic tests globally, the epidemiology of these illnesses is poorly studied, and few data existed concerning TTIs in Sub-Saharan Africa [9]. Sudan classified as a country with a high HBV and HCV infections endemicity [10–12]. Limited studies on HCV infection in Sudan revealed a low (2.74%) seroprevalence. Although there was a continuous increase in the incidence of HIV infected individuals, the frequency of illness is unknown...
and the previous reported seroprevalence of HIV and HBV infections had ranged from 0 to 18.3% and 5.1 to 26.81%, respectively [10].

Investigating the TTIs can provide data about the magnitude of unnoticeable infected individuals in the community, which is helpful in diagnosis and therapy of such diseases, and in articulating health policies and protocols. Therefore, our study aimed to investigate the prevalence and distribution of serologic markers of TTIs, in particular, anti-HIV1/2, HBV surface antigen (HBVsAg), anti-HCV, and anti-\textit{T. palladium} among volunteer male blood donors of White Nile state, Sudan.

**Main text**

**Materials and methods**

This was a single year retrospective epidemiological study conducted in the White Nile state of Sudan to gather the data of male volunteer blood donors out January 1, 2017 to December 31, 2017. Blood banks of Kosti, Al Douiem, and Rabak Teaching Hospitals have been selected as these are major hospitals in the state and situated in the most populated localities (Kosti, Al Douiem and Rabak, respectively), which were represented around 53.32% (940123) of the total state population according to the census of 2008.

The study population composed of male blood donors regardless of occupation, education level, and ethnic groups. The selection of volunteer blood donors based on a pre-set of inclusion criteria, and the main inclusion criteria were age between 18 and 65 years, weights over 45 kg, and free of illnesses as determined by past medical history, clinical examination, and laboratory investigations. While those did not fit these criteria or have a history of recent blood donation before less than 6 months were excluded. The data concerning the findings of blood bank investigations and the socio-demographic characteristics of blood donors were compiled from blood banks records. The gathered information includes age, locality, and blood banks investigations outcome for anti-HIV1/2, HBVsAg, anti-HCV, and anti-\textit{T. palladium} tests.

The laboratory examination of TTIs was based on serologic tests. Briefly, a 5 ml of venous blood was collected from every donor in a sterile blood container without anti-coagulant and left at room temperature for few minutes to form a clot. Afterward, each sample had centrifuged at 3000 rpm for 10 min to obtain serum that immediately tested for TTIs by rapid Immunochromatographic test devices (Acon, USA) according to manufacturer instructions. The positive tests were indicated by the presence of red color in test and control lines.

The gathered data was analyzed by IBM SPSS software version 21. The prevalence of the serologic markers of TTIs, co-infections, anti-HIV1/2, HBVsAg, anti-HCV, and anti-\textit{T. palladium} were expressed as numbers and percentages. Pearson Chi-Squared and Fishers Exact tests were used to assess the statistical difference among the gathered data. The association between the serologic markers of TTIs or co-infections and their influencing factors were also evaluated using binary logistic regression. A \(P\) value of \(<0.05\) was considered significant.

| Variable | Blood donors: N (%) | Prevalence: N (%) |
|----------|---------------------|-------------------|
|          | Overall 10897 | 285 (2.61) | 607 (5.57) | 153 (1.40) | 624 (5.72) | 65 (0.59) | 1734 (15.91) |
| Age      | 18–27 years 3950 (26.25) | 32 (0.81) | 157 (3.97) | 42 (1.06) | 197 (4.98) | 25 (0.63) | 453 (11.46) |
|          | 28–37 years 4183 (38.39) | 225 (5.37) | 356 (8.51) | 103 (2.46) | 355 (8.48) | 21 (0.50) | 1060 (25.34) |
|          | 38–47 years 2764 (25.36) | 28 (1.01) | 94 (3.40) | 8 (0.28) | 72 (2.60) | 19 (0.68) | 221 (7.99) |
|          | \(P\) value < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | 0.576 | < 0.001 |
| Residence| Al Douiem 3331 (30.60) | 47 (1.41) | 179 (5.37) | 62 (1.86) | 169 (5.07) | 12 (0.36) | 469 (14.07) |
|          | Kosti 4152 (38.10) | 164 (3.94) | 211 (5.08) | 28 (0.67) | 215 (5.17) | 27 (0.65) | 645 (15.53) |
|          | Rabak 3414 (31.30) | 74 (2.16) | 217 (6.35) | 63 (1.84) | 240 (7.02) | 26 (0.76) | 620 (18.16) |
|          | \(P\) value < 0.001 | < 0.001 | 0.047 | < 0.001 | < 0.001 | 0.086 | < 0.001 |

TTIs Transfusion-transmitted infections, \(N\) Number, \(HIV\) Human immunodeficiency virus, \(HBVsAg\) Hepatitis B virus surface antigen, \(HCV\) Hepatitis C virus, \(MI\) Multiple infections

Statistical differences were evaluated using Pearson Chi-Squared test
Results

The data of 10,897 male blood donors were retrieved from blood bank records, of them, the information of 4152 (38.10%), 3414 (31.30%), and 3331(30.60%) donors have gathered from Kosti, Rabak, and Al Douiem locality, correspondingly. Furthermore, the majority of individuals 4183 (38.39%) were aged 28–37 years as well as most of them 4152 (38.10%) were Kosti locality residents, Table 1.

Out of total donors, 1734 (15.91%) were tested positive for TTIs. Likewise, 1669 (15.31%) had a serological marker of a single type of TTIs. Moreover, there was a statistically significant difference in the occurrence of overall serologic markers of TTIs among age groups and geographic areas. In particular, the donors of age group 28–37 years (25.34%) had a higher frequency of the serologic markers of TTIs compared with 18–27 (11.46%) and 38–47 (7.99%) age groups. The blood donors of Rabak locality had shown a higher percentage of seropositivity for TTIs (18.16%) compared with individuals of 18–27 years age. Moreover, the odd of testing positive for TTIs were statistically much higher in 28–37 years old and Rabak locality; however, it is not significant except for anti-HIV/anti-T. palladium among age groups. Furthermore, there was a statistically significant difference in the occurrence of the serologic markers of multiple infections (MI) among age groups and study areas, P = 0.576 and 0.086, respectively, Table 1.

Table 2 Logistic regression analysis for the serologic markers of TTIs and MI

| Variable     | TTIs  | MI among TTIs positive cases |
|--------------|-------|-------------------------------|
|              | OR (95% CI) | P value | OR (95% CI) | P value |
| Age          |       |                               |               |         |
| 18–27 years  | 1     | –                              | 1              | –       |
| 28–37 years  | 2.620 (2.324–2.955) < 0.001 | 0.346 (0.192–0.625) < 0.001 |       |               |
| 38–47 years  | 0.671 (0.567–0.794) < 0.001 | 1.610 (0.867–2.992) 0.132 |       |               |
| Residence    |       |                               |               |         |
| Al Douiem    | 1     | –                              | 1              | –       |
| Kosti        | 1.122 (0.987–1.277) 0.079 | 2.100 (1.053–4.189) 0.031 |       |               |
| Rabak        | 1.354 (1.188–1.543) < 0.001 | 1.893 (0.946–3.790) 0.072 |       |               |

TTIs Transfusion-transmitted infections, MI Multiple infections, OR Odd ratio, CI Confidence interval

Notably, the prevalence of co-infections markers was 65 (0.59%). Moreover, there was no statistical difference in the occurrence of the serologic markers of multiple infections (MI) among age groups and study areas, P = 0.576 and 0.086, respectively, Table 1. Additional file 1: Figure S1a–c displayed the probability of the serologic markers of MI among TTIs seropositive cases. Out of the total of TTIs seropositive cases, 3.74% have shown the serologic indication of co-infections, Additional file 1: Figure S1a. Likewise, the probability of the serologic markers of MI was a significantly dissimilar among TTIs positive cases in blood donors of different age groups, and represented 5.51%, 1.98%, and 8.59% for 18–27, 28–37, 38–47 years age groups, respectively, Additional file 1: Figure S1b. The regression analysis has revealed that the individuals of 28–37 years age (OR: 0.346, 95% CI: 0.192–0.625) were statistically less likely to have the serologic sign of MI compared to individuals of 18–27 years age. Moreover, the odd of testing positive for the serologic markers of MI were much greater among the people of Kosti (OR: 2.100, 95% CI 1.053–4.189) compared to Al Douiem locality, Table 2.

Table 3 summarizes the co-occurrence of co-infections markers among the MI positive cases. Comparatively, anti-HIV/anti-HCV and anti-HCV/anti-T. palladium were more common in individuals of 38–47 years old and Rabak locality; however, it is not significant except for anti-HIV/anti-HCV among age groups. Furthermore, there was a statistically significant difference concerning the co-occurrence of the serologic markers of MI in 18–27 and 28–37 years age groups as well as in Rabak and Al Douiem localities. Notably, anti-HIV/anti-T. palladium represents 27.70% of overall markers of MI (P = 0.002). A 36% of anti-HIV/anti-T. palladium was detected in 18–27 years age group, whereas 33.33% of anti-HIV/HBsAg had seen in 28–37 years age group and 36.84% of HBVsAg/anti-T. palladium reported in individuals of ages ranged from 38–47 years old. Regionally, 29.63% of anti-HIV/HBsAg was found in Kosti locality, whereas 34.62% of anti-HIV/anti-T. palladium detected in the individuals of Rabak locality. Moreover, 41.67% of
HBVsAg/anti-\textit{T. palladium} was reported in Al Douiem locality, Table 3.

**Discussion**

Every year, transfusions therapies of blood and its constituents save millions of lives and decrease the morbidity of illnesses globally [13]. Nevertheless, to avoid its accompanied biohazards and harm, the physicians and health care practitioners should ensure the transfusion of safe blood to recipients. In this regard, the screening of blood donors for TTIs is helpful in prevention against the life threatening infections. The reliable screening approach for TTIs was nucleic acid amplification methods, which enable the early discovery of infectious agents. Western blot, indirect fluorescent antibody, recombinant immunoblot, and enzyme-linked immunosorbent assays were also major reliable screening methods. Unfortunately, these methods are not available in resource-limited settings such as the major areas of developing countries where rapid diagnostic tests (Screening and non-confirmatory) have been widely adopted [14]. In this study, the majority (38.39\%) of blood donors were age range 28–37 years, which was analogous to the previous studies outcomes [15–17]. On the other hand, the percentage of overall donors tested positive for TTIs (15.91\%) or, in particular, anti-HIV1/2 (2.61\%), anti-HCV (1.40\%), HBVsAg (5.57\%), anti-\textit{T. palladium} (5.72\%), and MI (0.59\%) are much higher in this study compared with the findings of many previous studies [3, 8, 15, 18]. In contrast, there are lowered compared to Bisetegen FS et al., Study [9]. The probable reasons for the dissimilarity between these studies may attribute to the difference in the study area and population, sample size, socioeconomic status and cultural habits of study communities, and diagnostic methods, which are known elements affecting the occurrence and distribution of various illnesses. Moreover, the lack of health survey and education programs in our study area could also be responsible.

Notably, Rabak residents and the individuals of ages range 28–37 years comprised the majority of TTIs positive cases. Although these outcomes have also strengthened by the findings of multivariate logistic regression, Pearson Chi-squared analysis found that the higher prevalence among the Rabak residents was only occurred by the significant greater frequency of HBVsAg, and anti-\textit{T. palladium}. Formerly, Rebouças KA et al., study has documented similar probability of TTIs among age groups [18], which could be related to the dissimilarity in the genetic constitution, immunity of individuals, and the magnitude of risk factors that may affect the individual’s susceptibility to TTIs. Likewise, it has known that the period of living in the infected community increases the likelihood of acquiring illnesses. On the other hand, Rabak is formerly suffering from more poverty and lack of health services compared to Kosti and Al Douiem locality, which are factors that extremely affect infection rates and distribution. Our findings have drawn attention to look for the real reason of the higher prevalence in this age group and area.

Concerning the co-occurrence of the serologic markers of TTIs among the MI positive cases, the probability of having anti-HIV/anti-\textit{T. palladium} (27.70\%) was statistically much higher among the individuals of White Nile state. Furthermore, we also found that the possibility and co-occurrence of the serologic markers of MI is

| Variable    | Total of MI | Co-occurrence: % (N) |
|-------------|-------------|-----------------------|
|             |             | anti-HIV/ HBVsAg | anti-HIV/anti-HCV | anti-HIV/anti-TP | HBVsAg/anti-HCV | HBVsAg/anti-TP | anti-HCV/ anti-TP | P value |
| Overall     | 65          | 23.07 (15)       | 16.92 (11)       | 27.70 (18)       | 4.61 (3)       | 20 (13)       | 7.70 (5)       | 0.002a |
| Age         |             |                     |                    |                     |            |             |             |          |
| 18–27 years | 25          | 24 (6)            | 0 (0)             | 36 (9)            | 4 (1)        | 28 (7)       | 8 (2)         | 0.001   |
| 28–37 years | 21          | 33.33 (7)         | 19.05 (4)         | 28.57 (6)         | 0 (0)        | 14.29 (3)    | 4.76 (1)      | 0.014   |
| 38–47 years | 19          | 10.52 (2)         | 36.84 (7)         | 15.80 (3)         | 10.52 (2)    | 15.80 (3)    | 10.52 (2)     | 0.316   |
| P value     | 0.567       | 0.139             | 0.008             | 0.122             | 0.679        | 0.196        | 1.000         |          |
| Residence   |             |                     |                    |                     |             |             |             |          |
| Al Douiem   | 12          | 25 (3)            | 8.33 (1)          | 25 (3)            | 0 (0)        | 41.67 (5)    | 0 (0)         | 0.025   |
| Kosti       | 27          | 29.63 (8)         | 14.82 (4)         | 22.22 (6)         | 11.11 (3)    | 14.82 (4)    | 7.40 (2)      | 0.320   |
| Rabak       | 26          | 15.38 (4)         | 23.08 (6)         | 34.62 (9)         | 0 (0)        | 15.38 (4)    | 11.54 (3)     | 0.171   |
| P value     | 0.006       | 0.208             | 0.100             | 0.122             | 0.036        | 1.000        | 0.251         |          |

MI: Multiple infections, N: Number, HIV: Human immunodeficiency virus, HBVsAg: Hepatitis B virus surface antigen, HCV: Hepatitis C virus, TP: \textit{T. palladium}

Pearson Chi-squared and Fishers Exact test have involved in the Statistical analysis.
our understanding regarding the relation underlying TTIs interactions, which need further deep studies. Moreover, it is also necessary for the formulation and application of public health strategies and polices.

Conclusions
Our study screened the rate of the serologic markers of TTIs in the White Nile state and its distribution among study areas and age groups, and indicated the need for deep studies to a better understanding of the epidemiology and risk factors of TTIs. Likewise, it is underscored the need for public health surveillance, therapeutic, and preventive programs.

Limitation
The study limitations include a low sample size, use of rapid diagnostic test, and lacks of several socio-demographic features of the blood donor’s such as occupation, blood group and rhesus, and education level.

Supplementary information
Supplementary information accompanies this paper at https://doi.org/10.1186/s13104-020-05333-6.

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Authors’ contributions
BSA and EBA contributed to study design and data interpretation. EBA, AAE, QMA and MMH have contributed to data collection. BSA was accountable for data analysis, and article writing. All authors contributed to manuscript revising and editing. All authors read and approved the final manuscript.

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Availability of data and materials
The datasets analysed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate
All the protocol has approved by the Ethics Review Committee of the University of El Imam El Mahdi and carried out according to ethical guidelines of the declaration of Helsinki for human research. Ethics Review Committees of Kosti, Ad Douiem, and Rabak Teaching Hospitals also provided the authorization.

Participant informed consent was not obtained since the study performed in retrospective manner as granted by the ethical committees. Blood donor’s privacy was secured by merely gathering the data concerning the characteristic of donors and Blood banks investigation outcomes, while ignoring the identity of owners.

Consent for publication
Not applicable.

Competing interests
All authors declare that they have no competing interest.

Author details
1 Department of Microbiology, Faculty of Medical Laboratory Sciences, University of El Imam El Mahdi, Kosti, Sudan. 2 Department of Medical Laboratory investigations, Kosti Police Hospital, Kosti, Sudan. 3 Department of Microbiology, College of Basic Medical Sciences, Dalian Medical University, Dalian, China.

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