Original Article

# Time Trend and Prevalence Analysis of Transfusion Transmitted Infections among Blood Donors: A Retrospective Study from 2001 to 2016

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## Abstract

**Context:** Transfusion-transmitted infections (TTIs) remain a major threat to the patients receiving blood. The incidence of the transmission of various infectious agents has reduced ever since the introduction of various molecular techniques for detection. **Aims:** The study tried to figure out accurate estimates of risk and trend of TTI over a period of sixteen years, essential for monitoring the safety of blood supply and evaluating the efficacy of the currently employed screening procedures. **Methods and Material:** A total of 57942 blood donors' records were analyzed for the period from January 2001 to December 2016. Chi-square test ($\chi 2$) was used to evaluate the relationship between serological positivity and particular donor characteristics. A *P* value of less than 0.05 was considered statistically significant. **Results:** Of the 57942 donations, overall prevalence of TTI was 2.7%. Of these, the reactivity rate of hepatitis B (HBV), hepatitis C, HIV, syphilis, and malaria was 1.8%, 0.42%, 0.2%, 0.31%, and 0.017%, respectively with significant *P* value ($P < 0.05$, CI: 95%). Overall prevalence was higher in replacement donors as compared to voluntary blood donors. Trend of TTI prevalence decreased from 2001 to 2016. **Conclusions:** This epidemiological research on TTI is important for the region, as estimated disease burden based on comprehensive epidemiological research provides the foundation for public policy to ensure an easily accessible and adequate supply of safe and quality blood and blood components to the needy patients.

**Keywords:** Blood donors, HBV, Trend, TTI

## Introduction

Life-threatening diseases like acute or chronic hepatitis, cirrhosis, and hepatocellular carcinoma caused by hepatitis B (HBV) and hepatitis C (HCV) pose a major health problem throughout the world associated with transfusion-transmitted infections (TTIs). TTIs remain a major threat to the patients receiving blood. Annually, more than 93 million blood donations take place worldwide. In India, 30 million blood components are transfused.[1,2] Within the country, however, higher endemicity is found in tribal areas that could be attributed to illiteracy and poor health-care resources, lack of proper diagnosis, awareness, and the limited number of studies in various geographical regions. The problem of occult hepatitis, non-seroconverting, or delayed seroconverting individual is also needed to be diagnosed before transfusion, for a safe blood transfusion service. This study is aimed to estimate disease burden and trend based on the comprehensive epidemiological research on TTI over the period of sixteen years essential for monitoring the safety of blood supply and evaluating the efficacy of the currently employed screening procedures. This study from central India will help in the detailed analysis of the prevalence and various demographic variables among the blood donor population and also provide baseline information for other scientific studies. The understanding of this can help in assessing and modifying the health-care services accordingly to ensure safe blood

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transfusions and providing data for appropriate policy making for blood donors for blood safety.

## Subjects and Methods

A retrospective study over a period of sixteen years, from January 2001 to December 2016, was carried out at the Department of Transfusion Medicine, Bhopal Memorial Hospital and Research Centre (BMHRC), Bhopal India. The data of voluntary non-remunerated blood donors who were accepted and donated blood (whole blood and apheresis) at the blood bank of tertiary care hospital in Central India were analyzed as part of the study. The blood donor records were reviewed for obtaining the demographics and TTI data.

### Socio-demographic characteristics

All the data regarding socio-demographic characters including age, gender, type of donations (voluntary/replacement blood donations), type of donors (first-time/repeat blood donor), frequency of donations, geographical regions (urban/rural), occupation, and religion were collected from the records and analyzed.

### Screening methods

All the donated blood units were tested for TTI by using DCGI approved 3rd generation enzyme-linked immune sorbent assay kits or rapid assays for the following infectious markers: HBsAg (M/s Span Diagnostic Ltd., M/s Transasia Biomedicals Ltd.), anti-HCV (M/s Transasia Biomedicals Ltd., M/s SD Bio Standard Diagnostics Pvt. Ltd.), anti-HIV1/2 (M/s Transasia Biomedicals Ltd., M/s Span Diagnostic Ltd.), anti-VDRL (M/s span diagnostic ltd.), and malaria by using malaria card test (Biolab diagnostics (i) Pvt. Ltd.). The strategy of screening blood units was followed and screened units were marked as reactive and non-reactive by one-time assay.

### Statistical analysis

All the data were retrieved from the records. Epi Info7 and SPSS software (SPSS version 16) were used to analyze the blood donor data. Excel sheets were imported into SPSS software (SPSS version 16). The seroprevalence of TTI markers among different demographic groups was evaluated by using Pearson's Chi-squire ($\chi 2$) test. *P* value less than 0.05 was considered statistically significant.

As a protocol of blood banks and ethics of research, the information of all blood donors included in the study remained confidential. All donor identifiers remained confidential. The study was approved by the Institutional Ethical Committee.

## Results

During the sixteen years of study period, a total of 57942 donations were collected. All donors were screened for TTI. All aspects of the study have been illustrated in study profile chart [Figure 1]. A total number of 1614 blood donors were reactive for various TTI. The demographic characteristics of reactive donors are summarized in Table 1. As per the record, most of the donors were males (96%). Overall, more than 50% of donors were younger or belong to 21–30 years of age. The proportion of the employed and first-time donors was higher as compared to the unemployed, students, and regular donors.

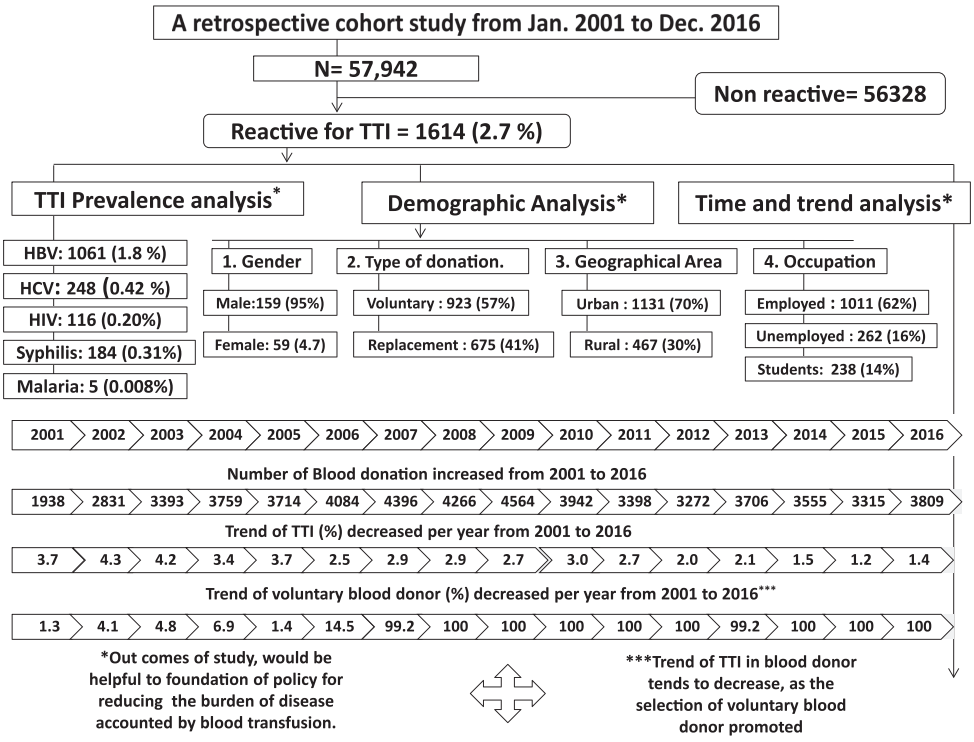


**Figure 1:** Study profile chart

**Table 1: Demographic characteristics of seroreactive blood donor population. Percentage of reactive blood donors, HBV, HCV, HIV, syphilis, and malaria in different demographics relative to total reactive blood donors (*n*=1614) were found significant***

| Demographic characteristics of the study population (*n*=1614) | | | | | | |
|---|---|---|---|---|---|---|
| **Donor characteristics** | **No. of donors (%)** | **HBV (%)** | **HCV (%)** | **HIV (%)** | **Syphilis (%)** | **Malaria (%)** |
| Age * | | | | | | |
| Less than 20 | 9.2 | 6.4 | 1.3 | 0.6 | 0.05 | 0 |
| 21-30 | 50.7 | 33.2 | 8.1 | 3.4 | 5.2 | 0.1 |
| 31-40 | 29.0 | 18.6 | 3.4 | 2.3 | 4.2 | 0.06 |
| 41-50 | 9.3 | 5.7 | 107 | 0.6 | 1.0 | 0.06 |
| More than 51 | 1.6 | 1.1 | 0.2 | 0.06 | 0.1 | 0 |
| Gender * | | | | | | |
| Male | 95 | 63 | 14 | 6.8 | 10.8 | 0.3 |
| Female | 4.7 | 2.1 | 0.8 | 0.3 | 0.37 | 0 |
| Type of donation * | | | | | | |
| Voluntary Donation | 57 | 37 | 8.7 | 4.2 | 6.6 | 0.3 |
| Replacement | 47.7 | 28 | 6.2 | 2.9 | 4.5 | 0 |
| Blood group | | | | | | |
| A | 24 | 16.6 | 3.3 | 1.7 | 2.4 | 0 |
| B | 35.8 | 22.4 | 6.2 | 2.3 | 4.5 | 0.3 |
| AB | 7.8 | 5.0 | 1.2 | 0.3 | 1.3 | 0 |
| O | 31.2 | 21.1 | 4.2 | 2.9 | 2.9 | 0.06 |
| Rh | | | | | | |
| Positive | 93 | 62 | 13.9 | 6.7 | 10.4 | 0.2 |
| Negative | 7 | 3.1 | 1.1 | 0.37 | 0.7 | 0.06 |
| Geographical area | | | | | | |
| Urban | 70 | 45.9 | 10.9 | 5.3 | 7.5 | 0.3 |
| Rural | 30 | 19.3 | 4.1 | 1.7 | 53.6 | 0 |
| Religion | | | | | | |
| Hindu | 72 | 46.5 | 11.7 | 5.3 | 8.5 | 0.1 |
| Muslim | 25 | 17.5 | 2.9 | 1.7 | 2.6 | 0.12 |
| Sikh | 1 | 0.7 | 0.1 | 0 | 0.12 | 0 |
| Christian | 1 | 0.4 | 0.3 | 0 | 0 | 0 |
| Occupation | | | | | | |
| Employed | 62 | 40.5 | 9.1 | 4.7 | 8.3 | 0.06 |
| Unemployed | 16 | 10.7 | 2.4 | 0.7 | 2.2 | 0.06 |
| Students | 14 | 10 | 2.6 | 3.7 | 0.4 | 0.12 |
| First time donors/Replacement donors * | | | | | | |
| First time | 61 | 42.8 | 8.3 | 4.3 | 5.6 | 0.1 |
| Regular | 32 | 18.5 | 5.8 | 2.4 | 5.3 | 0.06 |

Approximately 70% of donors came from urban regions and about 73% of donors were following the Hindu religion. The total number of seroreactive blood donors who came first time to donate blood was 991 (62%). Out of 521 reactive (32.6%) regular blood donors, 375 (69%), 50 (9%), 43 (8%) 16,(3%), 16 (3%), 7 (1%), 35 (7%) donated blood second time, third time, fourth time, fifth time, sixth time, seventh time, and more than ten times.

## Prevalence of TTIs among Blood Donors

The reactivity of the blood donors for markers of TTI was found to be 2.7% (1614 out of 57942) during the sixteen years of study period. Among them, 1.8% of blood donors (1061 out of 1614) showed reactivity for HBV, 0.42% (248 out of 1614) showed reactivity for HCV, 0.20% (116 out of 1614) showed reactivity for HIV, 0.31% (184 out of 1614) showed reactivity for syphilis and 0.01% (5 out of 1614) showed positivity for malaria. Seroreactivity prevalence rate for viral markers of TTI was found statistically significant ($P < 0.05$, CI: 95%).

## Trend of TTIs among Blood Donors

A total of 57942 blood units were collected during the study period of sixteen years [Table 2]. The highest prevalence of TTI was observed in 2002 which is 4.3% (124 out of 2831), followed by 4.2% (144 out of 3393) in 2001, and the lowest prevalence was observed in 2015, 1.2% (43 out of 3315). The difference was statistically significant when the prevalence was compared ($P < 0.05$, CI: 95%) over the years. As shown in Figure 2, the trend of percentage of seropositivity drastically decreased from 2001 to 2016. The difference was

statistically significant, when the prevalence of HBV, HCV, HIV, and syphilis was compared ($P < 0.05$, CI: 95%). The age and gender-specific prevalence of TTI among blood donors is represented in Table 1. TTI reactive donors in the age group 21–30 years were highest in number (50.7%). Of these, 49.6% (794 out of 1598) were males and 1.6% (26 out of 1598) were females. When both genders were compared, there was significant difference ($P < 0.05$, CI: 95%) in prevalence seen among different age groups. Seroprevalence rate of TTI was higher (3.8%) (675 out of 17719) in replacement donations, in comparison to voluntary blood donors (2.3%) (923 out of 38625) with significant level of $P$ value ($P < 0.05$, CI: 95%).

## Distribution of age, gender, religion, and type of donation (voluntary/replacement blood donation)

Distribution of demographics plays a crucial role in the aspect of risk behavior as well as disease outcomes. The trend of the present study indicated that the proportion of the population in the youngest age groups (median age 25: range 21–30) showed a higher risk of TTI. The overall gender-specific risk of TTI was found higher in the male population during the study period. Along with this, asymmetrical distribution of blood donor population was found in the case of the type of donation, first time or regular. In the initial years, blood donor population was mixed population including voluntary

**Table 2: Trend of prevalence transfusion transmitted infections (%). Prevalence of TTI counted 2.7% of total. Row wise percentage of HBV, HCV, HIV, Syphilis, and Malaria has been calculated per year**

| Time trend analysis of TTI | | | | | | | |
|---|---|---|---|---|---|---|---|
| Year | Donations | Transfusion transmitted infections (TTIs) (%) | | | | | |
| | | HBV | HCV | HIV | Syphilis | Malaria | Total (%) |
| 2001 | 1938 | 2.8 | 0.56 | 0.25 | 0.10 | 0 | 73 (3.7) |
| 2002 | 2831 | 2.4 | 1.1 | 0.24 | 0.56 | 0 | 124 (4.3) |
| 2003 | 3393 | 2.8 | 0.53 | 0.41 | 0.47 | 0 | 144 (4.2) |
| 2004 | 3759 | 2.4 | 0.34 | 0.23 | 0.37 | 0 | 129 (3.4) |
| 2005 | 3714 | 2.4 | 0.56 | 0.32 | 0.45 | 0 | 140 (3.7) |
| 2006 | 4084 | 1.7 | 0.36 | 0.097 | 0.26 | 0.02 | 103 (2.5) |
| 2007 | 4396 | 1.9 | 0.27 | 0.18 | 0.54 | 0 | 130 (2.9) |
| 2008 | 4266 | 1.7 | 0.60 | 0.18 | 0.49 | 0 | 129 (2.9) |
| 2009 | 4564 | 1.9 | 0.35 | 0.10 | 0.30 | 0 | 126 (2.7) |
| 2010 | 3942 | 1.9 | 0.3 | 0.17 | 0.60 | 0 | 119 (3.0) |
| 2011 | 3398 | 1.9 | 0.38 | 0.17 | 0.17 | 0.11 | 94 (2.7) |
| 2012 | 3272 | 1.0 | 0.55 | 0.33 | 0.21 | 0 | 66 (2.0) |
| 2013 | 3706 | 1.3 | 0.40 | 0.18 | 0.18 | 0 | 78 (2.1) |
| 2014 | 3555 | 1.0 | 0.28 | 0.14 | 0.11 | 0 | 55 (1.5) |
| 2015 | 3315 | 0.96 | 0.06 | 0.21 | 0.06 | 0 | 43 (1.2) |
| 2016 | 3809 | 1.0 | 0.34 | 0.02 | 0.02 | 0.02 | 54 (1.4) |
| Total | 57942 | 1061 (1.8) | 248 (0.42) | 116 (0.20) | 184 (0.31) | 5 (0.008) | 1614 (2.7) |

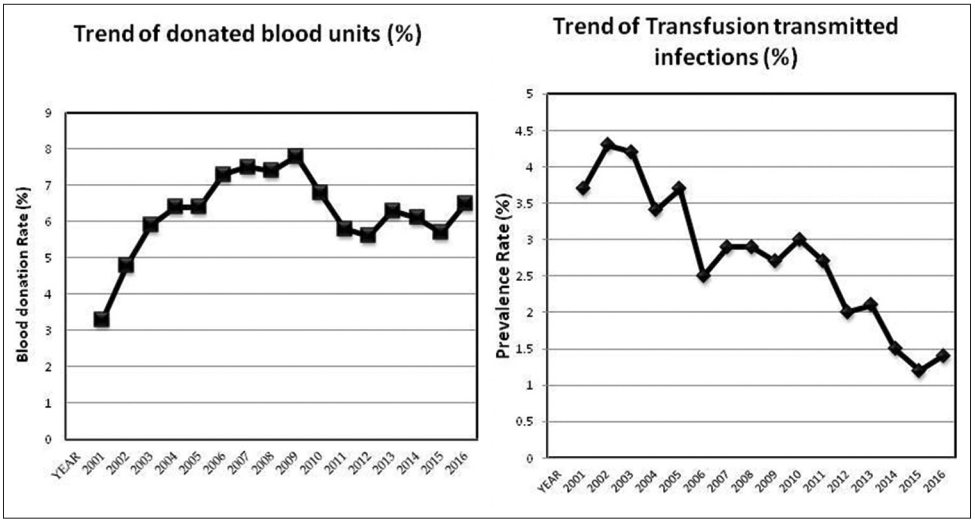


**Figure 2:** Time trend analysis of donated blood units versus TTIs

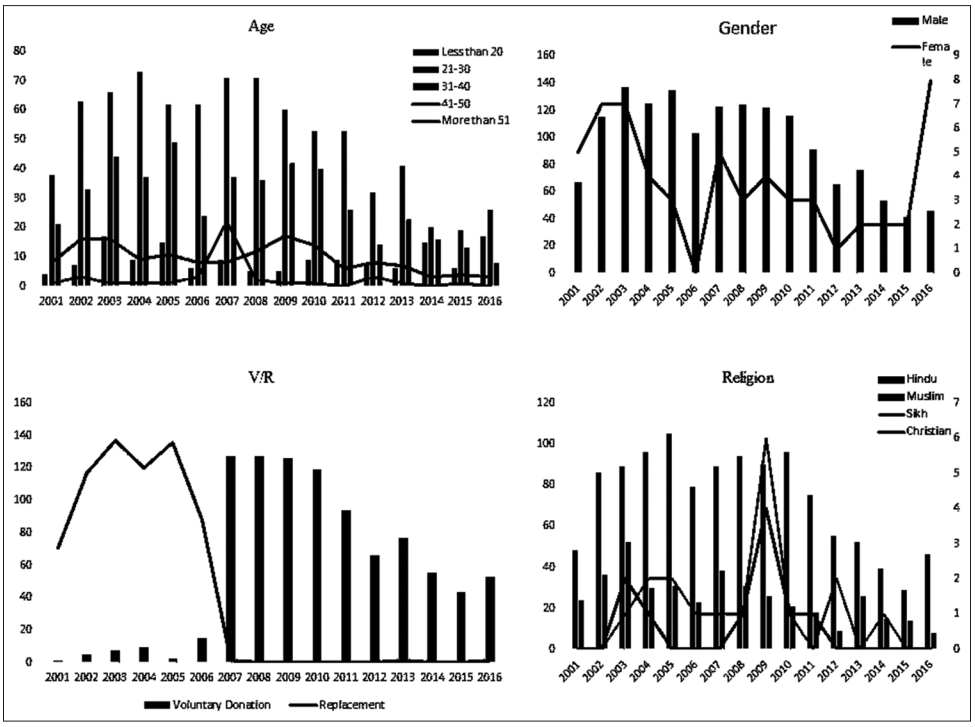


**Figure 3:** Trends of demographic characteristics age, gender, type of donations, and religion in blood donor population from 2001 to 2016

**Table 3: Characteristics of the research articles influencing the transfusion-transmitted infections found in the literature review included in our study**

| Characteristics of the research studies done on TTI | | | | | | |
|---|---|---|---|---|---|---|
| **Author** | **Total** | **HIV** | **HCV** | **HBV** | **Syphilis** | **Malaria** |
| Glynn, 2000[10] | 1000000 | 2.92 | 3.25 | 10.43 | NA | NA |
| Niederhauser, 2005[11] | 1000000 | 1 | NA | NA | NA | NA |
| Soldan, 2005[12] | 1000000 | 0.14 | 0.8 | 1.66 | NA | NA |
| Mohammed, 2016[16] | 4224 | 0.14 | 0.40 | 10.89 | 0.09 | NA |
| Motayo, 2015[13] | 130 | 6.15 | 1.54 | 10.00 | NA | NA |
| Attaullah, 2012[14] | 127878 | 0.060 | 2.461 | 2.684 | 0.425 | NA |
| Song, 2014[19] | 66311 | 0.31 | 0.87 | 0.87 | 0.70 | 1.00 |
| Makroo, 2008[17] | 180477 | 0.24 | 0.44 | 1.18 | 0.23 | NA |
| Arora, 2010[5] | 5849 | 0.34 | 1.18 | 1.69 | 0.92 | NA |
| Fernandes, 2010[9] | 9599 | 0.063 | 0.063 | 0.344 | 0.115 | NA |
| Pahuja, 2007[7] | 28956 | 0.56 | 0.66 | 2.23 | NA | NA |
| Pallavi, 2011[6] | 39060 | 0.44 | 0.23 | 1.27 | 0.28 | NA |
| Arshad, 2016[15] | 16557 | 1.70 | 0.04 | 1.84 | 0.21 | NA |
| Chaurasia, 2014[3] | 113014 | 0.27 | 0.63 | 1.38 | 0.32 | NA |
| Jain, 2012[4] | 47558 | 0.33 | 0.63 | 1.50 | 0.16 | NA |

and replacement blood donors, with most of the blood donors being voluntary after 2007 [Figure 3]. Trend of HBV, HCV, and HIV was found more prevalent in comparison to malaria and syphilis each year. Out of the total seroreactive blood donors' population students were least reactive.

## Discussion

The study tried to figure out that accurate estimates of risk and trend of TTI over the period of sixteen years are essential for monitoring the safety of blood supply and evaluating the efficacy of the currently employed screening procedures in a region moderately endemic for hepatitis. In Central India, very limited studies have been done to study the prevalence. Most of the studies have used small population groups and thus inferences cannot be drawn conclusively. This is the first study from Central India which estimates the prevalence of TTI in a large sample size. The study thus helps in understanding the prevalence and various demographic factors associated with it on a much larger scale. Overall prevalence of TTI was

found to be low (2.7%) compared to global data, but higher than reported in other parts of India.[3-9] The prevalence of HBV infection (1.8%) is relatively higher than the two viruses HIV and HCV. Studies done in developed countries show the prevalence rate to be lower; however, they are still higher than HCV and HIV.[10-12] On comparing with the developing country, the rate of prevalence of HBV in this study is lower than many of the studies done in Nigeria,[13] Pakistan,[14,15] and Eastern Ethiopia.[16] The prevalence of HCV infections is moderate to low in most of the developed countries. The present study has moderate prevalence levels when compared to other studies. Only few of the studies done in different part of India,[3,4,7-9,17] Bangladesh,[18] and China[19] have higher prevalence rates than the present study [Table 3]. The prevalence of HIV in developed countries is at a negligibly low rate[10-12] when compared to the developing countries.[13,15] The present study has seen that the overall prevalence rate of HIV is 0.42% which is quite low. Several other studies that have been done have seen varying results with respect to the prevalence of HIV in different regions of the world. Some of the studies done in India[3-5,8,9,17,20] have also observed a very low prevalence of infection among donors. Overall, the prevalence rates observed in the present study fit into the range reported by many of the groups that have done similar studies in India and other regions of the world. The differences observed among the Indian studies are based on factors such as the type of donor, life style, and risky health behaviors of the donors in a given geographical region. Syphilis transmission is highly regionalized with maximum number of cases seen in geographical regions with risky health practices. In developing countries, the overall prevalence of syphilis has drastically come down due to advance health-care treatment methods and safe sexual practices. Thus, there are no data available much for syphilis-based transmission in developed countries. Most of the blood screening tests are done for HIV, HCV, and HBV but not for syphilis. In developing countries due to poor medical care methods, syphilis is still transmitted by transfusion. The studies done in India have shown both low prevalence to high prevalence when compared to the present study. Studies done in Bangladesh and few of the selective studies done in India have identified higher prevalence than the present study. As already mentioned, many of the studies have not done screening for syphilis and hence the overall idea of prevalence is limited with only few studies for comparison. Malaria is highly endemic. It is restricted mainly to African and Asian continents. Screening for malaria transmission in blood is usually not done as it is not seen across the globe. The present study shows an extremely low rate of prevalence for malaria and is comparable to studies done in Bangladesh.[18]

Various studies have observed that voluntary non-remunerated blood donors who are regular decrease the incidence of TTI. Due to repeated blood donation by such donors the overall risk of transmission is reduced and thus the donor can be easily accepted or rejected.

In the present study, the trend of TTI in blood donors tends to decrease from January 2001 to 2016, as the selection of voluntary blood donors was promoted, and the goal of 100% voluntary non-remunerated blood donors has been achieved. Secondly, the use of better screening kits and equipment along with the training of technical staff played a crucial role in improving the status of blood donors donating blood in terms of TTI and safe blood transfusion. There has been development of screening methods that are highly sensitive,[21-23] rapid, and fast to interpret. As per World Health Organization (WHO) guidelines, the sensitivity should be 100% and specificity should be at least 98%. Thus, the available methods need to be optimized such that WHO criteria can be met easily.

There were some limitations to our study. As the study is limited to assessment of donor records, no information was collected from the donors directly about their immunization status and liver enzyme biomarker (AST/ALT) levels. Since the study is based on the serology of blood units from 2001, no data were available on window period infection or occult infections. This study tried to find out accurate estimates of risk and trends of TTI. Thus, the study contributes to foundation of the policy by focusing on (i) the selection of repeat, non-remunerated, voluntary blood donors; (ii) awareness among young population for the prevention of disease; (iii) molecular-based techniques should be implemented for screening and reducing the window period. This will further help in mapping the various regions, where there is a high incidence and prevalence of the diseases causing TTI and would help in controlling the TTI-based transmission of disease in patients needing blood transfusion, thereby making the process safer and ensuring safe blood of minimal risk.

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## Conflicts of interest

There are no conflicts of interest.

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