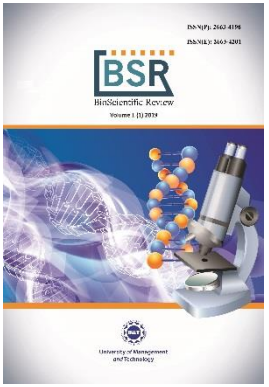

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Prevalence of ABO and Rh Blood Groups and their Association with Transfusion-Transmissible Infections (TTIs) among Blood Donors in Islamabad, Pakistan

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Abstract

Certain Rh positive blood groups show a link between the ABO blood grouping and the susceptibility to certain infectious ailments. For this purpose, a retrospective observational study was carried out with 7631 blood donors to determine the association of the ABO Blood Group System / Rh type with the viral infection due to hepatitis B virus (HBV), hepatitis C virus (HCV), human immunodeficiency virus (HIV) and syphilis. The data indicated that the highest incidence of blood group in blood donors was B, followed by O, A and AB blood groups. The incidence of HBsAg +ve, HCV Ab +ve and syphilis was the highest in donors with blood group B, followed by donors with blood groups O, A and AB. Blood group A was found to be more susceptible to HIV Ab +ve, followed by blood groups B, O and AB. Blood group B donors faced the greatest risk of viral infection with HBV, HCV, HIV, and syphilis, followed by the donors with blood groups O, A, and AB. Donors with blood group AB were found to have the lowest incidence rate of all viral infections. On the other hand, the rate of HBV, HCV, HIV, and syphilis was the highest among donors with blood group B, followed by donors with blood groups O, A, and AB.

1. Introduction

Blood group antigens signify the polymorphic characteristics inherited by people. Variations in the expressions of blood group antigens may enhance or decrease the susceptibility of the host to numerous infections [1]. The role of blood group in contracting infection is depicted by the fact that it may serve as receptor / co-receptor for bacteria, viruses and parasites. Additionally, the antigens of some blood groups enable uptake in cell, signal transduction, and/or hold micro-domains of the membrane. Blood groups can also alter the innate immune reaction to an infection [2, 3].

The ABO Blood Group System is the most common congenital blood group system. It is responsible for the distribution of blood types among individuals through the inheritance of A and B genes [4]. H antigen is formed either by the addition of α1-2 fucose by FUT1 or H-glycosyltransferase. H antigen can then serve as a substrate for ABO glycosyltransferase. Group A individuals express an α1-3 *N*-acetylgalactosamine (GalNAc), while group B individuals express an α1-3 galactose (Gal). Whereas, Group O individuals have inactive ABO genes and express only the H-antigen precursor [2].

Microbes also have the ability to stimulate antibodies against the antigens of ABO blood group. ABO antibodies are a part of the innate immune system which acts against those pathogenic bacteria and covered viruses that bring ABO-active antigens. Besides, blood groups have the ability to behave as false receptors. Some blood groups serve as receptors and ligands for bacteria, viruses and parasites. Research has also revealed that ABO antigens can block the binding of TTI agents to polysaccharide. However, cells that lack these antigens are at the risk of contracting Transfusion-Transmissible Infections (TTIs) [5, 2].

Hepatitis C virus (HCV), hepatitis B virus (HBV), and human immunodeficiency virus (HIV) are chief causes of death, worldwide [6]. Globally, it was reported that 36.70 million people are infected with HIV infection, 25.70 million /people are infected with HBV infection, and 71.0 million people are infected with HCV infection. It was assessed that 2.30 million and 2.70 million people are infected with HIV/HCV and HIV/HBV co-infection due to their same mode of transmission [7]. According to a study conducted in Pakistan, the prevalence rate of hepatitis B and hepatitis C was 6.7% and 14.3% respectively, with 80% co-morbidities of HIV/HCV and 20% of HBV/HCV [8, 9].

Individuals with a chronic infection of hepatitis have increased chances of contracting liver cirrhosis and liver cancer, along with the risk of other diseases. These infections are highly transmissible [10]. HCV and HBV infections are known among cases with HIV infection due to their shared course of viral transmission. Co-morbidities such as liver problems due to HCV or HBV infection are an important concern in HIV-infected cases [11].

Syphilis is due to *Treponema pallidum* that may infect an individual by entering into the mouth lining of the genital area. The prevalence rate of syphilis has increased worldwide, especially in homosexual men and in HIV donors [12].

In Pakistan, viral hepatitis (HCV, HBV) is a grave health problem which affects

millions of individuals in all parts of the country, including the province of Punjab. Moreover, an increased rate of occurrence of syphilis has been observed as well. To date, the prevalence rate of TTIs and the frequency of ABO and Rh blood groups in Islamabad, Pakistan have not been studied. Thus, the aim of this study was to assess the seroprevalence of HBV, HCV, HIV and syphilis in association with selected blood groups and also the possible association between these blood groups and viral infection.

2. Methodology

2.1. Sample Collection and Blood Group Testing

This is an observational retrospective research carried out at the Pakistan Institute of Medical Sciences (PIMS) in Islamabad, Pakistan, over a 5-year period (from 2016 to 2021). The institute's research ethics committee provided ethical support. The trial comprised 7631 consenting donors with either HCV, HBV, HIV, or syphilis, ranging in age from 18 to 60 years. Blood sample collection and group identification was carried out by using the tile method [13]. Blood sample was aseptically collected using the traditional method of finger prick. The conventional method of blood grouping was used to identify the blood group of donors. It was performed by using anti-sera (A, B and D) for agglutination test. The obtained results were recorded and were further confirmed according to the standard procedure. The samples were centrifuged at a high speed to obtain a clear supernatant serum.

2.2. Chemiluminescent Microparticle Immunoassay

Chemiluminescent Microparticle Immunoassay (CMIA) was used to screen for HBV, HCV, HIV, and syphilis. CMIA is a form of immunoassay which is performed in two steps using chemiluminescent microparticles. Anti HCV and HBV antigens are determined by comparing the chemiluminescent signal in the reaction to the cutoff signal. Reactive and non-reactive results were interpreted on the basis of the observed signal to the cutoff ratio (S/Co ratio) as defined by the manufacturer. All samples with the S/Co ratio of ≥ 1.0 were declared as anti HCV reactive [13].

2.1 Data Analysis

Data was analyzed via SPSS 20. The frequency and percentage of HCV, HBV, HIV and syphilis infected donors was assessed through descriptive statistics. The correlation between blood group and viral infection was estimated by using Pearson Regression analysis.

3. Results

The distribution of HBV and HCV infection among donors based on blood group borderline and positive out of the 7631 donors for each blood group is tabulated as Table 1. It was observed that among 7631 donors, 8.4% with blood group A were infected with HBV. This percentage rose to10.6% in donors with blood group B, although it fell to 9.8% in donors with blood group O and to 3.2% in donors with blood group AB.

Among 643 blood group A donors, 7.9% were border line HBsAg +ve, whereas 83.8% were HBsAg +ve . Among 809 blood group B donors, 7.29% were border line HBsAg +ve, whereas 83.9% were HBsAg +ve. Among 753 blood group O donors, 6.3% were border line HBsAg +ve, whereas 80.5% were HBsAg +ve . Among

247 blood group AB donors, 6.8% were border line HBsAg +ve, whereas 83.8% were HBsAg +ve.

Among 878 blood group A donors, 23.9% were border line HCV Ab +ve, whereas 67.99% were HCV Ab +ve. Among 1201 blood group B donors, 22.89% were border line HCV Ab +ve, whereas 68.4% were HCV Ab +ve . Among 1063 blood group O donors, 35.4% were border line HCV Ab +ve, whereas 67.16% were HCV Ab +ve. Among 78 blood group AB donors, 31.6% were border line HCV Ab +ve, whereas 69.61% were HCV Ab +ve.

The distribution of HIV and syphilis among donors based on blood group baseline positive and positive out of the total number of donors for every blood group is tabulated as Table 2.

Among 77 blood groups A donors, 44.1% were border line HIV Ab +ve, whereas 45.45% were HIV Ab +ve. Among 69 blood group B donors, 40.57% were border line HIV Ab +ve, whereas 43.47% were HIV Ab +ve. Among 65 blood group O donors, 58.46% were border line HIV Ab +ve, whereas 33.84% were HIV Ab +ve. Among 26 blood group AB donors, 53.84% were border line HIV Ab +ve, whereas 46.15% were HIV Ab +ve.

Among 353 blood group A donors, 6.79% were border line syphilis Ab+ve, whereas 85.26% were Syphilis Ab +ve. Among 551 blood group B donors, 3.26% were border line syphilis Ab +ve, whereas 86.93% were syphilis Ab +ve. Among 446 blood group O donors, 3.81% were border line syphilis Ab +ve, whereas 86.77%were syphilis Ab +ve. Among 111 blood group AB donors, 4.5% were border line syphilis Ab +ve, whereas 86.48% were syphilis Ab +ve.

Table 3 and Figure 1 show the prevalence of serologic and clinically confirmed viral infections in susceptible donors. The incidence rate of viral infection with HBV, HCV, HIV, and syphilis was the highest among blood group B donors, followed by donors with blood groups O, A, and AB, respectively. Donors with blood group AB had the lowest overall prevalence of viral infections.

Table 1. Distribution of HBV and HCV Infection Among Donors Based on Blood Group Baseline Positive and Positive Out of the Total Number of Donors for Every Blood Group

Blood Group	**Total Number of Donors with HBV**	**BL HBsAg + ve (%)**	**HBsAg + ve (%)**	**Total Number of Donors with HCV**	**BL HCV Ab + ve (%)**	**HCV Ab + ve (%)**
Blood group A	643 (8.4%)	51 (7.9 %)	526 (81.8%)	878 (11.5%)	210 (23.91%)	597 (67.99%)
Blood group B	809 (10.6%)	59 (7.29%)	679 (83.9 %)	1201 (15.7%)	275 (22.89%)	822 (68.44 %)
Blood group O	753 (9.8%)	48 (6.37%)	606 (80.5%)	1063 (13.9%)	267 (35.4%)	714 (67.16%)
Blood group AB	247 (3.2%)	17 (6.88%)	207 (83.8%)	339 (4.4%)	78 (31.6%)	236 (69.61%)
Total	2452	175	2018	3481	830	2369

BL=Border line

Table 2. Distribution of HIV and Syphilis Among Donors Based On Blood Group Baseline Positive and Positive Out of the Total Number of Donors for Every Blood Group

Blood Group	Total Number of Donors with HIV	BL HIV Ab + ve (%)	HIV Ab + ve (%)	Total Number of Donors with Syphilis	BL Syphilis Ab + ve (%)	Syphilis Ab + ve (%)
Blood group A	77 (1.0%)	34 (44.15%)	35 (45.45%)	353 (4.6%)	24 (6.79%)	301 (85.26%)
Blood group B	69 (0.9%)	28 (40.57%)	30 (43.47%)	551 (7.2%)	18 (3.26%)	479 (86.93%)
Blood group O	65 (0.8%)	38 (58.46%)	22 (33.84%)	446 (5.8%)	17 (3.81%)	387 (86.77 %)
Blood group AB	26 (0.3%)	14 (53.84%	12 (46.15%)	111 (1.45%)	5 (4.50%)	96 (86.48%)
Total	237	114	99	1461	64	1263

Table 3. Distribution of Serologic and Clinically Confirmed Viral Infections in Susceptible Donors

Blood group	Serologic effect HBV (freq and % ages	Total No H% ages BV	Serologic effect HCV	Total No HCV	Serologic effect HIV	Total No HIV	Serologic effect Syphilis	Total No Syphilis
A	HBV +ve = 526 HBV –ve =64	590 (89%)	HCV +ve = 597 HCV –ve =49	646 (92%)	HIV +ve = 35 HIV –ve = 8	43 (81%)	Syphilis +ve=301 Syphilis – ve=25	326 (92%)
B	HBV +ve = 679 HBV –ve = 61	740 (91.7%)	HCV +ve = 822 HCV –ve =71	893 (92%)	HIV +ve = 30 HIV –ve =11	41 (73%)	Syphilis +ve= 479 Syphilis – ve=49	528 (90%)
O	HBV +ve = 606 HBV –ve = 89	695 (87%)	HCV +ve = 714 HCV –ve = 66	780 (91.5%)	HIV+ve = 22 HIV –ve = 5	27 (81%)	Syphilis +ve=387 Syphilis – ve=42	429 (90%)
AB	HBV +ve = 207 HBV –ve = 22	229 (90%)	HCV +ve = 236 HCV –ve =19	255 (92.5%)	HIV +ve = 12 HIV –ve =0	12 (100%)	Syphilis +ve=96 Syphilis – ve=08	104 (92%)

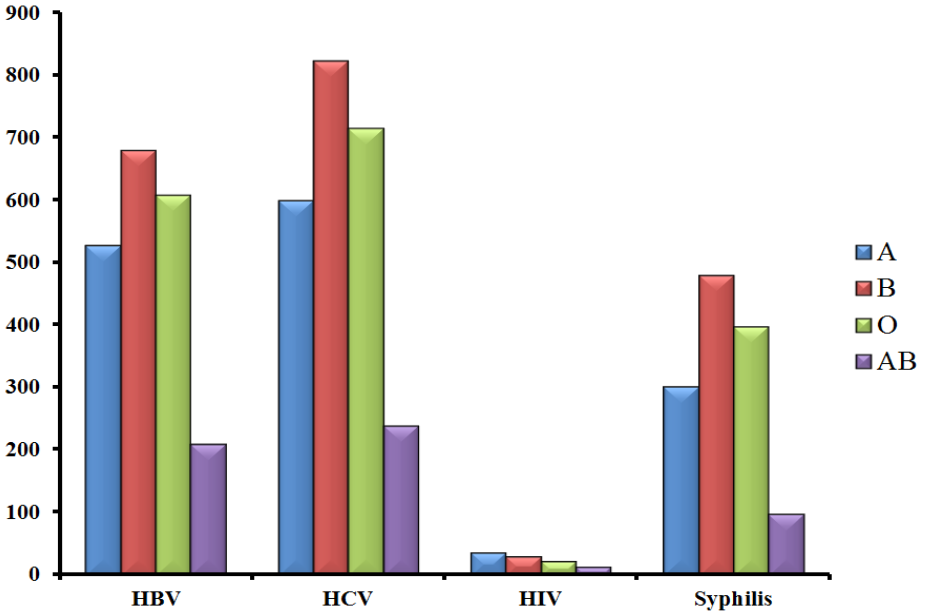

Figure 1. Distribution of serologic and clinically confirmed viral infections in susceptible donors

Among ABO blood system based on A –ve, B –ve, O –ve and AB –ve, we observed that the rate of incidence of viral infection due to HBV, HCV, HIV and syphilis was very low. It was found that donors with blood group A and blood group O were highly infected with HBV, followed by HCV, syphilis and HIV. On the other hand, donors with blood group B and blood group AB were highly infected with HCV, followed by HBV, syphilis and HIV (data not shown).

4. Discussion

HIV alters the immunity of cells which results in increased HBV replication. HBV, in turn, increases the replication of HIV by stimulating the secretion of cytokines and factors associated with transcription. This upsurge in the replication of both HBV and HIV may alter the body immune system [14].

We observed that 7631 donors with viral infection (HBV, HCV, HIV, and syphilis) visited PIMS. Among these donors, the highest frequency and percentage was that of blood group B antigen (10.6%), followed by blood group O antigen (9.8%), blood group A antigen (8.4%) and blood group AB antigen (3.2%). According to an Indian study carried out on 9280 people , blood group B (37.39%) was the most common blood group, followed by the blood group O (31.85%) [15]. The lowest frequency of blood group AB + has been observed all over the world [16]. However, a study was carried out on the ABO blood group of 4,744 people of Goban and it found that the phenotypic percentages of blood group antigens O, A, B and AB were 58.9%, 21%,

17% and 2.6%, respectively [17]. The incidence of the ABO blood group was compared with the data of a study carried out in Gabon that found that the respective frequencies of blood groups were 20.0 % for blood group A, 17.30% for blood group B, 4.10 % for blood group AB and 58.60% for blood group O [18]. It is proposed here that the worldwide distribution array of blood groups depends on many environmental factors, such as climate, humidity, and altitude, among others. Type B allele is the highest in the people of Central Asia and lowest among the native peoples of Australia and Americas [19]. The prevalence of ABO phenotype is different in different countries and it may be due to the genetic distance between different populations [17, 18].

It was found that the most common infection in our study population was syphilis, followed by HBV, HCV and HIV. A study of ABO blood groups concerned with 4,744 donors residing in Gabon found that HBV seroprevalence was twice as high among O negative donors as compared to O positive donors. It suggested a significant correlation between ABO blood group and HBV infection [17]. However, a study carried out on 365,029 Jordanian subjects found that among all blood groups HBsAg was the highly predominant viral infection, followed by HCV, syphilis, and HIV [20].

We found that donors with blood group B were infected equally with HCV and syphilis, followed by HBV and HIV. A study carried out in Central Africa also found that HCV was highly detected in subjects with B + ve blood group, followed by subjects with by A + ve , AB + ve and O + ve blood groups, respectively [17]. A cross-sectional study was carried out in Brazil over a period of eleven years and it reported that there is a high percentage of anti-hepatitis B surface / core antigens in HIV donors [21]. However, a survey based on thirty studies covering 241,868 HBV-infected subjects suggested that there was a low rate of HBV infection in in subjects with blood group B [22].

According to our study, donors with blood group A were infected equally with HCV and syphilis, followed by HBV and HIV. A study was carried out in the city of Peshawar, Pakistan on 41033 seemingly healthy subjects. It observed that the subjects with blood group A were at a greater risk to develop HIV and HBV, simultaneously [23].

Our data showed that donors with blood group O were infected equally with HCV and syphilis, followed by HBV and HIV. However, a study carried out in Central Africa found a higher incidence of HBsAg in subjects with blood group O + ve, followed by HCV, syphilis and HIV [20]. A Pakistani study found that blood group O may have a role in the prevention of blood borne diseases [23].

We observed that donors with blood group AB were infected equally with HCV and syphilis, followed by HBV and HIV. According to a research, individuals with blood group AB + ve face the greatest risk of syphilis infection, followed by those with O + ve, A + ve, and B + ve blood groups [23]. We agree with the findings of a research conducted at Iraq's Alanbar University which encompassed 430 healthy subjects. According to the study, subjects with blood group O had the greatest rate of occurrence of HBsAg and HCV Ab, while those with blood group AB with Rh positive had the lowest rate. The respective

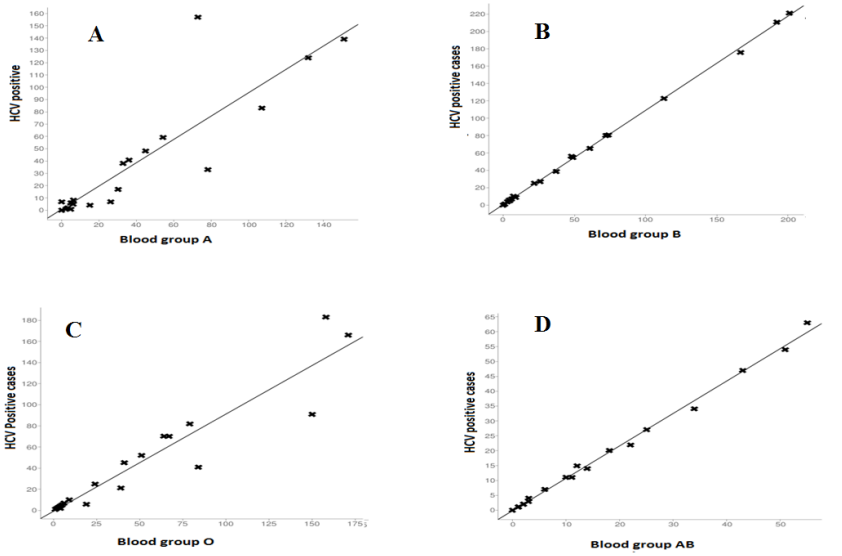

Figure 2. Strong positive correlation between HCV and different blood groups (A) represents HCV in blood group A, (B) represents HCV in blood group B, (C) represents HCV in blood group O, and (D) represents HCV in blood group AB

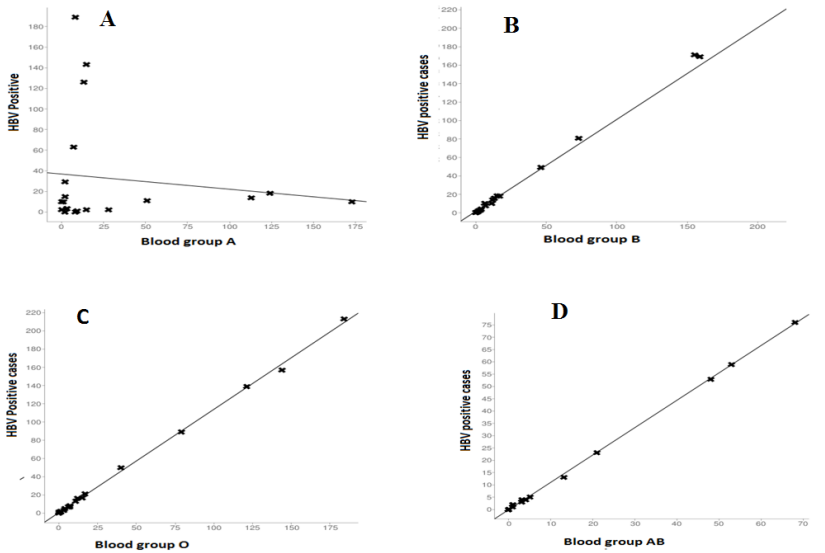

Figure 3. Strong positive correlation between HBV and different blood groups (A) represents HBV in blood group A, (B) represents HBV in blood group B, (C) represents HBV in blood group O, and (D) represents HBV in blood group AB

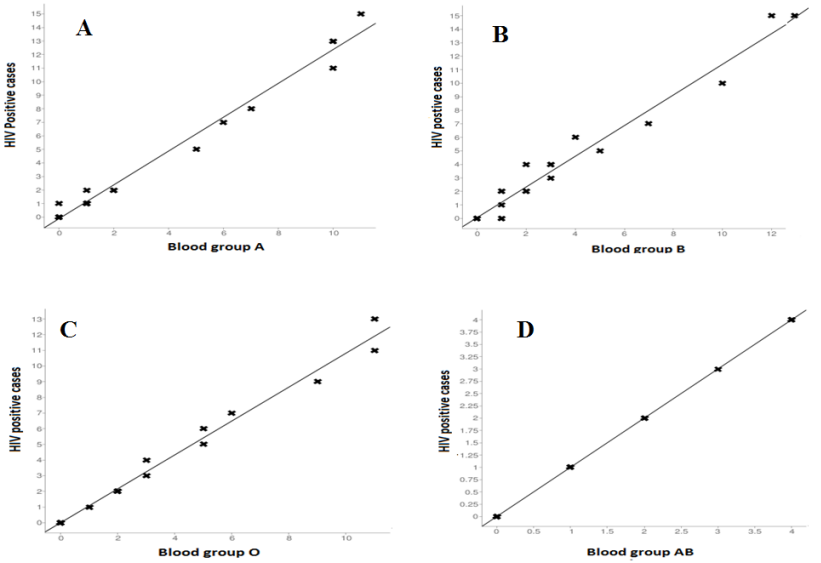

Figure 4. Strong positive correlation between HIV positive cases and different blood groups (A) represents HIV in blood group A, (B) represents HIV in blood group B, (C) represents HIV in blood group O, and (D) represents HIV in blood group AB

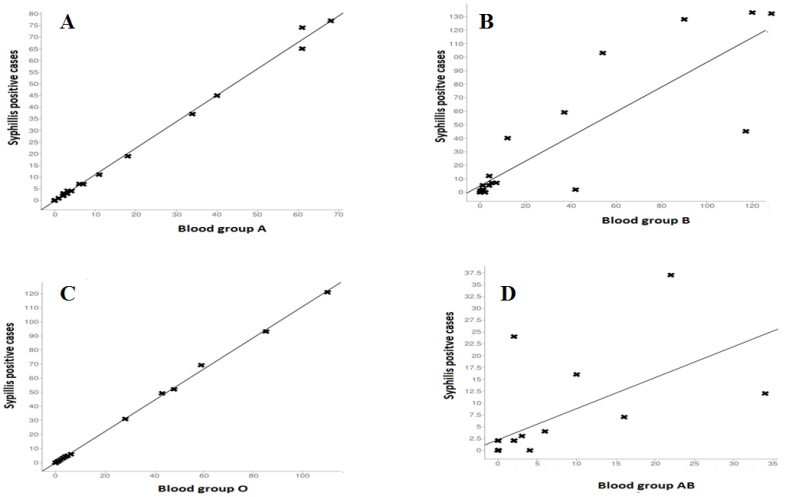

Figure 5. Very strong positive correlation between syphilis positive cases and different blood groups (A) represents syphilis in blood group A, (B) represents syphilis in blood group B, (C) represents syphilis in blood group O, and (D) represents syphilis in blood group AB

percentages of HBsAg and HCV Ab were found to be higher in donors with blood group B and lower in donors with blood group AB. Whereas, the distribution of Rh in hepatitis infected donors was found to be higher among Rh positive donors [24].

A retrospective study was carried out in Iran for a period of six years. It reported that individuals with AB blood group are more at risk of developing hepatitis B and C infections, in comparison with other blood groups. The reason is that individuals with this blood group have no antibodies against antigens A and B. The absence of the antibodies plays an important role in defining the usual resistance of human body against infectious agents with similar surface antigens [25].

We observed that all blood groups were least affected by HIV. With regard to HIV infection, the highest rate of infection was noted in donors with blood group AB + ve, followed by O + ve, B + ve and A + ve.

According to our study, the incidence rate of syphilis was equally high to HCV, followed by HBV, and the lowest rate of incidence was of HIV. A study was carried out on 57,308 Indian subjects to screen the venereal disease of syphilis. It observed that the prevalence rate of syphilis was 1.27% and the false positive rate was 0.14%. It was concluded that though the general seroprevalence of syphilis was small, the frequency of the incidence of false positive reactions was alarming [26]. Another study suggested that the high incidence rate of syphilis may be a reason of the loss of vision [27]. The prevalence rate of syphilis has increased all over the world, typically among homosexual men and individuals with HIV [12]. A study demonstrated that most of the reports of syphilis were based on false-negative serologic results and the late presence of sero-reactivity [28].

A direct and significant correlation was observed between the incidence of all blood groups with viral infections HBV, HCV, HIV and syphilis (Figure 2-5). However, a study observed no correlation between the incidence of HBV, HCV, HIV and syphilis and ABO blood groups [17]. Its limitation was that only the ABO Blood Group System with Rh positive group was included in it. Additionally, blood donors with occult viral infections of HBV, HCV, HIV and syphilis (viral DNA +ve but viral Ag –ve) were unobserved. Hence, there is a need to use a sensitive test for the detection of all types of viral DNA + ve subjects.

5. Conclusion

According to the findings, blood group B had the highest prevalence among the selected population of blood donors, followed by blood groups O, A, and AB. The incidence of HBV, HCV, HIV, and syphilis was the highest among donors with blood group B, followed by donors with blood groups O, A, and AB. Donors with blood group AB had the lowest risk of viral infection, overall.

It is proposed here that research should be conducted on a large scale in order to avoid viral infections that might cause hepatitis and other illnesses. A greater level of awareness and vaccination is required.

Conflict of Interest

The authors declare no conflict of interest.

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