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Review Article

The National Burden and Policy Implications of Human Immunodeficiency Virus Among Blood Donors in Pakistan: A Systematic Review and Meta-Analysis (1988-2026)

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ABSTRACT

Introduction: Human immunodeficiency virus (HIV) remains a major public health challenge and poses a significant threat to blood transfusion safety. Although numerous studies have investigated HIV prevalence among blood donors in Pakistan, a comprehensive national estimate has not previously been available.

Objective: This systematic review and meta-analysis aimed to determine the prevalence, temporal trends, and geographical distribution of HIV among healthy blood donors in Pakistan from 1988-2026.

Methodology: A systematic literature search was conducted to identify studies reporting HIV prevalence among blood donors in Pakistan from 1988 to 2026. Eligible studies were screened according to PRISMA guidelines. Data on study characteristics, sample size, HIV-positive cases, geographical location, and screening methodologies were extracted. Random-effects meta-analysis was performed to estimate pooled prevalence, while subgroup analyses were conducted by province, study period, and screening technique. Heterogeneity, publication bias, and sensitivity analyses were also assessed.

Results: A total of 125 studies comprising 12,663,749 blood donors were included. Overall, 13,892 donors tested positive for HIV, yielding an overall national prevalence of 0.109% (95% CI: 0.107-0.111). The random-effects pooled prevalence was 0.070% (95% CI: 0.049-0.099). Significant heterogeneity was observed across studies (I^2 = 99.7%, $p < 0.001$). Regionally, the highest prevalence was observed in Sindh and Gilgit-Baltistan, followed by Balochistan, Islamabad Capital Territory, Khyber Pakhtunkhwa, Punjab, and Azad Jammu & Kashmir. Temporal analysis demonstrated a significant increase in HIV prevalence over time (OR per year = 1.144; 95% CI: 1.139-1.149; $p < 0.001$). Studies using NAT and CLIA-based assays reported higher detection rates than those using ELISA or rapid diagnostic tests. Leave-one-out sensitivity analysis confirmed the robustness of the pooled estimate, while funnel plot asymmetry suggested possible small-study effects or publication bias.

Conclusion: The study provides comprehensive national synthesis of HIV prevalence among blood donors in Pakistan. Although the overall prevalence is relatively low, the increasing temporal trend and marked regional variations highlight challenges to blood safety.

Keywords: HIV; AIDS; Blood donors; Blood safety; Transfusion-transmitted infections; Seroprevalence; Pakistan

Introduction

Human immunodeficiency virus (HIV) is a retrovirus that progressively impairs the human immune system, ultimately leading to acquired immunodeficiency syndrome (AIDS) and increased susceptibility to opportunistic infections and life-threatening conditions.[1-3]

Despite decades of global efforts, HIV remains a major public health concern worldwide. According to the Joint United Nations Programme on HIV/AIDS (UNAIDS), approximately 91.4 million individuals have been infected with HIV since the beginning of the epidemic, with 44.1 million deaths attributed to AIDS-related illnesses. In 2024 alone, an estimated 40.8 million people were living with HIV globally, with 1.3 million new infections reported. Women and girls accounted for 45% of new HIV infections and 53% of all people living with HIV. Furthermore, 87% of individuals living with HIV were aware of

their status, while 77% were receiving antiretroviral therapy (ART).[4]

Although significant progress has been made in diagnosis and treatment, evidenced by increased awareness of HIV status and expanded access to antiretroviral therapy,[4] persistent challenges such as stigma, inequitable access to healthcare, and undiagnosed infections continue to hinder efforts to eliminate the epidemic.[5-8]

HIV has profound consequences not only for individuals but also for families and national economies, primarily due to loss of productivity, increased healthcare costs, and long-term social impacts.[9-11] In response, coordinated global strategies focusing on prevention, early diagnosis, and treatment have led to measurable reductions in disease burden.[12-14] However, the sustainability of these gains remains threatened in resource-limited settings and conflict affected regions.[15,16]

In Pakistan, HIV epidemiology presents unique challenges. The National AIDS Control Programme (NACP) estimates that approximately 330,000 people were living with HIV by the end of 2025. Of these, only about 25.6% are registered with the NACP, and approximately 18.4% are receiving ART through designated treatment centers. This significant gap between estimated and registered cases highlights underdiagnosis, limited access to care, and weaknesses in surveillance systems.[17] Additionally, periodic outbreaks reported in different regions of the country underscore systemic vulnerabilities in infection control practices and public health surveillance mechanisms.[18-23] In response to growing outbreaks, the Prime Minister of Pakistan constituted a national task force in May 2026 to investigate the alleged mishandling of HIV-related issues in the country, representing a potentially significant step toward strengthening HIV governance and public health oversight.[24]

Blood transfusion services play a critical role in healthcare delivery, particularly for patients undergoing surgery, trauma management, obstetric care, and chronic transfusion-dependent conditions such as thalassaemia. However, transfusion-transmitted infections (TTIs), including hepatitis B virus (HBV), hepatitis C virus (HCV), HIV/AIDS, syphilis, and malaria, remain a persistent threat to blood safety. In Pakistan, HIV screening in blood banks began in 1988[25] but was not mandatory until 1995, when federal government directives required screening of all donated blood for three major TTIs (HBV, HCV, HIV). Subsequent legislative developments, including blood safety laws introduced between 1997 and 2004 (with later revisions), established regulatory frameworks to ensure safer transfusion practices, promote voluntary blood donations, eliminate paid donations, and screening for five TTIs.[26-31]

Despite these advancements, blood safety continues to be compromised by weak governance, infrastructural limitations, variability screening practices, disparities in quality assurance and implementation of standards across blood centres and the evolving dynamics of the HIV epidemic, particularly among high-risk populations.[32-36] The phenomenon of 'bridging populations', where infections spread from high-risk groups to the general population, poses an additional risk to blood donors and recipients.[37] Furthermore, although serological screening has improved safety, it does not entirely eliminate the risk of transfusion-transmitted HIV, especially during the window period of infection.[38-40]

Blood recipients, especially those requiring frequent transfusions such as patients with thalassaemia, remain particularly vulnerable to TTIs.[41-43] Therefore, robust epidemiological data are essential for informed decision-making, resource allocation, and the development of targeted interventions to enhance blood safety.

A number of individual studies have investigated the prevalence of HIV among blood donors in Pakistan; however, these studies are often limited by small sample sizes, regional focus, and methodological heterogeneity, making it difficult to derive nationally representative estimates. To date, there is a lack of comprehensive synthesis of available evidence at the national level.

Systematic review and meta-analysis provide a powerful methodological approach to aggregate data from multiple studies, enhance statistical power, and generate more precise estimates of disease burden. By combining evidence across diverse settings and populations, this approach enables a more comprehensive understanding of HIV prevalence and its distribution among blood donors. Therefore, the present analysis aims to determine the pooled prevalence of HIV infection

among blood donors in Pakistan, assess temporal trends, and evaluate geographical variations. The findings of this study are expected to contribute to evidence-based policymaking, strengthen blood safety strategies, and guide future research and public health interventions aimed at reducing the burden of HIV in Pakistan.

Methodology

Protocol registration

A preliminary literature search and concept validation were conducted prior to protocol development to ensure the scientific rationale of the proposed study, avoid duplication of previously addressed research questions, and confirm the availability of sufficient literature for review. A preliminary search was performed in the PROSPERO database (International Prospective Register of Systematic Reviews) and the Database of Abstracts of Reviews of Effects (DARE) to identify similar or ongoing studies. The protocol for this study was subsequently registered in the PROSPERO database under the registration number CRD420261405362. As the study was based exclusively on previously published data, ethical approval was not required. The search strategy, study selection, data extraction, and reporting of results were conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 Statement.[44]

Inclusion criteria

Articles were included in the study if they met the following criteria: published between January 1988 and June 2026; availability of full text; reported prevalence of HIV among blood donors in Pakistan; published in English language; observational studies, including cross-sectional and cohort studies, as well as national or provincial surveillance reports; mentioned clearly the screening test used for HIV detection; and reported both the number of donors screened and the number of reactive cases. The review question was formulated using the CoCoPop framework for prevalence studies as follows (1) Condition: HIV prevalence, (2) Context: Pakistan, and (3) Population: Blood donors.

Exclusion criteria

The following types of publications were excluded: review articles, conference proceedings, case reports, commentaries, case series, editorials, qualitative studies, opinion papers, posters, duplicate publications, studies with inconsistent data, studies reporting self-reported HIV prevalence, studies conducted on Pakistani nationals residing abroad, and studies that did not meet the inclusion criteria. To minimize the risk of duplicate inclusion of the same blood donor population across multiple studies, the retrieved literature was rigorously screened during the study selection and data extraction phases. Potential overlap was assessed by comparing the study location, study period, institution, and other relevant characteristics. When similarities were identified, full-text articles were reviewed in detail to determine whether overlapping participant populations existed, and duplicate data were excluded accordingly.

Search strategy

A comprehensive literature search was conducted across multiple electronic databases, including PubMed, Scopus, ScienceDirect, Web of Science, Embase, PakMediNet, Google Scholar, and the Cochrane Library (including both the Cochrane Database of Systematic Reviews and the Cochrane Central Register of Controlled Trials). Additional searches were performed in World Health Organization (WHO) databases and national health repositories to identify relevant reports and grey literature. The search covered the period from January 1988 to June 2026. The search strategy included the keywords: "Human Immunodeficiency Virus" OR "HIV" OR "HIV/AIDS" AND "Blood Donors" AND "Prevalence" OR "anti-HIV" OR "Epidemiology" AND "Pakistan". Boolean operators ("AND" and "OR") were applied to refine the search strategy. An advanced search was also performed in PubMed using relevant Medical Subject Headings (MeSH) terms related to HIV. In addition, the reference lists of retrieved articles and relevant review papers were manually screened to identify additional eligible studies. The database search was independently conducted by two reviewers (UW and SZ) between April 28 and June 10, 2026.

Outcome of interest

The primary outcome of interest was the seroprevalence of HIV among blood donors in

Pakistan. HIV prevalence estimates included in the analysis were based on laboratory detection of HIV infection through biological assessment of blood samples using the diagnostic methods reported in the included studies.

Study screening and selection

The study selection process was conducted in two stages. In the first stage, all records retrieved from the databases were imported into EndNote™ X8.2 for duplicate removal. Titles and abstracts were independently screened by two reviewers (UW and SZ) to assess study relevance. In the second stage, the full texts of potentially eligible articles were independently reviewed by two reviewers (SS and NS) against the predefined inclusion criteria. Any disagreements regarding study eligibility were resolved through discussion with a third reviewer (UQ). The overall study selection process was illustrated using a PRISMA flow diagram, showing the number of records identified, screened, excluded, and ultimately included in the review. This study formed part of a broader research project assessing the seroprevalence of transfusion-transmissible infections, including HBV, HCV, HIV, and syphilis among blood donors in Pakistan. Owing to the substantial volume of data, the project was divided into four separate analyses, each focusing on an individual transfusion-transmissible infection.

Data extraction

A standardized data extraction form was developed to ensure uniformity in data collection from the studies included for narrative synthesis and meta-analysis. Data extraction was performed independently by the authors UW, AW, AG, SZ, SS, and UQ, while any discrepancies or conflicts were resolved through discussion with JB and OKK. The extracted variables included (a) study characteristics: author(s), publication year, study location, and study design; (b) population characteristics: number of donors, age, gender, and study setting (urban or rural); (c) outcome measures: HIV prevalence among blood donors (reported as percentage or proportion); (d) screening methods: type of diagnostic assay used, including rapid diagnostic tests (RDTs), enzyme-linked immunosorbent assay (ELISA), chemiluminescent immunoassay (CLIA), and polymerase chain reaction/nucleic acid testing (PCR/NAT). Any discrepancies in extracted data were resolved through consensus discussions to ensure accuracy and minimize bias. The extracted data were stored in Microsoft Excel 2021 (Microsoft Corporation, Redmond, Washington, USA). To further ensure data accuracy and consistency, all extracted data underwent a secondary verification process, during which the same reviewers cross-checked studies different from those they had initially extracted.

Quality assessment

Two review authors (UW and JB) independently assessed the methodological quality of the included studies to minimize assessment errors and reduce the influence of individual bias or preconceptions. To improve the reliability and consistency of the evaluations, the reviewers first discussed the application of the assessment tool and pilot-tested the risk-of-bias checklist on a sample of articles before commencing the formal assessment process. Any discrepancies in quality assessment were resolved through discussion between the two reviewers. In cases where consensus could not be reached, a third reviewer (OKK) was consulted, and final decisions were made with appropriate justification. The Joanna Briggs Institute (JBI) Critical Appraisal Checklists for cross-sectional and cohort studies were used for quality assessment.[45] The JBI checklist comprises eight items for cross-sectional studies and eleven items for cohort studies.[46] These tools assessed potential sources of bias related to participant recruitment, measurement of outcomes and independent variables, and statistical analysis. Each checklist item was rated as "yes," "no," or "unclear." Quality scores were calculated based on the total number of "yes" responses. For cross-sectional studies, articles scoring 7-8, 4-6, and 0-3 points were categorized as having low, moderate, and high risk of bias, respectively. For cohort studies, scores of 9-11, 5-8, and 0-4 points indicated low, moderate, and high risk of bias, respectively.

Statistical analysis

The extracted data were exported to STATA version 17 (StataCorp 2021, College Station, TX, USA) for statistical analysis. A narrative synthesis of all included studies was initially conducted, whereby eligible articles were summarized according to publication year, geographic region, study design, and sample size. For the meta-

analysis, the number of HIV-reactive blood donors and the total number of successfully screened donors were used to calculate the pooled prevalence of HIV. The pooled prevalence estimates were generated using the "metaprop" command in STATA. The findings were presented through descriptive text and forest plots displaying individual study estimates, confidence intervals, and the overall pooled effect size. Statistical heterogeneity among studies was assessed using the Cochran Q test and quantified with the I^2 statistic, with $p < 0.05$ considered indicative of significant heterogeneity.

A meta-regression analysis was performed using study year as a continuous moderator variable. For each study, HIV prevalence was calculated as the proportion of HIV-positive donors relative to the total number screened. A random-effects meta-regression model was then fitted to assess the association between study year and reported HIV prevalence, while accounting for between-study heterogeneity. Because prevalence estimates were small and highly variable across studies, the proportions were modeled on the logit scale. The regression coefficient (β) represented the average annual change in log-odds of HIV prevalence with increasing study year. The coefficient was exponentiated to obtain the odds ratio (OR) per year with its corresponding 95% confidence interval (CI). Statistical significance was assessed using the p-value of the regression coefficient. A bubble plot was generated to visually present the meta-regression findings. In this plot, each bubble represents an individual study; the position of the bubble reflects the study year and the reported HIV prevalence, while the size of the bubble is proportional to the study weight or sample size. The fitted regression line and its 95% confidence band were superimposed to illustrate the overall temporal trend.

A subgroup analysis was performed to assess variation in HIV prevalence according to the screening technique used in the included studies. Screening methods were categorized as rapid diagnostic test (RDT), enzyme-linked immunosorbent assay (ELISA), chemiluminescence-based immunoassays (CLIA/CMIA/ECLIA), nucleic acid testing (NAT), and mixed methods, where more than one screening platform was used. For each study, HIV prevalence was calculated as the number of HIV-positive blood donors divided by the total number of donors screened and expressed as a percentage. Pooled prevalence estimates for each screening-method subgroup were calculated, and 95% confidence intervals were used to indicate the precision of the estimates. Differences in HIV prevalence across screening techniques were assessed using the chi-square test for subgroup differences, with statistical significance set at $p < 0.05$.

Publication bias was evaluated using a funnel plot of transformed proportions against sample size, while asymmetry was further assessed using Egger's regression test, where $p < 0.05$ suggested potential publication bias. Descriptive statistics, including mean, median, and range, were calculated to illustrate the distribution of HIV prevalence across studies. A time-series analysis (1988-2026) was also performed to explore temporal trends and identify fluctuations or changes in HIV prevalence over time. Additionally, a leave-one-out sensitivity analysis was conducted using the "metaninf" command to identify potential sources of heterogeneity and assess the robustness of the pooled estimates. The final results were presented in the form of text, tables, and figures.

Ethical considerations

As this study was based exclusively on previously published literature, the units of analysis were the published articles rather than individual human participants. Therefore, informed consent from study participants was not required. Likewise, no additional ethical approval was necessary. It was assumed that all included studies had obtained ethical clearance from their respective institutional review boards or ethics committees. Furthermore, the ethical and methodological principles outlined in the PRISMA statement were strictly followed to ensure transparency, accuracy, reproducibility, and integrity of the systematic review findings.

Results

Figure 1 depicts the PRISMA flow diagram for study selection. A total of 2,765 records were identified through database searches, with an additional 23 records obtained through handcomb searching. After removing 519 duplicates, 2,269 records remained for title and abstract screening. Following full-text assessment and resolution of

disagreements by consensus, 125 unique studies were included in the systematic review and meta-analysis.[47-171]

Detailed characteristics of the included studies are presented in Table 1. A total of 125 studies conducted between 1988 and 2026 were included in the systematic review, comprising 12,663,749 blood donors, of whom 13,892 tested positive for HIV. The overall crude prevalence of HIV among blood donors in Pakistan was 0.109% (95% CI: 0.107-0.111). Using a random-effects meta-analysis, the pooled prevalence was estimated at 0.070% (95% CI: 0.049-0.099). Considerable between-study heterogeneity was observed (I^2 = 99.7%, Cochran's Q = 35,086.4, df = 124, p < 0.001), supporting the use of a random-effects model (Fig. 2).

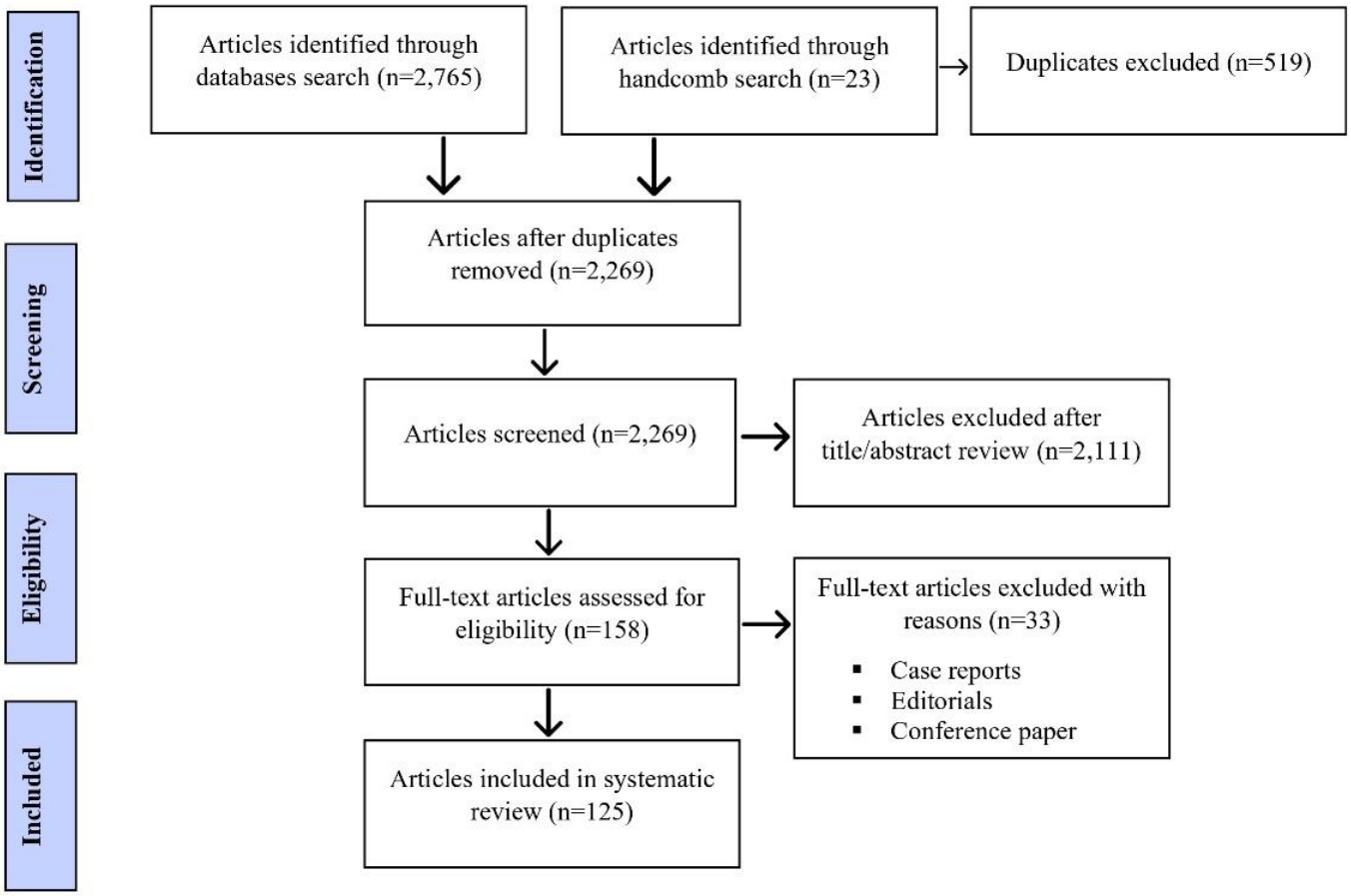

Fig. 1: *Flowchart of the process through which articles were selected based on PRISMA guidelines*

The highest HIV prevalence (Fig. 3) was observed in Sindh (0.143%; 95% CI: 0.141-0.146), followed by Gilgit-Baltistan (0.142%; 95% CI: 0.039-0.519), Balochistan (0.140%; 95% CI: 0.104-0.188), Islamabad Capital Territory (0.12%; 95% CI: 0.117-0.132), Khyber Pakhtunkhwa (0.11%; 95% CI: 0.103-0.116), Punjab (0.04%; 95% CI: 0.039-0.043), and Azad Jammu & Kashmir (0.03%; 95% CI: 0.021-0.057). Differences in HIV prevalence among provinces were statistically significant (χ^2 for subgroup differences, p < 0.001).

The earliest data were reported from Karachi in 1988 (Mujeeb *et al.*),[47] while the most recent studies were reported in 2026 from Mardan and Karachi.[170-171] The included studies were predominantly cross-sectional and employed a range of screening assays including RDTs, ELISA, CLIA/CMIA/ECLIA, NAT, and one study utilizing a combination of methods. ELISA was the most frequently used assay (39.2%), followed by CLIA-based methods (31.2%), RDTs (20%), NAT (8.8%), and 1 mixed-method study (0.8%). A gradual transition from conventional serological screening to chemiluminescence and nucleic acid testing (NAT) was evident after 2010, reflecting improvements in diagnostic sensitivity. Subgroup analysis according to screening methodology demonstrated significant differences in HIV prevalence (p < 0.001) indicating that screening methodology contributed to variability in reported prevalence estimates. Studies employing mixed screening approaches yielded the highest pooled

Table 1: *Studies (n=125) included in the systematic review that assessed the prevalence of HBV among blood donors across Pakistan*

S. No.	Author and Year	Province/Region	Sample Size	HIV Reactive (%)	Technique
1.	Mujeeb *et al.,* 1988[47]	Karachi, Sindh	523	3 (0.6%)	ELISA
2.	Khanani *et al*., 1988[48]	Karachi, Sindh	121	1 (0.82%)	ELISA
3.	Mujeeb *et al*., 1991[49]	Karachi, Sindh	1,655	3 (0.18%)	ELISA
4.	Raziq *et al*., 1993[50]	Peshawar, KP	33,402	0	RDT
5.	Mujeeb *et al*., 1993[51]	Karachi, Sindh	666	0	ELISA
6.	Kayani *et al*., 1994[52]	Karachi, Sindh	32,127	1 (0.003%)	ELISA
7.	Kakepto *et al*., 1996[53]	Karachi & Hyderabad, Sindh	51,127	10 (0.02%)	ELISA
8.	Iqbal and Rehan, 1996[54]	Lahore, Punjab	12,482	0	ELISA
9.	Mujeeb *et al*., 2000[55]	Karachi, Sindh	612	0	RDT
10.	Ahmed *et al*., 2000[56]	Abbottabad, KP	960	0	RDT
11.	Rahman *et al*., 2002[57]	Punjab	1,176,284	12 (0.001%)	ELISA
12.	Khattak *et al*., 2002[58]	Rawalpindi, Punjab	103,858	7 (0.007%)	ELISA
13.	Mumtaz *et al*., 2002[59]	Rawalpindi, Punjab	553	0	RDT
14.	Khan *et al*., 2002[60]	Peshawar, KP	23,278	2 (0.008%)	ELISA
15.	Shiekh *et al*., 2004[61]	Quetta, Balochistan	5,000	11 (0.22%)	ELISA
16.	Asif *et al*., 2004[62]	ICT	3,430	8 (0.25%)	CLIA
17.	Zaidi *et al*., 2004[63]	Peshawar, KP	41,047	0	ELISA
18.	Mahmood *et al.,* 2004[64]	Multan, Punjab	6,000	0	ELISA
19.	Sirhindi *et al*., 2005[65]	Lahore, Punjab	18,216	0	RDT
20.	Jehangir *et al.,* 2006[66]	Multan, Punjab	25,631	0	ELISA
21.	Khan *et al*., 2006[67]	Liaqatpur, Punjab	1,426	0	RDT
22.	Fayyaz *et al*., 2006[68]	Bahawalpur, Punjab	27,938	0	ELISA
23.	Sultan *et al*., 2007[69]	Lahore, Punjab	41,498	11 (0.03%)	ELISA
24.	Azam *et al*., 2007[70]	Karachi, Sindh	688	1 (0.14%)	RDT
25.	Khan *et al*., 2007[71]	Rawalpindi, Punjab	139,163	0	RDT
26.	Bhatti *et al*., 2007[72]	Rawalpindi, Punjab	94,177	4 (0.004%)	ELISA
27.	Siddiqui *et al*., 2008[73]	Multan, Punjab	1,104	0	RDT
28.	Niazi *et al*., 2008[74]	Rawalpindi, Punjab	4,427	0	CLIA
29.	Manzoor *et al*., 2009[75]	Lahore, Punjab	6,659	3 (0.05%)	ELISA
30.	Shah *et al*., 2009[76]	Lahore, Punjab	60,719	3 (0.006%)	ELISA
31.	Qazi *et al*., 2010[77]	Peshawar, KP	100	0	RDT
32.	Shaikh *et al*., 2010[78]	Karachi, Sindh	2,000	0	ELISA
33.	Khan *et al*., 2011[79]	Peshawar, KP	3,915	0	ELISA
34.	Borhany *et al*., 2011[80]	Karachi, Sindh	5,717	0	ELISA
35.	Safi *et al*., 2011[81]	Peshawar, KP	62,251	28 (0.045%)	ELISA
36.	Attaullah *et al*., 2012[82]	Peshawar, KP	127,828	77 (0.06%)	ELISA
37.	Waheed *et al*., 2012[83]	ICT	10,145	0	ELISA
38.	Umair *et al*., 2012[84]	Mirpur, AJK	8,927	0	ELISA
39.	Zahra *et al*., 2013[85]	Karachi, Sindh	13,170	7 (0.05%)	CLIA
40.	Butt *et al*., 2013[86]	Kasur, Punjab	833	0	RDT
41.	Irfan *et al*., 2013[87]	Karachi, Sindh	108,598	111 (0.10%)	CLIA
42.	Khattak *et al*., 2014[88]	Peshawar, KP	6,000	8 (0.13%)	ELISA
43.	Kamran *et al*., 2014[89]	Rawalpindi, Punjab	300	0	RDT
44.	Moiz *et al*., 2014[90]	Karachi, Sindh	42,830	29 (0.06%)	NAT
45.	Zaheer *et al*., 2014[91]	ICT	160,376	27 (0.017%)	ELISA
46.	Moiz *et al*., 2015[92]	Karachi, Sindh	2,023,379	142 (0.001%)	CLIA
47.	Sheikh *et al*., 2015[93]	Gwadar, Balochistan	300	3 (1.0%)	ELISA
48.	Dossal *et al*., 2015[94]	Karachi, Sindh	23,559	12 (0.051%)	ELISA
49.	Niazi *et al*., 2015[95]	Rawalpindi, Punjab	56,772	12 (0.02%)	NAT
50.	Qasim *et al*., 2015[96]	Mirpur, AJK	8,927	0	ELISA
51.	Hussain *et al*., 2015[97]	Multan, Punjab	48,020	5 (0.01%)	RDT
52.	Wazeer *et al*., 2015[98]	Mirpur, AJK	4,622	0	ELISA
53.	Waheed *et al*., 2016[99]	ICT	65,376	45 (0.6%)	CLIA
54.	Raza *et al*., 2016[100]	Karachi, Sindh	33,595	34 (0.10%)	NAT
55.	Niazi *et al*., 2016[101]	Rawalpindi, Punjab	160,552	26 (0.02%)	ELISA
56.	Ghani *et al*., 2016[102]	Rawalpindi, Punjab	626,413	66 (0.01%)	CLIA
57.	Sial *et al*., 2016[103]	Lahore, Punjab	29,522	20 (0.07%)	CLIA
58.	Sultan *et al*., 2016[104]	Karachi, Sindh	148,268	172 (0.11%)	CLIA
59.	Ghafoor *et al*., 2016[105]	Rahim Yar Khan, Punjab	1,500	2 (0.13%)	RDT
60.	Ahmed *et al*., 2016[106]	Peshawar, KP	8,349	1 (0.01%)	ELISA
61.	Arshad *et al*., 2016[107]	Karachi, Sindh	16,602	6 (0.04%)	CLIA
62.	Saeed *et al*., 2017[108]	Lahore, Punjab	18,274	4 (0.02%)	RDT

63.	Zameer *et al*., 2017[109]	Lahore, Punjab	10,048	11 (0.11%)	RDT
64.	Memon *et al*., 2017[110]	Hyderabad, Sindh	4,683	3 (0.06%)	CLIA
65.	Batool *et al*., 2017[111]	Peshawar, KP	41,033	30 (0.07%)	CLIA
66.	Ahmad *et al*., 2017[112]	Peshawar, KP	3,679	4 (0.10%)	CLIA
67.	Sultan *et al*., 2017[113]	Karachi, Sindh	16,957	14 (0.08%)	NAT
68.	Raza *et al*., 2018[114]	Karachi, Sindh	16,660	12 (0.7%)	NAT
69.	Awan *et al*., 2018[115]	ICT	30,470	49 (0.16%)	NAT
70.	Azeem *et al*., 2018[116]	KP	204,942	144 (0.07%)	ELISA
71.	Zeeshan *et al*., 2018[117]	Mardan, KP	4,552	2 (0.04%)	CLIA
72.	Saba & Afridi 2018[118]	Peshawar, KP	4,237	15 (0.35%)	CLIA
73.	Akhtar *et al*., 2018[119]	Multan, Punjab	7,270	38 (0.52%)	RDT
74.	Ali *et al*., 2018[120]	Karachi, Sindh	49,687	11 (0.02%)	CLIA
75.	Siddiqui *et al*., 2011[121]	ICT	847	2 (0.24%)	CLIA
76.	Aslam *et al*., 2019[122]	Multan, Punjab	1,014	0	RDT
77.	Mengal *et al*., 2019[123]	Quetta, Balochistan	23,814	24 (0.10%)	CLIA
78.	Ahmed *et al*., 2019[124]	Muzaffarabad, AJK	10,632	14 (0.13%)	CLIA
79.	Rauf & Cheema 2019[125]	Faisalabad, Punjab	6,594	12 (0.18%)	CLIA
80.	Zahoor et a., 2019[126]	Peshawar, KP	11,760	19 (0.16%)	CLIA
81.	Rana *et al*., 2019[127]	Karachi, Sindh	3,610	2 (0.06%)	CLIA
82.	Zaheer *et al*., 2019[128]	ICT	75,348	70 (0.09%)	CLIA
83.	Jahan *et al.,* 2019[129]	Faisalabad, Punjab	1,942	10 (0.5%)	ELISA
84.	Sadiq *et al*., 2019[130]	Nawabshah, Sindh	37,845	2,389 (6.33%)	CLIA
85.	Haq *et al*., 2020[131]	Peshawar, KP	8,634	63 (0.73%)	NAT
86.	Saeed *et al*., 2020[132]	ICT	18,500	476 (5.1%)	CLIA
87.	Ghazanfer & Osman 2021[133]	Sialkot, Punjab	84,305	10 (0.01%)	RDT
88.	Sijjeel *et al*., 2021[134]	ICT	143,053	237 (0.16%)	CLIA
89.	Saeed and Ullah 2021[135]	ICT	312,320	124 (0.04%)	ELISA
90.	Arshad *et al*., 2021[136]	Lahore, Punjab	200	1 (0.5%)	ELISA
91.	Qadir *et al*., 2021[137]	Karachi, Sindh	29,732	168 (0.5%)	CLIA
92.	Saba *et al*., 2021[138]	Peshawar, KP	41,817	96 (0.23%)	CLIA
93.	Bhatti *et al*., 2021[139]	Sialkot, Punjab	400	1 (3.84%)	RDT
94.	Samo *et al*., 2021[140]	Hyderabad, Sindh	353	3 (0.8%)	RDT
95.	Khan *et al*., 2021[141]	Peshawar, KP	119,263	21 (0.01%)	ELISA
96.	Ghazanfar *et al.,* 2022[142]	Rawalpindi, Punjab	223,242	0	RDT
97.	Bhatti *et al*., 2022[143]	ICT	120,968	125 (0.1%)	NAT
98.	Ullah *et al*., 2022[144]	Multan, Punjab	7,858	1 (0.01%)	ELISA
99.	Ahmed *et al*., 2022[145]	Karachi, Sindh	23,656	15 (0.06%)	ELISA
100.	Shah *et al*., 2023[146]	Peshawar, KP	6,311	0	ELISA
101.	Sabir *et al*., 2023[147]	Rawalpindi, Punjab	308,767	806 (0.26%)	NAT
102.	Wazeer *et al*., 2023[148]	Mirpur, AJK	7,356	0	CLIA
103.	Zorob *et al*., 2023[149]	Rawalpindi, Punjab	15,405	29 (0.19%)	CLIA
104.	Amjed *et al*., 2023[150]	Lahore, Punjab	2,236	9 (0.40%)	CLIA
105.	Raza *et al*., 2023[151]	Faisalabad, Punjab	1,500	1 (0.06%)	RDT
106.	Aslam *et al*., 2023[152]	Lahore, Punjab	6,380	2 (0.03%)	ELISA
107.	Zeeshan *et al*., 2023[153]	Peshawar, KP	6,378	6 (0.1%)	ELISA
108.	Qadir *et al*., 2023[154]	DI Khan, KP	3,329	9 (0.27%)	CLIA
109.	Jadoon *et al*., 2023[155]	Laki Marwat, KP	100	0	RDT
110.	Hassni *et al*., 2024[156]	ICT	523	5 (1.0%)	CLIA
111.	Jamal *et al*., 2024[157]	Sindh	4,199,195	6,711 (0.015%)	RDT, ELISA & CLIA
112.	Babar *et al*., 2024[158]	Swabi, KP	10,939	44 (0.40%)	ELISA
113.	Saeed *et al*., 2024[159]	Lahore, Punjab	6,616	6 (2.3%)	CLIA
114.	Waheed *et al*., 2024[160]	Karachi, Sindh	56,732	151 (0.30%)	CLIA
115.	Saba *et al*., 2024[161]	Peshawar, KP	62,185	151 (0.24%)	CLIA
116.	Sarwar *et al*., 2024[162]	Faisalabad, Punjab	491	0	ELISA
117.	Naz *et al*., 2024[163]	DI Khan, KP	25,000	152 (0.61%)	ELISA
118.	Hussain *et al*., 2025[164]	Skardu, GB	1,400	2 (0.14%)	RDT
119.	Akbar *et al*., 2025[165]	Quetta, Balochistan	1,680	5 (0.3%)	ELISA
120.	Sabir *et al*., 2025[166]	Rawalpindi, Punjab	275,014	367 (0.13%)	NAT
121.	Ullah *et al*., 2025[167]	ICT	9,213	13 (0.14%)	CLIA
122.	Kousar *et al*., 2025[168]	Karachi, Sindh	46,455	0	NAT
123.	Shah *et al.,* 2025[169]	Malakand, KP	94,716	220 (0.23%)	CLIA
124.	Iqbal *et al*., 2026[170]	Mardan, KP	63,847	45 (0.07%)	CLIA
125.	Sajjad *et al*., 2026[171]	Karachi, Sindh	8,265	25 (0.30%)	ELISA
		Total	**12,663,749**	**13,892 (0.109%)**	

RDT: Rapid Diagnostic Test; ELISA: Enzyme Linked Immunosorbent Assay; CLIA: Chemiluminescence Immunoassay; NAT: Nucleic Acid Testing; AJK: Azad Jammu & Kashmir; ICT: Islamabad Capital Territory

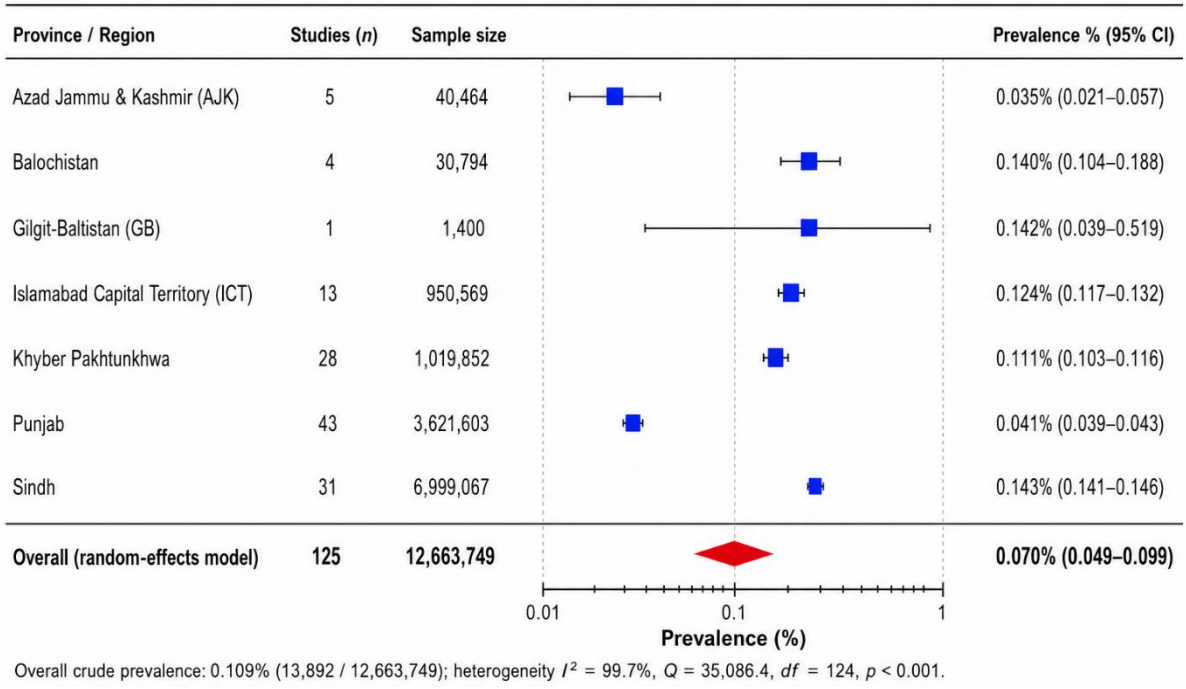

Fig. 2: *Forest plot of pooled HIV prevalence by province/region among blood donors in Pakistan*

prevalence (0.160%), followed by NAT (0.158%), CLIA/CMIA/ECLIA (0.121%), ELISA (0.027%), and RDTs (0.013%). These findings (Fig. 4) likely reflect differences in analytical sensitivity and the ability of advanced screening assays to detect infections during the serological window period of HIV.

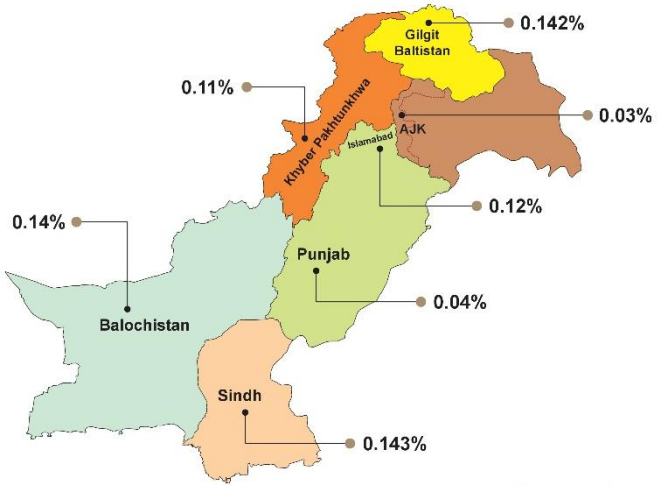

Fig. 3: *Geographical distribution of HBV prevalence across Pakistan*

Temporal analysis demonstrated (Fig. 5) a statistically significant increasing trend in HIV prevalence among blood donors over the study period ($p < 0.001$). Meta-regression using study year as a continuous covariate showed that the odds of HIV positivity increased by approximately 14.4% per calendar year (OR = 1.144; 95% CI: 1.139-1.149; $p < 0.001$).

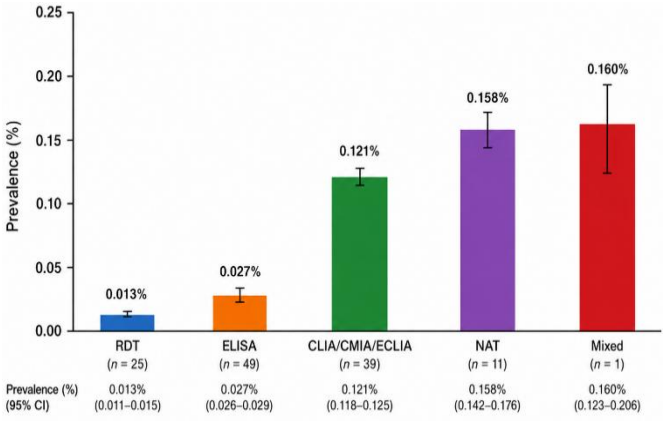

Fig. 4: *HIV prevalence analysis according to screening methodology*

Period-wise analysis showed that prevalence increased from 0.004% during 1988-2009 to 0.017% during 2010-2015, peaked at 0.223% during 2016-2020, and remained elevated at 0.150% during 2021-2026, indicating a sustained upward trend in HIV prevalence among blood donors.

Meta-regression analysis demonstrated a statistically significant increasing trend in HIV prevalence among blood donors in Pakistan over time. Study year was positively associated with HIV prevalence, with a regression coefficient of $\beta = 0.1346$ (95% CI: 0.1300-0.1392; $p < 0.001$). The meta-regression bubble plot (Fig. 6) visually confirmed this upward trend, showing that studies conducted in more recent years generally

reported higher HIV prevalence compared with earlier studies. Each bubble in figure 6 represents one study, with bubble size proportional to study size or statistical weight. The upward regression line indicates a significant increase in HIV prevalence over time). Although some dispersion of values was observed, the overall slope of the regression line remained consistently positive, indicating a clear temporal increase in HIV prevalence among blood donors. These findings are in agreement with the period-wise temporal analysis, which showed that prevalence rose from very low levels in the earlier years to substantially higher levels in recent periods. Visual inspection of the funnel plot suggested asymmetry, which was supported by Egger's regression test (intercept = -4.42, p = 0.011), indicating the presence of potential publication bias or small-study effects. However, the substantial clinical and methodological heterogeneity across studies may also have contributed to the observed asymmetry (Fig. 7).

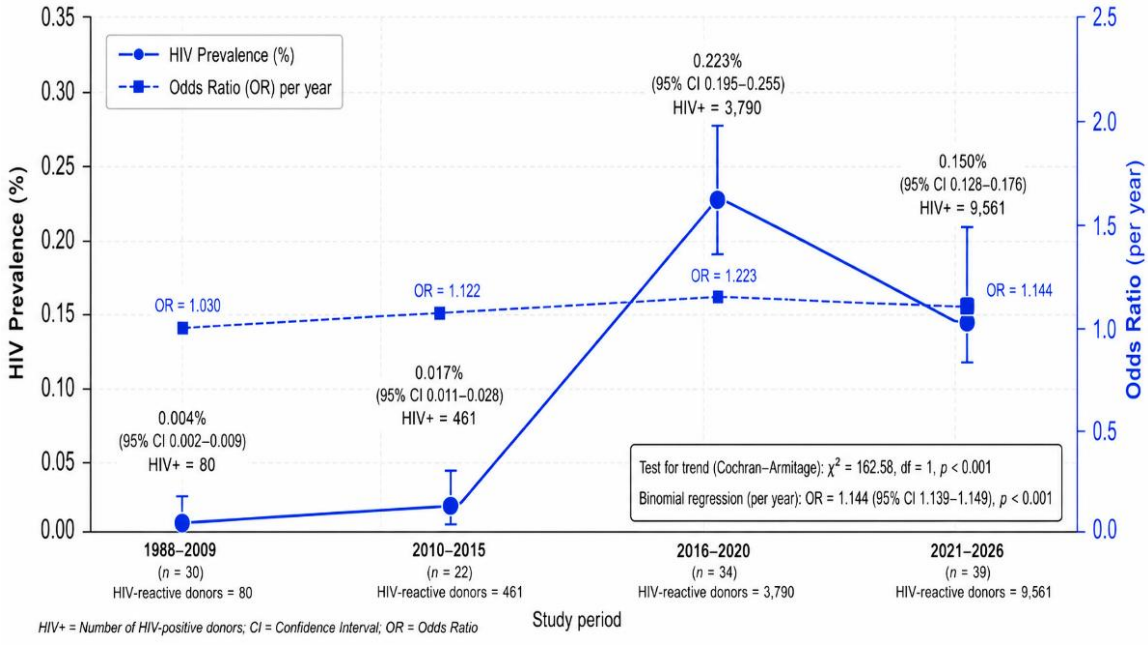

Fig. 5: *Temporal trend analysis of HIV prevalence in blood donors*

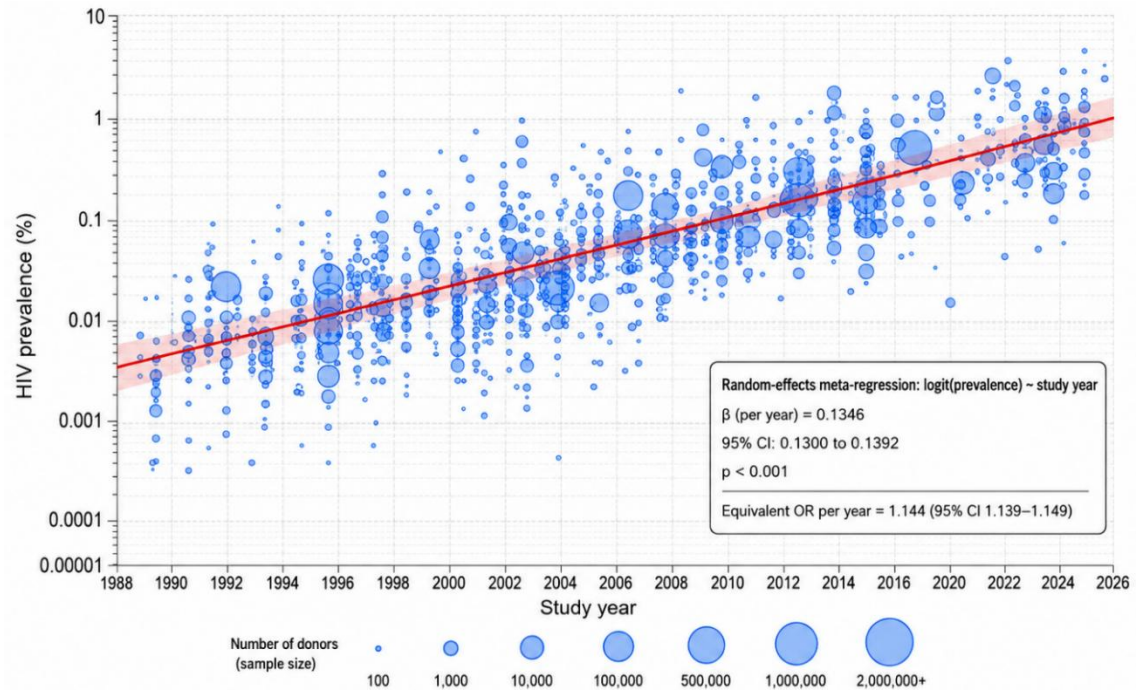

Fig. 6: *Meta-regression bubble plot showing the relationship between study year and HIV prevalence among blood donors in Pakistan*

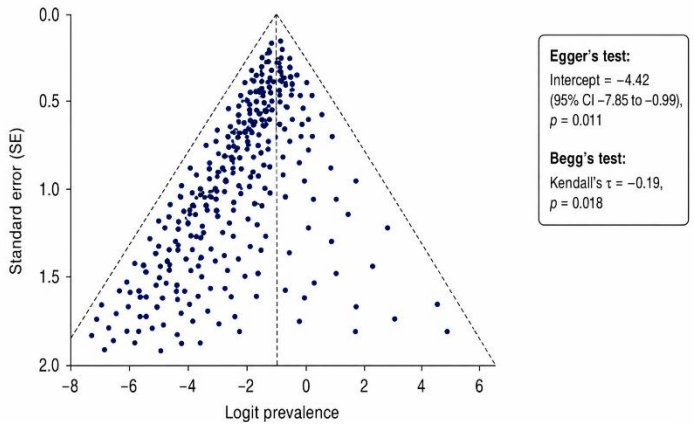

Fig. 7: *Funnel plot showing visual asymmetry suggesting potential publication bias, small-study effects, or heterogeneity*

Leave-one-out sensitivity analysis using the metaninf approach demonstrated (Fig. 8) that the pooled prevalence remained stable following sequential exclusion of each individual study, ranging from 0.067% to 0.075%, compared with the overall pooled estimate of 0.070% (95% CI: 0.049-0.099). Exclusion of the study by Sadiq *et al.,* (2019)[130] produced the largest change in the pooled estimate (0.075%) and reduced heterogeneity (I^2 = 98.6%), suggesting that this study contributed substantially to between-study variability. Nevertheless, no single study materially altered the overall findings, confirming the robustness of the meta-analysis.

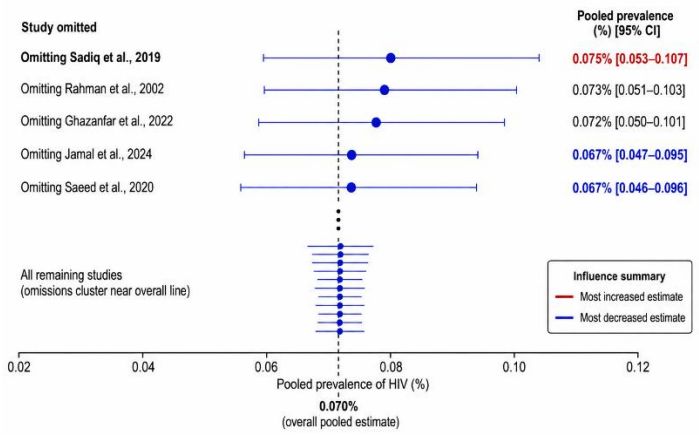

Fig. 8: *Leave-one-out sensitivity analysis using the metaninf approach*

Discussion

HIV infection remains a major threat to blood transfusion safety, particularly in developing countries. In Pakistan, the majority of blood donations (82%)[172] are collected from family or replacement donors rather than voluntary non-remunerated blood donors (VNRBDs), which represent the gold standard recommended by WHO, ISBT and national blood safety legislation for ensuring a safe and sustainable blood supply.[173-175]

Replacement donation occurs when relatives or friends donate blood on behalf of a patient requiring transfusion. This practice may increase the risk of transfusion-transmissible infections (TTIs), including HIV, as donors often feel compelled to donate despite having limited knowledge of their health status or potential risk factors. Consequently, strengthening voluntary blood donation programme remains essential for improving blood safety and reducing the transmission of infectious diseases through transfusion.[176]

Although blood donor screening and HIV testing have improved at many blood centres, Pakistan still lacks a standardized system for notifying blood donors of their HIV test results and ensuring timely linkage to HIV testing, care, and treatment services. This gap not only limits access to early diagnosis and treatment but also represents a missed opportunity for preventing onward transmission and strengthening public health surveillance.

This systematic review and meta-analysis represent the first comprehensive synthesis of HIV prevalence among blood donors in Pakistan, encompassing 125 studies conducted over a period of nearly four decades (1988-2026) and including more than 12.6 million blood donations. The overall prevalence of HIV among blood donors was found to be 0.109%, indicating that although HIV prevalence in the donor population remains relatively low compared with the general epidemic in some high-risk groups, it continues to pose a significant challenge to blood safety in the country.

The prevalence of HIV among blood donors in Pakistan (0.109%) is lower than that reported from several countries in sub-Saharan Africa but remains higher than that observed in many Asian and high-income settings. A 2023 study by Thakur *et al.,* from India reported a pooled HIV prevalence of 0.20% among blood donors,[177] which is almost twice the estimate observed in the present study, whereas substantially lower

prevalences have been reported from China (0.00992%),[178] Bangladesh (0.01%),[179] Iran (0.0047%),[180] and Afghanistan (0.04%).[181] The relatively lower prevalence in these countries may reflect stronger donor selection systems, greater reliance on voluntary non-remunerated blood donation, and more comprehensive public health interventions aimed at HIV prevention and control.

In contrast, considerably higher HIV prevalences have been documented in several African countries, including South Africa (0.381%),[182] Ethiopia (0.5%),[183] Nigeria (1.1%),[184] Sudan (2.61%),[185] Uganda (1.9%),[186] and Kenya (3.5%).[187] These differences are likely attributable to variations in the underlying burden of HIV in the general population, the stage of the epidemic, socioeconomic determinants, healthcare infrastructure, and the effectiveness of blood safety programmes. Although Pakistan continues to be classified as a country with a concentrated epidemic, the observed increase in HIV prevalence among blood donors over time suggests that the infection is progressively extending beyond traditional high-risk groups and poses an increasing challenge to transfusion safety.[188]

A notable finding of this study is the substantial geographical variation in HIV prevalence across provinces and regions. Sindh exhibited the highest burden, followed by Balochistan and Islamabad Capital Territory, whereas Punjab and Azad Jammu & Kashmir showed comparatively lower prevalence rates. The higher prevalence observed in Sindh may partly reflect the well-documented HIV outbreaks reported in the province over the past decade, particularly among vulnerable populations, as well as its large urban centres and population mobility.[189,190] Similarly, the findings from Balochistan may be influenced by cross-border migration, limited healthcare access, and relatively weaker surveillance systems. Such regional disparities emphasize the need for province-specific interventions and targeted blood safety strategies. The temporal analysis demonstrated a significant increase in HIV prevalence among blood donors over time, particularly after 2015. The increasing slope observed in the meta-regression suggests that the burden of HIV in the donor population is not static and may be rising in parallel with the evolving HIV epidemic in the country. This has important implications for blood safety, as blood donors are often considered a relatively low-risk population. A rising trend in donor seroprevalence may indicate broader transmission in the community, possible bridging from high-risk groups to the general population, and the need for strengthened donor selection and surveillance systems. These findings are consistent with reports indicating an expanding HIV epidemic in Pakistan, driven by increased transmission among key populations and subsequent bridging into the general population.[191-192] The emergence of multiple localized outbreaks, together with growing concerns regarding infection control practices and unsafe medical procedures, has heightened national attention toward HIV prevention and control. The constitution of a national task force by the Government of Pakistan in May 2026 further reflects the seriousness of the evolving epidemic and the urgent need for coordinated public health responses.

Differences in HIV prevalence according to screening methodology were also evident. Studies employing NAT and CLIA-based assays reported higher prevalence rates compared with those using conventional ELISA and RDTs. This likely reflects the superior analytical sensitivity of advanced screening technologies, particularly their ability to detect infections during the serological window period. Therefore, differences in screening methodology may partly explain the heterogeneity observed across studies. These findings support the need for quality-assured, highly sensitive screening platforms and standardized testing strategies to improve blood safety and obtain more accurate estimates of HIV burden among blood donors in Pakistan. The gradual introduction of NAT in selected regional blood centres and tertiary care institutions therefore represents an important advancement in enhancing blood safety. Nevertheless, widespread implementation remains constrained by financial and infrastructural limitations, particularly in resource-limited settings.

The present meta-analysis demonstrated considerable between-study heterogeneity, which may be attributed to differences in geographical location, study period, donor demographics, blood donation practices, screening techniques, and sample sizes. The leave-one-out sensitivity analysis confirmed the robustness of the pooled

estimate, as no individual study substantially altered the overall prevalence. Although certain studies contributed more prominently to heterogeneity, the overall conclusions remained unchanged, indicating the stability and reliability of the findings. The presence of funnel plot asymmetry and significant Egger's and Begg's tests suggest potential publication bias or small-study effects; however, the marked methodological and regional diversity among studies may also account for this observation.

The findings of this review have important policy implications for Pakistan's blood transfusion system. Expansion of voluntary non-remunerated blood donation, universal implementation of high-sensitivity screening technologies such as NAT, improved donor education, and stronger integration between NACP and blood transfusion services will be critical to preventing further increases in transfusion-transmitted HIV and timely public health interventions. Strengthening haemovigilance and regulatory enforcement through the blood transfusion authorities across all public and private blood centres should therefore remain a national priority.

This study has several strengths, including its large sample size, comprehensive geographical coverage, and inclusion of nearly four decades of data. Nevertheless, certain limitations should be acknowledged. The included studies exhibited substantial heterogeneity with respect to methodology and screening techniques. Several regions, particularly Gilgit-Baltistan and Balochistan, were underrepresented, limiting the precision of regional estimates. In addition, many studies relied solely on serological assays without confirmatory testing or nucleic acid testing, potentially resulting in underestimation or overestimation of the true prevalence. Despite these limitations, the present work provides the most comprehensive evidence to date regarding HIV prevalence among blood donors in Pakistan and establishes an important baseline for future surveillance, policy formulation, and research.

Conclusion

The current analysis included 125 studies and more than 12.6 million blood donors over a 39-year period, providing the first comprehensive national estimate of HIV prevalence among blood donors in Pakistan. Although the overall prevalence remains relatively low (0.109%), significant geographical disparities and an increasing temporal trend underscore the evolving nature of the HIV epidemic and its implications for blood safety. Strengthening voluntary non-remunerated blood donation, expanding access to high-sensitivity screening technologies (e.g. NAT), enhancing haemovigilance, and integrating blood donor surveillance with NACP are essential to further reduce the risk of transfusion-transmitted HIV and ensure a safe and sustainable blood supply in Pakistan.

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Data sharing statement

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Declaration of interests

The authors declare that they have no competing interests.

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References

1. Gebremichael G, Tadele N, Gebremedhin KB, Mengistu D. Opportunistic infections among people living with HIV/AIDS attending antiretroviral therapy clinics in Gedeo Zone, Southern Ethiopia. BMC Res Notes. 2024;17(1):225. https://doi.org/10.1186/s13104-024-06888-4.
2. Chéret A. Acute HIV-1 infection: Paradigm and singularity. Viruses. 2025;17(3):366. https://doi.org/10.3390/v17030366.
3. Beyrer C, Ratevosian J, Gelderblom H, Rosenberg NE. The HIV/AIDS pandemic: where are we now? AIDS. 2025;39(11):1497-1504. https://doi.org/10.1097/QAD.0000000000004308.
4. Joint United Nations Programme on HIV/AIDS. Global HIV & AIDS statistics: fact sheet [Internet]. Geneva: UNAIDS; [cited 2026 Feb 5]. Available from: https://www.unaids.org/en/resources/fact-sheet.

5. Nyblade L, Mingkwan P, Stockton MA. Stigma reduction: an essential ingredient to ending AIDS by 2030. Lancet HIV. 2021;8(2):e106-e113. https://doi.org/10.1016/S2352-3018(20)30309-X.
6. GBD 2021 HIV Collaborators. Global, regional, and national burden of HIV/AIDS, 1990-2021, and forecasts to 2050, for 204 countries and territories: the Global Burden of Disease Study 2021. Lancet HIV. 2024;11(12):e807-e822. https://doi.org/10.1016/S2352-3018(24)00212-1.
7. Barabara ML, Cohen SR, Minja LM, Marchand V, Hanson O, Masenga GG, et al. HIV stigma and self-efficacy caring for women living with HIV: A mixed-methods study of labour and delivery providers-empirical research mixed methods. Nurs Open. 2025;12(4):e70226. https://doi.org/10.1002/nop2.70226.
8. Fan Z, Zheng S, Cui W, Zheng C, Sun Q, Yin J. Assessing HIV/AIDS patients' access to antiretroviral drugs using the healthcare accessibility framework: a cross-sectional study from Shandong, China. BMC Infect Dis. 2025;25(1):155. https://doi.org/10.1186/s12879-025-10567-5.
9. Kulohoma BW, Wesonga CA. HIV response financing challenges in Sub-Saharan Africa: barriers to achieving the 95-95-95 UNAIDS targets. Front Public Health. 2025;13:1658229. https://doi.org/10.3389/fpubh.2025.1658229.
10. Madu CV, Alum EU, Aloh HE, Ugwu OPC, Obeagu EI, Uti DE, et al. The price of progress: Assessing the financial costs of HIV/AIDS management in East Africa. Medicine (Baltimore). 2025;104(18):e42300. https://doi.org/10.1097/MD.0000000000042300.
11. Özdemir HÖ, Tosun S, Kabadurmuş FNK, Özdemir D. The impact of socioeconomic factors on the healthcare costs of people living with HIV in Turkey. BMC Public Health. 2020;20(1):368. https://doi.org/10.1186/s12889-020-08469-z.
12. Kumah E, Boakye DS, Boateng R, Agyei E. Advancing the Global Fight Against HIV/AIDS: Strategies, barriers, and the road to eradication. Ann Glob Health. 2023;89(1):83. https://doi.org/10.5334/aogh.4277.
13. Farzin L, Shamsipur M, Samandari L, Sheibani S. HIV biosensors for early diagnosis of infection: The intertwine of nanotechnology with sensing strategies. Talanta. 2020;206:120201. https://doi.org/10.1016/j.talanta.2019.120201.
14. Duarte FHDS, Silva SO, Enders BC, Lira ALBC, Dantas RAN, Dantas DV. Early diagnosis of HIV/aids infection: concept analysis. Rev Bras Enferm. 2023;76(3):e20220565. https://doi.org/10.1590/0034-7167-2022-0565.
15. Ebrahim SH, Kanagasabai U, Broyles LN, Owens C, Behel S. HIV/AIDS in conflict-affected countries, 2024-2025. J Epidemiol Glob Health. 2026. https://doi.org/10.1007/s44197-026-00546-7.
16. Rossouw T, Tucker JD, van Zyl GU, Sikwesi K, Godfrey C. Barriers to HIV remission research in low- and middle-income countries. J Int AIDS Soc. 2017;20(1):21521. https://doi.org/10.7448/IAS.20.1.21521.
17. Jamil MS, Pasha MS, Ali A, Memon S, Soomro AA, Dharejo Z, et al. Identifying undiagnosed HIV infected individuals in a community-based door to door testing initiative in outbreak affected areas of Larkana and surrounding districts, Pakistan. Lancet Reg Health Southeast Asia. 2026;44:100713. https://doi.org/10.1016/j.lansea.2025.100713.
18. Rabold EM, Ali H, Fernandez D, Knuth M, Schenkel K, Asghar RJ, et al. Systematic review of reported HIV outbreaks, Pakistan, 2000-2019. Emerg Infect Dis. 2021;27(4):1039-1047. https://doi.org/10.3201/eid2704.204205.
19. Raza HA, Raja MHR, Khakwani MM, Khakwani M, Jamil B. Pathways to prevention: insights on stemming HIV outbreaks in Larkana, Pakistan. J Pak Med Assoc. 2024;74(3):544-548. https://doi.org/10.47391/JPMA.9042.
20. Mir F, Nathwani AA, Simms V, Abidi SH, Siddiqui AR, Hotwani A, et al. Factors associated with HIV infection among children in Larkana District, Pakistan: a matched case-control study. Lancet HIV. 2021;8(6):e342-e352. https://doi.org/10.1016/S2352-3018(21)00049-7.
21. Hermez J, Ismail M, Morgan O, Pasha MS, Schenkel K, Doherty M, et al. A pediatric HIV outbreak in Pakistan. East Mediterr Health J. 2024;30(1):60-67. https://doi.org/10.26719/emhj.24.002.
22. Jamal D, Waheed U, Abdella Y, Zaheer HA. Massive HIV outbreak in Larkana, Sindh Province, Pakistan. Vox Sanguinis 2019; 114 (Suppl. 2): p 77. https://doi.org/10.1111/vox.12847.
23. Waheed U, Zaheer HA. Possible transmission of human immunodeficiency virus through blood transfusion in Pakistan. Glob J Transfus Med 2019;4:117-8. https://doi.org/10.4103/GJTM.GJTM_9_19.
24. Bhatti MW. HIV taskforce to submit report to PM in a week [Internet]. The News International. 2026 May 15. Available from: The News International [cited 2026 May 15].
25. Khanani RM, Hafeez A, Rab SM, Rasheed S. Human immunodeficiency virus-associated disorders in Pakistan. AIDS Res Hum Retroviruses. 1988;4(2):149-54. https://doi.org/10.1089/aid.1988.4.149.
26. The Gazette of Pakistan. Islamabad Transfusion of Safe Blood Ordinance, 2002. Islamabad: Ministry of Law, Justice, Human Rights and Parliamentary Affairs, Law, Justice and Human Rights Division, Government of Pakistan; 2002.
27. Zaheer HA, Waheed U. Legislative reforms of the blood transfusion system in Pakistan. Transfus Med. 2014;24(2):117-119. https://doi.org/10.1111/tme.12107.
28. Waheed U, Ahmed N, Hussain W, Wazeer A, Saba N, Qasim Z, Zaheer HA. Implementation of blood safety legislation in Azad Jammu and Kashmir, Pakistan. Hematol Transfus Int J. 2020;8(4):86-88. https://doi.org/10.15406/HTIJ.2020.08.00230.
29. Sheikh NS, Baloch AH, Waheed U, Zaheer HA. Implementation of blood safety act in Balochistan, Pakistan. In: Proceedings of the Annual Conference of the Pakistan Society of Haematology; 2018 Feb; Rawalpindi, Pakistan.
30. Saeed Q, Waheed U. Role of regulations in improving quality of blood transfusion services in Islamabad: Recent developments and future strategies. Ann Pak Inst Med Sci. 2023; 19(2):52-56. https://doi.org/10.48036/apims.v19i2.814.
31. Safe Blood Transfusion Programme, Ministry of National Health Services, Regulations & Coordination, Government of Pakistan. Inventory of blood transfusion services acts and ordinances (1997–2004) of Pakistan. Islamabad: Safe Blood Transfusion Programme; 2012. ISBN: 978-969-9881-12-1.
32. Raza HA, Raja MHR, Khakwani MM, Jamil B. Pakistan's HIV high-risk populations: Critical appraisal of failure to curtail spread beyond key populations. IJID Reg. 2024;11:100364. https://doi.org/10.1016/j.ijregi.2024.100364.
33. Waheed U, Noor FA, Saba N, Wazeer A, Qasim Z, Arshad M, et al. Genetic diversity of human immunodeficiency virus type 1 in asymptomatic blood donors in Islamabad,

Pakistan. J Lab Physicians. 2020;12(2):92-97. https://doi.org/10.1055/s-0040-1716593.
34. Rizwan-Ul-Hasan S, Farrukh F, Ahmed S, Abidi SH. A mathematical modeling approach to measure the probability of HIV-1 transmission for different high-risk groups of Pakistan. J Infect Dev Ctries. 2021;15(8):1212-1215. https://doi.org/10.3855/jidc.12664.
35. Waheed U, Hayat K, Ahmad B, Waheed Y, Zaheer HA. Evaluation of HIV/AIDS diagnostics kits and formulation of a testing strategy for Pakistan. J Clin Virol. 2013;56(4):367-9. https://doi.org/10.1016/j.jcv.2012.12.012.
36. Zaheer HA, Waheed U. Impact of regulation of blood transfusion services in Islamabad, Pakistan. Glob J Transfus Med 2016;1(1):29-31. https://doi.org/10.4103/2455-8893.178003.
37. Khanani MR, Somani M, Rehmani SS, Veras NM, Salemi M, Ali SH. The spread of HIV in Pakistan: bridging of the epidemic between populations. PLoS One. 2011;6(7):e22449. https://doi.org/10.1371/journal.pone.0022449.
38. Stekler JD, Violette LR, Clark HA, McDougal SJ, Niemann LA, Katz DA, et al. Prospective evaluation of HIV testing technologies in a clinical setting: Protocol for project DETECT. JMIR Res Protoc. 2020;9(1):e16332. https://doi.org/10.2196/16332.
39. Sosa-Jurado F, Palencia-Lara R, Xicoténcatl-Grijalva C, Bernal-Soto M, Montiel-Jarquin Á, Ibarra-Pichardo Y, et al. Donated blood screening for HIV, HCV and HBV by ID-NAT and the residual risk of iatrogenic transmission in a tertiary care hospital blood bank in Puebla, Mexico. Viruses. 2023;15(6):1331. https://doi.org/10.3390/v15061331.
40. Bermúdez-Forero MI, García-Otálora MA. Nucleic acid testing in Colombian blood banks (2018-2024): Implementation, yield estimates and implications for safer transfusion policy. Vox Sang. 2025;120(10):977-986. https://doi.org/10.1111/vox.70078.
41. Kiani RA, Anwar M, Waheed U, Asad MJ, Abbasi S, Zaheer HA. Epidemiology of transfusion transmitted infection among patients with β-thalassaemia major in Pakistan. J Blood Transfus. 2016;2016:8135649. https://doi.org/10.1155/2016/8135649.
42. Farooq A, Waheed U, Saba N, Kaleem M, Majeed N, Wazeer A, et al. Molecular and genetic characterization of hepatitis B virus among multitransfused thalassaemia patients in Islamabad, Pakistan. J Family Med Prim Care. 2021;10(2):998-1002. https://doi.org/10.4103/jfmpc.jfmpc_1880_20.
43. Waheed U, Saba N, Wazeer A, Ahmed S. A systematic review and meta-analysis on the epidemiology of Hepatitis B and Hepatitis C virus among beta-thalassemia major patients in Pakistan. J Lab Physicians. 2021;13(3):270-276. https://doi.org/10.1055/s-0041-1731110.
44. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372:n71. https://doi.org/10.1136/bmj.n71.
45. Hilton M. JBI Critical appraisal checklist for systematic reviews and research syntheses. J Can Health Libr Assoc. 2024;45(3):180-183. https://doi.org/10.29173/jchla29801.
46. Joanna Briggs Institute. The Joanna Briggs Institute critical appraisal tools for use in JBI systematic reviews: checklist for prevalence studies [Internet]. Adelaide: Faculty of Health and Medical Sciences, University of Adelaide; 2020 [cited 2026 May 5]. Available from: https://jbi.global/sites/default/files/2020-08/Checklist_for_Prevalence_Studies.pdf.
47. Mujeeb SA, Hashmi MR. A study of HIV-antibody in sera of blood donors and people at risk. J Pak Med Assoc. 1988;38(8):221-222.
48. Khanani RM, Hafeez A, Rab SM, Rasheed S. Human immunodeficiency virus-associated disorders in Pakistan. AIDS Research and Human Retroviruses. 1988;4(2):149-154. https://doi.org/10.1089/aid.1988.4.149.
49. Mujeeb SA, Khanani MR, Khursheed TE, Siddiqui AK. Prevalence of HIV-infection among blood donors. J Pak Med Assoc. 1991;41(10):253-254.
50. Raziq F, Alam N, Ali I. Serosurveillance of HIV infection. Pak J Pathol. 1993;4(2):117-119.
51. Mujeeb SA, Hafeez A. Prevalence and pattern of HIV infection in Karachi. J Pak Med Assoc. 1993;43(1):2-4.
52. Kayani N, Sheikh A, Khan A, Mithani C, Khurshid M. A view of HIV-infection in Karachi. J Pak Med Assoc. 1994;44(1):8-11.
53. Kakepoto GN, Bhally HS, Khaliq G, Kayani N, Burney IA, Siddiqui T, Khurshid M. Epidemiology of blood-borne viruses: a study of healthy blood donors in Southern Pakistan. Southeast Asian J Trop Med Public Health. 1996;27(4):703-706.
54. Iqbal J, Rehan N. Sero-prevalence of HIV: six years' experience at Shaikh Zayed Hospital, Lahore. J Pak Med Assoc. 1996;46(11):255-258.
55. Mujeeb SA, Aamir K, Mehmood K. Seroprevalence of HBV, HCV and HIV infections among college going first time voluntary blood donors. J Pak Med Assoc. 2000;50(8):269-270.
56. Ahmed F, Shah SH, Tariq M, Khan JA. Prevalence of Hepatitis B carrier and HIV in healthy blood donors at Ayub Teaching Hospital. Pakistan J Med Res. 2000;39(2):91-92.
57. Rahman MU, Akhtar GN, Lodhi Y. Transfusion transmitted HIV & HBV infections in Punjab, Pakistan. Pak J Med Sci. 2002;18(1): 18-25.
58. Khattak MF, Salamat N, Bhatti FA, Qureshi TZ. Seroprevalence of hepatitis B, C and HIV in blood donors in northern Pakistan. J Pak Med Assoc. 2002;52(9):398-402.
59. Mumtaz S, Rehman M, Muzaffar M, Hassan M, Iqbal W. Frequency of seropositive blood donors for hepatitis B, C and HIV viruses in railway hospital Rawalpindi. Pak J Med Res. 2002;41(2): 51-53.
60. Khan Z, Raziq F, Aslam N. Prevalence of HIV in blood donors in NWFP. Journal of Postgraduate Medical Institute. 2002;16(2):187-189.
61. Sheikh AA, Sheikh AS, Sheikh NS, Rafi-U-Shan, Malik MT, Afridi F. High frequency of false positive results in HIV screening in blood banks. J Ayub Med Coll Abbottabad. 2004;16(1):28-31.
62. Asif N, Khokhar N, Ilahi F. Sero-prevalence of HBV, HCV, HIV infection among voluntary non remunerated and replacement donors in Northern Pakistan. Pak J Med Sci. 2004; 20(1): 24-28.
63. Zaidi A, Tariq WZ, Haider KA, Ali L, Sattar A, Faqeer F, et al. Seroprevalence of hepatitis B, C and HIV in healthy blood donors in northwest of Pakistan. Pak J Pathol. 2004; 15(1): 11-16.
64. Mahmood MA, Khawar S, Anjum AH, Ahmed SM, Rafiq S, Nazir I, Usman M. Prevalence of Hepatitis B, C and HIV infections in blood donors of Multan region. Ann. King Edw. Med. Univ. 2004;10(4):459-461.
65. Sirhindi, Khan AA, Alam SS, Ghori MA, Rehman RU, Soomro NA, et al. Frequency of Hepatitis B, C and human immunodeficiency virus in blood donors at Shaikh Zayed

hospital, Lahore. Proceeding Shaikh Zayed Postgrad Med Inst. 2005;19(1):33-36.

66. Jehangir W, Ali F, Shahnawaz U, Iqbal T, Qureshi HJ. Prevalence of Hepatitis B, C and HIV in blood donors of South Punjab. Esculapio. 2006;2(3):6-7.
67. Khan MA, Ashraf M, Rehman A, Ali A, Ashraf M, Ditta A. Prevalence of HBV, HCV and HIV in blood donors at Liaquetpur. Profess Med J. 2006; 13(1): 23-26.
68. Fayyaz M, Qazi MA, Ahmed G, Khan MA, Chaudhary GMD. Hepatitis B, C & HIV; Sero-prevalence of infection in blood donors. Profess Med J. 2006; 13(4): 632-636.
69. Sultan F, Mehmood T, Mahmood MT. Infectious pathogens in volunteer and replacement blood donors in Pakistan: a ten-year experience. Int J Infect Dis. 2007;11(5):407-412. https://doi.org/10.1016/j.ijid.2006.10.004.
70. Azam M, Jamal N, Imtiaz F, Haque Z, Ayoob Z. Blood donor screening for hepatitis and HIV. Journal of the Dow University of Health Sciences (JDUHS). 2007;1(2):82-83.
71. Khan ZT, Asim S, Tariz Z, Ehsan IA, Malik RA, Ashfaq B, Hayat A. Prevalence of transfusion transmitted infections in healthy blood donors in Rawalpindi District, Pakistan – a five year study. Int J Pathol. 2007;5(1):21-25.
72. Bhatti FA, Ullah Z, Salamat N, Ayub M, Ghani E. Anti-hepatitis B core antigen testing, viral markers, and occult hepatitis B virus infection in Pakistani blood donors: implications for transfusion practice. Transfusion. 2007;47(1):74-79.
73. Siddiqui MMA, Mohammad Mohsin K, Mohammad Zafar Iqbal Khan N. Prevalence of hepatitis C, hepatitis B and human immunodeficiency virus infection among blood donors at Fatimid center Multan. Medical Forum Monthly 2008; 19: 26-31.
74. Niazi A, Tahir M, Danish KF, Shazia AM. Low Seroprevalence of HBV, HCV, HIV and malaria in voluntary non-remunerated blood donors. Ann. Pak. Inst. Med. Sci. 2008:162-164.
75. Manzoor I, Hashmi N, Daud SE, Ajmal SA, Fatima HI, Rasheed ZA, Syed SA. Seroprevalence of transfusion transmissible infections (TTIs) in blood donors. Biomedica. 2009;25(10):154-158.
76. Shah SA, Ehsan A. Seroprevalence of surrogate markers for hepatitis B, hepatitis C and HIV in healthy blood donors at Shaikh Zayed Medical Complex, Lahore. Ann. King Edw. Med. Univ. 2009;15(1):5-10.
77. Qazi A, Khan A, Haq M, Khan IU, Ayub R. Screening of 100 blood donors for Hepatitis B, C and HIV for their counseling for voluntary blood donation. KJMS. 2010;2(1):27-33.
78. Shaikh ZA, Ali G, Makhdoom PA. Analysis of blood donors at a major tertiary care hospital of Karachi and Seroprevalence of blood borne hepatitis and HIV. Medical Channel. 2010; 16(4):630-632.
79. Khan A, Bukhari SS, Alvi MI, Qazi A. Seroprevalence of hepatitis B, hepatitis C and HIV in blood donors of Peshawar. Gomal Journal of Medical Sciences. 2011;9(1):46-50.
80. Borhany M, Shamsi T, Boota S, Ali H, Tahir N, Naz A, et al. Transfusion transmitted infections in patients with hemophilia of Karachi, Pakistan. Clin Appl Thromb Hemost 2011;17(6):651-655.
81. Safi SZ, Afzal MS, Waheed Y, Butt UJ, Fatima K, Parvez Y, Qadri I. Seroprevalence of hepatitis C and human immunodeficiency viruses in blood donors of northwestern Pakistan. Asian Biomed. 2011;5(3):389-392.
82. Attaullah S, Khan S, Khan J. Trend of transfusion transmitted infections frequency in blood donors: Provide a road map for its prevention and control. J Transl Med. 2012; 10:20. https://doi.org/10.1186/1479-5876-10-20.
83. Waheed U, Khan H, Satti HS, Ansari MA, Malik MA, Zaheer HA. Prevalence of transfusion transmitted infections among blood donors of a teaching hospital in Islamabad. Ann Pak Inst Med Sci. 2012;8(4):236-239.
84. Umair M, Mahmood RT, Inam M, Waqas A, Wazeer A. Sero-prevalence of hepatitis B, hepatitis C, Human immunodeficiency virus, Syphilis and Malaria in blood donors of Mirpur, Azad Jammu Kashmir. Pakistan. J Public Health Biol Sci. 2012;1(4):110-114.
85. Zehra SK, Bano S, Hakim ST, Nadeem SG. Prevalence of transfusion transmitted infection in replacement and voluntary blood donor. RADS Journal of Biological Research & Applied Sciences. 2013;4(2):56-63. https://doi.org/10.37962/jbas.v4i2.26.
86. Butt KK, Shafiq F, Yousaf A. Prevalence of HIV, ANTI-HCV, HBsAg and VDRL positive cases in blood donors of Bhatti International Trust Hospital, Kasur. Pakistan J Med Health Sci. 2013;7(3):662-663.
87. Irfan SM, Uddin J, Zaheer HA, Sultan S, Baig A. Trends in transfusion transmitted infections among replacement blood donors in Karachi, Pakistan. Turk J Haematol 2013; 30(2): 163-167. https://doi.org/10.4274/Tjh.2012.0132.
88. Khattak MU, Munir I, Nasim Z, Iqbal A, Ali I, Ahmad MA, et al. Incidence of HIV/AIDS in healthy blood donors of Khyber Pakhtunkhwa, Pakistan. Int J Pure Appl Sci Technol. 2014; 22(2):18-24.
89. Kamran M, Mahmood RT, Khan MA, Mehmood A, Nisar L, Asad MJ. Prevalence of transfusion transmitted infections among blood donors; A prospective study. AJPCT. 2014;2(4):540-543.
90. Moiz B, Moatter T, Shaikh U, Adil S, Ali N, Mahar F, et al. Estimating window period blood donations for human immunodeficiency virus Type 1, hepatitis C virus, and hepatitis B virus by nucleic acid amplification testing in Southern Pakistan. Transfusion. 2014;54(6):1652-1659. https://doi.org/10.1111/trf.12521.
91. Zaheer HA, Saeed U, Waheed Y, Karimi S, Waheed U. Prevalence and trends of hepatitis B, hepatitis C and human immunodeficiency viruses among blood donors in Islamabad, Pakistan 2005-2013. J Blood Disorders Transf. 2014;5(6): 217.
92. Moiz B, Ali B, Chatha MH, Raheem A, Zaheer HA. HIV prevalence in blood donors and recipients in Pakistan: a meta-analysis and analysis of blood-bank data. WHO South East Asia J Public Health. 2015;4(2):176-83. https://doi.org/10.4103/2224-3151.206687.
93. Sheikh A. Seroprevalence of blood borne viruses among blood donors attended during an earthquake campaign at Gwadar Port, a south-west coastal area of Pakistan. Annals of Oncology 2015;26 (Suppl. 9):ix156-x160. https://doi.org/10.1093/annonc/mdv535.14.
94. Dossal R, Hussain S, Baloch S. Progress report 2015: Fatimid Foundation Blood Transfusion Services, Karachi, Pakistan. Karachi: Fatimid Foundation; 2015.
95. Niazi SK, Bhatti FA, Salamat N, Ghani E, Tayyab M. Impact of nucleic acid amplification test on screening of blood donors in Northern Pakistan. Transfusion. 2015;55(7):1803-1811. https://doi.org/10.1111/trf.13017.
96. Qasim Z, Wazeer A, Shahid I. Progress report 2015: Blood Transfusion Services, DHQ Teaching Hospital, Mirpur, Department of Health, Government of Azad Jammu and Kashmir. Mirpur: Department of Health, Government of Azad Jammu and Kashmir; 2015.
97. Hussain A, Mumtaz HM, Aslam MS, Abbas Z. Seroprevalence of transfusion based transmissible infections among clinically healthy donors in the

community of Multan. Pakistan. J Inf Mol Biol. 2015;3(2):47-51.

98. Wazeer A, Azmat M, Qasim Z. Sero-prevalence of hepatitis B, hepatitis C, human immunodeficiency virus, syphilis and malaria in blood donors of Mirpur, Azad Jammu Kashmir, Pakistan. In: Proceedings of the XI Annual Conference of Asian Association of Transfusion Medicine; 2015; Islamabad, Pakistan. p. 115.
99. Waheed U, Hasan SI, Wazeer A, Zaheer HA. The status of blood safety in Islamabad, Pakistan. Ann Pak Inst Med Sci. 2016;12(4):209-214.
100. Raza N. Revisiting reactive blood donor demographics - A single center experience. J Liaquat Univ Med Health Sci. 2016;15(4):208-212. https://doi.org/10.22442/jlumhs.161540494.
101. Niazi SK, Mahmood A, Alam M, Ghani E. Seroprevalence of transfusion transmissible infections in blood donors: A three-year experience. Pak Armed Forces Med J. 2016; 66(2): 190-193.
102. Ghani E, Rathore MA, Khan SA. Trends in human immunodeficiency virus seroprevalence in blood donors in northern Pakistan. Public Health. 2016;131:71-74.
103. Sial GR, Khan S, Shahid SU, Bhatti S, Farooq F. Prevalence of transfusion transmitted infections in asymptomatic blood donors: Is syphilis alarming?. Biomedica. 2016;32(1):8-12.
104. Sultan S, Murad S, Irfan SM, Biag MA. Trends of venereal infections among healthy blood donors at Karachi. Arch Iran Med. 2016; 19(3):192-196.
105. Ghafoor MB, Hussain M, Leghari AR, Mehwish A, Zulfiqar S, Mustafa G. Major transfusion-transmissible infections among blood donors in Rahim Yar Khan, a district of Southern Punjab, Pakistan. Isra Medical Journal. 2016;8(4):246-248.
106. Ahmed T, Rahool, Khattak NN, Khan F, Din S, Khan MS. Prevalence of hepatitis B virus, hepatitis C virus and HIV in blood donors of different areas of Khyber Pukhtoonkhwa, Pakistan. J. Biodiv. & Environ. Sci. 2016;9(1):304-309.
107. Arshad A, Borhany M, Anwar N, Naseer I, Ansari R, Boota S, et al. Prevalence of transfusion transmissible infections in blood donors of Pakistan. BMC Hematol. 2016;16:27. https://doi.org/10.1186/s12878-016-0068-2.
108. Saeed M, Hussain S, Rasheed F, Ahmad M, Arif M, Hamid Rahmani MT. Silent killers: Transfusion Transmissible Infections-TTI, among asymptomatic population of Pakistan. J Pak Med Assoc. 2017;67(3):369-374.
109. Zameer M, Shahzad F, Khan FS, Ali H, Saeed U, Farooq M. Transfusion transmissible infections among healthy blood donors at blood bank from Children's Hospital & Institute of Child Health Lahore: A 5 months study. Pak Armed Forces Med J. 2017; 67(1):131-136.
110. Memon FA, Ujjan ID, Memon AI, Shaikh AR, Rao AR, Naz A. Seroprevalence of transfusion transmitted infections among different blood group donors at Blood Bank LUMHS, Hyderabad. Pak J Med Sci. 2017;33(2):443-446. https://doi.org/10.12669/pjms.332.11691.
111. Batool Z, Durrani SH, Tariq S. Association of ABO and Rh blood group types to Hepatitis B, Hepatitis C, HIV and Syphilis infection, a five year' experience in healthy blood donors in a tertiary care hospital. J Ayub Med Coll Abbottabad. 2017;29(1):90-92.
112. Ahmad T, Nadeem M, Khan FU, Uddin S, Maqsood-Ur-Rehman M, Anwar N. Incidence of HBV, HCV and HIV among blood donors from Peshawar KPK, Pakistan. Journal of Entomology and Zoology Studies. 2017; 5(4): 608-610.
113. Sultan S, Nasir MI, Rafiq S, Baig MA, Akbani S, Irfan SM. Multiplex real-time RT-PCR assay for transfusion transmitted viruses in sero-negative allogeneic blood donors: an experience from Southern Pakistan. Malays J Pathol. 2017;39(2):149-154.
114. Raza N, Qureshi H, Qureshi A. Reactive blood donor notification; their responses and perceptions: experience from Southern Pakistan. J Ayub Med Coll Abbottabad. 2018;30(3):351-355.
115. Awan SA, Junaid A, Sheikh S. Transfusion transmissible infections: Maximizing donor surveillance. Cureus. 2018;10(12):e3787. https://doi.org/10.7759/cureus.3787.
116. Azeem R, Altaf N, Idrees M, Riaz, Afridi S, Batool Z. Seroprevalence of transfusion transmissible infected blood donors in Northern Pakistan. Adv Basic Med Sci. 2018;2(1):26-30.
117. Zeeshan M, Anwar F, Shah IA, Shah M. Prevalence of HBV, HCV, HIV and syphilis in blood donor at Mardan Medical Complex, Khyber Pakhtunkhwa, Pakistan. Int J Biosci. 2018;12(5):295-301. http://doi.org/10.12692/ijb/125.295-301.
118. Saba N, Afridi SR. Epidemiology of transfusion transmitted infections among blood donors: Experience from Regional Blood Centre, Peshawar. In: Proceedings of the Annual Conference of the Pakistan Society of Haematology; 2018 Feb; Rawalpindi, Pakistan.
119. Akhter N, Fatima S, Batool Y, Samad A, Fayyaz N, Khan ZM. Seroprevalence of transfusion transmitted infections among healthy donors in a tertiary care hospital in Southern Punjab, Pakistan. Biomedica. 2018;34(3):168-172.
120. Ali M, Karim F. Monitoring response rate of blood donors concerning positive screening tests for HIV and syphilis: an institutional approach toward donor hemovigilance. The Egyptian Journal of Haematology. 2018;43(4):217-221. http://doi.org/10.4103/ejh.ejh_17_18.
121. Siddiqui FM, Siddiqui N, Oluwatayo O, Jabeen S, Qadir SM, Sajjad AK. Prevalence of transfusion-transmissible infections among voluntary blood donors in tertiary health-care facility in Islamabad. Pakistan. J Clin Trials. 2019;9(6):1000383.
122. Aslam M, Qureshi U, Ansari M. Prevalence of viral hepatitis & HIV infections among blood donors at Amna Thalassemia Center Multan. Pakistan J Med Health Sci. 2019;13:653-656.
123. Mengal MH, Baloch AH. Progress report 2019: Quetta Regional Blood Centre. Quetta: Department of Health, Government of Balochistan; 2019.
124. Ahmed N, Hussain W. Progress report 2019: Muzaffarabad Regional Blood Centre. Muzaffarabad: Department of Health, Government of Azad Jammu and Kashmir; 2019.
125. Rauf R, Cheema A. Potential risk of transfusion-transmissible infections among blood donors in district Faisalabad of Pakistan. Clin Med (Lond). 2019;19(Suppl 3):27. http://doi.org/10.7861/clinmedicine.19-3s-s27.
126. Zahoor M, Zahoor S, Khan K, Mehmood K, Shah MM, Khan MZ. Seroprevalence of Hepatitis B, C and HIV infection in healthy blood donors; A single centre study in Peshawar. KJMS. 2019;12(2):192-195.
127. Rana AA, Ali Z, Amin F, Sharif N. Prevalence of Hepatitis B, C and HIV Viruses in Blood Donors at Patel Hospital. Liaquat Med Research J. 2019;1(1):12-14.
128. Zaheer HA, Waheed U, Nasir K, Tahir S. Islamabad Blood Transfusion Authority annual report 2019. 1st ed. Islamabad: Ministry of National Health Services, Regulations & Coordination, Government of Pakistan; 2019.
129. Jahan S, Mushtaq S, Ali FA. Screening of blood donors for transfusion yransmitted infections in tertiary care hospital

of Faisalabad. Journal of Aziz Fatimah Medical & Dental College. 2019;1(1): 28-31. https://doi.org/10.55279/jafmdc.v1i1.29.

130. Sadiq S, Lakhani M, Baig S, Qureshi MS, Shah M. Accidental diagnosis of infections among blood donors. Intl J Clinical Med. 2019;10(10):463-468. https://doi.org/10.4236/ijcm.2019.1010039.
131. Haq I, Ullah R, Din M, Ahmad S, Anwar F, Ali M, Khan HU. Unrecognized HIV infection in asymptomatic volunteer blood donors at district Peshawar, Khyber Pakhtunkhwa, Pakistan. New Microbes New Infect. 2020;35:100685. https://doi.org/10.1016/j.nmni.2020.100685.
132. Saeed T, Anjum F, Sarfraz M, urRehman T, Maqsood A, Paracha TR, et al. HIV-Sero-prevalence trend among blood donors in Federal Area of Pakistan. Int J Sci Eng Res. 2020;11:46-52.
133. Ghazanfer S, Osman H. Frequency of TTIs in apparently healthy blood donors in Sialkot District, a small district of Punjab-Pakistan with big reservoir of TTIs. J. Haematol. Stem Cell Res. 2021;1(1):29-33.
134. Sijjeel F, Khalid A, Khan MY, Khurshid R, Habiba UE, Majid H, et al. Prevalence of ABO and Rh blood groups and their association with Transfusion-Transmissible infections (TTIs) among blood donors in Islamabad, Pakistan. BioScientific Review. 2021;3(4):13-26.
135. Saeed S, Ullah A. Temporal trends in the prevalence of hepatitis B, hepatitis C and human immuno-deficiency virus in blood donors of Pakistan. Br J Haematol. 2021;193(S1):138.
136. Arshad S, Arif A, Ahmad R, Seemab Z, Shaheen F, Tanveer R. Hepatitis B, C, and HIV Infections among blood donors at several hospitals in Lahore, Pakistan. Journal of Pharmaceutical Research International. 2021;33(55A):112-126. https://doi.org/10.9734/jpri/2021/v33i55A33814.
137. Qadir H, Nasir N, Kouser S, Mansoori H, Qadir N, Baig R, Qadir A. Seroprevalence of Hepatitis B, Hepatitis C, Human Immunodeficiency Virus, syphilis, and malaria among blood donors at tertiary care hospital blood bank. J Pak Med Assoc. 2021;71(3):897-899. https://doi.org/10.47391/JPMA.1344.
138. Saba N, Nasir JA, Waheed U, Aslam S, Mohammad I, Wazeer A, et al. Seroprevalence of transfusion-transmitted infections among voluntary and replacement blood donors at the Peshawar Regional Blood Centre, Khyber Pakhtunkhwa, Pakistan. J Lab Physicians. 2021;13(2):162-168. https://doi.org/10.1055/s-0041-1729485.
139. Bhatti AK, Waheed Q, Azhar M, Butt TM, Rafiq H, Abid MM. Prevalence of blood transfusion diseases among blood donors. 6th ed. Pretoria, South Africa: Med Forum. 2021;32(6):93-95.
140. Samo AA, Baig NM, Sidhu A, Shaikh SN, Laghari ZA. Seropositivity of hepatitis B, hepatitis C, Human immunodeficiency virus and syphilis in blood donors of Hyderabad, Sindh, Pakistan. Sindh University Research Journal - SURJ (Science Series). 2021;53(2):155-158.
141. Khan MI, Ahmed N, Waqar S. Frequency and trends of Hepatitis B & C, and human immune deficiency virus in blood donors presenting to blood bank of a Tertiary Hospital in Peshawar, Pakistan. Professional Med J. 2021;28(4):515-519. https://doi.org/10.29309/TPMJ/2021.28.04.4798.
142. Ghazanfar S, Hassan S, Shahid Z, Khan MS, Malik AR, Bhutta HS, et al. Frequency of transfusion transmissible infections among blood donors of Rawalpindi District, Pakistan. Afr Health Sci. 2022;22(3):590-598. https://doi.org/10.4314/ahs.v22i3.63.
143. Bhatti MM, Junaid A, Sadiq F. The prevalence of transfusion transmitted infections among blood donors in Pakistan: A retrospective study. Oman Med J. 2022;37(3):e386. https://doi.org/10.5001/omj.2022.65.
144. Ullah S, Rasheed A, Saleem U, Ijaz A. Transfusion related transmission of infections among blood donors of South Punjab. Journal of Rawalpindi Medical College. 2022;26(4):558-562. https://doi.org/10.37939/jrmc.v26i4.1874.
145. Ahmed R, Fatima M, Ashfaq J, Tariq SF, Naseer I, Asif M, Borhany M. Frequency of hepatitis B, C, and human immunodeficiency virus in blood donors. Cureus. 2022;14(6):e25978. https://doi.org/10.7759/cureus.25978.
146. Shah H, ur Rahman Z, Khan M, Zaman F, Badshah S. The prevalence of blood borne diseases in blood donors of Peshawar, Khyber Pakhtunkhwa, Pakistan. Recent Adv Antiinfect Drug Discov. 2023;18(3):215-220. https://doi.org/10.2174/2772434418666230213124806.
147. Sabir N, Ghafoor T, Fatima S, Lodhi R, Mehmood A, Zaman G. Prevalence and association of transfusion-transmissible infections with age of blood donors: A regional transfusion centre study in northern Pakistan. J Coll Physicians Surg Pak. 2023;33(9):978-982. https://doi.org/10.29271/jcpsp.2023.09.978.
148. Wazeer A, Qasim Z. Progress report 2023: Mirpur Regional Blood Centre. 1st ed. Mirpur: State Ministry of Health, Government of Azad Jammu and Kashmir; 2023.
149. Zorob T, Farooqi MA, Ahsan A, Zaki A, Rathore MA, Farooqi HMU. Prevalence and trends in hepatitis B & C virus among blood donors in Pakistan: A regional transfusion center study. Livers. 2023;3(2):271-281. https://doi.org/10.3390/livers3020018.
150. Amjed S, Zaki MR, Khalid M, Hafeez H, Akbar A, Jafar J. Seroprevalence of transfusion-transmitted infection in different type of blood donors. Riphah Journal of Allied Health Sciences. 2023;2(2):58-63. https://doi.org/10.53389/RJAHS.2023020205.
151. Raza SK, Bajwa H, Javaid H, Anwar R, Hashim M, Saleem K. Prevalence of transmissible infectious diseases among healthy blood donors in Faisalabad, Pakistan. Pakistan Journal of Health Sciences. 2023;4(3)142-146. https://doi.org/10.54393/pjhs.v4i03.544.
152. Aslam U, Gohar A, Ahmad F, Hasan M, Nausherwan M. Transfusion transmitted infections in blood donors of Pakistan Red Crescent Lahore: A mixed method study. Ann King Edward Med Uni. 2023;29(4):338-346. https://doi.org/10.21649/akemu.v23i4.5068.
153. Zeeshan M, Rahman A, Ahmad A, Khan N, Muhammad W. Prevalence of transfusion transmissible infections among volunteer blood donors. J Xi'an Shiyou Univ Nat Sci Ed. 2023;19(6):873-893.
154. Qadir S, Alizai AI, Shah H, Naeem A, Naeem H, Waheed K. Seroprevalence of transfusion-transmissible infections by type and their distribution across gender in blood donors, a regional blood center study, Pakistan. Professional Med J. 2023;30(4):529-534. https://doi.org/10.29309/TPMJ/2023.30.04.7373.
155. Jadoon A, Nawaz S, Sherin F, Idrees M, Marwat ZI, Safdar M. Screening and donor awareness of hepatitis B, hepatitis C, and HIV in Khyber Pakhtunkhwa. J Basic Clin Med Sci. 2023;2(1):30-35. https://doi.org/10.58398/0002.000011.
156. Hassni MA, Mir R, Tanveer ZH, Zahra F, Hasni K, Iftikhar H, et al. Prevalence and causes of blood deferral in tertiary care teaching hospital Islamabad. National J Life Health Sci. 2024;3(1):14-19. https://doi.org/10.62746/njlhs.v3n1.19.
157. Jamal DE, Waheed S, Gul S, Ali M. Prevalence and trends of Hepatitis C, Hepatitis B, and Human Immunodeficiency

Viruses over half a decade among healthy blood donors across Sindh, Pakistan. Cureus. 2024;16(4):e58374. https://doi.org/10.7759/cureus.58374.

158. Babar N, Mahboob A, Anwar B, Shah AA, Babar A, Najeeb S. Trends in serological markers of transfusion transmissible infections among blood donors in a tertiary care hospital. J Islamabad Med Dental Coll. 2024;13(2):326-332. https://doi.org/10.35787/jimdc.v13i2%20(A).1235.
159. Saeed N, Akhtar A, Mudassar M, Danish M, Muzaffar A, Tariq TM. Blood donor deferral patterns and frequency at a tertiary care hospital in Lahore. J. Haematol. Stem Cell Res. 2024;4(1):188-191.
160. Waheed S, Khan MS, Qamar S, Shah SM, Rafiq E. Trend of infectious disease positivity in exchange and voluntary blood donors at Regional Blood Centre, Karachi. Nat J Health Sci. 2024;9(3):204-208. https://doi.org/10.21089/njhs.93.0204.
161. Saba N, Nisar M, Muhammad I. Progress report 2024: Peshawar Regional Blood Centre. 1st ed. Peshawar: Department of Health, Government of Khyber Pakhtunkhwa; 2024.
162. Sarwar A, Saqib M, Taqveem A, Khurshid M, Mansoor MK. Seroprevalence of transfusion-transmissible infections in blood donors: insights from public and private blood centers in Jaranwala. Global Immunological & Infectious Diseases Review. 2024;9(3):77-84. http://doi.org/10.31703/giidr.2024(IX-III).09.
163. Naz R, Ahmad R. Prevalence and risk assessment of transfusion-transmissible infections among blood donors in Pakistan. Bioscience Insights. 2024;1(2):15-23.
164. Hussain M, Ali I, Ali M, Ali W, Ali I, Riaz N. Prevalence of transfusion transmitted infection among healthy male blood donors in district Skardu, Gilgit Baltistan, Pakistan. Frontier in Medical and Health Research. 2025;3(5):655-670.
165. Akbar A, Qayyum M, Farhad S, Shinwari N, Iqbal K, Rasool G. Prevalence of Hepatitis B, C, and HIV among healthy blood donors at the Regional Blood Center, Quetta, Pakistan. Indus J Biosci. Res. 2025;3(7):592-597. https://doi.org/10.70749/ijbr.v3i7.2027.
166. Sabir N, Akhtar F, Ghafoor T, Lodhi R, Ali S, Fatimah S. Frequency and association of transfusion-transmissible infections with type of blood donors in a regional transfusion center. Pak Armed Forces Med J. 2025; 75(Suppl-7): S106.
167. Ullah M, Hanif A, Arshad M, Azeem M, Stanikzai H, Atif M, et al. Prevalence and trends of transfusion-transmitted infections in volunteer blood donors of Islamabad and Rawalpindi: A retrospective study. Insights-Journal of Health and Rehabilitation. 2025;3(6):39-46. http://doi.org/10.71000/n856w085.
168. Kouser S, Qadir H, Ahmad M, Tahir H, Sajjad M, Khan F, Shamim G. Nucleic acid amplification testing for human immunodeficiency virus, Hepatitis B virus, and Hepatitis C virus in blood donors at a tertiary care hospital blood bank. Cureus. 2025;17(1):e77571. http://doi.org/10.7759/cureus.77571.
169. Shah SM, Ahmad S, Elahi N, Tariq M, Alam S, Shah T. Trends in voluntary and replacement blood donors: Seroprevalence of transfusion-transmitted infections in Malakand Division, 2021-2024. J Coll Physicians Surg Pak. 2025;35(10):1340-1344. http://doi.org/10.29271/jcpsp.2025.10.1340.
170. Iqbal K, Farhad S, Khan MS, Jan MH, Khan IZ, Umair M, et al. Prevalence and pattern of transfusion transmitted infections among blood donors visiting a tertiary care hospital, Pakistan. BMC Infect Dis. 2026;26(1):764. http://doi.org/10.1186/s12879-026-13030-1.
171. Sajjad M, Arshad F, Abbas FF, Aki AL, Naseem S, Bukhari U. Frequency of Hepatitis B, Hepatitis C and Human Immunodeficiency Virus in Blood Donors. J Muhammad Med Coll. 2026;16 (2):152-155. https://doi.org/10.62118/jmmc.v16i02.710.
172. Zaheer HA. Waheed U, Nasir K, Tahir S. Annual Report 2019. Safe Blood Transfusion Programme, Ministry of National Health Services, Regulations & Coordination, Government of Pakistan.
173. WHO Expert Group. Expert Consensus Statement on achieving self-sufficiency in safe blood and blood products, based on voluntary non-remunerated blood donation (VNRBD). Vox Sang. 2012;103(4):337-342. https://doi.org/10.1111/j.1423-0410.2012.01630.x.
174. The Gazette of Pakistan. Islamabad Transfusion of Safe Blood Ordinance, 2002. Islamabad: Ministry of Law, Justice, Human Rights and Parliamentary Affairs, Government of Pakistan; 2002.
175. The Gazette of Pakistan. Islamabad Transfusion of Safe Blood Rules, 2005 SR0 307 (1) 12005, Ministry of Health, Government of Pakistan;. 2005
176. Waheed U, Hosseini N. Social media and voluntary blood donation. J Islamabad Med Dental Coll. 2023;12(2) 68-70. https://doi.org/10.35787/jimdc.v12i2.1010.
177. Thakur SK, Singh S, Negi DK, Sinha AK. Prevalence of TTI among Indian blood donors. Bioinformation. 2023;19(5):582-589. https://doi.org/10.6026/97320630019582.
178. Zhu H, Ding W, Han W, Zheng X, Hu Y, Dong J, et al. Prevalence and residual risk of HIV in volunteer blood donors of Zhejiang Province, China, from 2018 to 2022. Can J Infect Dis Med Microbiol. 2024;2024:4749097. https://doi.org/10.1155/2024/4749097.
179. Chowdhury B, Ferdous MG, Sarker S, Ansari ZE, Islam MA, Haque SMA. Seropositivity of HBV, HCV, HIV and Syphilis among blood donors in Mymensingh Medical College Hospital, Bangladesh. Mymensingh Med J. 2026;35(1):37-43.
180. Azadbakht M, Ardakani MT, Delirakbariazar M, Kasraian L, Khaledi A, Foruozandeh H, et al. Seroprevalence and trend of HBV, HCV, and HIV infections among blood donors of Fars Province, Iran (2006-2018). Ethiop J Health Sci. 2020;30(3):397-408. https://doi.org/10.4314/ejhs.v30i3.11.
181. Hashemi E, Waheed U, Saba N, Wazeer A. First report from Afghanistan on the prevalence of blood-borne infections: A retrospective cross-sectional multicentre study for an epidemiological assessment. J Blood Med. 2022;13:45-50. https://doi.org/10.2147/JBM.S344180.
182. Vermeulen M, Chowdhury D, Swanevelder R, Grebe E, Brambilla D, Jentsch U, et al; REDS-III International Program South Africa. HIV incidence in South African blood donors from 2012 to 2016: a comparison of estimation methods. Vox Sang. 2021;116(1):71-80. https://doi.org/10.1111/vox.12987.
183. Shiferaw E, Tadilo W, Melkie I, Shiferaw M. Sero-prevalence and trends of transfusion-transmissible infections among blood donors at Bahir Dar district blood bank, northwest Ethiopia: A four year retrospective study. PLoS One. 2019;14(4):e0214755. https://doi.org/10.1371/journal.pone.0214755.
184. Tijani BA, Adedeji YO, Muhibi MA, Ala OO, Adedeji AA, Lawal SF, et al. Prevalence of transfusion-transmissible infections among blood donors in a tertiary health institution in South-west, Nigeria: a three-year retrospective study. BMC Infect Dis. 2025;25(1):1352. https://doi.org/10.1186/s12879-025-11818-1.

185. Ahmed EB, Essa AA, Almugadam BS, Ahmed QM, Hussein MM. Transfusion transmitted infections among male blood donors of White Nile State, Sudan: Screening of the current seroprevalence and distribution. BMC Res Notes. 2020;13(1):549. https://doi.org/10.1186/s13104-020-05333-6.
186. Cwinyaai N, Opio D, Kajumbula H, Zalwango JF, Akunzirwe R, Okello T, Francis A. Prevalence and factors associated with transfusion-transmissible infections among blood donors in Arua regional blood bank, Uganda. BMC Infect Dis. 2024;24(1):926. https://doi.org/10.1186/s12879-024-09838-4.
187. Bartonjo G, Oundo J, Ng'ang'a Z. Prevalence and associated risk factors of transfusion transmissible infections among blood donors at Regional Blood Transfusion Center Nakuru and Tenwek Mission Hospital, Kenya. Pan Afr Med J. 2019;34:31. https://doi.org/10.11604/pamj.2019.34.31.17885.
188. Study finds HIV spreading to Pakistan's general population. AIDS Policy Law. 2011;26(11):3.
189. Burki T. Pakistan continues to battle paediatric HIV outbreak. Lancet HIV. 2022;9(5):e307. https://doi.org/10.1016/S2352-3018(22)00063-7.
190. Abid MA, Khani MK, Abid MB. Pakistan's battle against HIV. Int J STD AIDS. 2023;34(9):657-658. https://doi.org/10.1177/09564624231166433.
191. Raza HA, Raja MHR, Khakwani MM, Jamil B. HIV at a crossroads in Pakistan. Lancet HIV. 2024;11(5):e283. https://doi.org/10.1016/S2352-3018(24)00087-0.
192. Waheed U, Satti HS, Arshad M, Farooq A, Zaheer HA. Epidemiology of HIV/AIDS and syphilis among high risk groups in Pakistan. Pak. J. Zool. 2017;49(5) :1829-1834. http://doi.org/10.17582/journal.pjz/2017.49.5.1829.1834.

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