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Prevalence of HBV, HCV, HIV, and syphilis among potential expatriates entering GCC states in different districts of KPK, Pakistan

Urooj Amjad[1*], Yaseen Khan[1], Muhammad Junaid Qadri[2], Nayab Amjad[3], Muhammad Habib-e-Ajmi[4]

[1]Caring and Curing Center, Peshawar, Pakistan
[2]Atlas Medical Center, Peshawar, Pakistan
[3]Lady Reading Hospital, Peshawar, Pakistan
[4]College of Pharmacy, Lahore, Pakistan

Abstract
Viral hepatitis and syphilis have emerged as significant public health concerns on a global scale. The study was conducted retrospectively to assess the prevalence of hepatitis B, hepatitis C, HIV, and syphilis among the potential expatriates entering the Gulf Cooperation Council (GCC) states in the year 2022. A total of 42,688 blood samples were tested using enzyme-linked immunosorbent assay (ELISA kits) with the ARCHITECT i1000SR and i2000SR automated immunoassay analyzers, utilizing the microparticle immunoassay technology. The collected data was analyzed using the SPSS version 26. The subjects' ages ranged from 20 to 51 years with a mean age of 28.09 ± 6.153 years, and they belonged to different districts of KPK. The study noted a higher proportion of males than females, with 4.6% (1971) of the subjects being female and 95.4% (40,717) male. Among the females, all were housewives, in contrast to the males of which 98% were engaged in labor work and only 2% being professionals. Of a total of 42,688 samples, HBV occurrence was 0.67% (287/42,688), while HCV was slightly higher as 0.83% (358/42,688). Syphilis showed the highest occurrence as 0.9% (398/42,688), and HIV was limited to 0.1% (56/42,688). This health check-up program is very vital to determine the health status of the expatriates and ensure that they are free from any infectious disease which may be detrimental to the community's security. These implications hold significance for public health policies and the enhancement of health screening models in the GCC states.

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Introduction

The member countries of the Gulf Cooperation Council (GCC) are Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates which boast of largely expatriate populations that perform different tasks in construction industries, healthcare, domestic services, and many others (Cao et al., 2018; Erumban and Al-Mejren, 2024). These expatriates are crucial to the economic development of the region, but the implication of their stay brings into the region concerns such as spread of infectious diseases. Due to active mobility of people into the GCC states, the probability of bringing in diseases which would be fatal for both the host population and the expatriates (Temiz and Gül, 2008; Riazantseva, 2016). The health of expatriates does not only concern the citizens' health,

***CONTACT** Urooj Amjad, amjadurooj5@gmail.com, Caring and Curing Center, Peshawar, Pakistan

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but it is also a determinant of public health threats of the GCC region states. Infectious diseases, if not diagnosed early or treated properly, could easily spread within a society resulting to epidemics or pandemics that may overburden the health facilities or pose risks to the public, as has been witnessed with COVID-19. Hence, it is vital that potential expatriates undergo a thorough medical check-up in order to qualify for living and working in these countries (Noubiap-Jean et al., 2013; Ali and Cochrane, 2024). The initial idea behind the health check-up program adopted by the GCC states is to ensure that the health of the expatriates is thoroughly examined and any ailment diagnosed is treated before the affected individual joins the society (Tagny et al., 2010; Ali and Cochrane, 2024). Screenings done in this program include clinical examinations, laboratory findings, and radiologic tests in a bid to identify conditions that may put the health of individuals and that of the community at risk (Ballard et al., 2021). Of more concern is the screening for hepatitis B (HBV) and hepatitis C (HCV), human immunodeficiency virus (HIV) as well as the syphilis, a sexually transmitted infection (STI), which is screened using Venereal Disease Research Laboratory (VDRL). These diseases are alarming and may pose serious threats to the health of the people in the region if not combated effectively (Rawson et al., 2023).

Thus, this investigation was carried out with the prime objective to screen the expatriates from the GCC states for the four potential diseases mentioned earlier so as to ensure the safety of GCC states population.

Materials and Methods

Study area

The research data was retrieved from the Caring and Curing Center (C&C) Peshawar, Khyber Pakhtoonkhwa (KP) which is involved in the health screening of expatriates entering in the GCC countries for a working permit and residence. This was a retrospective study conducted using the potential expatriate records from the year 2022.

Inclusion criteria

Only expatriates were included in this study as selection criteria.

Exclusion Criteria

Individuals who did not intend to go outside their country of citizenship were excluded from the study.

Protocol

To identify the presence of syphilis, HbsAg, HIV and HCV antibodies in the blood samples, the samples were collected and examined using a screening method known as Micro-particle Immunoassay (CMIA). The analysis was conducted with the ARCHITECT i1000SR and i2000SR automated immunoassay analyzers. Some of the qualitative variables in the dataset included the expatriates' age, gender, geographic origin, and occupation.

Statistical analysis of data

The analysis process began with data cleaning and formatting steps that aimed at eliminating errors and missing data. The demographic details and the results of the serological testing of expatriates were then analyzed using the SPSS version 26. A second level of analysis was done using statistical tools that sought to look for co-relationships in the data between demographic variables and the incidence of diseases. This approach enabled a review of the efficiency of the health screening process and information on demographic factors that strongly relate with positive serological test.

Results

Of the 42,688 subjects in this study, 1,423 (3.3%) were aged $\leq$20, 16,862 (39.5%) between 21 and 25 years old, 10,494 (24.6%) aged 26 to 30, 7,696 (18%) between 31 and 35, 5,087 (11.9%) aged 36 to 40, 1,060 (2.5%) between 41 and 45, and 66 (2%) aged 46 to 51. The mean age of the subjects was 28.09 years, with a standard deviation of 6.153 (**Table 1**). Of all subjects (42,688) screened, the prevalence of HbsAG was 26%, HCV 33%, HIV 5%, and VDRL 36% (**Figure 1**).

Among the 42,688 subjects of this study, 1,971(4.6%) were female, while 40,717(95.4%) male (Table 2).

Among the 42,688 subjects in this study, 42,411 (99.4%) were tested as negative for HbsAg, while 287 (0.67%) tested as positive. For HCV, 42,336 (99.2%) were tested as negative, while 358 (0.83%) as positive. Regarding HIV, 42,638 (99.9%) were tested as negative, and 56 (0.10%) as positive. Lastly, 42,288 (99.1%) were tested as negative for VDRL, and 398 (0.9%) as positive (Table 3).

Among the female subjects, two cases of HbsAg were found as positive in the age groups of ≤ 21 and 36-40. Moreover, only one case was detected as positive in each of the age groups 22-25, 26-30, and 31-35. No positive cases were found in the age groups 41-45 and 46-51. In the male subjects, 52 cases were positive in the age group ≤ 20, 86 in the 22-25 range, 67 in the age group 26-30, 45 in the 31-35, 20 in the 36-40 range, 9 in the age group of 41-45 years old, and only one case was detected as positive in the 46-51 range (Table 4).

Among the female subjects, seventeen (17) cases within the age group of ≤ 21 and 22-25 years old were positive to HCV. Moreover, two (02) subjects within the range of 26-30 years old, three (03) cases within the range of 31-35, and one (01) subject within the range of 36-40 were tested positive to HCV, while there were no positive cases within the range of 41-45 and 46-51. Among the male subjects, forty-six (46) cases were tested positive within the age group of ≤ 20. Moreover, seventy-nine (79) cases within the range of 22-25 and 26-30, sixty (60) within the range of 31-35, forty-seven (47) within the age groups of 36-40, and seven (07) within the range of 41- 45 were recorded to be positive, while no subject within the age group of 46-51 was tested as positive to HCV (Table 5).

Among the female subjects, one (01) case within each of the age groups of ≤ 21 and 31-35 years old was positive to HIV, while there were no positive cases within the ranges 22-25, 26-30, 36-40, 41-45 and 46-51. Among the male subjects, four (4) cases were positive within the age group of ≤ 21, fifteen (15) within each of the ranges of 22-25 and 26-30, ten (10) within the range of 31-35, seven (7) within the age group of 36-40, and two (02) within the range of 41-45, while no subject within the age group of 46-51 was tested as

Table 1. Age groups analysis of subjects

Age group (Years)	Frequency	Percent (%)
≤ 20	1423	3.3
21 -25	16862	39.5
26 -30	10494	24.6
31 -35	7696	18.0
36 -40	5087	11.9
41 -45	1060	2.5
46 -51	66	0.2
Total	42688	100.0

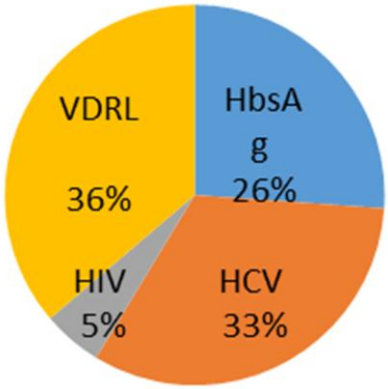

Figure 1. Prevalence of infections: A Pie chart illustrating the distribution of different types of viral hepatitis and syphilis infections based on their prevalence.

Table 2. Gender analysis of subjects

Gender	Frequency	Percent (%)
Female	1,971	4.6
Male	40,717	95.4
Total	42,688	100.0

Table 3. Prevalence of different screening parameters

Para.	Positive (%)	Negative (%)	Total (%)
HbsAg	287 (0.67)	42,411 (99.4)	42,688 (100)
HCV	358 (0.83)	42,336 (99.2)	42,688 (100)
HIV	56 (0.10)	42,638 (99.9)	42,688 (100)
VDRL	398(0.9)	42,288 (99.1)	42,688 (100)

Table 4. Age and gender distribution based on HbsAg test

		HbsAg	
	Age (Years)	-Ve count	+Ve count
Female	≤ 21	282	02
	22 -25	603	01
	26 -30	478	01
	31 -35	380	01
	36 -40	174	02
	41 -45	45	0
	46 -51	2	0
Male	≤ 21	5909	52
	22 -25	11350	86
	26 -30	9948	67
	31 -35	7270	45
	36-40	4891	20
	41-45	1006	09
	46 –51	63	01

positive to HIV (Table 6).

Among the female subjects, one (01) case within each age group of ≤ 21 and 36-40 years old was found to be positive to VDRL, and four (04) within the range of 22-25, five (05) within the range of 26-30, and two (02) within the range of 31-35 were also found to be positive. However, there were no positive cases within the ranges 41-45 and 46-51. Among the male subjects, sixty-one (61) cases within the age group of ≤ 21 year old were recorded to be negative, and eighty-nine (89) within the range of 22-25, ninety two (92) within the age group of 26-30, seventy-four (74) within the range of 31-35, sixty-three (63) within the age group of 36-40, and six (06) within the range of 41-45 were also positive, while no subject within the age group of 46-51 was tested as positive to VDRL (Table 7).

Table 5. Age and gender distribution based on HCV test

		HCV	
	Age (Years)	-ve count	+ve count
Female	≤ 21	267	17
	22 -25	587	17
	26 -30	477	02
	31 -35	378	03
	36 -40	175	01
	41 -45	45	0
	46 -51	02	0
Male	≤ 21	5915	46
	22 -25	11357	79
	26 -30	9936	79
	31 -35	7255	60
	36-40	4864	47
	41-45	1008	07
	46 –51	64	0

The subjects recruited for this study were categorized by their respective areas along with the results of their screening tests. The findings showed positive cases in every district of KPK (Table 8). However, the highest numbers of positive cases for HbsAg and HCV were observed in Mardan (35 and 41, respectively). The highest number of HIV positive cases was reported in Charsadda and Batagram, with 8 cases each, while Bannu had the highest number of VDRL positive cases, totaling 63.

Table 6. Age and gender distribution based on HIV test

		HIV	
	Age (Years)	-ve count	+ve count
Female	≤ 21	283	1
	22 -25	604	0
	26 -30	479	0
	31 -35	380	1
	36 -40	176	0
	41 -45	45	0
	46 -51	2	0
Male	≤ 21	5957	4
	22 -25	11421	15
	26 -30	9999	15
	31 -35	7305	10
	36-40	4904	7
	41-45	1013	2
	46 –51	64	0

Table 7. Age and gender distribution based on VDRL test

		VDRL	
	Age (Years)	-ve count	+ve count
Female	≤ 21	283	1
	22 -25	600	4
	26 -30	474	5
	31 -35	379	2
	36 -40	175	1
	41 -45	45	0
	46 -51	2	0
Male	≤ 21	5900	61
	22 -25	11347	89
	26 -30	9923	92
	31 -35	7241	74
	36-40	4848	63
	41-45	1009	6
	46 –51	64	0

The subjects in this study were arranged based on their occupation with their corresponding results of the screening test carried out (Table 9). The results revealed higher positive cases (HbsAg = 260, HCV = 301, HIV = 42, VDRL = 326) in laborers followed by drivers (HbsAg = 6, HCV = 22, HIV = 6, VDRL = 15), electricians (HbsAg = 13, HCV = 1, HIV = 0, VDRL = 1), masons (HbsAg = 4, HCV = 8, HIV = 01,VDRL = 17), computer operators (HbsAg = 2, HCV = 2, HIV = 0, VDRL = 4), carpenters (HbsAg = 1, HCV = 11, HIV = 2, VDRL = 10), engineers (HbsAg = 1, HCV = 1, HIV = 1, VDRL = 4), while there were no positive cases of HbsAg and HIV in painters, salesmen, shuttering carpenters, and welders. One HCV and four VDRL cases were found in painters and welders, respectively, while no case of HCV or VDRL was observed in salesmen and shuttering carpenters.

Table 8. Geographic patterns of HbsAg, HCV, HIV and VDRL prevalence

Area	HbsAg	HCV	HIV	VDRL
Abbottabad	Neg.= 2346 Pos.= 16 Total= 2362	Neg. =2348 Pos. = 14 Total= 2362	Neg. = 2360 Pos. = 2 Total = 2362	Neg. = 2351 Pos. = 11 Total = 2362
Attock	Neg.= 1999 Pos. = 19 Total= 2018	Neg. = 1998 Pos. = 20 Total= 2018	Neg. = 2016 Pos. = 2 Total = 2018	Neg.= 2009 Pos. = 9 Total = 2018
Bannu	Neg.= 3570 Pos. = 26 Total= 3596	Neg. = 3574 Pos. = 22 Total= 3596	Neg. = 3590 Pos.= 6 Total = 3596	Neg. = 3533 Pos. = 63 Total = 3596
Batagram	Neg.= 1253 Pos. = 19 Total= 1272	Neg. = 1263 Pos. = 9 Total= 1272	Neg. = 1264 Pos. = 8 Total = 1272	Neg. = 1255 Pos. = 17 Total = 1272
Batkhela	Neg.= 1204 Pos. = 11 Total= 1215	Neg. = 1204 Pos. = 11 Total= 1215	Neg. = 1213 Pos. = 2 Total = 1215	Neg. =1198 Pos. = 17 Total = 1215
Buner	Neg. = 1615 Pos. = 14 Total= 1629	Neg. = 1613 Pos. = 16 Total= 1629	Neg. = 1627 Pos. = 2 Total = 1629	Neg.= 1614 Pos. = 15 Total = 1629
Charsadda	Neg. = 3376 Pos.= 20 Total= 3396	Neg. = 3362 Pos. = 34 Total= 3396	Neg. = 3388 Pos.= 8 Total = 3396	Neg. = 3377 Pos. = 19 Total = 3396
Dir	Neg. = 3691 Pos. = 28 Total= 3719	Neg. = 3691 Pos. = 28 Total= 3719	Neg. =3715 Pos. = 4 Total = 3719	Neg. = 3684 Pos. = 35 Total = 3719
Haripur	Neg. = 1196 Pos.= 7 Total= 1203	Neg. = 1192 Pos. = 11 Total= 1203	Neg. = 1203 Pos. = 0 Total = 1203	Neg. =1197 Pos. = 6 Total = 1203
Karak	Neg. = 1703 Pos. = 11 Total= 1714	Neg. = 1698 Pos. = 16 Total= 1714	Neg. = 1712 Pos. = 2 Total = 1714	Neg. = 1689 Pos. = 25 Total = 1714
Kohat	Neg. = 862 Pos. = 2 Total= 864	Neg. = 851 Pos. = 13 Total= 864	Neg. = 862 Pos. = 2 Total = 864	Neg. = 852 Pos. = 12 Total = 864
Mansehra	Neg. = 2121 Pos. = 12 Total=2133	Neg. = 2102 Pos. = 31 Total= 2133	Neg. = 2132 Pos. = 1 Total = 2133	Neg. = 2115 Pos. = 18 Total = 2133
Mardan	Neg. = 4718 Pos. = 35 Total= 4753	Neg. = 4712 Pos. = 41 Total= 4753	Neg. =4750 Pos. = 3 Total = 4753	Neg. = 4713 Pos. = 40 Total = 4753
Nowshehra	Neg. = 431 Pos. = 2 Total= 433	Neg. = 430 Pos. = 3 Total= 433	Neg. = 433 Pos. = 0 Total = 433	Neg.= 428 Pos.= 5 Total = 433
Parachinar	Neg.= 1753 Pos. = 10 Total= 1763	Neg.= 1752 Pos. = 11 Total= 1763	Neg.= 1762 Pos. = 1 Total= 1763	Neg.= 1738 Pos. = 25 Total= 1763
Peshawar	Neg.= 5063 Pos.= 34 Total= 5097	Neg. = 5058 Pos. = 39 Total= 5097	Neg. = 5092 Pos. = 5 Total= 5097	Neg. = 5062 Pos. = 35 Total= 5097
Shangla	Neg.= 2509 Pos. = 11 Total= 2520	Neg. = 2509 Pos. = 11 Total= 2520	Neg. = 2517 Pos. = 3 Total= 2520	Neg. = 2507 Pos. = 13 Total= 2520
Swabi	Neg.= 1262 Pos. = 4 Total= 1266	Neg.= 1256 Pos. = 9 Total= 1266	Neg.= 1265 Pos. = 1 Total= 1266	Neg. = 1252 Pos. = 14 Total= 1266
Swat	Neg.= 1279 Pos. = 2 Total= 1281	Neg.= 1708 Pos. = 11 Total= 1281	Neg. = 1279 Pos. = 2 Total= 1281	Neg. = 1270 Pos. = 11 Total= 1281
Waziristan	Neg.= 450 Pos. = 4 Total= 454	Neg.= 446 Pos. = 8 Total= 454	Neg.= 452 Pos. = 2 Total= 454	Neg. = 446 Pos. = 8 Total= 454
Total	42688	42688	42688	42688

Table 9. Occupational analysis of HbsAg, HCV, HIV and VDRL test results

Profession	HbsAg	HCV	HIV	VDRL
Carpenter	Neg. = 742 Pos. = 1 Total = 743	Neg. = 732 Pos. = 11 Total = 743	Neg. = 741 Pos. = 2 Total = 743	Neg. = 733 Pos. = 10 Total = 743
Computer operator	Neg. = 299 Pos. = 2 Total = 301	Neg. = 299 Pos. = 2 Total = 301	Neg. = 301 Pos. = 0 Total = 301	Neg. = 297 Pos. = 4 Total = 340
Driver	Neg. = 1980 Pos. = 6 Total = 1986	Neg. = 1964 Pos. = 22 Total = 1986	Neg. = 1980 Pos. = 6 Total = 1986	Neg. = 1971 Pos. = 15 Total = 1986
Electrician	Neg. = 45 Pos. = 13 Total = 58	Neg. = 57 Pos. = 1 Total = 58	Neg. = 58 Pos. = 0 Total = 58	Neg. = 57 Pos. = 1 Total = 58
Engineer	Neg. = 346 Pos. = 1 Total = 347	Neg. = 346 Pos. = 1 Total =347	Neg. = 346 Pos. = 1 Total = 347	Neg. = 343 Pos. = 4 Total =347
Laborer	Neg. = 35802 Pos. = 260 Total = 36062	Neg. = 35761 Pos. = 301 Total =36062	Neg. = 36020 Pos. = 42 Total = 36062	Neg. = 35736 Pos. = 326 Total = 36062
Mason	Neg. = 935 Pos. = 4 Total = 939	Neg. = 931 Pos. = 8 Total = 939	Neg. = 938 Pos. = 1 Total = 939	Neg. = 922 Pos. = 17 Total = 939
Painter	Neg. = 69 Pos. = 0 Total = 69	Neg. = 68 Pos. = 1 Total = 69	Neg. = 69 Pos. = 0 Total = 69	Neg. = 69 Pos. = 0 Total = 69
Salesman	Neg. = 57 Pos. = 0 Total = 57	Neg. = 57 Pos. = 0 Total = 57	Neg. = 57 Pos. = 0 Total = 57	Neg. = 57 Pos. = 0 Total = 57
Shuttering carpenter	Neg. = 69 Pos. = 0 Total = 69	Neg. = 69 Pos. = 0 Total =69	Neg. = 69 Pos. = 0 Total = 69	Neg. = 69 Pos. = 0 Total = 69
Welder	Neg. = 86 Pos. = 0 Total = 86	Neg. = 86 Pos. = 0 Total =86	Neg. = 86 Pos. = 0 Total = 86	Neg. = 82 Pos. = 4 Total =86

Discussion

In our study, majority of the subjects (95.4%) were males and laborers, while 4.6% were females, which is similar to the study already carried out in Ethiopia showing 96.3% male and only 3.7% females (Gelaw et al., 2008). Another study conducted in southern India showed high prevalence of males, i.e., 97.41%, and lower prevalence of females, i.e., 2.59% (Koram et al., 2014). The disease prevalence is highly dependent on the profession of expatriates who are deployed to these countries. Closely associated jobs inherent in physical contact, and exposure to unfavorable climate and conditions had a higher prevalence rate of positive serological tests for hepatitis B and syphilis VDRL test (Okoroiwu-Henshaw et al., 2018). Such associations could be attributed to the working environment and conditions of these occupations, indicating that poor hygiene practices, diminished access to health care, or physically demanding tasks increase their vulnerability to the infection. The predominant age group in our study was that ranging from 21 to 25 years (39.5 %). This aligns with figures published by the World Health Organization (WHO), which reported that 45% of donors were aged 25 or younger (WHO, 2013). Our study findings indicate that there is a significant need for awareness-raising activities aimed at the younger age group.

Hepatitis B is a highly infectious disease, affecting approximately 2 billion people globally, with an estimated 350 million chronic cases (Hussein et al., 2019); it is also hyper-endemic in Sub-Saharan Africa and Asia (Barkat et al., 2020). In our study, the prevalence rate of HbsAg was 0.67% which is lower than that of the study conducted in India which accounted for 3.5% of HbsAg (Lavanya et al., 2012). A study conducted in Iran showed a similar pattern of prevalence of HbsAg and it was estimated about 0.8% in blood donors (Poorolajal et al., 2009), which is in agreement with our study. Another study conducted in Nepal showed lower prevalence (0.47%) of HbsAg in blood donors, being contrastive to our study (Shrestha et al., 2009).

In our study, the seroprevalence of HbsAg was higher in the age group of 21–25 (0.2%,

11,350/42,688) followed by the age group of 26–30 (0.15%, 9,948/42,688) compared to the other age groups. These findings contrast with those of a previous study conducted in Lomé, West Africa, which reported a higher prevalence of HbsAg in the 20–29 group (Kolou et al., 2017). Similarly, a study in China found a higher prevalence of HbsAg in the 10–14 and 30–34 years age groups, which differs from our findings (Xia-Guo et al., 1996).

HCV is known to cause both acute and chronic hepatitis, with severity ranging from mild illness to more serious conditions such as liver cirrhosis and cancer (Suhail et al., 2022). The prevalence of HCV in this study was 0.83%, which is similar to the study conducted in India that showed 0.84% in blood donors (Bhawani et al., 2010). Another study conducted in Pakistan showed higher prevalence (4.0%) of HCV in blood donors (Khattak et al., 2002), being contradictory to our study.

In our study, the seroprevalence of HCV was found to be 0.18% (9,936/42,688) in the 21–25 age group and 0.18% (11,357/42,688) in the 26–30 age group, which is higher than those of other age groups. These findings align with a previous study conducted in Nepal, which reported a higher prevalence of HCV infection in the 21–30 years age group (Shrestha-Ashish et al., 2009). In contrast, a study in Iran found a higher prevalence of HCV infection in the 50–56 age range (Zali-Mohammad et al., 1996). The increased risk of HCV infection in younger individuals can be attributed to factors such as drug injection, blood transfusions, and needle exposure in the studied area (Kirk et al., 2006).

Human immunodeficiency virus (HIV) continues to be a major global public health issue, having claimed an estimated 42.3 million lives to date (Anonymous, 2024). Transmission of HIV remains ongoing in all countries worldwide (WHO). The prevalence of HIV in this study was 0.1% in the subjects in our study, which is similar to the study conducted in Ethiopia that showed lower prevalence (0.1%) of HIV among blood donors (Mohammed et al., 2016). Another study conducted in Cameroon, Central Africa showed higher prevalence (2.9%) of HIV in blood donors, which is in contrast to our study (Mbanya et al., 2005). Similarly, a study conducted in Nepal also showed lower prevalence (0.008%) of HIV (Acar et al., 2010).

In our study, the seroprevalence of HIV was 0.03% (11,421/42,688) in the 21–25 age group and 0.03% (9,999/42,688) in the 26–30 age group, which is higher compared to those of the other age groups. These findings are in agreement with an earlier study conducted in eastern Ethiopia (Mohammed et al., 2016), which reported a higher occurrence of HIV infection in 21–29 age group. The prevalence of HIV was notably higher in the 20–29 age group, making the risk of HIV infection in this age range, being 1.5 times greater than that of the other age groups.

Syphilis, a sexually transmitted infection, if not treated early can lead to the life-threatening problems. In this study, 0.9% (398/42688) of the subjects presented a positive VDRL test that is similar to the study conducted in eastern Africa which showed 0.9% occurrence of syphilis (Mutagoma et al., 2016). Furthermore, a study conducted in Brazil showed lower prevalence (0.7%) of syphilis in women with lethal pregnancies (Casal-Charliana et al., 2011), being contrast to our study. In our study, the seroprevalence of syphilis was highest in the age group of 26–30, followed by 21–25, and 31–35, with rates of 0.21%, 0.20%, and 0.71%, respectively, which are higher than those of the other age groups.

The subjects in this study were categorized by their areas, along with the results of their screening tests. The results indicated positive cases across all districts of KPK. Specifically, Mardan had the highest rates for HbsAg and HCV at 0.17%, Charsadda and Batagram had the highest HIV positive cases at 0.02%, and Bannu had the highest number of VDRL positive cases at 0.14% compared to those of the other districts. A previous study in KPK among pregnant women found a significant variation in HCV prevalence at the district level, with rates as follows: Mardan (9.33%), Kohat (7.33%), Peshawar (6.00%), and Nowshera and Charsadda (4.33%) (Afsheen et al., 2018). These results are similar to those of our study, as Mardan showed a higher prevalence of infections. Another study conducted in Mardan reported higher rates of HBV (1.3%) and HCV (1.2%) among blood donors compared to our study (Zeeshan et al., 2018). Additionally, a study at Khalifa Gul Nawaz Teaching Hospital (KGNTH) in Bannu showed 1.67% HbsAg and 1.04% HCV among voluntary blood donors (Ullah et al. 2017). A higher prevalence of HCV (8.66%) was observed among pregnant women at a tertiary care hospital in Charsada (Hajira et al., 2023). In Peshawar, a study found a 0.3% prevalence of syphilis among blood donors (Shah et al., 2023), which is higher than 0.08% prevalence as observed in our study for Peshawar district. Given this situation, there is an urgent need for enhanced efforts to raise awareness about hepatitis prevention and early treatment.

Conclusion

In conclusion, the prevalence of HbsAg had been 0.67%, HCV 0.83%, HIV 0.1%, and syphilis 0.9%. The distribution of these was higher in the age groups of 21-25 and 26-30. The health check-up program for the expatriates entering in the GCC states is important in maintaining high standards of health. The analysis of the data reveals the significance of strict checks and further evolution in health regulations to face the difficulties of the infectious diseases. The GCC states can tweak them further and improve public health safety within their respective countries while also reducing the chances of having expatriate workers bringing in new diseases into their countries. Based on the analysis, more attention should be paid to the proper frequency and extent of the health check-ups, especially for the populations most vulnerable due to their geographical background and occupation. Moreover, initiating education programs for expatriates that may raise the level of knowledge regarding the necessity of early diagnostics and treatment of infections is necessary. The current challenge therefore requires increased efforts in carrying out vaccination especially for various target groups, because hepatitis B is very much around. Health of the expatriates should be followed from time to time and more research should be carried out now and then in order to enhance the health policies.

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Ethical approval
This work was approved by the Institutional Ethical Review Board/Committee (IERB/C) of Yashfeen Education System, Lahore, Pakistan (Approval number YES/ERC/03-25/01/005 dated 03-31-2025).

Handling of bio-hazardous materials

The authors certify that all experimental materials were handled with great care during collection and experimental procedures. After completion of the study, all materials were properly discarded to minimize/eliminate any types of bio-contamination(s).

Supplementary material
No supplementary material is included with this manuscript.

Conflict of interest
The authors declare no conflict of interest.

Availability of primary data and materials
As per editorial policy, experimental materials, primary data, or software codes are not submitted to the publisher/Journal management. These are available with the corresponding author (s) and/or with other author(s) as declared by the corresponding author (s) of this manuscript.

Authors' consent
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Declaration of generative AI and AI-assisted technologies in the writing process

It is declared that the authors did not use any AI tools or AI-assisted services in the preparation, analysis, or creation of this manuscript submitted for publication in the International Journal of Applied and Experimental Biology (IJAaEB).

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