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Evaluating the Prevalence of Co-Infection and Associated Risk Factors in HIV/AIDS Patients: A Study in Faisalabad, Punjab, Pakistan

Muneeb Shafqat[1], Muhammad Owais Fazal[2], Ghulam Abbas Tahir[2], Usman Musharaf[2], Ali Siftain[3], Muhammad Abid Rasheed[3], Muhammad Abdullah[4]

[1]Faisalabad Teaching Hospital, Faisalabad, Pakistan
[2]Department of Medicine, Faisalabad Medical University, Faisalabad, Pakistan
[3]Department of Public Health, Government College University, Faisalabad, Pakistan
[4]Department of Undergraduate Education, Independent Medical College, Faisalabad, Pakistan
Email: drowais78@hotmail.com

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Abstract

This study sought to assess the prevalence of co-infections and their associated risk factors among HIV/AIDS patients in Faisalabad, Punjab, Pakistan. A cross-sectional design was utilized, gathering data from 250 HIV/AIDS patients via interviews, medical records, and laboratory tests. The study evaluated demographic, behavioral, clinical, and healthcare-related factors to discern significant correlations with co-infections, including tuberculosis, hepatitis B, hepatitis C, and syphilis. We employed both univariate and multivariate analyses to determine the prevalence of co-infections and the impact of various risk factors on them. Syphilis, tuberculosis, and hepatitis B were the most prevalent co-infections among the participants, comprising 42.8% of the total. Intravenous (IV) drug use, unsafe sexual practices, low educational attainment, and non-adherence to antiretroviral therapy (ART) constituted significant risk factors. Higher co-infection rates were also strongly linked to socioeconomic factors, such as unstable housing, low income, and limited access to safe drinking water. The study underscored the importance of healthcare access, as individuals lacking access to healthcare services are more susceptible to co-infections. Moreover, insufficient comprehension of HIV/AIDS correlated with elevated co-infection rates, underscoring the imperative for targeted educational initiatives. The study concludes that reducing the prevalence of co-infection among HIV/AIDS patients necessitates the mitigation of behavioral, social, and clinical risk factors. To reduce the number of co-infections in this group of people, it is essential to enhance ART adherence, facilitate access to medical care, and educate them about public health.

Keywords

Prevalence, TB, HIV, Co-Infection, Pakistan Region, Tuberculosis, Risk Factors, HIV/AIDS

1. Introduction

Considered one of the deadliest worldwide epidemics in recent memory is the HIV epidemic, as shown in Figure 1. According to UNAIDS and WHO (2010), it has been characterized as heterogeneous, differing from nation to nation and population to population. Previous studies have shown that several biological variables, such as male Herpes simplex virus type 2 (HSV-2) infection, can partially explain the variability. However, biological factors only make HIV acquisition or transmission more likely when unprotected sexual contact is present. The level of male circumcision or HSV-2 has no bearing on HIV transmission when it is absent. Hence, it has been suggested that sexual risk behaviours, such as multiple sexual partnerships and unprotected sexual encounters, are the cornerstones of HIV transmission. Modifications to these behaviours have been linked to a decrease in the rate of HIV infection transmission [1] [2].

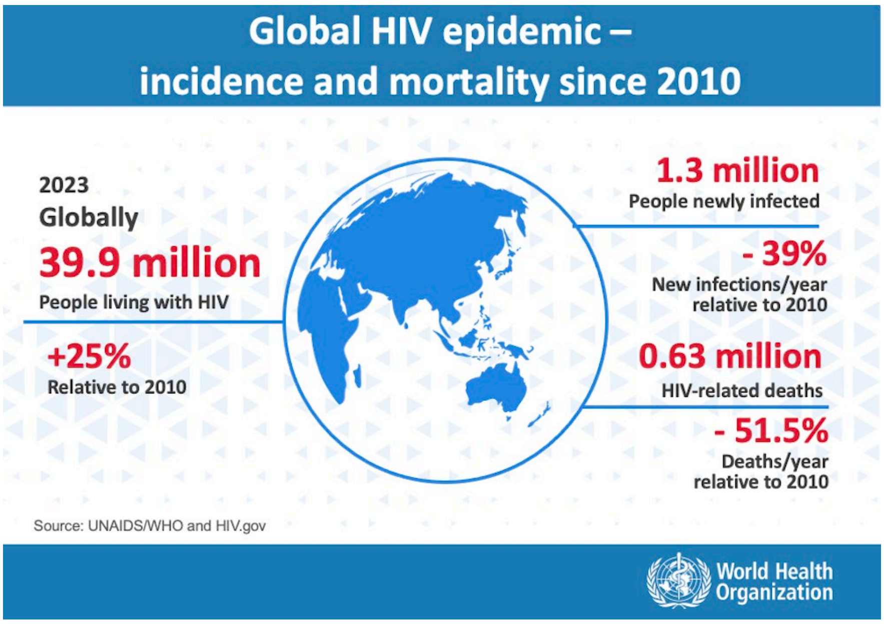

Figure 1. Global HIV pandemic.

Like other infectious illnesses, the HIV epidemic can only be stopped by having a thorough grasp of the factors that influence virus transmission. Understanding trends in disease severity and assessing the effectiveness of therapeutic programs depend on tracking changes in key variables. The need for a country-specific definition of the factors driving the epidemic population has arisen from variations in HIV transmission within and between Sub-Saharan African nations (UNAIDS and WHO, 2010) [3] [4].

Although Pakistan currently portrays a low HIV prevalence, the concerns of a widespread HIV epidemic are primarily due to unsafe high-risk practices. More Pakistani men are infected with HIV than women, and modes of HIV transmission include sexual relations, infected blood, and drug addiction [1] [4]-[6]. Another factor that poses serious intimidation to the Pakistani population is the limited knowledge about HIV/AIDS. In view of the current scenario, a comprehensive study to characterize HIV in the local populations is suggested [1] [7]. A common misconception in Pakistani society is that, being Muslim, HIV cannot be contracted [7]. Such foresight demands continuous monitoring and preventive interventions to control the spread of HIV. The study aimed to determine the co-infection prevalence and associated risk factors in HIV/AIDS patients: a study in Faisalabad, Punjab, Pakistan, as shown in **Figure 2**.

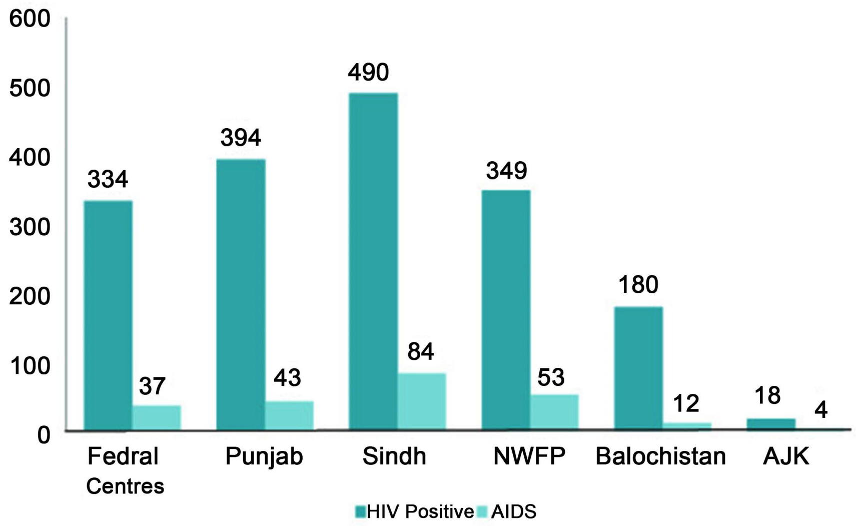

Figure 2. HIV cases in Pakistan.

HIV/AIDS remains a significant public health challenge globally, and co-infections such as tuberculosis, hepatitis B, and hepatitis C are common among HIV/AIDS patients, leading to increased morbidity and mortality [8]. Understanding the prevalence of these co-infections is crucial for effective disease management and prevention. Pakistan has a low rate of HIV, but the risk of a large outbreak is high because of unsafe behaviors like drug use and sex without protection [9]. There is insufficient comprehensive data regarding the prevalence of co-infections and their associated risk factors among HIV/AIDS patients in Pakistan, especially in areas such as Faisalabad, Punjab.

The study seeks to pinpoint significant risk factors (e.g., intravenous drug use, unprotected sexual practices, inadequate education, poor adherence to antiretroviral therapy, and socioeconomic difficulties) that facilitate the emergence of co-infections [10]. It is crucial to understand these concepts to plan effective and targeted interventions. HIV/AIDS and co-infections have a bigger impact on low-income groups, which makes it harder for families and healthcare systems to pay for care. The study shows that HIV/AIDS patients have a lot of socioeconomic problems, like being poor, not having access to clean water, and living in unstable conditions, which makes them more likely to get other infections. The study highlights the importance of healthcare access and education in reducing co-infection rates. Limited access to healthcare services and inadequate knowledge regarding HIV/AIDS constitute substantial obstacles to effective disease management. The results can help shape policies that aim to improve healthcare facilities and educate people about health.

The study offers evidence-based recommendations for public health interventions, including harm reduction programs for intravenous drug users, educational campaigns to encourage safer sexual practices, and initiatives to enhance adherence to antiretroviral therapy (ART). These interventions are essential for alleviating the burden of co-infections in HIV/AIDS patients. The study's results have important policy implications, especially for making healthcare systems stronger, getting more money for HIV/AIDS programs, and lowering the stigma that comes with the disease. The study advocates for comprehensive healthcare services that tackle both HIV and associated co-infections.

1.1. Goals and Objectives

- To ascertain the prevalence of co-infections (including tuberculosis, hepatitis B, hepatitis C, etc.) among HIV/AIDS patients in Faisalabad, Punjab, Pakistan.
- To pinpoint the precise risk factors linked to co-infections in individuals with HIV/AIDS.

1.2. Materials and Methods

The study utilized a cross-sectional design to assess the prevalence of co-infections and their associated risk factors among HIV/AIDS patients in Faisalabad, Punjab, Pakistan. Interviews, medical records, and lab tests were used to gather the data. Demographic data, HIV treatment history, medical history, and behavioral risk factors were evaluated. A statistical method was used to determine the frequency of concurrent infections and to identify any significant associations between them and risk factors. During the research process, strict adherence to ethical principles, including informed consent and confidentiality, was maintained.

1.3. Criteria for Inclusion

The research's inclusion criteria encompassed individuals aged eighteen years or older with a confirmed diagnosis of HIV or AIDS. Participants could write a statement indicating their agreement to participate in the study, and they were treated by licensed healthcare professionals in Faisalabad. Only individuals who could read and understand the survey questions in Punjabi, Urdu, or another approved language were eligible to participate. Additionally, to obtain a comprehensive understanding of the prevalence of co-infections, individuals with and without these conditions (such as syphilis, hepatitis B, hepatitis C, or tuberculosis) were included.

1.4. Criteria for Exclusion

However, the criteria for exclusion did not include people who lived in Faisalabad, were younger than 18, or could not give informed permission because they had serious mental illnesses or disorders. Patients lacking comprehensive health records regarding their HIV assessment and treatment, or those not undergoing treatment at proximate medical facilities, were also excluded.

1.5. Target Population and Study Population

The study's target demographic consisted of all individuals living with HIV/AIDS (PLHIV) in Faisalabad, Punjab. This group includes individuals who are currently receiving medical care, regardless of whether they have other infections. The study population comprises 250 participants who fulfill the eligibility criteria, chosen from the target group. To determine the prevalence of concurrent infections and their associated risk factors, the study sample comprised a heterogeneous cohort of individuals, including both those with co-infection diagnoses and those without.

1.6. Method for Sampling

Participants were recruited during their routine medical appointments at healthcare centers to ensure they met the participation criteria and had given their consent to participate. This method is ideal for this study because the target population is readily accessible in a medical setting. In certain instances, purposive sampling is used to ensure the inclusion of specific subgroups, such as patients with co-infections like tuberculosis or hepatitis. The total sample size of 250 patients was chosen based on their availability and willingness to participate.

1.7. Statistical Examination

The first step was to sort the variables into two groups: categorical and continuous. Categorical variables, including gender, co-infection status, marital status, and education level, denoted distinct groups or categories. In contrast, constant variables, such as age, CD4 count, viral load, and income level (when recorded numerically), were quantitative and could assume any value within a defined range. This classification was essential for identifying the suitable statistical techniques for analysis. We conducted a univariate analysis to examine the distribution and characteristics of each variable independently. We made frequency tables for categorical variables to show the number and percentage of each category. We also used bar charts to illustrate how the data was distributed. A bivariate analysis was conducted to investigate the correlation between two variables. The chi-square test was utilized to ascertain the presence of a significant association between categorical variables. A chi-square test was used to examine the relationship between gender and co-infection status, for example. The SPSS software tool was used to do the analysis. In Excel, charts were used to visualize data, and pivot tables were utilized to create frequency tables and cross-tabulations. In SPSS, the "Descriptives" and "Frequencies" options were used for univariate analysis, "Crosstabs" for bivariate analysis of categorical variables, and "Compare Means" for categorical vs. continuous variables. The results of the analyses were interpreted in the context of the research questions. The association between gender and co-infection status was evaluated, and the relationship between age and viral load was examined. This comprehensive approach ensured a thorough understanding of the factors associated with co-infections in HIV/AIDS patients.

2. Results

The study comprised a total of 250 participants, among which 91 participants aged 26 - 35, with significant HIV prevalence in younger and middle-aged individuals, largely attributed to unsafe sexual practices and drug use. The sample included more males (136) than females (101), indicating a potential male predominance due to high-risk behaviors. Socioeconomically, the majority were single (110), unemployed (137), and had limited education, which might hinder HIV awareness and healthcare access. Most were diagnosed between 2020-2024, notably in 2022, with 209 receiving antiretroviral therapy (ART), suggesting good management adherence. Co-infections were prevalent, with syphilis, tuberculosis, and hepatitis B noted. Approximately 93 participants reported unprotected sex, raising concerns about preventive education needs. Many smoked or consumed alcohol, potentially affecting health management. While 230 participants had healthcare access, only 107 sought medical attention monthly, with socioeconomic issues like limited income and lack of clean water affecting care. Knowledge levels varied, with 162 receiving prior counseling, yet only 113 wanted further education sessions (**Table 1**).

Missing data and denominators were explicitly assessed for each variable. Unless otherwise stated, percentages were calculated using the valid denominator for each variable rather than the full sample size. The total study sample included 250 participants. Age data were complete for all participants. However, some variables had incomplete documentation or non-response; therefore, their denominators differ from 250. Variables such as gender, marital status, education level, occupation, and ART status had one missing response each. ART adherence, healthcare visit frequency, income level, and HIV/AIDS knowledge had smaller valid denominators because of incomplete responses or unavailable medical-record documentation.

Variables such as age group, gender, marital status, education level, occupation, ART status, and overall co-infection status were treated as mutually exclusive categories. By contrast, co-infection type was treated as a multiple-response variable because some participants had more than one co-infection. Therefore, the sum of individual co-infection types does not necessarily equal the total number of participants with co-infection.

Percentages are based on the valid denominator for each variable. Missing, unavailable, or not applicable responses were excluded from percentage calculations but are reported separately. Mutually exclusive variables are expected to sum to the valid denominator. Multiple-response variables, including co-infection type, may exceed or fall below the number of participants with co-infection because one participant may report more than one co-infection, and some co-infection details were not completely documented in the medical record.

Table 1. Demographic, clinical, behavioral, and socioeconomic characteristics of HIV/AIDS patients included in the study.

Category	Count
Age Group 26 - 35	91
Age Group 18 - 25	69
Age Group 36 - 45	51
Age Group 46 and Above	39
Male Participants	136
Female Participants	101
Other Participants	12
Single	110
Married	93
Divorced	24
Widowed	13
Separated	9
No Formal Education	74
Primary Education	102
Secondary Education	59
Higher Education	14
Unemployed	137
Self-employed	54
Employed	47
Students	11
Diagnosis Year 2020-2024	69
Diagnosis Year 2022	69
Receiving ART	209
Not Receiving ART	40
ART Duration (3 - 5 Years)	104
ART Duration (>5 Years)	71
ART Duration (<1 Year)	68
ART Duration (1 - 2 Years)	6
ART Adherence (Always)	155

Continued

ART Adherence (Mostly)	42
ART Adherence (Never)	32
Co-infections (Syphilis)	32
Co-infections (Tuberculosis)	26
Co-infections (Hepatitis B)	12
Co-infections (After HIV Diagnosis)	65
Co-infections (Before HIV Diagnosis)	29
Co-infections (Concurrent)	55
No Co-infections	102
Co-infections (Receiving Treatment)	77
Co-infections (Not Receiving Treatment)	173
Intravenous Drug Use	21
Needle Sharing	5
Unprotected Sex (Always)	93
Unprotected Sex (Mostly)	9
Unprotected Sex (Never)	46
Blood Transfusions	51
Blood Screening (Never)	149
Tobacco Smoking	152
Alcohol Consumption	99
Access to Healthcare	230
Monthly Healthcare Visits	107
Healthcare Visits (Every 3 Months)	82
Healthcare Visits (When Symptomatic)	39
Income 40,000 - 60,000 PKR	144
Income < 20,000 PKR	43
Lack Access to Clean Water	118
Homeless	17
Knowledge of HIV (Good)	92
Knowledge of HIV (Fair)	116
Knowledge of HIV (Poor)	19
Received Counseling or Education on HIV	162
Interest in Further HIV Education	113

2.1. Association between Risk Factors and Co-Infection Status: Chi-Square Test Analysis

The study utilized the chi-square test to analyze the relationship between various risk factors and co-infection status among HIV/AIDS patients, focusing on co-infections like Hepatitis B, Hepatitis C, Syphilis, and Tuberculosis. Key demographic, behavioral, clinical, and healthcare access factors were examined. Significant findings included higher diagnosed co-infections among individuals aged 26 - 35 and 46 and above, with females showing a greater prevalence than males. Marital status revealed that widowed individuals had the highest diagnosed co-infections, while education level indicated that lower education correlates with higher co-infection prevalence. Monthly income also showed significance, with lower-income groups facing more diagnosed co-infections, whereas occupation was not significantly associated with co-infection status (Table 2).

Table 2. Association between demographic factors and co-infection status among HIV/AIDS patients: Chi-square test analysis.

Category	Chi-square Value (χ^2)	Degrees of Freedom (df)	p-value	Key Findings
Age and Co-infections	15.582	3	0.001	Younger individuals (18 - 25 years) had fewer co-infections, while those aged 26 - 35 and 46+ had more co-infections.
Gender and Co-infections	24.392	2	0.000	Females had more co-infections than expected, males fewer. The "Other" gender had no co-infections.
Marital Status and Co-infections	27.562	4	0.000	Widowed individuals had more co-infections, separated individuals had none. Single individuals had a higher proportion of co-infections.
Education Level and Co-infections	54.376	3	<0.001	No formal education had more co-infections; higher education had fewer co-infections.
Occupation and Co-infections	5.838	3	0.120	Occupation was not a significant factor for co-infections.
Income and Co-infections	14.027	3	0.003	Lower-income individuals (<$20,000) and middle-income individuals ($40,000 - $60,000) had a higher prevalence of co-infections. Those earning > $ 60,000 had fewer.

The chi-square test for association revealed significant relationships between certain behavioral risk factors and diagnosed co-infections. Intravenous drug use showed a strong association ($\chi^2 = 17.246$, $p < 0.001$), while needle sharing had a borderline significance ($\chi^2 = 3.818$, $p = 0.051$). Past STIs, tobacco, and alcohol consumption were not significantly associated with co-infections. Unprotected sex exhibited a strong link ($\chi^2 = 29.971$, $p < 0.001$). In terms of clinical factors, significant associations were found between the year of HIV diagnosis ($\chi^2 = 46.853$, $p = 0.000$), current ART status ($\chi^2 = 7.549$, $p = 0.006$), and duration on ART ($\chi^2 = 16.248$, $p = 0.001$) with diagnosed co-infections. Adherence to ART was critical, showing a strong association ($\chi^2 = 39.212$, $p = 0.000$). Additionally, frequency of healthcare visits ($\chi^2 = 22.335$, $p < 0.001$) and access to healthcare services ($\chi^2 = 12.288$, $p = 0.000$) were significantly related to co-infections. Lack of access to clean drinking water ($\chi^2 = 31.901$, $p = 0.000$) and poor knowledge about HIV/AIDS ($\chi^2 = 11.922$, $p = 0.008$) also indicated strong associations. However, counseling or education did not show a significant relationship ($\chi^2 = 3.181$, $p = 0.074$), nor did interest in educational sessions ($\chi^2 = 1.418$, $p = 0.234$) (Table 3).

Table 3. Association between behavioral, clinical, healthcare, and knowledge-related risk factors and co-infection status: Chi-Square test analysis.

Risk Factor	Chi-square Value (χ^2)	Degrees of Freedom (df)	p-value	Significance	Key Findings
Intravenous Drug Use	17.246	1	<0.001	Statistically significant	Higher proportion of co-infections in intravenous drug users compared to non-users.
Needle Sharing	3.818	1	0.051	Borderline significant	Borderline significance; needle-sharing individuals had higher co-infection rates.
History of STIs	1.978	1	0.160	Not statistically significant	No significant association between past STIs and co-infections.
Unprotected Sexual Intercourse	29.971	4	<0.001	Statistically significant	Strong link between unprotected sex and co-infection diagnosis.
Smoking Tobacco	0.061	1	0.805	Not statistically significant	No significant relationship between smoking tobacco and co-infections.
Alcohol Consumption	0.899	1	0.343	Not statistically significant	No significant relationship between alcohol consumption and co-infections.
Year of HIV Diagnosis	46.853	4	0.000	Statistically significant	Higher prevalence of co-infections in earlier years (2020-2023) compared to 2024.
Current ART Status	7.549	1	0.006	Statistically significant	ART users had a lower proportion of diagnosed co-infections compared to non-users.
Duration on ART	16.248	3	0.001	Statistically significant	Those on ART for 3 - 5 years had a higher prevalence of co-infections, while those on ART for >5 years had fewer co-infections.
Adherence to ART	39.212	4	0.000	Statistically significant	Adherence to ART was associated with lower rates of co-infections.
Frequency of Healthcare Visits	22.335	4	<0.001	Statistically significant	More frequent healthcare visits were linked to a higher prevalence of co-infections.
Access to Healthcare Services	12.288	1	0.000	Statistically significant	Lack of healthcare access was strongly associated with higher co-infection rates.
Access to Clean Drinking Water	31.901	1	0.000	Statistically significant	Those without access to clean drinking water had a significantly higher prevalence of co-infections.
Knowledge About HIV/AIDS	11.922	3	0.008	Statistically significant	Poor knowledge about HIV/AIDS was associated with higher rates of co-infections.
Received Counseling or Education on HIV	3.181	1	0.074	Not statistically significant	No significant relationship between receiving counseling/education and co-infections.
Interest in Educational Sessions	1.418	1	0.234	Not statistically significant	No significant association between interest in attending educational sessions and co-infections.

2.2. Multivariate Analysis of Risk Factors Associated with Co-Infections in HIV/AIDS Patients

The research examined the correlation between demographic factors and the likelihood of obtaining a co-infection diagnosis. The regression analysis indicated that age, marital status, occupation, education level, living situation, and monthly household income were significant predictors of co-infection diagnosis. People between the ages of 26 and 35 were more likely to be diagnosed with co-infections. There were no significant differences in people between the ages of 36 and 45 or older. Sex was not a significant predictor of co-infection diagnosis. The diagnosis of co-infection was also influenced by factors such as marital status, occupation, level of education, place of residence, and monthly income. The multivariate regression analysis indicated that the comprehensive regression model accounted for roughly 20.64% of the variance in diagnosed co-infections. Intravenous drug use showed the strongest link to diagnosed co-infections. Sharing needles also had a strong link to diagnosed co-infections, but with a negative coefficient, which could mean that it protects against them or that it was a confounding factor in the dataset. Some findings from the adjusted model were counterintuitive and were therefore interpreted cautiously. Although needle sharing showed a negative adjusted association with co-infection status, this should not be interpreted as a protective effect. The estimate may have been influenced by the small number of participants reporting needle sharing, sparse-data bias, overlap with intravenous drug use, or residual confounding. Similarly, the higher adjusted odds among participants who reported never engaging in unprotected sexual intercourse may reflect reporting bias, prior behaviour modification after diagnosis, reverse causality, or confounding by other clinical and healthcare-seeking factors. The unexpected negative association observed for needle sharing and the positive association among those reporting no unprotected sexual intercourse should be interpreted with caution, as these findings may reflect sparse data, reporting bias, reverse causality, residual confounding, or model instability rather than true protective or causal effects.

The study investigated the correlation between sexually transmitted infections (STIs) and identified co-infections. The findings indicated a significant correlation between adherence to antiretroviral therapy (ART) and diagnosed co-infections, with individuals who infrequently or never adhered to ART exhibiting elevated probabilities of diagnosis. Nonetheless, individuals who adhered occasionally did not exhibit a statistically significant effect. The present ART status exhibited a tenuous correlation, indicating that being on ART may influence diagnosed co-infections. Another aspect examined was the frequency of doctor visits.

The study also examined how diagnosed co-infections impacted access to healthcare and clean drinking water. Having access to healthcare services was associated with a higher likelihood of co-infections, while access to clean drinking water was linked to a lower likelihood of co-infections. Understanding HIV/AIDS was a major predictor, and people who didn't know much about it were the most likely to have co-infections. Moreover, obtaining counseling or education and exhibiting an interest in educational sessions were significantly correlated with diagnosed co-infections, accounting for 11.47% of the variance in diagnosed co-infections. The study indicates that knowledge and educational factors influence the diagnosis of co-infections (**Table 4** and **Table 5**).

Table 4. Multivariate analysis of demographic, behavioral, clinical, and healthcare factors associated with HIV/AIDS co-infections.

Variable	Regression Coefficient (β)	p-value	Significance	Key Findings
Age (26 - 35 years)	0.284	0.002	Statistically significant	Higher likelihood of co-infections for individuals aged 26 - 35.
Age (36 - 45 years)	0.0069	0.942	Not statistically significant	No significant difference compared to the 18 - 25 age group.
Age (46 Years and Above)	−0.1364	0.142	Not statistically significant	No significant difference compared to the 18 - 25 age group.
Gender (Male)	0.1541	0.080	Not statistically significant	No significant association with co-infections.
Gender (Other)	0.091	0.614	Not statistically significant	No significant association with co-infections.
Marital Status (Married)	0.319	0.009	Statistically significant	Higher likelihood of co-infections in married individuals.
Marital Status (Single)	0.378	0.003	Statistically significant	Higher likelihood of co-infections in single individuals.
Marital Status (Widowed)	0.562	0.001	Statistically significant	Higher likelihood of co-infections in widowed individuals.
Occupation (Student)	0.374	0.017	Statistically significant	Higher likelihood of co-infections in students.
Occupation (Self-employed)	0.1335	0.180	Not statistically significant	No significant association with co-infections.
Occupation (Unemployed)	−0.0886	0.321	Not statistically significant	No significant association with co-infections.
Education (No Formal Education)	0.392	0.006	Statistically significant	Higher likelihood of co-infections in individuals with no formal education.
Education (Primary Education)	−0.218	0.081	Not statistically significant	No significant difference in risk compared to higher education.
Education (Secondary Education)	−0.316	0.011	Statistically significant	Lower likelihood of co-infections in individuals with secondary education compared to those with higher education.
Living Situation (Own House)	−0.943	<0.001	Statistically significant	Lower likelihood of co-infections for individuals living in their own house.
Living Situation (Rented House)	−0.918	<0.001	Statistically significant	Lower likelihood of co-infections for individuals living in rented houses.
Living Situation (Temporary Shelter)	−0.192	0.210	Not statistically significant	No significant difference compared to being homeless.
Income (20,000 - 40,000)	0.4344	<0.001	Statistically significant	Higher likelihood of co-infections in individuals earning 20,000 - 40,000.
Income (40,000 - 60,000)	0.4054	<0.001	Statistically significant	Higher likelihood of co-infections in individuals earning 40,000 - 60,000.
Income (Above 60,000)	0.397	0.004	Statistically significant	Higher likelihood of co-infections in individuals earning above 60,000.
Intravenous Drug Use	0.530	<0.001	Statistically significant	Strong association between intravenous drug use and co-infections.
Needle Sharing	−0.721	0.001	Statistically significant	Negative association, suggesting a potential protective effect or confounding factor.
History of STIs	−0.1065	0.094	Not statistically significant	No significant relationship with co-infections.

Continued

Unprotected Sexual Intercourse (Never)	0.3853	<0.001	Statistically significant	Higher likelihood of co-infections in individuals who never engaged in unprotected sexual intercourse.
Unprotected Sexual Intercourse (Sometimes)	0.2220	0.003	Statistically significant	Positive association with co-infections in individuals who sometimes engaged in unprotected sexual intercourse.
Smoking Tobacco	0.061	0.524	Not statistically significant	No significant relationship with co-infections.
Alcohol Consumption	0.061	0.376	Not statistically significant	No significant relationship with co-infections.
Adherence to ART (Never)	0.530	0.001	Statistically significant	Higher likelihood of co-infections in individuals who never adhered to ART.
Adherence to ART (Rarely)	0.578	0.002	Statistically significant	Higher likelihood of co-infections in individuals who rarely adhered to ART.
Adherence to ART (Sometimes)	−0.352	0.114	Not statistically significant	No significant effect on co-infections for individuals who sometimes adhered to ART.
Frequency of Healthcare Visits (Monthly)	0.1515	0.029	Statistically significant	Monthly visits to healthcare facilities are significantly associated with co-infections.
Access to Healthcare Services	−0.274	0.013	Statistically significant	Access to healthcare services is negatively associated with co-infections.
Access to Clean Drinking Water	−0.3211	<0.001	Statistically significant	Access to clean drinking water is negatively associated with co-infections.
Knowledge about HIV/AIDS (Poor)	0.600	<0.001	Statistically significant	Higher likelihood of co-infections in individuals with poor knowledge about HIV/AIDS.
Knowledge about HIV/AIDS (Fair)	0.335	0.005	Statistically significant	Higher likelihood of co-infections in individuals with fair knowledge about HIV/AIDS.
Knowledge about HIV/AIDS (Good)	-	0.781	Not statistically significant	No significant association between good knowledge and co-infections.
Received Counseling or Education	0.2153	0.002	Statistically significant	Receiving counseling or education is significantly associated with co-infections.
Interest in Educational Sessions	0.1801	0.018	Statistically significant	Interest in educational sessions is significantly associated with co-infections

Table 5. Multivariable binary logistic regression model for factors associated with co-infection status among HIV/AIDS patients.

Variable	Category	Reference category	β	Adjusted OR (aOR)	Approx. 95% CI	p-value
Age Group	26 - 35 years	18 - 25 years	0.284	1.33	1.11 - 1.59	0.002
Age Group	36 - 45 years	18 - 25 years	0.0069	1.01	0.84 - 1.21	0.942
Age Group	46 years and above	18 - 25 years	−0.1364	0.87	0.73 - 1.05	0.142
Gender	Male	Female	0.1541	1.17	0.98 - 1.39	0.080
Gender	Other	Female	0.091	1.10	0.77 - 1.56	0.614
Marital Status	Married	Divorced/separated	0.319	1.38	1.08 - 1.75	0.009
Marital Status	Single	Divorced/separated	0.378	1.46	1.14 - 1.87	0.003
Marital Status	Widowed	Divorced/separated	0.562	1.75	1.26 - 2.45	0.001
Occupation	Student	Employed	0.374	1.45	1.07 - 1.98	0.017
Occupation	Self-employed	Employed	0.1335	1.14	0.94 - 1.39	0.180
Occupation	Unemployed	Employed	−0.0886	0.92	0.77 - 1.09	0.321

Continued

Education Level	No formal education	Higher education	0.392	1.48	1.12 - 1.96	0.006
Education Level	Primary education	Higher education	−0.218	0.80	0.63 - 1.03	0.081
Education Level	Secondary education	Higher education	−0.316	0.73	0.57 - 0.93	0.011
Living Situation	Own house	Homeless	−0.943	0.39	0.22 - 0.68	<0.001
Living Situation	Rented house	Homeless	−0.918	0.40	0.23 - 0.69	<0.001
Living Situation	Temporary shelter	Homeless	−0.192	0.83	0.61 - 1.11	0.210
Monthly Income	20,000 - 40,000 PKR	<20,000 PKR	0.4344	1.54	1.19 - 2.00	<0.001
Monthly Income	40,000 - 60,000 PKR	<20,000 PKR	0.4054	1.50	1.18 - 1.91	<0.001
Monthly Income	Above 60,000 PKR	<20,000 PKR	0.397	1.49	1.14 - 1.95	0.004
Intravenous Drug Use	Yes	No	0.530	1.70	1.24 - 2.33	<0.001
Needle Sharing	Yes	No	−0.721	0.49	0.32 - 0.75	0.001
History of STIs	Yes	No	−0.1065	0.90	0.79 - 1.02	0.094
Unprotected Sexual Intercourse	Never	Always/mostly	0.3853	1.47	1.17 - 1.85	<0.001
Unprotected Sexual Intercourse	Sometimes	Always/mostly	0.2220	1.25	1.08 - 1.45	0.003
Smoking Tobacco	Yes	No	0.061	1.06	0.88 - 1.28	0.524
Alcohol Consumption	Yes	No	0.061	1.06	0.93 - 1.22	0.376
ART Adherence	Never	Always	0.530	1.70	1.24 - 2.33	0.001
ART Adherence	Rarely	Always	0.578	1.78	1.24 - 2.57	0.002
ART Adherence	Sometimes	Always	−0.352	0.70	0.45 - 1.09	0.114
Healthcare Visits	Monthly	Less frequent/when symptomatic	0.1515	1.16	1.02 - 1.33	0.029
Access to Healthcare Services	Yes	No	−0.274	0.76	0.61 - 0.94	0.013
Access to Clean Drinking Water	Yes	No	−0.3211	0.73	0.60 - 0.88	<0.001
Knowledge about HIV/AIDS	Poor	Good	0.600	1.82	1.27 - 2.60	<0.001
Knowledge about HIV/AIDS	Fair	Good	0.335	1.40	1.11 - 1.77	0.005
Received Counseling/Education on HIV	Yes	No	0.2153	1.24	1.08 - 1.42	0.002
Interest in Educational Sessions	Yes	No	0.1801	1.20	1.03 - 1.39	0.018

3. Discussion

As this study used a cross-sectional design, the findings should be interpreted as associations rather than causal relationships. Therefore, the observed relationships between demographic, behavioural, clinical, socioeconomic, and healthcare-related factors and co-infection status do not establish temporality or causality.

3.1. Prevalence and Characteristics of Study Participants

The study shows that HIV is most common in young adults and middle-aged people [11], with a large number of men and a lot of single people. This suggests that we need different approaches to prevent issues affecting men and women. Education is essential for HIV control, given that many individuals lack formal education. Health outcomes are also affected by people's economic situation and job status. Many people have low incomes and can't get clean water. People may not stick to ART because of side effects, stigma, lack of education, or trouble getting to medical facilities.

3.2. Association between Risk Factors and Co-Infection Status: Chi-Square Test Analysis

3.2.1. Association between Demographic Factors and Co-Infection Status

The study found a significant association between age, gender, marital status, and diagnosed co-infections. Individuals aged 26 - 35 and above are more prone to co-infections [12], possibly due to increased exposure, lifestyle factors, or underlying health conditions. Younger individuals have a lower prevalence, while females have a higher number due to healthcare-seeking behavior, hormonal variations, or societal roles. Marital status also plays a role, with widowed and single individuals having a higher risk. Education level also plays a role in co-infection prevalence.

3.2.2. Association between Behavioral Factors and Co-Infection Status

The study reveals a significant association between intravenous drug use and co-infections, highlighting the vulnerability of drug users to infectious diseases due to contaminated needles and compromised immune function. The study also suggests needle-sharing behaviors may increase the risk of transmitting infectious diseases [13]. Past STI exposure did not show a significant relationship with co-infections, suggesting other factors like healthcare access and treatment adherence may influence this outcome [14]. Unprotected sexual intercourse and tobacco smoking or alcohol consumption did not show significant associations with co-infections, suggesting indirect effects [15]. The study emphasizes the need for targeted intervention programs, prevention strategies, and increased healthcare accessibility for at-risk populations.

3.2.3. Association between Clinical Factors and Co-Infection Status

The study found significant associations between clinical factors and co-infections in HIV patients. The year of diagnosis was linked to increased risk factors or treatment differences. Lower co-infection rates in 2024 were attributed to improved treatment protocols and healthcare management. ART's protective role against co-infections was evident [16]. However, prolonged ART use increased co-infections, possibly due to drug resistance.

3.2.4. Association between Access to Healthcare and Co-Infection Status

Access to essential healthcare services and clean drinking water is crucial for preventing co-infections, especially among immunocompromised individuals [17].

Lack of healthcare services increases the risk of co-infections, leading to delayed diagnoses and inadequate preventive measures. Clean drinking water quality is also linked to co-infection status, as contaminated sources harbor bacteria, viruses, and other pathogens, further compromising the immune system and exacerbating existing health conditions.

3.2.5. Association between Knowledge and Education and Co-Infection Status

The study found that knowledge about HIV/AIDS significantly impacts the likelihood of being diagnosed with co-infections [18]. People with poor knowledge had higher rates of co-infections. This suggests that inadequate understanding can lead to risky behaviors, poor treatment adherence, and delayed medical interventions. Educating individuals on HIV/AIDS could reduce co-infection rates. However, the effectiveness of counseling or education on HIV/AIDS may depend on factors like quality, duration, and frequency.

3.3. Multivariate Analysis of Risk Factors Associated with Co-Infections in HIV/AIDS Patients

3.3.1. Multivariate Analysis of Demographic Factors

The study reveals that demographic factors such as age, marital status, education level, living situation, and household income significantly influence the diagnosis of co-infection [19]. Individuals aged 26 - 35 are at higher risk due to lifestyle and environmental factors. Marital status and education level also play a role in susceptibility to co-infection. Living in stable housing is a protective factor, potentially due to better sanitation and access to healthcare. Financial stability may facilitate better healthcare access and preventive measures, while higher incomes may result in increased diagnoses.

3.3.2. Multivariate Analysis of Behavioral Factors

The study found a strong association between intravenous drug use and co-infections, highlighting the need for harm reduction strategies like needle exchange programs [20]. Sharing needles had a negative relationship, possibly due to unmeasured confounders. The history of STIs did not significantly predict co-infections, suggesting underreporting or misclassification. Smoking and alcohol consumption did not show significant associations, suggesting indirect effects. The model's adjusted R-squared value (20.64%) suggests unmeasured factors may also play a role. Further research should consider additional variables to improve predictive accuracy.

3.3.3. Multivariate Analysis of Clinical Factors

The study highlights the importance of ART adherence in preventing co-infections among patients [21]. Non-adherence leads to higher odds of co-infections, indicating the need for enhanced adherence interventions. Consistency in ART intake is more crucial than duration, suggesting that longer ART use doesn't necessarily reduce co-infection risk. Regular healthcare visits, especially monthly ones, are associated with higher likelihood of diagnosed co-infections. Routine medical checkups are more effective than symptom-driven care. The model provides valuable insights into the relationship between clinical characteristics and infection risk.

3.3.4. Multivariate Analysis of Health Care

The study found that healthcare accessibility and knowledge-related factors significantly impact the diagnosis of co-infections. Improved healthcare access reduces infectious disease burden by facilitating early diagnosis and treatment, while clean drinking water prevents additional infections.

3.3.5. Multivariate Analysis of Knowledge and Education

The study reveals that individuals with poor knowledge about HIV/AIDS are at a higher risk of being diagnosed with co-infections, suggesting misinformation or lack of awareness about prevention. Counseling and education are crucial for managing the condition. However, low R-squared values suggest additional factors like socioeconomic status, nutritional factors, and immune system status may also contribute to co-infection diagnosis. The findings emphasize the need for systemic healthcare improvements and targeted educational interventions

The difference between the non-significant chi-square result and the significant adjusted association for counseling/education may be explained by confounding or suppression effects, as the multivariable model adjusted for related factors such as education level, HIV/AIDS knowledge, healthcare access, and ART adherence.

3.4. Limitations of the Study

This study was limited to patients in Faisalabad, Punjab. It does not represent the whole population of Pakistan and other regions, which limits the generalizability of demographic and socioeconomic events. Behavioral factors like art adherence, IV drug use, and sexual practice are reported by the patient themselves, which might be biased and can impact the overall results. There are certain con infections discussed in this study, and other infections, such as malignancies and fungal infections, are not addressed. This study only addresses the healthcare service access, but not the quality of the healthcare service, which could be a significant factor. This study only focuses on the income level of the individuals, but does not explore other factors such as financial burden or income loss, etc.

3.5. Socioeconomic Impact of Society

The study concludes that low income of the families is a significant factor for co-infection occurrence, which indicates that infection occurrence and low income can lead the patients to poverty, and limited healthcare systems can be assessed. The study showed that low-salaried persons and the unemployed who are affected by HIV/AIDS are led to unstable economic conditions. The healthcare system access suggested that there is a need to improve the resources of the healthcare system. A significant number of individuals lack education, which suggests that education is important to get employment and ultimately bring them out of poverty and poor health.

3.6. Potential Implications

This research highlights the necessity of focused public health campaigns, such as prevention for addicts, more secure sexual behavior, and enhanced access to medical care, to lower co-infections amongst patients living with HIV/AIDS. Various demographic categories should be the focus of educational efforts that increase knowledge about co-infections and avoidance. Counselling and support groups are essential for increasing ART adherence. To strengthen healthcare systems, especially in areas with limited resources, it is crucial to increase the availability of diagnostic tools, medicines, and trained staff. Controlling socioeconomic factors, such as transportation, education, and poverty, can help reduce the number of co-infections. The report also requests additional funding and programs to combat stigma, demonstrating the impact of policy. Lastly, future studies should also examine social stigma, financial difficulties, and long-term health consequences.

3.7. Conclusion

This study assessed the prevalence of co-infections and factors associated with co-infection status among HIV/AIDS patients in Faisalabad, Punjab, Pakistan. Co-infections, particularly syphilis, tuberculosis, and hepatitis B, were commonly reported among the study participants. Several demographic, behavioural, clinical, and socioeconomic factors were associated with co-infection status, including intravenous drug use, unprotected sexual practices, lower educational attainment, inadequate ART adherence, unstable living conditions, lack of access to clean drinking water, and limited healthcare access. These findings should be interpreted as associations rather than causal effects because of the cross-sectional nature of the study. The results may help identify groups with a higher burden of co-infections and may inform integrated HIV and co-infection screening, ART adherence support, safer-sex education, harm-reduction services, and healthcare access strategies for vulnerable populations. Further longitudinal studies are needed to clarify temporal relationships and assess whether these factors contribute to subsequent co-infection risk.

3.8. Perspective/Directions

Longitudinal studies should be employed in future research to track the progression of co-infections over time, identify persistent patterns, and evaluate treatment effectiveness. Additionally, including factors such as socioeconomic status, nutritional condition, and comorbidities can enhance intervention strategies and predictive modeling. Personalized healthcare strategies, such as ART adherence programs tailored to different age groups, may help improve the effectiveness of treatments. Investigating how factors such as pollution and climate can contribute to co-infections could help us gain a deeper understanding of how to effectively treat the disease. Finally, to improve patient outcomes, it is essential to focus on developing and utilizing rapid diagnostic tests to identify co-infections early on.

3.9. Recommendations

To improve public health programs, it is important to increase prevention efforts for people who are addicted to injecting drugs through needle exchange programs and rehabilitation services. It's also very important to improve efforts to help people understand HIV and safe sex, especially for groups that are more likely to get it. Support groups, counseling services, and patient education in the community can all help people stay on ART. The primary goal of healthcare system reforms should be to increase the availability of equipment, enabling skilled workers, medications, and advanced technologies to be accessed promptly, particularly in areas with limited resources. Telemedicine, mobile clinics, and cost-cutting measures can all help lower barriers to healthcare services and lower the risk of infection. Everyone should also have access to clean drinking water and sanitary facilities.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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