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HBV, HCV, AND HIV SEROPOSITIVITY: RISKS AND PREVENTION STRATEGIES.

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ABSTRACT

BACKGROUND: Serological testing serves as the frontline methodology for the diagnosis of viral infections including hepatitis B virus (HBV), hepatitis C virus (HCV) and human immunodeficiency virus (HIV) infection, especially in cases where direct identification of the pathogen is complicated**. OBJECTIVE:** Public screening and health monitoring of a population using serological assays are vital from a public health perspective since these tests identify both current and past infections. **METHODS:** This cross-sectional study diagnosed 150 patients for HBsAg, anti-HCV, and HIV antigen/antibody using rapid serum immunochromatographic lateral flow assays. Each sample was processed using the enclosed instructions, and test lines and control lines' marking were used to conclude on results interpretation. Stratifications were made based on sex, age, region of residence, and transfusion history. Relations of patient attributes and infection status were studied with Chi-square tests. **RESULTS:** Within the cohort of 150 patients, the prevalence rates of HBsAg and HCV were 63.3% and 42.0% respectively. There was no statistically significant difference associated with gender for positivity of HBsAg ($p = 1.00$), HCV ($p = 0.60$), or HIV ($p = 0.36$). There were also no age group associations with positivity for any of the infections (HBsAg: $p = 0.50$; HCV: 0.38; HIV: 0.47). Area of residence was not significantly associated with infection status for HBsAg ($p = 0.92$), HCV ($p = 0.57$), or HIV ($p = 0.21$). A significant association was observed between a history of blood transfusion and HCV positivity ($p = 0.023$), and borderline association for HIV ($p = 0.062$); for HBsAg no significant association was noted ($p = 0.20$). **CONCLUSION:** The investigation exposed the examined population with concerning levels of HBV and HCV seropositivity alongside notable associations between HCV infection and a history of blood transfusions. The study illustrates the persistent danger of transfusion-related infections and reinforces the need for stringent blood donation protocols, enhanced infection control measures, and intensive epidemiological surveillance. Additional studies with broader scopes, along with deeper analyses into the factors of risk are necessary for designing effective health policy frameworks for prevention and proactive public health responses**.**

KEYWORDS: Serology, Hepatitis B, Hepatitis C, HIV, Prevalence, Blood transfusion, Rapid diagnostic test, Infection control

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INTRODUCTION

The term serology has traditionally been defined as the study of the components of blood serum, more specifically antibodies, within various bodily fluids such as blood and saliva[1]. In medical diagnostics, serological tests are vital in determining the indirect evidence of infection(s) by detecting pathogen-specific antibodies or antigens within a given patient's blood[1]. This method becomes useful in cases where direct detection of the pathogen is challenging (throughculture or nucleic acid testing), as serological tests provide wider and deeper diagnostic opportunities to determine infections of all ages; both active and dormant [2]. Take, for instance, certain virus infections, where the specific antibodies tend to persist for a long period after the acute phase is over, which enables serology to demonstrate an antecedent even though the infectious agent is not present in the body[1,3] Antibodies are also proteins that are generated by the B-lymphocytes of the immune system and are designed to bind to foreign materials (antigens) such as viruses and bacteria to neutralize them[4,5]. Similarly, each antibody is designed to identify a unique antigen "like a key in a lock" and designates the pathogen for destruction while stopping its dissemination. The essence of serological diagnostics is built from this very precise reciprocal reaction between antigen and antibody: certain antibodies (or antigens) present in circulation can function as measurable proxies for infections that require further investigation[6].

As noted, the immune system responds to a new infection by first producing immunoglobulin M (IgM) antibodies, and later synthesized immunoglobulin G (IgG) antibodies that are more durable[7]. Thus, serological assays are able, in some instances, to differentiate acute or recent infections – signified by IgM or rising IgG titers – from past infections or immunity depicted by IgG[8]. This capacity of serology has proven invaluable in clinical diagnostics, especially within the realms of infectious disease, as well as in public health. Serological tests are essential for the diagnosis of viral diseases and serve many critical purposes. Their availability and speed, along with low cost, makes them ideal for large population screening[9]. For example, serological assays such as ELISA and rapid antibody tests are routinely used pre-transfusion to screen for transfusion transmissible infections including but not limited to, hepatitis B, hepatitis C, and HIV[10, 11]. This use directly enhances the safety of blood products by eliminating infected contributions[12].

METHODOLOGY

Blood samples were taken from the participants and processed to obtain serum which was analyzed using serological techniques. HBsAg, Anti-HCV, and HIV antigen/antibody tests were performed using rapid Lateral Flow Tests (immunochromatographic assays) on the serum specimens. All tests were performed according to the manufactures' instructions under standard laboratory conditions. Prior

to use, test cassettes were stored at room temperature until equilibrated, labeled, and assigned to corresponding tests.

Toward each serological examination, a separate rapid test strip or cassette was prepared, and patient serum was applied using a disposable dropper. After applying a single drop, 2-3 drops of the provided buffer solution were added to the sample well, promoting the lateral flow of serum across the test membrane. The chromatographic segment of the strip is traversed by serum under the action of buffer solution, where specific reactions take place between the serum and test reagents for the antigens (HBsAg, anti-HCV, or HIV antigen/antibody) supporting immunochemical interactions in the region of the test marker. The test devices were left on a flat surface until the room temperature and the development time of around 15 minutes. No results were read during the period of 20 minutes after application of samples. During this time the strips develop visible lines comprising immuno complexes.

After the specified development time, the results are interpreted through visual examination of the control and test indicator lines on each strip. Each indivisual rapid test device contains an internal control band which must show up for the assay to be considered valid. The appearance of a separate colored line in the test region in addition to the control line is interpreted as a positive result for the relevant infection marker. If no line emerged in the test region (with only the control line visible), the result was noted as negative. In cases where control line did not appear at all, the result was marked as irretrievably lost owing to a failed procedural run, and the assessment was conducted afresh using another strip. Observations were made after 15-20 minutes of development time, and no tests were carried out past the 20 minute mark to ensure compliance and accuracy in interpretation. All rapid test protocols were followed with structure quality controls and within the standardized laboratory procedures to ensure accurate detection of HBsAg, HCV antibodies, and HIV antigen/antibody.

RESULTS

This study included 150 patients with records for testing Hepatitis B surface antigen (HBsAg), Hepatitis C virus (HCV) and Human Immunodeficiency Virus (HIV). The participants' data were stratified by gender, age category, area of residence, and history of blood transfusion. The significance of associations was evaluated using Chi-square tests which are summarized in the corresponding tables with p-values reported.

Table 1. Distribution of Test Results by Gender

Disease	Gender	Positive	Negative	Total	χ^2	p-value
HBsAg	Male	20	12	32		
HBsAg	Female	18	10	28		
					0.00	1.00
HCV	Male	11	18	29		
HCV	Female	10	11	21		
					0.27	0.60
HIV	Male	1	17	18		
HIV	Female	2	10	12		
					0.85	0.36

Interpretation: There was no statistically significant association between gender and positivity for HBsAg, HCV, or HIV.

Table 2. Distribution of Test Results by Age Category

Disease	Age Group	Positive	Negative	Total	χ^2	p-value
HBsAg	<20	5	7	12		
HBsAg	20–39	18	10	28		
HBsAg	40–59	10	3	13		
HBsAg	≥60	5	2	7		
					2.35	0.50
HCV	<20	2	9	11		
HCV	20–39	10	8	18		
HCV	40–59	7	8	15		
HCV	≥60	2	4	6		
					3.06	0.38
HIV	<20	0	7	7		
HIV	20–39	2	9	11		
HIV	40–59	1	8	9		
HIV	≥60	0	3	3		
					2.55	0.47

Interpretation: No significant association was observed between age group and positivity for HBsAg, HCV, or HIV.

Table 3. Distribution by Area of Residence

Disease	Area	Positive	Negative	Total	χ^2	p-value
HBsAg	Urban	22	12	34		
HBsAg	Rural	16	10	26		
					0.01	0.92
HCV	Urban	13	15	28		
HCV	Rural	8	13	21		
					0.32	0.57
HIV	Urban	1	14	15		
HIV	Rural	2	9	11		
					1.54	0.21

Interpretation: Area of residence (urban/rural) showed no significant association with positivity for any of the infections.

Table 4. Distribution by History of Blood Transfusion

Disease	Blood Transfusion	Positive	Negative	Total	χ^2	p-value
HBsAg	Yes	19	7	26		
HBsAg	No	19	15	34		
					1.61	0.20
HCV	Yes	13	8	21		
HCV	No	8	20	28		
					5.12	0.023*
HIV	Yes	2	5	7		
HIV	No	1	18	19		
					3.49	0.062

***p < 0.05, statistically significant.**

Interpretation: A significant association was found between history of blood transfusion and HCV positivity (p = 0.023). No significant association was found for HBsAg or HIV.

Table 5. Overall Disease Prevalence by Gender and Age Category

Gender	Age Group	HBsAg Positive	HCV Positive	HIV Positive	Total Patients
Male	<20	3	1	0	6
Male	20–39	9	5	1	11
Male	40–59	6	3	0	6
Male	≥60	2	2	0	4
Female	<20	2	1	0	6
Female	20–39	9	5	1	9
Female	40–59	4	4	1	7
Female	≥60	3	1	1	3
Infection	Variable	χ^2	p-value		
HBsAg	Gender & Age	NS	NS		
HCV	Blood transfusion	5.12	0.023*		
HIV	All variables	NS	NS		

NS: Not Significant (p > 0.05).

DISCUSSION

This research examined the sociodemographic and blood transfusion history-related prevalence of infections of Hepatitis B virus (HBV), Hepatitis C virus (HCV) and Human Immunodeficiency Virus (HIV) in 150 patients. The findings indicated a strikingly high prevalence of HBsAg at 63.3% and HCV at 42.0%, with HIV at a lower, but still notable, prevalence of 10.0%. These figures are significantly greater than estimates provided by the WHO. As of 2019, chronic HBV infection was reported in about 296 million people (3.8% of the global population) and chronic HCV infection in 58 million (0.75% of the population)[13]. The worldwide prevalence of HIV is about 0.7%, with 38.4 million people living with the disease in 2021. The substantially high prevalence detected in our study population suggests some selection bias because participants were likely to have been seen at a clinic where they were assumed to have these infections rather than in the general population[14].

Focusing on infection rates among different genders, our study found no significant disparities across all three viruses, although there are some slight differences in the overall numbers. This contrasts with Stockdale et al.'s systematic review which reported a greater global prevalence of HBV in men with a 1.4 to one ratio[15]. Furthermore, Pe-truzziello et al. performed a meta-analysis and reported that men generally had a greater prevalence of HCV than women in most regions of the world. For HIV, UNAIDS global estimates indicate women and girls represented 49% of new HIV infections in 2021[16]. These figures were much higher or lower depending on the region alongside the gap. The absence of disparity between sexes in our study could result from the spatial descriptive epidemiology of the population and the population characteristics being studied. As far as we could see, there were no important patterns associated with age, but we did observe the highest frequency of HBsAg and HCV positive cases in the 20 to 39 age group. Razavi et al. identified some global trends where HCV is largely seen in people aged 55 to 64 due to past waves of infections and there is partial agreement for this[17]. For HBV, Schweitzer et al. in their systematic review has described clearly defined age structures, especially in high endemicity regions where early childhood peaks are due to vertical and some early horizontal transmission, in contrast with intermediate endemicity regions which tend to be adult-centric[18]. The WHO asserts that the most affected populations of HIV are

within the age range of 25 to 49 years old, which supports our finding of HIV cases mostly occurring in the 20- to 59-year-old age group.

The lack of prominent differences between the people living in cities and in the countryside contradicts many wide-ranging studies. Scientific studies shows that HBV prevalence was significantly higher in the countryside than in the cities[19]. For HCV, Gao et al.For some developing countries, the rural population had higher prevalence rates because of less access to health services[20]. The urban-rural gap in our analysis may be due to more refinement that have been achieved in the patterns of infrastructural development, equal access healthcare socioeconomic healthcare leveling, or sample size limitations, leading to low statistical power.

The strongest finding was the significant correlation of blood transfusion history with HCV positivity (p=0.023), alongside an almost significant trend with HIV (p=0.062). This aligns with what is already known about transmission risks. A meta-analysis by Westbrook et al. estimated a risk range of 0.45-10.0% of HCV transmission per unit transfused during blood transfusions in the pre-screening era. WHO still attributes 8-16% of HCV infections in developing countries to unsafe blood transfusions. For HIV, Custer et al.'s review estimated the residual risk of HIV transmission via screened blood supply at 1:1.5 million in high-income countries, but much higher in resource constrained settings with limited advanced screening technologies.

The discrepancies observed between blood transfusion history and positive HBsAg test results have been documented within older studies; however, more recent studies align with our findings. Bloch and colleagues' international study demonstrated that the risk of Hepatitis B Virus (HBV) infection from blood transfusion had greatly diminished in regions with adequate donor screening facilities due to effective screening protocols. Current estimates range between 1 in 500,000 to 1 in 1,000,000 infections per unit transfused. This suggests that either screening standards for the region are effective for HBV compared to HCV, or other transmission vectors for HBV are more common in the studied population.

When interpreting our results, several limitations must be considered. The statistical power of 150 patients is limited, especially concerning subgroup analyses. The cross-sectional nature of the study means that no causative relationship or the temporal order of infection can be established. Furthermore, the study is devoid of crucial data on other risk factors such as intravenous drug use, sex work, vaccine history, and other occupational risk factors which have been extensively described by Nelson et al in regard to HCV and later by Ott et al. for HBV and Beyrer et al. for HIV regarding the primary Infection risks. This specific investigation reveals alarming rates of HBV, HCV and HIV infections, especially among people with a history of blood transfusions, which increases the risk of contracting HCV. This study underscores the need for proper blood safety measures, including screening and targeted infection control, as well as proactive tailored infection prevention strategies. Further research with larger sample sizes, detailed analysis of risk factors, and prolonged time frames would yield better results for public health intervention strategies concerning these infectious diseases[21, 22].

ETHICS APPROVAL: The ERC gave ethical review approval.

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All persons who meet authorship criteria are listed as authors, and all authors certify that they have participated in the work to take

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