**Seroprevalence of Hepatitis B and C Viruses among Health Care Workers in Ibb City, Yemen**

**Abstract: -** Hepatitis B and C virus infections are one of the most widespread health problems in the world, especially in health care workers (HCWs), and constitute the major threat that challenges the health system in developing countries. Therefore, the present work aimed to find out the prevalence rate of HBV and HCV infections and risk factors among HCWs working in many hospitals in Ibb governorate, Yemen. A cross-sectional study was conducted from January to May 2023 to collect samples and data relevant to each single subject. We included 120 HCWs working in many hospitals. A questionnaire was administered to collect data on demographic characteristics and medical history. The serum of HCWs was tested for hepatitis B surface antigen (HBsAg) and anti-HCV antibodies in Cobas e 411 analyzers with Electro-Chemiluminescence Immunoassay Assay (ECLIA) according to the manufacturer’s instruction. Data were analyzed by SPSS 22. The overall prevalence of HBsAg was 3.3% (4/120) and that of anti-HCV antibody was 3.3% (4/120) among participating HCWs. HBV and HCV co-infection was 25.0% (1/4) among participating HCWs. In HCWs, the only risk factors significantly associated with HBsAg were profession, with a higher risk of occupational transmission in those working as hygienists, lab technicians, and nurses. While the only risk factors significantly associated with anti-HCV antibodies were periodical hepatitis virus testing, with a higher risk of occupational transmission in those working as lab technicians and hygienists. A high seroprevalence of hepatitis B and C virus infection was found in the study area despite their good knowledge towards the occupational risk of viral hepatitis infection.   
***Keywords:****Hepatitis B Virus, Hepatitis C Virus, Health Care Workers, HBV DNA, Yemen.*

1. **INTRODUCTION**

Human hepatitis B virus (HBV) is a type of hepadnavirus that is spread by contact with infected blood and body fluids and causes acute and chronic neuroinflammatory liver diseases. HBV is a noncytopathic virus; inflammation of the liver is mediated by host immune responses to HBV-infected hepatocytes. HBV infection in immunocompetent adults results in a self-limited, transient liver disease, and subsequent viral clearance is achieved in more than 95% of adults, whereas more than 90% of neonates exposed to HBV at birth become persistently infected[1-4]. HBV causes transient and chronic infections of the liver. Transient infections may produce serious illness and approximately 0.5% terminate with fatal, fulminant hepatitis[5].

Globally, more than two billion people are estimated to have been infected with HBV, and about 240–400 million have chronic HBV infection. Approximately 600,000 to 1 million people die every year from its consequences. It is estimated that 15-25% of perinatally infected subjects will die from HBV-related liver disease. The World Health Organization (WHO) organizes “World Hepatitis Day” on July 28 every year to increase awareness and understanding of viral hepatitis. Many patient support groups and scientific organizations participate in this important event[6].New estimates for viral hepatitis based on data from 130 countries in the latest global progress report on HIV, viral hepatitis, and sexually transmitted infections show that in 2019 there were 296 million people living with chronic HBV infection and 58 million people living with chronic HCV infection, and 3 million new infections and 1·1 million deaths from viral hepatitis B and C combined[7, 8].

The self-limiting outcome of infection has been detected in a very small proportion of patients with chronic HBV infection. Annually, HBsAg seroclearance rate was reported between 0.1 and 2.3% depending on the endemicity of the area for HBV infection, mean age of participants, years of follow-up, and serum levels of HBV DNA and HBsAg[9]. HBV may be viable for at least a week on environmental surfaces at room temperature. Reported transmission incidents have involved the transfer of HBV from contaminated surfaces via staff members' gloves or hands or contaminated equipment in dialysis centers[10]. Many previous studies in Yemen have shown the prevalence of HBV chronic infection ranges from 7.4 to 18.5% among adults in the general population[11-14]. HCV is a member of the Flaviviridae family (Hoofnagle, 2002). Infection with HCV can lead to acute and chronic hepatitis disease. Approximately 70–85% of HCV infections progress to chronic disease, although this varies according to patient gender, age, race, and immune status[15]. Chronic HCV infection may lead to cirrhosis and hepatocellular carcinoma (HCC)[16, 17]. and is a major healthcare concern with over 170 million persons (roughly 3% of the human population) infected worldwide. The highest prevalence is found in Africa, the Eastern Mediterranean, and Asian regions[18, 19]. HBV and HCV are responsible for the two most widespread forms of chronic hepatitis worldwide[20-22].

HBV or hepatitis C virus infection is transmitted from patients to HCWs and vice versa and also to HCWs’ families, and it is of vital importance in all healthcare settings worldwide since these workers are exposed daily to these infections over almost four decades[7, 23, 24]. It has been estimated that 14.4% and 1.4% of hospital workers are infected with HBV and HCV, respectively[25].

Approximately three million HCWs are exposed to percutaneous blood-borne viruses each year, with an estimated 66,000 cases of HBV and 16,000 cases of HCV acquired annually[26]. These infections are significant risk factors for hepatocellular carcinoma and other liver-related morbidities[27]. Healthcare workers are exposed to the risk of acquiring HBV and HCV infection through mucosal-cutaneous exposure (eyes or mouth mucosa or skin) to potentially infectious blood or blood products or through percutaneous exposure to contaminated sharp objects (needles, blades, etc.). Needle pricks with contaminated needles, cuts from sharp instruments, and blood splashes to the conjunctiva are the most frequent causes of exposure; injuries are largely preventable by taking standard universal precautions[23]. 25% of the total occupational exposure is mucosal-cutaneous and 75% percutaneous[28]. The risk of HBV or HCV infecting a healthcare worker is higher in percutaneous than in mucosal-cutaneous exposure[23]. Seroprevalence rates of HBV and HCV are higher among HCWs, including physicians, nurses, dentists, dialysis staff, laboratory workers, other hospital technicians, and cleaning staff than in the general population[29-33]. In addition, they are exposed to an increased risk of occupational infection with HBV, HCV, and HIV[34]. Many questions remain about occupational risk and the long-term implications of infection by HBV and HCV[35].

HBV vaccination of anti-HBs-negative healthcare workers is recommended in all countries, but numerous healthcare workers remain exposed to infection because they have eluded HBV vaccination[23]. A safe and effective vaccine against HBV has been available for 20 years and is effective in preventing infection and the serious consequences of hepatitis, including liver cancer and cirrhosis, when given before or after exposure (Mesfin et al., 2014), but there is currently no vaccine for HCV[36]. The hepatitis B vaccine is recommended for both pre- and post-exposure prophylaxis for individuals at risk of exposure to blood, blood products, or bodily secretions. It is essential for HCWs to receive the HBV vaccine, and those who are vaccinated should undergo annual testing for anti-HBs levels. If the anti-HBs level is below 10 mIU/ml, the individual is considered susceptible and may require booster doses. Vaccinating healthcare workers (HCWs) against hepatitis B is crucial in preventing the transmission of the virus within healthcare settings, reducing the risk of nosocomial transmission between HCWs and patients, and vice versa. The vaccine offers long-term protection against hepatitis B infection, potentially providing lifelong immunity[37-40].

1. **AIMS OF THE STUDY**

The current study was designed to : (1) Detect the hepatitis B surface antigen and HCV antibody (anti-HCV) among HCWs in Ibb city, Yemen. city -Yemen, (2) To understand the predisposing risk factors (sex, duration of work, HBV Vaccination, periodical testing for hepatitis virus infection, history of blood transfusion, history of surgical operation) with the above-mentioned hepatitis virus markers.

and (3) Explore the relationship of risk factors with different hepatitis HCWs serological markers; HBsAg and anti-HCV antibodies.

1. **MATERIALS AND METHODS**

The present cross-sectional study was conducted among a total of 120 HCWs who worked in many hospitals and those who had direct patient care or specimen contact at least for the last 1 year in Ibb City, Yemen between January 2023 to May 2023 to collect sample data relevant to each single subject.

A total of 120 HCWs were included in this study 66(57.5%) males and 54(42.5%) females. HCWs of any age and gender, including Operation Technicians, Lab Technicians, Hygienists, Surgeons, and Nurses, were selected through randomly ordered lists generated from human resources databases for each profession. Patients were excluded if they were non-healthcare workers (HCWs) not belonging to the professions of Operation Technician, Lab Technician, Hygienist, Surgeon, or Nurse, as well as those diagnosed with cirrhosis, hepatocellular carcinoma, or autoimmune hepatitis.

Demographic information for healthcare workers, including name, gender, age, duration of employment, Hepatitis B virus vaccination status, periodic testing for hepatitis virus infection, history of blood transfusions, past surgical operations, and family medical history, was collected through a questionnaire. Consent was obtained from all participants, who were informed that their participation was voluntary and that they could withdraw at any time without providing a reason. Approval was also secured from the administration of the targeted hospitals.

The HCWs blood samples were collected from targeted hospitals and proceeded to ALFA Medical Laboratories, Ibb City- Yemen. Separated serum was tested in Cobas e 411 analyzer (Roche Diagnostic GmbH, Mannheim, Germany**)** with Electro- Chemiluminescence Immunoassay (ECLIA) technique for detecting of HBsAg and anti-HCV antibodies among HCWs according to the manufacturer’s instruction. Finally, the data were analyzed using a statistical package of social science program (SPSS, version 22) and the results were presented as percentages, numbers and tabulation. Chi-square X2 test was used for categorical variables. *P*- *P-values* <0.05 were considered statistically significant.

1. **RESULTS**

Our study was conducted on 120 healthcare workers attending many hospitals in Ibb city with different professions. The majority of them were Operation Technician,(N=49, 40.8%), followed by Lab Technicians (N=48, 40.0%), followed by Hygienist (N=10, 8.3%), followed by Surgeons (N=7, 5.8%) and Nurses (N=6, 5.0%) as showing in **Figure.1**

**Figure 1:** Distribution of HCW patients according to work position.

Out of 120 HCWs tested, there are 66(57.5%) males and 54(42.5%) as shown in **Table 1.**

**Table 1:** Distribution of HCWs gender and profession.

|  |  |  |  |
| --- | --- | --- | --- |
| **HCWs Profession** | **Males** | **Females** | **Total** |
| **%** | **%** | **%** |
| Lab Technician | 24.2 | 15.8 | 40.0 |
| Hygienist | 5 | 3.4 | 8.4 |
| Operation Technician | 22.5 | 18.3 | 40.8 |
| Nurse | 2.5 | 2.5 | 5.0 |
| Surgeon | 3.3 | 2.5 | 5.8 |
| Total | 57.5 | 42.5 | 100 |

Our findings showed that the time duration of HCW'swork experienceranged from one year to more than five years. Most HCWs worked for more than five year(N=69, 57.5%), followed by one year(N=12, 10%) , three year(N=17, 14.1%) , two year(N=11, 9.1%) and finally five year (N=11, (9.1%). The duration of HCWs work distribution in the five work professions is illustrated in **Figure2**  
**Figure 2:** Duration of HCW work in the five work professions.

Our findings showed that only 30 (25%) of 120 HCWs were vaccinated. 90(75%) HCWs were not vaccinated. The highest percentage of vaccination was found in Lab Technician 14 (11.7%), followed by Operation Technician 10 (8.3%), Nurse 3 (2.5%) and Surgeon 2(1.7%) while the lowest percentage was found in Hygienist 1(0.8%) as showing in **Figure3**.

**Figure 3:** Distribution of HCWs by HBV vaccination.

An investigation into the criteria for periodical testing for hepatitis virus infection revealed that only 37(30.8%) HCWs were tested regularly for hepatitis B and C viruses, while 83 (69.2%) HCWs were either not tested at all or not tested periodically. The highest percentage of those tested periodically was among Lab Technicians 23 (62.2%), followed by Operation Technicians 11 (29.7%) and Nurses 2 (5.4%), with the lowest percentages found in Surgeons 1 (2.7%) and Hygienists (0%). The number of periodically tested HCWs compared to those not tested is illustrated in **Table 2**.

**Table 2:** Distribution of HCWs by periodical testing for HBsAg and anti-HCV.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **HCWs Profession** | **Periodically tested** | | **Not periodically tested** | |
| **No** | **%** | **No** | **%** |
| Lab Technician | 23 | 62.2% | 25 | 37.8% |
| Hygienist | 0 | 0% | 10 | 100% |
| Operation Technician | 11 | 29.7% | 38 | 70.3% |
| Nurse | 2 | 5.4% | 4 | 94.6% |
| Surgeon | 1 | 2.7% | 6 | 97.3% |

Our findings showed that out of the total study population, 11 (9.1%) HCWs received blood transfusions. The total number of HCWs who received a blood transfusion in each of the five HCWs positions is illustrated in **Table 3**,

**Table 3:** Distribution of HCWs by received blood transfusion.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **HCWs Profession** | **Have blood** **transfusion** | | **Have not blood** **transfusion** | |
| **No** | **%** | **No** | **%** |
| Lab Technician | 6 | 5 | 42 | 35 |
| Hygienist | 0 | 0 | 10 | 8.4 |
| Operation Technician | 4 | 3.3 | 45 | 37.5 |
| Nurse | 1 | 0.8 | 5 | 4.2 |
| Surgeon | 0 | 0 | 7 | 5.8 |
| Total | 11 | 9.1 | 109 | 90.9 |

Surgical operations are considered risk factors for the transmission of hepatitis viruses. Our findings showed that out of the total study population, 22.5% of the subjects underwent a surgical operation(s), while the other 77.5% did not as shown in **Figure 4**.

**Figure 4:** Distribution of HCWs by surgical operation.

Our findings showed that the overall prevalence of HBsAg and anti- HCV among HCWsin Ibb city hospitals was 3.3% as shown in **Table 4.**

**Table 4:** Distribution of HBsAg and Anti-HCV among HCWs.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **HCWs Profession** | **HBsAg** | | | | **Anti- HCV** | | | |
| **Positive** | | **Negative** | | **Positive** | | **Negative** | |
| **No** | **%** | **No** | **%** | **No** | **%** | **No** | **%** |
| Lab Technician | 1 | 2 | 47 | 98 | 3 | 6.2 | 45 | 93.8 |
| Hygienist | 2 | 20 | 8 | 80 | 1 | 10 | 9 | 90 |
| Operation Technician | 0 | 0 | 49 | 100 | 0 | 0 | 49 | 100 |
| Nurse | 1 | 16.7 | 5 | 83.3 | 0 | 0 | 6 | 100 |
| Surgeon | 0 | 0 | 7 | 98 | 0 | 0 | 7 | 100 |
| Total | 4 | 3.3 | 116 | 96.7 | 4 | 3.3 | 116 | 96.7 |

Our results indicated that one case of mixed hepatitis B and C virus infection was identified as positive for both HBV and HCV. Our findings showed that there was a statistically significant (*P* < 0.05) relationship between HBsAgand Anti-HCV mixed infectionas shown in **Table 5.**

**Table 5:** Mixed hepatitis B and C virus infection.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Mixed Hepatitis B and C Viruses Infection** | | | | | | ***p*-*value*** |
|  | | | **Anti-HCV** | | Total | 0.014\* |
| Negative | Positive |
| **HBsAg** | Negative | No | 113 | 3 | 116 |
| % | 97.4% | 2.6% | 100% |
| Positive | No | 3 | 1 | 4 |
| % | 75.0% | 25.0% | 100% |
| Total | | No | 116 | 4 | 120 |
| % | 96.7% | 3.3% | 100% |

**\*Statistically significant ; Probability value** (***P-******value* < 0.05 significant).**

Our findings showed that there was no statistically significant relationship between HBV, HCV and gender of HCW cases (*p*-value > 0.05). Males were found to be more susceptible to HBV than females as shown in **Table 6**.

**Table 6:** Relationship between HBV and HCV infection and gender among HCWs.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variable** | | **HBV Positive** | **HBV Negative** | **HCV Positive** | **HCV Negative** |
| **HCWs Gender** | Male | 3 | 63 | 4 | 62 |
| Female | 1 | 53 | 0 | 54 |
| *P*- value | 0.413 | | 0.066 | |

**\*Statistically significant ; Probability value** (***P-******value* < 0.05 significant).**

Our findings showed that there was a statistically significant relationship between HBV (*P*-value < 0.05) and HCWs profession. For HBV the highest prevalence of positivity was found in Hygienists, followed by Lab Technicians and Nurses , while both Operation Technician and Surgeon had no prevalence 0%. On the other hand, for HCV no statistically significant relationship was found with HCV (*p*-value > 0.05) and HCW position as shown in **Table 7.**

**Table 7:** Relationship between HBV and HCV infection and HCWs profession.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variable** | | **HBV Positive** | **HBV Negative** | **HCV Positive** | **HCV Negative** |
| **Profession** | Lab Technician | 1 | 47 | 3 | 45 |
| Hygienist | 2 | 8 | 1 | 9 |
| Operation Technician | 0 | 49 | 0 | 49 |
| Nurse | 1 | 5 | 0 | 6 |
| Surgeon | 0 | 7 | 0 | 7 |
| *P* value | 0.007**\*** | | 0.310 | |

**\*Statistically significant ; Probability value** (***P-******value* < 0.05 significant).**

Our findings showed that there was no statistically significant relationship between HBV, HCV (*p*-value > 0.05) and HCWs work duration as shown in **Table 8.**

**Table 8:** Relationship between HBV and HCV infection and HCWs work duration.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variable** | | **HBV Positive** | **HBV Negative** | **HCV Positive** | **HCV Negative** |
| **Work duration** | One year | 0 | 17 | 0 | 17 |
| Two years | 1 | 10 | 0 | 11 |
| Three years | 0 | 17 | 0 | 17 |
| Five years | 1 | 10 | 0 | 11 |
| More than 5 years | 2 | 62 | 4 | 60 |
| *P* value | 0.486 | | 0.460 | |

**\*Statistically significant ; Probability value** (***P-******value* < 0.05 significant).**

Our findings showed that there was no statistically significant relationship between HBV and periodicalhepatitis virus testing among HCWs cases (*p*-value > 0.05). On the other hand, a statistically significant relationship was found between HCVand periodicalhepatitis virus with periodicalhepatitis virus testing (*P*-value < 0.05) as shown in **Table 9.**

**Table 9:** Relationship between HBV and HCV infection and periodicalhepatitis virus testing among HCWs.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variable** | | **HBV Positive** | **HBV Negative** | **HCV Positive** | **HCV Negative** |
| **Periodical hepatitis viruses testing** | Yes | 2 | 2 | 0 | 33 |
| No | 35 | 81 | 4 | 83 |
| *P* value | 0.399 | | 0.002**\*** | |

**\*Statistically significant ; Probability value** (***P-******value* < 0.05 significant).**

1. **DISCUSSION**

HBV and HCV infections continue to pose significant health challenges, significantly impacting morbidity and mortality rates. The well-being and safety of healthcare workers in numerous developing nations, particularly concerning the occupational spread of HBV and HCV, are often overlooked. It is crucial to ascertain the prevalence of these infections among healthcare workers and assess the related risk factors to implement successful preventive measures[41].

Our results indicated that the positivity of HBsAg and anti-HCV antibodies was higher among males than females in this study as showing in **Table. 1.** Our findings revealed that a significant portion of healthcare workers (57.5%) had work experience exceeding five years, which contrasts with the results reported by other study[24], that noted 64.3% of healthcare workers had 1-3 years of work experience as showing in **Figure.2**.

HBsAg positivity can indicate either acute (active) or chronic infections, while HBsAg negativity can indicate either the absence of infection (susceptibility) or immunity resulting from vaccination or a resolved infection. These statuses can be distinguished by conducting HBsAb and HBcAb IgM tests. However, due to resource limitations, we did not perform these tests. There is a possibility that we may have overestimated the adherence to standard precautions as it was self-reported by the respondents (social desirability bias), and no direct observation of actual practice was carried out. The same applies to the history of occupational exposure, which was self-reported by the respondents (recall bias), and no effort was made to cross-check this information with their health records.

Additionally, our study revealed that the majority of healthcare workers (75%) had not been vaccinated as showing in **Figure. 3**, which contrasts with findings from previous studies (84%) and (84.7%), where a significant proportion of healthcare workers had received the hepatitis B vaccination.[42, 43] This lack of vaccination is likely attributed to non-compliance with HBV vaccination protocols, despite the availability of pre-employment screening and vaccination services in Ibb City. The discrepancy may be explained by the fact that the WHO recommended the inclusion of the HBV vaccine in Yemen's national immunization program in 1998, particularly targeting neonates to combat vertical transmission. Since most of the healthcare workers in our study were born before the mandatory childhood hepatitis B vaccine was introduced into the national immunization program, it is assumed that they have received vaccination as part of their occupational requirements. The remaining healthcare workers obtained immunity through self-initiated vaccination efforts, constituting only 25% of the HCWs. It is crucial for healthcare workers to adhere to a standard vaccination schedule, with serum anti-HBs levels assessed 1-2 months after completing a 3-dose vaccination series[44]. The World Health Assembly endorsed recommendations in May 1992, urging all countries to integrate the HBV vaccine into their national immunization programs[45].

Based on our findings, it was observed that only 30.8% of healthcare workers underwent regular testing for hepatitis B and C viruses, while the majority (69.2%) either did not undergo testing at all or were not tested periodically as showing in **Table. 2**. There was no statistically significant relationship identified between HBV and periodic hepatitis B virus testing among healthcare workers (*P-*value > 0.05). In contrast, a statistically significant relationship was noted for HCV concerning periodic hepatitis virus testing (*P-*value < 0.05) as showing in **Table.9**.

Our study indicated that the majority of healthcare workers (90.9%) had no history of blood transfusionas as showing in **Table. 3**, a finding that aligns closely with other previous study [46].

There was no statistically significant relationship found between HBV, HCV (*p-*value > 0.05), and blood transfusion among healthcare workers, consistent with the findings of previous study, and in contrast to the results of Anwar *et al*, regarding HCV infection. Additionally, in our study, 22.5% of participants underwent surgical operationsas showing in **Figure. 4**, which differs significantly from the 62.0% reported in a previous studies [46, 47].

In our study, the HBV seroprevalence among healthcare workers in Ibb City was 3.3%, indicating an intermediate level of endemicity (2%–7%) based on the WHO's classification of HBV infection prevalence [48]. These findings closely align with previous studies in various regions: Turkey (3.0% ), Rwanda (2.9% ), Pakistan (2.4%), Georgia (2%), Libya (1.8%)[49-55]. However, the prevalence was notably lower compared to studies from the United States (0.1%) and Saudi Arabia (0.3%)[43, 56]. These differences could be attributed to variations in HBV knowledge levels, adherence to standard precautions, and attitudes and practices concerning occupational exposure. Also, the prevalence of anti-HCV antibodies among the participants in our study was 3.3%. This figure closely resembles findings from previous research in Pakistan (3.2%), Libya (2%), Cameroon (1.7%), and Rwanda (1.3%). Notably, it was notably higher compared to a study in Egypt (8.0%) and Pakistan (5.6%)[50, 51, 53, 55, 57, 58]. This consistency in prevalence rates might suggest that healthcare workers share similar levels of knowledge and adherence to standard precautions, leading to comparable exposure and infection rates. In one instance from our study, there was a case of mixed hepatitis B and C virus infection (0.83%), which aligns closely with a previous study's findings (3.2% )[53] as showing in **Table. 4&5**.

Our results indicated that the positivity of HBsAg and anti-HCV antibodies was higher among males than females in this study as showing in **Table. 6**; however, this difference was not statistically significant (*P-*value > 0.05). This observation could be attributed to the higher level of social activity among males compared to females in Yemen. Additionally, males may be more exposed to gender-specific risk factors for HBV, such as practices like hairdressing and circumcision. It is worth noting that these findings contradict those of other studies[47].

In this study, the occupational risk of HBsAg positivity was most prevalent among hygienists (2), followed by lab technicians (1) and nurses (1), with significant statistical significance (*P-*value < 0.05). Contrary to findings from other studies like the one from Sudan, which showed the highest prevalence among cleaning staff and nurses, and a study from Belize, which reported higher rates among nurses and non-professional staff [47, 59]. On the other hand, the occupational risk of anti-HCV antibody positivity was higher among lab technicians (3) and hygienists (1), although this was statistically insignificant (*P* > 0.05). These results contrast with the study from Sudan [47]as showing in **Table.7.** Effective prevention of HBV infection primarily involves vaccinating unexposed healthcare workers; however, efforts should be made to promote vaccine acceptance among high-risk categories[60].

Our results have showed no statistically significant relationship was identified between HBV and HCV infections (*p-*value > 0.05) as showing in **Table.8**, aligning with a previous study[47].

Healthcare workers exhibited a lower risk of occupational exposure to HBV and HCV infections compared to other groups like medical students, possibly due to their strong knowledge and adherence to universal infection control procedures. However, inexperienced staff lacking knowledge and technical expertise may face potential risks. It is imperative to introduce education and training programs in infection control for healthcare staff promptly and periodically to mitigate these risks.

1. **CONCLUSION**

From our previous comprehensive study, we concluded that the prevalence of HBV and HCV infections among healthcare workers indicated an intermediate endemicity of HBV infection, as classified by the WHO while the prevalence of HCV was not high. Additionally, we identified several risk factors for HBV and HCV infections among HCWs, including hepatitis B virus vaccination status, profession, male gender, and the frequency of periodic hepatitis virus testing. The occupational risk of HBV infection among the HCWs in this study was high for the Hygienist, Lab Technician, and Nurse while the occupation risk of HCV infection was high for the Lab Technician and Hygienist. Effective prevention of HBV infection primarily relies on vaccinating unexposed HCWs, and promoting vaccine acceptance in these high-risk categories is essential. Since there is currently no anti-HCV vaccine available to combat HCV transmission, HCWs should protect themselves by rigorously applying universal prophylactic measures whenever they are potentially exposed. To address these issues, we recommend the development of a novel continuing medical education and pre-employment awareness program for HCWs, focusing on occupationally transmitted blood-borne diseases, standard precautions to prevent such infections, and safe injection practices.

**COMPETING INTERESTS DISCLAIMER**:

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

**REFERENCES**

1. Ganem, D. and A.M. Prince, *Hepatitis B virus infection—natural history and clinical consequences.* New England journal of medicine, 2004. **350**(11): p. 1118-1129.

2. Guidotti, L.G. and F.V. Chisari, *Immunobiology and pathogenesis of viral hepatitis.* Annu. Rev. Pathol. Mech. Dis., 2006. **1**(1): p. 23-61.

3. Ishikawa, T., *Immunoregulation of Hepatitis B Virus Infection―Rationale and Clinical Application* Nagoya journal of medical science, 2012. **74**(3-4): p. 217.

4. Al-Huthaifi, A., B. Al-Ofairi, and A. Humaid, *SERUM HBEAG AND HBV DNA MARKER LEVELS IN PATIENTS WITH CHRONIC HEPATITIS B INFECTION IN SANA’A CITY - YEMEN.* International Journal of Arts and Science Research 2020. **7(1)** (ISSN: 2393 – 9532 ): p. 20-28.

5. Seeger, C. and W.S. Mason, *Hepatitis B virus biology.* Microbiology and molecular biology reviews, 2000. **64**(1): p. 51-68.

6. Niederau, C., *Chronic hepatitis B in 2014: great therapeutic progress, large diagnostic deficit.* World journal of gastroenterology: WJG, 2014. **20**(33): p. 11595.

7. Riches, N., et al., *Vertical transmission of hepatitis B virus in the WHO African region: a systematic review and meta-analysis.* The Lancet Global Health, 2025. **13**(3): p. e447-e458.

8. Organization, W.H., *Interim guidance for country validation of viral hepatitis elimination*, in *Interim guidance for country validation of viral hepatitis elimination*. 2021.

9. Mohamadkhani, A., A. Katoonizadeh, and H. Poustchi, *Immune-regulatory events in the clearance of HBsAg in chronic hepatitis B: focuses on HLA-DP.* Middle East journal of digestive diseases, 2015. **7**(1): p. 5.

10. Favero, M., *Hepatitis-B antigen on environmental surfaces.* 1973.

11. Scott, D., et al., *A seroepidemiological survey of viral hepatitis in the Yemen Arab Republic.* Transactions of the Royal Society of Tropical Medicine and Hygiene, 1990. **84**(2): p. 288-291.

12. Haidar, N.A., *Prevalence of hepatitis B and hepatitis C in blood donors and high risk groups in Hajjah, Yemen Republic.* Saudi medical journal, 2002. **23**(9): p. 1090-1094.

13. Sallam, T.A. and C.W. Tong, *Two distinct types of hepatitis B virus core promoter variants in Yemeni blood donors.* Journal of medical virology, 2002. **68**(3): p. 328-334.

14. Al-Ofairi, B., A. Humaid, and A. Al-Huthaifi, *Serum HBe Ag and HBV DNA markers among different stages of chronic hepatitis B patients in Sana’a city, Yemen.* IJISRT. **5**(3): p. 625-634.

15. Munakata, T., et al., *Hepatitis C virus induces E6AP-dependent degradation of the retinoblastoma protein.* PLoS pathogens, 2007. **3**(9): p. e139.

16. Di Bisceglie, A.M., *Hepatitis C and hepatocellular carcinoma.* Hepatology, 1997. **26**: p. 34S-38S.

17. Lauer, G.M. and B.D. Walker, *Hepatitis C virus infection.* New England journal of medicine, 2001. **345**(1): p. 41-52.

18. Choo, Q.-L., et al., *Isolation of a cDNA clone derived from a blood-borne non-A, non-B viral hepatitis genome.* Science, 1989. **244**(4902): p. 359-362.

19. Lavanchy, D., *The global burden of hepatitis C.* Liver international, 2009. **29**: p. 74-81.

20. Sagnelli, E., et al., *The importance of HCV on the burden of chronic liver disease in Italy: a multicenter prevalence study of 9,997 cases.* Journal of medical virology, 2005. **75**(4): p. 522-527.

21. Sagnelli, E., et al., *Chronic hepatitis B in Italy: new features of an old disease—approaching the universal prevalence of hepatitis B e antigen—negative cases and the eradication of hepatitis D infection.* Clinical infectious diseases, 2008. **46**(1): p. 110-113.

22. Sagnelli, E., et al., *Impact of comorbidities on the severity of chronic hepatitis B at presentation.* World Journal of Gastroenterology: WJG, 2012. **18**(14): p. 1616.

23. Coppola, N., et al., *Hepatitis B virus and hepatitis C virus infection in healthcare workers.* World journal of hepatology, 2016. **8**(5): p. 273.

24. Hebo, H.J., D.H. Gemeda, and K.A. Abdusemed, *Hepatitis B and C viral infection: prevalence, knowledge, attitude, practice, and occupational exposure among healthcare workers of Jimma University Medical Center, southwest Ethiopia.* The Scientific World Journal, 2019. **2019**(1): p. 9482607.

25. Askarian, M., et al., *Precautions for health care workers to avoid hepatitis B and C virus infection.* 2011.

26. Kermode, M., et al., *Occupational exposure to blood and risk of bloodborne virus infection among health care workers in rural north Indian health care settings.* American journal of infection control, 2005. **33**(1): p. 34-41.

27. Omer, R., et al., *The role of hepatitis B and hepatitis C viral infections in the incidence of hepatocellular carcinoma in Sudan.* Transactions of the Royal Society of Tropical Medicine and Hygiene, 2001. **95**(5): p. 487-491.

28. Elseviers, M.M., et al., *Sharps injuries amongst healthcare workers: review of incidence, transmissions and costs.* Journal of renal care, 2014. **40**(3): p. 150-156.

29. Feldman, R. and E. Schiff, *Hepatitis in dental professionals.* Gastroenterology, 1973. **65**: p. 539.

30. DIENSTAG, J.L. and D.M. RYAN, *Occupational exposure to hepatitis B virus in hospital personnel: infection or immunization?* American journal of epidemiology, 1982. **115**(1): p. 26-39.

31. West, D.J., *The risk of hepatitis B infection among health professionals in the United States: a review.* The American journal of the medical sciences, 1984. **287**(2): p. 26-33.

32. Tarantola, A., D. Abiteboul, and A. Rachline, *Infection risks following accidental exposure to blood or body fluids in health care workers: a review of pathogens transmitted in published cases.* American journal of infection control, 2006. **34**(6): p. 367-375.

33. Organization, W.H., *Global hepatitis report 2024: action for access in low-and middle-income countries*. 2024: World Health Organization.

34. Chouhan, S., *HEPATITIS B PROPHYLAXIS PRACTICE AMONG MEDICAL STUDENTS: AN OVERVIEW.* Hepatitis B Annual, 2008. **5**.

35. MacDonald, M., N. Crofts, and J. Kaldor, *Transmission of hepatitis C virus: rates, routes, and cofactors.* Epidemiologic reviews, 1996. **18**(2): p. 137-148.

36. Organization, W.H., *Guidance on prevention of viral hepatitis B and C among people who inject drugs*, in *Guidance on prevention of viral hepatitis B and C among people who inject drugs*. 2012.

37. Allen, G., *Infection Control Update, An Issue of Perioperative Nursing Clinics: Infection Control Update, An Issue of Perioperative Nursing Clinics*. Vol. 5. 2010: Elsevier Health Sciences.

38. Patel, P.K., et al., *Strategies to prevent catheter-associated urinary tract infections in acute-care hospitals: 2022 Update.* Infection Control & Hospital Epidemiology, 2023. **44**(8): p. 1209-1231.

39. Control, C.f.D. and Prevention, *Recommendations for preventing transmission of infections among chronic hemodialysis patients.* MMWR, 2001. **50**(5): p. 1-43.

40. Organization, W.H., *Guidelines for the prevention, diagnosis, care and treatment for people with chronic hepatitis B infection*. 2024: World Health Organization.

41. Al-Tawfiq, J.A. and A. Anani, *Profile of viral hepatitis A, B, and C in a Saudi Arabian hospital.* Medical science monitor: international medical journal of experimental and clinical research, 2008. **14**(1): p. CR52-56.

42. Alam, M., *Knowledge, attitude and practices among health care workers on needle-stick injuries.* Annals of Saudi Medicine, 2002. **22**(5-6): p. 396-399.

43. Alqahtani, J.M., et al., *Seroprevalence of hepatitis B and C virus infections among health students and health care workers in the Najran region, southwestern Saudi Arabia: the need for national guidelines for health students.* BMC public health, 2014. **14**: p. 1-7.

44. Haviari, S., et al., *Vaccination of healthcare workers: A review.* Human vaccines & immunotherapeutics, 2015. **11**(11): p. 2522-2537.

45. Kane, M., *Global programme for control of hepatitis B infection.* Vaccine, 1995. **13**: p. S47-S49.

46. Anwar, W.A., et al., *Hepatitis C virus infection and risk factors among patients and health-care workers of Ain Shams University hospitals, Cairo, Egypt.* Plos one, 2021. **16**(2): p. e0246836.

47. Nail, A., S. Eltiganni, and A. Imam, *Seroprevalence of Hepatitis B and C among health care workers in Omdurman, Sudan.* Sudan Journal of Medical Sciences, 2008. **3**(3): p. 201-206.

48. Zampino, R., et al., *Hepatitis B virus burden in developing countries.* World journal of gastroenterology, 2015. **21**(42): p. 11941.

49. Ozsoy, M., et al., *Seroprevalences of hepatitis B and C among health care workers in Turkey.* Journal of viral hepatitis, 2003. **10**(2): p. 150-156.

50. Kateera, F., et al., *Hepatitis B and C seroprevalence among health care workers in a tertiary hospital in Rwanda.* Transactions of the Royal Society of Tropical Medicine and Hygiene, 2015. **109**(3): p. 203-208.

51. Aziz, S., et al., *Prevalence of HIV, hepatitis B and C amongst health workers of Civil Hospital Karachi.* Journal-Pakistan Medical Association, 2002. **52**(3): p. 92-94.

52. Aziz, S., et al., *Prevalence of HIV, hepatitis B and C amongst health workers of Civil Hospital Karachi.* JPMA. The Journal of the Pakistan Medical Association, 2006. **56**(1 Suppl 1): p. S48-50.

53. Adeel, M.Y., *Seroprevalence of hepatitis B and hepatitis C in health care workers in Abbottabad.* J Ayub Med Coll Abbottabad, 2008. **20**(3).

54. Butsashvili, M., et al., *Occupational exposure to body fluids among health care workers in Georgia.* Occupational medicine, 2012. **62**(8): p. 620-626.

55. Elzouki, A.-N., et al., *Hepatitis B and C status among health care workers in the five main hospitals in eastern Libya.* Journal of infection and public health, 2014. **7**(6): p. 534-541.

56. Thomas, D.L., et al., *Viral hepatitis in health care personnel at the Johns Hopkins Hospital: the seroprevalence of and risk factors for hepatitis B virus and hepatitis C virus infection.* Archives of internal medicine, 1993. **153**(14): p. 1705-1712.

57. Fritzsche, C., et al., *Hepatitis B and C: neglected diseases among health care workers in Cameroon.* Transactions of the Royal Society of Tropical Medicine and Hygiene, 2013. **107**(3): p. 158-164.

58. MK, M., *Hepatitis C virus infection and risk factors in health-care workers at Ain Shams University Hospitals, Cairo, Egypt.* 2015.

59. Hakre, S., et al., *Prevalence of hepatitis B virus among health care workers in Belize, Central America.* The American journal of tropical medicine and hygiene, 1995. **53**(2): p. 118-122.

60. Baddoura, R., C. Haddad, and M. Germanos, *Hepatitis B and C seroprevalence in the Lebanese population.* 2002.