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# SERO-PREVALENCE AND ASSOCIATED RISK FACTORS OF BLOOD-BORNE VIRAL INFECTION AMONG HEALTHCARE WORKERS OF A TERTIARY REFERRAL HOSPITAL: A SINGLE-CENTER EXPERIENCE

# SEROPREWALENCJA I POWIĄZANE CZYNNIKI RYZYKA ZAKAŻEŃ WIRUSOWYCH PRZENOSZONYCH PRZEZ KREW WŚRÓD PRACOWNIKÓW OPIEKI ZDROWOTNEJ W SZPITALU SPECJALISTYCZNYM: DOŚWIADCZENIE JEDNEGO OŚRODKA

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**Summary**

**Background**. Healthcare workers (HCWs) are often exposed to contaminated blood and body fluids from infected patients. There is no research on blood-borne infection in Iraqi Kurdistan; therefore, this study aimed to determine the prevalence of blood-borne infections of hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV) and their associated risk factors among HCWs in the hospital.
**Material and methods.** This cross-sectional study included 800 HCWs from a major tertiary teaching hospital, who were selected using a non-random technique.
**Results**. The mean age of the HCWs was 35.15 years (range: 18-70 years), consisting of males (56.0%) and females (44.0%) from various specialties and different departments. The seroprevalence of HBV was 0.75% (n=6) among HCWs. However, the seroprevalence of HBV was not significantly different among HCWs with different characteristics. Only one HCW had a positive result for HCV (0.13%), while no HCWs were found to have HIV. The study showed that 34.63% had experienced needlestick injuries, and 64.88% had received the HBV vaccination. Additionally, 27.20% were smokers, and 1.42% were alcohol consumers. Other characteristics included previous hospitalization (17.28%), a history of blood transfusion (6.23%), a history of surgical operations (27.48%), and a history of dental interventions (86.69%).
**Conclusions**. The study revealed a low seroprevalence of HBV and HCV among HCWs. No active HIV infection and almost none of them had contact with HCV.

**Keywords**: tertiary healthcare, blood-borne infections, tertiary hospital, viral diseases, healthcare workers

**Streszczenie**

**Wprowadzenie.** Pracownicy opieki zdrowotnej są często narażeni na kontakt z zakażoną krwią i płynami ustrojowymi pochodzącymi od zakażonych pacjentów. Nie ma badań dotyczących zakażeń krwiopochodnych w irackim Kurdystanie; dlatego też celem niniejszej pracy było określenie częstości występowania zakażeń krwiopochodnych wirusem zapalenia wątroby typu B (HBV), wirusem zapalenia wątroby typu C (HCV) i ludzkim wirusem niedoboru odporności (HIV) oraz związanych z nimi czynników ryzyka wśród pracowników opieki zdrowotnej w szpitalu.
**Materiał i metody**. W badaniach przekrojowych wzięło udział 800 pracowników opieki zdrowotnej z głównego specjalistycznego szpitala klinicznego, którzy zostali wybrani techniką nielosową.
**Wyniki.** Średni wiek pracowników opieki zdrowotnej wynosił 35,15 lat (zakres: 18-70 lat), na personel składali się mężczyźni (56,0%) i kobiety (44,0%) o różnych specjalizacjach i z różnych oddziałów. Seroprewalencja HBV wśród pracowników opieki zdrowotnej wynosiła 0,75% (n=6). Nie różniła się ona jednak istotnie wśród pracowników o różnych charakterystykach. Tylko jeden pracownik miał pozytywny wynik na obecność wirusa HCV (0,13%), podczas gdy u żadnego z nich nie wykryto wirusa HIV. Badanie wykazało, że 34,63% pracowników doświadczyło zranienia igłą, a 64,88% otrzymało szczepionkę przeciwko HBV. Dodatkowo, 27,20% było palaczami, a 1,42% spożywało alkohol. Inne cechy obejmowały wcześniejszą hospitalizację (17,28%), transfuzję krwi (6,23%), operacje chirurgiczne (27,48%) i interwencje stomatologiczne (86.69%).
**Wnioski.** Badanie wykazało niską seroprewalencję HBV i HCV wśród pracowników opieki zdrowotnej. Nie stwierdzono aktywnego zakażenia HIV i prawie żaden z pracowników nie miał kontaktu z HCV.

**Słowa kluczowe:** specjalistyczna opieka zdrowotna, zakażenia krwiopochodne, szpital specjalistyczny, choroby wirusowe, pracownicy służby zdrowia

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## Introduction

Blood-borne viruses (BBVs) encompass a range of viruses that can be transmitted through blood and blood products, sexual contact, and body fluids contaminated with infected blood. The primary BBVs of concern are the Hepatitis B Virus (HBV), Hepatitis C Virus (HCV), and Human Immunodeficiency Virus (HIV) [1]. A recent World Health Organization (WHO) report stated that globally, 296 million people were living with chronic HBV and 58 million with chronic HCV in 2019, while 37.7 million were living with HIV in 2020 [2].

These viruses are of significant medical importance due to their widespread distribution and the spectrum of clinical manifestations and associated complications [3]. Globally, it is essential to emphasize the substantial concern surrounding the transmission of such BBVs, particularly in developing countries [4]. Specific populations most affected by BBVs include healthcare workers (HCWs), intravenous drug users, individuals exposed through sexual transmission (e.g., men who have sex with men), and more [5].

HCWs are consistently exposed to contaminated blood from infected patients, placing them at high risk of contracting these infections [4]. Certain fields within HCW professions, such as nursing, surgery, and laboratory technology, play a crucial role in increasing the likelihood of percutaneous injuries [6]. Additionally, factors such as low HBV vaccination rates, lack of screening, and inadequate infection control measures contribute to an increased incidence of BBVs [5].

Accidental sharp injuries in healthcare settings can compromise the health and safety of a significant portion of exposed HCWs. The risk of HBV, HCV, and HIV transmission following a needlestick injury (NSI) from a viremic patient is estimated to be 6-30%, 1.8%, and 0.3%, respectively, in a susceptible individual [7]. The WHO estimates that approximately three million HCWs are exposed to BBVs, including 2 million to HBV infections, 0.9 million to HCV, and 170,000 to HIV infections. Around 40% of HBV and HCV cases and 2.5% of HIV cases in HCWs are attributed to occupational accidents [8]. This rate may be underestimated due to limited documentation of occupational exposures in developing countries.

Despite the absence of studies on BBV prevalence in the healthcare setting of Duhok, Iraqi Kurdistan, available data suggest a generally low prevalence of these viruses, although these studies were not population-based surveys [9,10]. Therefore, the study's objective was to determine the seroprevalence of HBV, HCV, and HIV among HCWs in a tertiary referral hospital. Furthermore, the study aimed to highlight significant risk factors contributing to the acquisition of these viruses.

## Material and methods

### *Study design and population*

This cross-sectional study involved 800 HCWs from a major tertiary teaching hospital, who were selected using a non-random technique. Of the staff who were invited to participate in this screening project, 800 HCWs from Azadi Teaching Hospital agreed to participate in this study. Participants were recruited from various departments and specialties within the hospital. The study received ethical approval from the Duhok General Directorate of Health and permission from the hospital administration. All participants provided verbal informed consent. We received consent from the Azadi Teaching Hospital for the publication of the data.

### *Sampling technique*

The present study served as a screening initiative led by the Duhok General Directorate of Health, aimed at assessing blood-borne infections among HCWs. Initially, the project intended to encompass the entire Azadi Hospital population. However, due to incompatible schedules and a handful of individuals declining to

participate, the researchers encountered limitations in accessing the blood samples of all staff members. Out of a total of 1245 staff affiliated with Azadi Hospital, 800 individuals were successfully included in the study (yielding a response rate of 64.26%). It is important to note that the researchers faced challenges in obtaining a randomized sample of HCWs, primarily due to disparities between the working schedules of several medical staff members and the designated data collection times. These logistical constraints contributed to the inability to ensure a fully representative sample for this study.

*Setting*

Blood samples were obtained via venipuncture from HCWs at Azadi Hospital, the main tertiary care referral hospital in Duhok governorate. The hospital provides medical, therapeutic, and surgical care for adult patients. Verbal consent was obtained before taking the blood samples. HCWs from various departments, including administration, cardiology, coronary care unit (CCU), consultation, ear, nose, and throat (ENT), emergency, hemato-oncology, intensive care unit (ICU), laboratory, maintenance, medicine, pharmacy, physiotherapy, radiology, and surgery were included. The hemato-oncology department comprised of HCWs working in the blood transfusion and oncology unit. HCWs from the gynecology, neurology, psychiatry, cardiology, and internal medicine units were included in the medicine department.

*Inclusion and exclusion criteria*

This study included 800 HCWs of both genders and various age groups from different departments, both medical and administrative. HCWs who had worked for less than six months were excluded, as this period did not provide sufficient opportunity for exposure to the infection. Initially, we included 800 HCWs, but we were only able to obtain the general and medical characteristics of 353 HCWs. Blood samples were taken from the HCWs with their names in the first step, while medical and general characteristics were extracted from the local hospital repository. However, some characteristics were not available in the repository, and attempts to obtain this information from HCWs were unsuccessful due to conflicting schedules. Therefore, we were only able to gather the following information from 353 HCWs: smoking status, alcohol consumption, history of previous hospitalization, history of blood transfusion, history of surgical operation, and history of dental intervention.

*Laboratory investigations*

The blood samples collected from HCWs were screened for hepatitis B surface antigen (HBsAg), anti-HBs antibodies, anti-HCV, and anti-HIV using Enzyme-linked immunosorbent assay (ELISA) at Azadi Hospital Laboratory. We followed the standard protocol for the measurements of viral blood-borne infections. The Microwell Method-96 wells; 12×8-well Antibody coated Strips – Individual breakaway of the DIALAB kit (Austria) was used for the HBsAg and HCV Ab measurements. The details of the HBsAg measurement can be read in the catalog REF Z00360 Z03504 Z03505 and the HCV Ab measurement in the HCV Ab catalog Ref. Z01370 on the www.dialab.at. The Vironostika® HIV Ag/Ab is an ELISA for the detection of antibodies to human immunodeficiency virus (anti-HIV-1, anti-HIV-2 and anti-HIV-1 group O) and HIV-1 antigen (HIV-1 p24 antigen) in human serum or plasma and is shown in the screening of blood to assess the unknown status related to an infection with HIV-1 and/or HIV-2. BioMérieux SA is the name of the manufacturer. Vironostika ® HIV Ag/Ab is an ELISA, based on a one-step 'sandwich' principle. The details can be read in Vironostika ® HIV Ag/Ab using 192 and 576 tests per kit in catalog numbers REF 259851 and 259852 on the https://www.biomerieux.com/us/en.html.

*Definition*

The cutoff value of 10 mIU/mL for anti-HBs antibodies is used for identifying a positive result [11]. This threshold was established according to the manufacturer's instructions (See Laboratory investigations for the determination of the parameters). Alcohol consumption was characterized in accordance with the guidelines outlined in Chapter 12: Alcohol Guidance [12].

*Statistical analysis*

The general and medical characteristics of HCWs were presented using either mean and standard deviation or number and percentage, depending on the type of data. The seroprevalence of HBV, HCV, and HIV among HCWs was reported in terms of both the number and percentage. To compare HBV prevalence among HCWs with different medical and general characteristics, Pearson chi-squared tests or Fisher's exact tests were utilized based on sample size. Statistical significance was defined as a *p*-value less than 0.05. All statistical analyses were performed using JMP Pro 14.3.0 (https://www.jmp.com/en_us/home.html).

## Results

*Characteristics and risk factors*

The mean age of the HCWs was 35.15, ranging from 18 to 70 years old. The HCWs encompassed different age groups, with the majority falling within the middle age range (20-49 years old). The gender distribution consisted of males (56.0%) and females (44.0%), spanning various specialties. The specialties included in this study were administrative staff (18.75%), cleaners (8.25%), doctors (25.25%), nurses (32.88%), paramedics (11.63%), pharmacists (1.75%), and police personnel (1.50%). These HCWs were recruited from diverse departments of the hospital, including administration, medical, surgical, intensive care unit (ICU), medicine, and the lab (Table 1). The study revealed that 34.63% of HCWs had experienced NSI, and 64.88% had received the HBV vaccination. Additionally, 27.20% were smokers, and 1.42% consumed alcohol. Other notable characteristics of HCWs included a history of previous hospitalization (17.28%), a history of blood transfusion (6.23%), a history of surgical operations (27.48%), and a history of dental interventions (86.69%; Table 1).

**Table 1.** General and medical characteristics of healthcare workers at Azadi teaching hospital

| **HCWs' characteristics (n=800)** | | **No. (%)** |
|---|---|---|
| **Age (18-70 years)** | **Std Err Mean:** 0.33 | **Mean**: 35.15 (SD: 9.29) |
| **Age category** | 18-19 | 5 (0.63) |
| | 20-29 | 242 (30.25) |
| | 30-39 | 338 (42.25) |
| | 40-49 | 149 (18.63) |
| | 50-59 | 48 (6.00) |
| | 60-69 | 16 (2.00) |
| | 70-79 | 2 (0.25) |
| **Sex** | Male | 448 (56.0) |
| | Female | 352 (44.0) |
| **Specialty** | Administrative staff | 150 (18.75) |
| | Cleaner | 66 (8.25) |
| | Doctor | 202 (25.25) |
| | Nurse | 263 (32.88) |
| | Paramedic | 93 (11.63) |
| | Pharmacist | 14 (1.75) |
| | Police | 12 (1.50) |

| HCWs' characteristics (n=800) | | No. (%) |
|---|---|---|
| **Department** | Administration | 101 (12.63) |
| | Cardiology | 23 (2.88) |
| | CCU | 14 (1.75) |
| | Consultation | 49 (6.13) |
| | E.N.T | 5 (0.63) |
| | Emergency | 29 (3.63) |
| | Hemato-oncology | 31 (3.88) |
| | ICU | 17 (2.13) |
| | Laboratory | 52 (6.50) |
| | Maintenance | 44 (5.50) |
| | Medicine | 98 (12.25) |
| | Pharmacy | 39 (4.88) |
| | Physiotherapy | 7 (0.88) |
| | Radiology | 67 (8.38) |
| | Surgery | 224 (28.0) |
| **Employment** | Contract | 79 (9.88) |
| | Permanent | 721 (90.13) |
| **Needlestick injury** | No | 523 (65.37) |
| | Yes | 277 (34.63) |
| **HBV vaccination** | No | 281 (35.13) |
| | Yes | 519 (64.87) |
| **Smoker** | No | 257 (72.81) |
| | Yes | 96 (27.20) |
| **Alcohol consumption*** | No | 348 (98.58) |
| | Yes | 5 (1.42) |
| **Previous hospitalization** | No | 292 (82.72) |
| | Yes | 61 (17.28) |
| **History of blood transfusion** | No | 331 (93.77) |
| | Yes | 22 (6.23) |
| **History of surgical operation** | No | 256 (72.52) |
| | Yes | 97 (27.48) |
| **History of dental intervention** | No | 47 (13.31) |
| | Yes | 306 (86.69) |
| **Anti-HBs (Range: 3-500)** | - | Mean: 240.53 (SD: 222.83) |

Notes: * all five HCWs indicated low-risk drinking, with each reporting consumption below 14 units.

*Seroprevalence of blood-borne infection*

The study demonstrated a seroprevalence of 0.75% (n=6) for HBV and 0.13% for HCV among HCWs at Azadi Hospital. No cases of HIV were found among HCWs of Azadi Hospital in this region (Figure 1). The seroprevalence of HBV did not exhibit significant differences across HCWs with varying characteristics, such as age, sex, specialty, department of work, history of hospitalization, surgery, smoking, alcohol intake, history of NSI, and other attributes (Table 2). Furthermore, the study identified only one HCW with a positive result for HCV (0.13%), while no HCWs were found to have HIV.

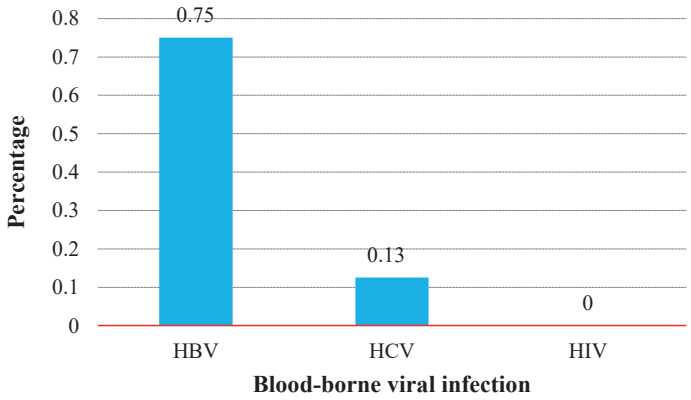


**Figure 1.** Serological status for blood-borne viruses among a study group of HCWs

**Table 2.** Sero-prevalence of hepatitis HBV among healthcare workers with different characteristics

| HCWs' characteristics (n=800) | | HBV no. (%) | | *p* (two-tailed) |
|---|---|---|---|---|
| | | Negative 794 (99.25%) | Positive 6 (0.75%) | |
| **Age category** | 18-19 | 5 (100) | 0 (0.00) | 0.2241 |
| | 20-29 | 241 (99.59) | 1 (0.41) | |
| | 30-39 | 336 (99.41) | 2 (0.59) | |
| | 40-49 | 148 (99.33) | 1 (0.67) | |
| | 50-59 | 47 (97.92) | 1 (2.08) | |
| | 60-69 | 15 (93.75) | 1 (6.25) | |
| | 70-79 | 2 (100) | 0 (0.00) | |
| **Sex** | Male | 443 (98.88) | 5 (1.12) | 0.2372 |
| | Female | 351 (99.72) | 1 (0.28) | |
| **Specialty** | Administrative staff | 149 (99.33) | 1 (0.67) | 0.9056 |
| | Cleaner | 65 (98.48) | 1 (1.52) | |
| | Doctor | 201 (99.50) | 1 (0.50) | |
| | Nurse | 260 (98.86) | 3 (1.14) | |
| | Paramedic | 93 (100) | 0 (0.00) | |
| | Pharmacist | 14 (100) | 0 (0.00) | |
| | Police | 12 (100) | 0 (0.00) | |
| **Department** | Administration | 100 (99.01) | 1 (0.99) | 0.9470 |
| | Cardiology | 23 (100.00) | 0 (0.00) | |
| | CCU | 14 (100.00) | 0 (0.00) | |
| | Consultation | 48 (97.96) | 1 (2.04) | |
| | E.N.T | 5 (100.00) | 0 (0.00) | |
| | Emergency | 29 (100.00) | 0 (0.00) | |
| | Hemato-oncology | 31 (100.00) | 0 (0.00) | |
| | ICU | 17 (100.00) | 0 (0.00) | |
| | Laboratory | 51 (98.08) | 1 (1.92) | |
| | Maintenance | 44 (100.00) | 0 (0.00) | |
| | Medicine | 98 (100.00) | 0 (0.00) | |
| | Pharmacy | 38 (97.44) | 1 (2.56) | |
| | Physiotherapy | 7 (100.00) | 0 (0.00) | |
| | Radiology | 66 (98.51) | 1 (1.49) | |
| | Surgery | 223 (99.55) | 1 (0.45) | |

| HCWs' characteristics (n=800) | | HBV no. (%) | | *p* (two-tailed) |
|---|---|---|---|---|
| | | Negative 794 (99.25%) | Positive 6 (0.75%) | |
| **Employment** | Contract | 79 (100) | 0 (0.00) | 1.0000 |
| | Permanent | 715 (99.17) | 6 (0.83) | |
| **Needlestick injury** | No | 517 (98.85) | 6 (1.15) | 0.0981 |
| | Yes | 277 (100) | 0 (0.00) | |
| **HBV vaccination** | No | 278 (98.93) | 3 (1.07) | 0.4289 |
| | Yes | 516 (99.42) | 3 (0.58) | |
| **Smoker** | No | 256 (99.61) | 1 (0.39) | 0.4705 |
| | Yes | 95 (98.96) | 1 (1.04) | |
| **Alcohol consumption** | No | 346 (99.43) | 2 (0.57) | 1.0000 |
| | Yes | 5 (100) | 0 (0.00) | |
| **Previous hospitalization** | No | 290 (99.32) | 2 (0.68) | 1.0000 |
| | Yes | 61 (100) | 0 (0.00) | |
| **Hx of blood transfusion** | No | 330 (99.70) | 1 (0.30) | 0.1209 |
| | Yes | 21 (95.45) | 1 (4.55) | |
| **Hx of surgical operation** | No | 255 (99.61) | 1 (0.39) | 0.4746 |
| | Yes | 96 (98.97) | 1 (1.03) | |
| **Hx of dental intervention** | No | 47 (100) | 0 (0.00) | 1.0000 |
| | Yes | 304 (99.35) | 2 (0.65) | |

Notes: Pearson chi-squared tests were performed for statistical analyses.

Both male and female HCWs across different age groups were found to be infected by HBV. The infected HCWs originated from various specialties, including administrative staff (n=1), nurses (n=3), doctors (n=1), and cleaners (n=1). Moreover, they represented diverse departments, such as radiology (n=1), consultation (n=1), surgery (n=1), pharmacy (n=1), administration (n=1), and the laboratory (n=1). Notably, they had no history of NSI, and three of them had received the HBV vaccination (Table 3). The study also indicated that older HCWs exhibited a higher seroprevalence of HBV compared with their younger counterparts (Figure 2).

**Table 3.** Case series of positive HCWs with positive HBV infection

| Characteristics of HCWs with positive HBV infection | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Age** | **Sex** | **Specialty** | **Department** | **Employment** | **HBV** | **HCV** | **Anti-HIV** | **Needlestick injury** | **HBV vaccination** |
| 27 | Male | Administrative Staff | Radiology | Permanent | Positive | Negative | Negative | No | No |
| 34 | Female | Nurse | Consultation | Permanent | Positive | Negative | Negative | No | Yes |
| 48 | Male | Doctor | Surgery | Permanent | Positive | Negative | Negative | No | No |
| 54 | Male | Nurse | Pharmacy | Permanent | Positive | Negative | Negative | No | Yes |
| 60 | Male | Nurse | Administration | Permanent | Positive | Negative | Negative | No | Yes |
| 33 | Male | Cleaner | Laboratory | Permanent | Positive | Negative | Negative | No | No |

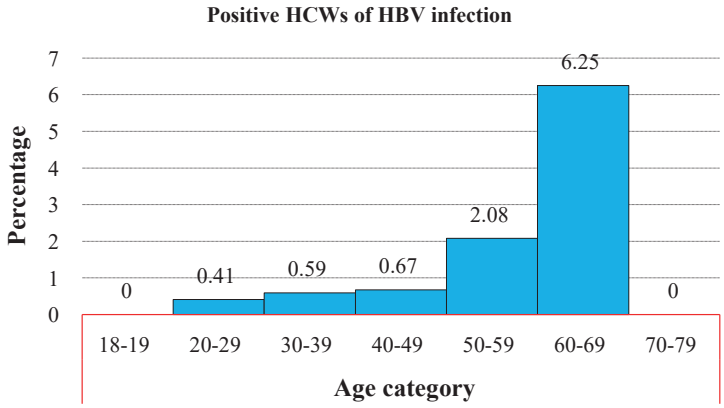


**Figure 2.** Sero-prevalence of HBV interpreted as a positive among different HCWs' age groups

## Discussion

This study showed that seroprevalence of HBV, HCV, and HIV infections was low among HCWs in this region (0.75%, 0.13%, and 0.0%, respectively). The prevalence of these viruses was lower compared with studies in the general population from the same region [9,10]. A study by Merza et al. on 4851 patients who underwent elective surgery, stated that the frequency of HBV was 1.79%, while that of HCV was 0.14 [9]. Another study by our research group on 214 tuberculosis patients found that the prevalence rates of HBV, HCV, and HIV were 1.87%, 0.47%, and zero, respectively [10]. The prevalence of HBV and HCV among the general population of Iraq for the year 2006-2007 revealed a rate of 1.6% and 0.04%, respectively [13]. The prevalence rates of HBV, HCV, and HIV in our study were lower than those reported among HCWs in most previous studies. Reported prevalence rates of HBV among HCWs were 2.18% in Pakistan [14], 2.9% in Rwanda [15], 1.8% in Libya [16], 7% in Tanzania [17], 1.4% in France [18], and 1.6% in Belgium [18]. Correspondingly, the recorded prevalence of HCV among HCWs in Pakistan [19], Rwanda [15], Libya [16], France [18], and Belgium [18] was 0.8%, 1.3%, 2%, 4.4%, and 4.4%, respectively. Furthermore, no HIV cases were revealed in the HCWs under study, which was consistent with studies from Iran [1] and Pakistan [19]. Our HIV finding was extremely low compared with studies from France (2.7%) [18], and Belgium (2.1%) [18].

The low prevalence of BBVs among HCWs in this study could be reflected by the low prevalence of such viruses among the general population. Furthermore, it could be interpreted in part by adherence to infection control measures. In our study, the occurrence of HBV, HCV, and HIV among HCWs is minimal. This can be partly attributed to the low prevalence of these viruses within the general population in our area [9,10].

The rate of exposure to NSIs was low (34.63%) in this study compared with studies from Libya (50%) [16], and Iran (63.3%) [20]. Additionally, we did not find a significant association of NSI with acquisition of BBVs ($p$=0.0981). Overall, NSIs are the major risk factors for acquiring BBVs [19,21]. A study by Tang et al. on 6297 HCWs found that NSIs were the most prevalent (63%) [22].

The rate of HBV vaccination (64.88% fully vaccinated) among HCWs in the present study was low compared with studies from Pakistan (fully vaccinated 86%, partially vaccinated 12%) [21], and Brazil (86.4%) [23]. Our vaccination coverage was comparable with a Tanzanian study (63.5%). In contrast, a study by Elzouki et al. on 601 HCWs, reported a 51.4% positive immunity rate against HBV [16]. In general, the low vaccination rate in our study should encourage HCWs to receive complete HBV vaccine doses. HBV vaccination is commonly recommended among HCWs in Iraq; however, making it a compulsory program would be essential. It's worth highlighting that in the late 1980s, the HBV vaccine was introduced as a routine component of the Expanded

Program of Immunization for Infants [24]. Consequently, for the present study, HCWs aged ≤ 33 years were selected for inclusion in Iraq's HBV vaccination program.

Concerning seroprevalence of HBV in association with risk factors, we did not find a significant difference among HCWs with demographic and clinical characteristics. In the present study, although there was no significant association, 3 nurses were HBV positive. This finding was in line with other studies confirming that nurses are at high risk of contracting BBVs because they are interacting with patients firsthand [1,14,16,17,25,26]. A high proportion (86.69%) of HCWs underwent dental intervention, but there was no significant difference between HBV positive and HBV negative staff. On the other hand, dental interventions were found to be an independent risk factor for acquiring HBV amongst tuberculosis patients studied previously [10]. In parallel, several research documents reported significant association with dental treatment [14,25,27]. Hence, dental clinics should apply adequate infection control policies to prevent such unforeseen events. There is a possibility that advanced age could be a predictor of contracting HBV infection. However, in our study, we did not observe such an association. It's important to note that the low infection rate in our sample prevented us from accurately identifying predictors of infection. Other researchers have documented increasing HBV incidence with increasing age [14,17,28]. We can determine that, as the age of HCWs advances, the possibility of exposure to BBVs increases, hence a higher probability of contracting the virus.

The main limitation of this study is a single-center study, and we didn't investigate anti-HBc, which might result in some missing HBV cases. Hence, in the event of an occurrence of isolated anti-HBc, two possibilities arise: it could indicate that a patient is within the window period before HBsAg becomes detectable, or that a patient possesses a low titer of HBsAg. These scenarios might potentially lead us to underestimate the actual prevalence rate of HBV in our study.

## Conclusions

In conclusion, seroprevalence of HBV and HCV was low among HCWs. There was no active HIV infection, and hardly any of them had had contact with HCV. The rate of HBV vaccination was low, hence HCWs should be encouraged to receive complete vaccine doses. Since no vaccines for HCV and HIV are available, strict infection control measures should be followed up. Overall, continuous education programs on preventive measures against BBVs are recommended. Screening of HBV, HCV, and HIV of HCWs, particularly those newly appointed, is a priority in ensuring complete HBV vaccination. Further prospective studies with larger sample sizes from different healthcare facilities are recommended to better understand the prevalence and associated risk factors.

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