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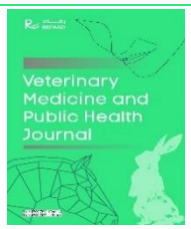
*Veterinary Medicine and Public Health Journal (VMPH)*

Journal Homepage: https://www.refaad.com/Journal/Index/7

E-ISSN 2707-7195 | P-ISSN 2707-7187

Vol. 6, No. 3, 2025, pp. 81 - 89




# Incidence of Hepatitis B Virus in Mosul City: A comprehensive Review, Statistics, and Meta-Analysis

**Ali Adel Dawood[1*], Zina Waadallah Aziz[2], Omar Natiq Salem[3], Zaid Ali Abdul Razzaq[3], Muhammad Nashwan Hazem[3], Bashir Suhaib Muhammad[3], Suhaib Anwar Mustafa[3], Zaid Hazem Allawi[3]**

[1] Assistant Prof, Department of Anatomy, College of Medicine, University of Mosul, Mosul, Iraq.
[2] Consultant physician / Ibn-Sina Teaching Hospital, Mosul, Iraq.
[3] Student in 5th stage, College of Medicine, University of Mosul, Mosul, Iraq.
[*] Corresponding Author: Ali Dawood (aad@uomosul.edu.iq)

Review Article
https://doi.org/10.31559/VMPH2025.6.3.1
Received: 5 June 2025
Revised: 6 Jul 2025
Accepted: 21 Jul 2025

**How to cite this article:** Dawood, A. A., et al. (2025). Incidence of Hepatitis B Virus in Mosul City: A comprehensive Review, Statistics, and Meta-Analysis. *Veterinary Medicine and Public Health Journal*, 6 (3), 81-89. https://doi.org/10.31559/VMPH2025.6.3.1



**Abstract:**

**Objectives:** This study aimed to assess the prevalence of HBV, analyze its distribution across different demographic groups (age, gender, marital status), and identify risk factors associated with HBV infection in the population of Nineveh to guide public health interventions.

**Methods:** A descriptive study data was conducted using hospital records from Ibn-Sina Hospital in Mosul city from (February 2024 - January 2025). 16,900 individuals screened for HBV using ELISA were analyzed. The statistical analysis including calculations, measures, chi-square tests, relative risk, and geographical analysis was conducted using SPSS version 25.

**Results:** The overall HBV prevalence among the screened population was 0.72%. A significant association was found between age and HBV infection ($\chi^2$=59.03, p<0.0001), with the highest prevalence in individuals over 40 years old (63.11%). Males exhibited a slightly higher prevalence (0.75%) compared to females (0.70%). Married individuals had a higher HBV prevalence than single individuals. Surgical procedures were identified as a significant risk factor, with surgical patients having a 43.26 times higher risk of HBV infection compared to dialysis patients. September 2024 recorded the highest number of HBV positive cases (16), while April 2024 had the lowest (4).

**Conclusion:** Strengthening preventative measures such as maternal screening, occupational safety protocols, increased screening programs for older adults, and improved healthcare access in rural areas are crucial for effective HBV control in Nineveh.

***Keywords:*** *HBV; Incidence; gender; analysis.*

## 1 Introduction

Hepatitis B virus is a hepatotropic virus and important human pathogen. Although there are effective vaccines and treatment strategies, it is still a significant health concern worldwide due to high morbidity and mortality, with the highest prevalence of chronic HBV found in Asia and Africa (Chuang et al., 2022; Guvenir & Arikan, 2020; Ogunnaike et al., 2023). This infection can be transmitted through sexual intercourse, parenteral contact, vertical transmission (mother-to-child), and blood transfusion (Becker et al., 2013).

HBV can be broadly divided into acute and chronic categories. Acute HBV infections are generally self-limiting with clearance of hepatitis B surface antigen (HBsAg) within 6 months, and only a few cases cause hepatocellular necrosis leading to acute liver failure. Chronic HBV infection is characterized by the persistence of HBsAg for more than 6 months, which could cause advanced liver fibrosis, cirrhosis, and hepatocellular carcinoma (Boora et al., 2023; Cao et al., 2020; Sterling et al., 2023).

Symptoms of acute HBV involve jaundice, right upper quadrant pain, fever, skin rash, myalgia, fatigue, nausea, and anorexia. In chronic HBV, the patient may be asymptomatic (only serologic or histopathologic changes) or have nonspecific symptoms (AMBOSS, 2024).

HBV is an enveloped DNA virus classified into ten genotypes (A–J) and 40 sub-genotypes. These genotypes and sub-genotypes have been reported to affect disease transmission, progression, and treatment outcomes (Tsukuda & Watashi, 2020; Guvenir & Arikan, 2020).

Various serological assays can detect virus-specific antigens (HBsAg, HBeAg, HBcAg) and antibodies (Anti-HBs, Anti-HBe, Anti-HBc). These tests are used to determine whether a patient is susceptible to infection (acute or chronic) or immune due to past infection or HBV vaccination. Abdominal ultrasound is used to evaluate liver parenchyma and biliary tract to screen for fibrosis and hepatocellular carcinoma. Other tests include CBC (mild leukopenia, thrombocytopenia), LFT (elevated ALT, AST, ALP, bilirubin; decreased albumin; prolonged PT/INR), and GUE (dark-colored urine, bilirubinemia). Biopsy is indicated in diagnostic uncertainty when results will guide treatment decisions or exclude other causes of liver damage (Murray et al., 2020; Kumar et al., 2021; AMBOSS, 2024).

Treatment of acute HBV consists of supportive measures, and for chronic active HBV, nucleoside or nucleotide analogs are the preferred agents to reduce viral replication and infectivity. Liver transplantation is the last resort for end-stage liver disease. Prophylactic immunization with a recombinant vaccine is recommended for all age groups (AMBOSS, 2024; European Association for the Study of the Liver [EASL], 2017).

This study aimed to examine the statistical distribution of HBV patients in the study sample, with a focus on identifying the demographic and clinical factors associated with disease incidence and progression, in order to gain a better understanding of the health problem's dimensions and identify the groups most vulnerable to infection.

## 2 Materials and Methodology

### 2.1 Study design and sampling:

Descriptive study for understanding the prevalence, distribution, and characteristic factors of HBV in Nineveh. This study took place in Mosul city at Ibn-Sina Hospital and conducted over 12-month period, from February 2024 to January 2025. The data was collected depending on the hospital's record, where patient samples were tested for HBV using ELISA & the information provided an excel sheet containing the test result & relevant patient information.

This study included 16,900 individuals who underwent HBV screening during the study period. This sample size was sufficient to provide statistically significant results for the analysis of prevalence, age distribution, and risk factor where (HB+) cases were 122 individuals and (HB-) cases were 16,778 individuals.

### 2.2 Instrument statistical analysis and ethical approval:

Descriptive statistics utilized to summarize the data of HBV among various demographic categories of age, gender, marital status, and source of infection. Age distribution of HBV-positive participants was determined by average (mean), median, mode, range, and standard deviation.

Chi square was run to test the hypothesis that there was difference in the HBV distribution among the age groups as well as the surgical and dialysis patients. On incidence comparisons, the chance of finding someone with HBV infection was computed using relative risk (RR) in surgical patients compared with dialysis patients who had odds ratio (OR). Statistical analyses were done

through SPSS 25. Any of the p-value < 0.05 was even found significant.

## 3 Results

Testing and vaccination coverage of HBV is provided on a monthly basis in (Table 1) and pictured in (Figure 1). In the duration of the study, 16,900 persons were tested, out of which 122 turned out to be positive in regard to HBV (HB+). September 2024 registered the greatest number of HBV cases; 16 positive and April 2024 the least number; 4 positives. The percentage or the number of vaccinated individuals vaccinated against HBV is 1,742 with the highest vaccination performed in March 2024 (556 vaccinations) (Figure 2).

**Table 1:** Distribution of HBV cases by month.

| Date | People Tested | HB+ | Vaccination |
|---|---|---|---|
| 2024 February | 1444 | 10 | N/A |
| 2024 March | 1232 | 13 | 556 |
| 2024 April | 1271 | 4 | 490 |
| 2024 May | 1121 | 14 | 212 |
| 2024 June | 1674 | 10 | 102 |
| 2024 July | 1327 | 9 | 100 |
| 2024 August | 1839 | 11 | 21 |
| 2024 September | 1764 | 16 | 124 |
| 2024 October | 1308 | 9 | 95 |
| 2024 November | 1478 | 9 | 5 |
| 2024 December | 1533 | 9 | 5 |
| 2025 January | 909 | 8 | 22 |
| | **16900** | **122** | **1742** |

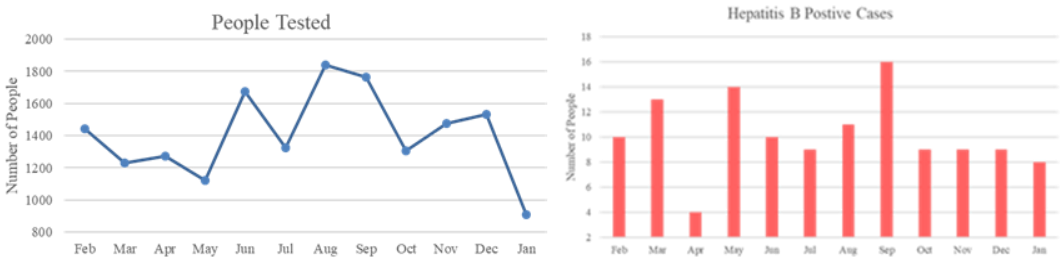



**Figure 1:** People test for HBV by month.

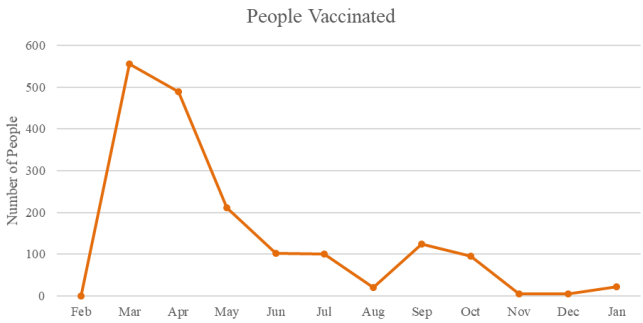



**Figure 2:** Vaccinated people against HBV by month.

Table 2 and Figure 3 show the age distribution of HBV cases. Of 122 cases of HB+, 8 cases (6.55%) fell under the age of 20 years, 37 cases (30.32%) concerned the age group 20-40 years, whereas most cases 77 cases (63.11%) were in ages older than 40 years. The chi-square statistical analysis indicated that there was significance in the variance of HBV in the different age groups ($X^2 = 59.03$, $p < 0.0001$). Moreover, patients with age (>40 years) were found to be 9.63 times more at risk of getting infected with HBV than the age of younger people (<20 years).

**Table 2:** Distribution of HBV cases by age.

| Age Category | HB+ | Percentage |
|---|---|---|
| Young age (<20) | 8 | 6.55% |
| Middle age (20–40) | 37 | 30.32% |
| Old age (>40) | 77 | 63.11% |

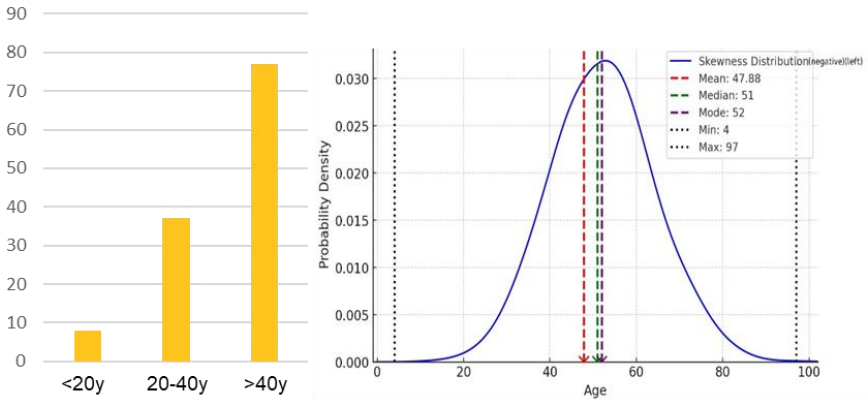



**Figure 3:** Distribution of HBV cases by age.

X (data set) = {4, 10, 12, 12, 13, 19, 19, 19, 20, 20, 20, 21, 22, 23, 25, 27, 27, 27, 29, 29, 29, 30, 30, 31, 31, 31, 31, 32, 32, 32, 33, 33, 34, 35, 35, 35, 35, 36, 36, 38, 38, 38, 39, 40, 40, 41, 41, 42, 42, 43, 45, 45, 45, 45, 45, 47, 47, 47, 49, 49, 51, 51, 52, 52, 52, 52, 52, 52, 52, 53, 54, 54, 54, 55, 55, 55, 55, 56, 56, 58, 58, 59, 60, 60, 60, 60, 60, 60, 62, 63, 63, 64, 65, 65, 65, 65, 65, 66, 66, 67, 67, 67, 67, 68, 68, 69, 69, 70, 70, 70, 70, 71, 72, 72, 73, 73, 74, 74, 75, 75, 82, 97}

N (total number of scores) = {122}

Mean ($\mu$) = $\sum x / n$

Mean ($\mu$) = 5832 / 122

Mean ($\mu$) = 47.88

Median = (n/2) + (n/2 + 1) / 2

Median = (122/2) + (122/2 + 1) / 2

Median = 51

Mode = most frequent value

Mode = 52

Range = Max - Min

Range = 97 - 4

Range = 93

Standard Deviation ($\sigma$) = $\sqrt{\sum(x - \mu)^2 / 2}$

Standard Deviation ($\sigma$) = $\sqrt{673.445 / 2}$

Standard Deviation ($\sigma$) = 18.35

- Null Hypothesis ($H_0$): the distribution of Hepatitis B cases is equal across all age categories
- Alternative Hypothesis ($H_1$): the distribution of Hepatitis B cases is not equal across age categories
- $\chi 2 = \sum(Oi - Ei)^2/Ei$

where:

Oi = observed frequency (8, 37, 77)

Ei = expected frequency (if distribution were equal) >> each age category: (122/3 = 40.67) cases

$\chi 2$ = (8- 40.67) $^2$/40.67 + (37- 40.67) $^2$/40.67 + (77- 40.67) $^2$/40.67 = 59.03

- Degrees of Freedom (df): 3 - 1 = 2
- Critical Value for alpha = 0.05 is 5.99
- Conclusion: Since $\chi 2$ = (59.03 > 5.99), we reject the null hypothesis & the distribution of Hepatitis B cases is significantly different across age categories. *P*-value is less than 0.0001.

Relative Risk (RR): comparing the risk of Hepatitis B in old age (>40) vs young age (<20).

RR = Risk in Old Age / Risk in Young Age.

RR = {77/122}/ {8/122} = 9.63

Interpretation: Individuals > 40 have 9.63 times higher risk compared to those < 20.

Table 3, and Figure 4 show the distribution of HBV according to gender. There were 65 positive males in 8711 with a result of 0.75 percent therefore there were 57 positive females in 8189 resulting to 0.70 percent. The results show that there is an increased margin of HBV among the males than among the females.

**Table 3:** Distribution of HBV cases by gender

| Gender | People Tested | HB+ | Prevalence | Percentage |
|---|---|---|---|---|
| Male | 8711 | 65 | 0.75% | 53.3% |
| Female | 8189 | 57 | 0.70% | 46.7% |

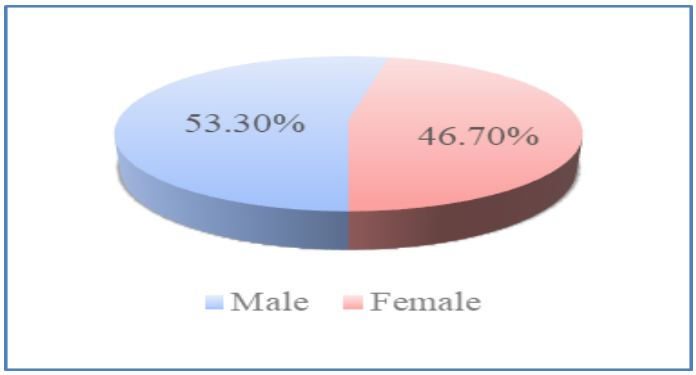



**Figure 4:** Distribution of HBV cases by gender.

There was also an association between marital status and HBV prevalence as provided in (Table 4). Among the 122 HB+ cases, 99 (81.1) cases were among married cases and 23 (18.9) were among the single individuals, implying that there were greater chances of infection among the married individuals.

**Table 4:** Distribution of HBV cases by marital status.

| Marital status | HB+ | Percentage |
|---|---|---|
| Married | 99 | 81.1% |
| Single | 23 | 18.9% |

There was description of the HBV transmission source (Tables 5-6 and Figures 5-6). The highest percentages of infections were caused by surgical procedures (77 cases, 63.11%), pre-marital screening (14 cases, 11.48%) as well as endoscopic procedures (12 cases, 9.83%). The contribution made by blood transfusion was 5 cases (4.09%) and the presence of dialysis-related infections was low with 2 cases (1.64%). By carrying out a chi-square test of independence, the relationship between surgical patients and status of HBV emerged to be statistically significant (using a critical value of 0.05, 2-tailed) with a 2 degrees of freedom value of 81.18 and a probability of < 0.0001. The risk and chances of the surgical patients of contracting HBV infection were highest (43.26 and 44.07 times) as compared to dialysis patients.

**Table 5:** Distribution of HBV by Source.

| Reported cases | HB+ | Percentage |
|---|---|---|
| Surgical procedure | 77 | 63.11% |
| Pre-marital screening | 14 | 11.48% |
| Endoscopic procedure | 12 | 9.83% |
| Consultancy referral | 10 | 8.21% |
| Blood patient | 5 | 4.09% |
| Kidney dialysis | 2 | 1.64% |
| Emergency | 1 | 0.82% |
| Laboratory | 1 | 0.82% |

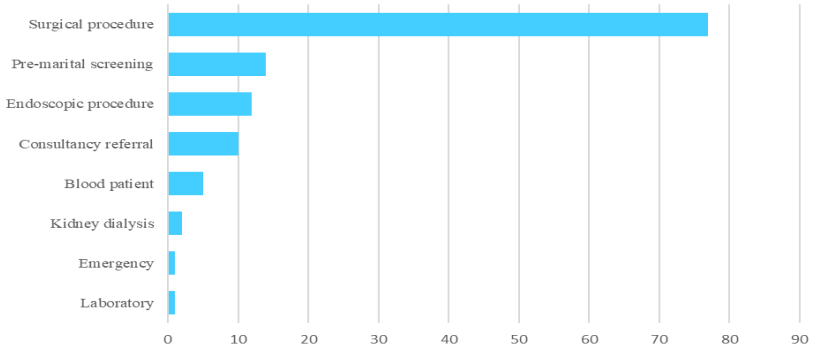



**Figure 5:** Distribution of HBV cases by source.

**Note:** Table 6 does not show the cases of HBV-positive patients (n=79), which are only those sourced out of surgical and dialysis patient groups. The rest of the 43 cases was identified in other ways like endoscopy, screening of pre-marital, and consultancy referrals.

**Table 6:** HBV cases [Surgical vs Dialysis] patients.

| Patient Source | HB+ | HB- | Total |
|---|---|---|---|
| Surgical patient | 77 | 3743 | **3820** |
| Dialysis patient | 2 | 4285 | **4287** |
| **Total** | **79** | **8028** | **8107** |

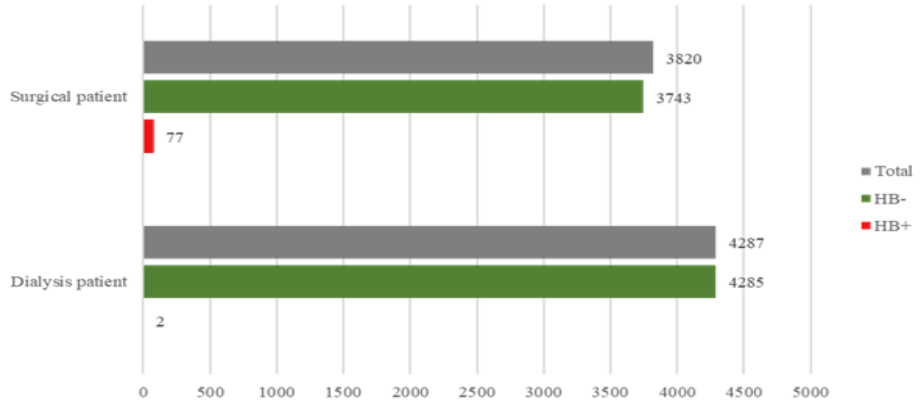



**Figure 6:** HBV cases [Surgical vs Dialysis] patients.

Step 1: State the hypotheses

• Null Hypothesis ($H_0$): There is no association between the type of patient (surgical vs dialysis) and HBV status (HB+ vs HB-)

• Alternative Hypothesis ($H_1$): there is an association between the type of patient and HBV status

Step 2: Calculate expected frequencies

E = Row Total × Column total / Grand total

- Expected frequency for surgical patients (HB+): E (11) = 3820 × 79 / 8107 = 37.22
- Expected frequency for surgical patients (HB-): E (12) = 3820 × 8028 / 8107 = 3782.78
- Expected frequency for dialysis patients (HB+): E (21) = 4287 × 79 / 8107 = 41.78
- Expected frequency for dialysis patients (HB-): E (22) = 4287 × 8028 / 8107 = 4245.22

Step 3: Calculate the chi-square statistic

$\chi 2 = \sum(Oi - Ei)^2/Ei$

- For Surgical patients (HB+) : $\chi 2 = \sum(77 - 37.22)^2/37.22 = 42.52$
- For Surgical patients (HB-) : $\chi 2 = \sum(3743 - 3782.78)^2/3782.78 = 0.42$
- For Dialysis patients (HB+) : $\chi 2 = \sum(2 - 41.78)^2/41.78 = 37.87$
- For Dialysis patients (HB-) : $\chi 2 = \sum(4285 - 4245.22)^2/4245.22 = 0.37$
- Summing up : $\chi 2 = 81.18$

Step 4: Determine degree of freedom

df = (Number of rows - 1) × (Number of columns - 1) = (2 - 1) × (2 - 1) = 1

Step 5: Find the critical value & P-value

- for (df = 1) & ($\chi 2 = 81.18$), the P-value is extremely small (much less than 0.0001)
- the critical value for (df = 1) at a significance level of 0.05 is 3.84

Step 6: Conclusion

- Since the calculated $\chi 2 = 81.18$ is much larger than the critical value = 3.84 and the P-value is extremely small, we reject the null hypothesis
- this means there is a significant association between the type of patient (surgical vs dialysis) and HBV status (HB+ vs HB-)

RR = Risk in Surgical patients / Risk in Dialysis patients

RR = (a)×(a+b) / (c)×(c+d)

where:

- (a = 77) (HB+ in surgical patients)
- (b = 3743) (HB- in surgical patients)
- (c = 2) (HB+ in dialysis patients)
- (d = 4285) (HB- in dialysis patients)

RR = (77) × (77+3743) / (2) × (2+4285) = 43.26.

So, there was an interesting observation as surgical patients were found to be at high risk of exposure to HBV than those on dialysis, possibly because of the invasiveness of the surgical procedures. It is not necessarily associated with a greater infection rate per procedure, but the risk of a cumulative exposure.

OR = Odd in surgical patients / Odd in dialysis patients

OR = (a × d) / (b × c)

OR = (77 × 4285) = (3743 × 2) = 44.07

So, surgical patients have 44.07 times higher odds of being HB+ compared to dialysis patients.

Table 7 and Figure 7 shows the geographical distribution of cases of HBV. Rashidya had the highest number of cases, 16 cases, then Kibbeh neighborhood, and Zammar Al Arabi neighborhood, the cases were 5 each. In other regions, the number of cases was usually less than five cases per region. Interestingly, the prevalence of the cases was concentrated more in low-income neighborhoods, so they might have a potential socio-economic connection in the formation of the HBV.

**Table 7:** Distribution of Hepatitis B Cases by Region.

| Region | HB+ |
|---|---|
| Rashidya | 16 (for each region) |
| Kibbeh<br>Zammar<br>Al Arabi neighborhood | 5 (for each region) |
| Tal Afar | 4 (for each region) |
| Alqosh<br>Wadi Hajar<br>Rabiah<br>Saddam neighborhood | 3 (for each region) |
| Al-Jadaa Camp<br>Al-Zanjili<br>Al-Kuwair<br>Al-Baaj<br>Telkeef<br>Al-Zahraa Neighborhood<br>Al-Barid Neighborhood<br>Bissan Neighborhood<br>Al-Sukkar Neighborhood<br>Al-Mithaq Neighborhood<br>Al-Intisar Neighborhood<br>Mahlabia | 2 (for each region) |
| Other region (51) | 1 (for each region) |

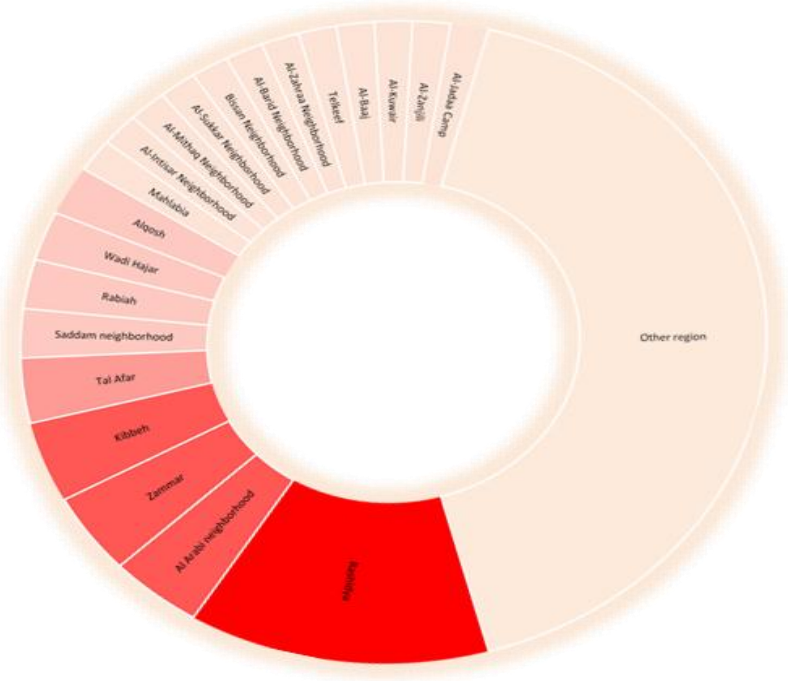



**Figure 7:** Distribution of HBV cases by region.

## 4 Discussion

HBV prevalence is 0.72% in Nineveh, suggesting moderate control of HBV. This contrasts with some Asian and African countries where prevalence ranges from 5% to 10%. For example, Vietnam has an HBV prevalence of 8.1% (Komada et al., 2022), Bangladesh 5.4% (Uz-Zaman et al., 2018), Nigeria 8.8% (Ajuwon et al., 2021), and Ethiopia 6.1% (Abebe et al., 2020).

The majority of cases in Nineveh occur in older adults (>40 years) (63.11%), followed by middle-aged individuals (20–40 years) (30.32%), and a smaller proportion in young-aged individuals (<20 years) (6.55%). This age distribution is consistent with trends in Vietnam (47.2%), Nigeria (55.5%), and Ethiopia (47.7%) (Komada et al., 2022; Ajuwon et al., 2021; Abebe et al., 2020). Middle-aged individuals in Nineveh (30.32%) have a lower HBV burden than in Vietnam (42.6%), Bangladesh (40.3%), and Ethiopia (39.2%), possibly reflecting better occupational safety measures (Komada et al., 2022; Uz-Zaman et al., 2018; Abebe et al., 2020).

The gender-based HBV prevalence in Nineveh (male: 0.75%, female: 0.72%) with male predominance aligns with data from Vietnam (male: 2.3%, female: 1.7%), Bangladesh (male: 6.1%, female: 4.7%), Ethiopia (male: 6.8%, female: 5.6%), and Nigeria (male: 10.2%, female: 7.9%) (Komada et al., 2022; Uz-Zaman et al., 2018; Abebe et al., 2020; Ajuwon et al., 2021).

The most common risk factor for HBV transmission was surgical procedures (63.11%), followed by pre-marital screening (11.48%) and endoscopic procedures (9.83%). Other contributing factors included consultancy referrals, blood transfusion, kidney dialysis, emergency procedures, and laboratory exposure. A study conducted in India reported that 58% of HBV cases were linked to surgical interventions, reflecting a comparable trend (Pande et al., 2011). In contrast, a study in Nigeria indicated that blood transfusion accounted for 15% of HBV cases, significantly higher than the 4.09% observed in our study (Ajuwon et al., 2021). This discrepancy may be attributed to differences in blood screening protocols and healthcare infrastructure.

The lower prevalence of HBV transmission through kidney dialysis in our study (1.64%) compared to Egypt (5.3%) suggests better sterilization practices or differences in patient populations (Helaly et al., 2015; André, 2000).

Furthermore, we found HBV prevalence in older adults (>40 years) as the highest (63.11%), which is in accordance with statistics in the case of Vietnam and Nigeria. Most substantive risk factor was surgical procedure (63.11 %), the same as published in India. In comparison, the transmission via blood transfusion and dialysis were comparatively low and this was probably occasioned by superior sterilization and screening measures. Social economic aspects were also determinants whereby more cases were being noticed in socially underserved areas like Rashidya, Kibbeh and Zammar Al Arabi.

### 4.1 Study limitations

Some limitations characterize this study. First, it is scored upon hospital statistics of one location (Ibn-Sina Hospital in Mosul), which does not cover the whole population of Nineveh comprehensively. Hospital users can be diverse, in terms of health status, social-economic outlook, or welfare access, with regard to the general population. Second, the data collected retrospectively does not allow creating any causal associations. Third, not all of the risk factors including sexual behavior, vaccination history, or occupational exposure were fully recorded in the hospital records that would affect the analysis process. It is suggested that these findings should be confirmed and extended by future community-based studies with a wider sampling and prospective data collection.

## 5 Conclusions

This study confirms significant associations between HBV prevalence and key demographic and medical factors with high-risk group being (male, old age, married, surgical patient, living in rural area). The findings underscore the importance of targeted public health strategies to reduce HBV transmission, so with implementing the recommended interventions, healthcare authorities can further control the spread of HBV and improve overall health outcomes in the region.

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