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Original article

Epidemiological Patterns of HBV, HCV, and HIV Infections Among Health Certificate Applicants at Al-Afia Hospital, Aljufra, Libya: An Eight-Year Retrospective Laboratory-Based Study

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Abstract
Hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV) are still important public health issues in the world, especially in the lower- and middle-income countries. In Libya, there are few studies that have addressed the prevalence of these three viruses in different populations during the process of medical examination. The present study was carried out to determine the prevalence and the pattern of these viruses in populations attending for health certificates examination at Al-Afia Hospital in Houn, Libya. A retrospective cross-sectional study was used; data were collected over the period of time (January 2018 to December 2025). The information obtained in this study included the total number of people tested and the number of confirmed cases with infections due to HBV, HCV, and HIV. Prevalence rates were computed on an annual basis, and the results were further categorized based on gender. The exact binomial 95% confidence intervals (CIs) were estimated for all proportions. Trends across time were evaluated through the chi-square test and Fisher's exact test. The number of people screened during the study period was 10,703. The prevalence rate of hepatitis infections varied between 1.02% and 4.89%. On the other hand, the prevalence of HIV was relatively low, ranging between 0.10% and 1.90%. Hepatitis B virus dominated the population, representing the majority of hepatitis cases (71.4%–100% for men and 16.6%–100% for women). However, the distribution of HCV had more variation, especially in women, with a maximum percentage of 83.3% recorded in 2019 (95% CI: 53.5–100). There was a significant trend in hepatitis infections, but not significant for HIV cases over time ($p > 0.05$). No difference in gender distribution was detected except for 2019, when there was a significant difference ($p = 0.01$). Increased confidence intervals in women were due to smaller sample sizes. HIV infections were uncommon, and no gender preference was apparent. To conclude, the overall prevalence of HBV was highest among patients undergoing routine health screening in Houn, Libya, compared to HCV. On the other hand, the prevalence of HCV and HIV was lower and did not show any gender bias. This study suggests that continued monitoring and specific public health approaches are required in order to ensure proper control of hepatitis and prevent HIV.
Keywords. Hepatitis B Virus, Hepatitis C Virus, HIV, Seroprevalence, Health Screening, Epidemiology, Libya.

Introduction

Infectious diseases associated with hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV) continue to be some of the leading health concerns globally, characterized by high levels of morbidity, mortality, and economic costs. The pathogens have similar mechanisms for spread involving contact with infected blood, risky medical interventions, and unprotected sex, allowing for co-infection in multiple settings [1]. Even though there have been great strides in vaccination, antiviral treatments, and preventive measures against the spread of these diseases, the impact of the infections is still notably higher in developing countries due to limited healthcare facilities and monitoring systems [2-4].

The global impact of viral hepatitis and HIV infections is quite high. Studies have shown that at least 296 million people are suffering from chronic hepatitis B infections, and 58 million people are affected by hepatitis C virus infections; meanwhile, 39 million people are infected with HIV globally [5]. In addition, it has been reported that most of the people with HIV they were more susceptible to HBV infection [6,7]. These pathogens contribute to millions of deaths every year, primarily as a consequence of associated complications like liver cirrhosis, hepatocellular carcinoma, and acquired immunodeficiency syndrome (AIDS) [8]. The overlap in the epidemiology of hepatitis B virus, hepatitis C virus, and HIV underscores the need for an integrated approach to their surveillance and prevention. Screening for infectious diseases among populations represents an essential element of public health towards the early detection of such diseases, especially when the disease is known to have asymptomatic periods that last for long durations. There are many viruses whose infections can remain undetected for long periods, such as HBV, HCV, and HIV.

As a result, a large number of patients remain ignorant of their infection. This is due to the fact that the infections continue contributing to the spread of the disease despite remaining undetected [4,9,10]. Blood donor screening programs that focus on certain target populations, such as blood donors, migrants, health professionals, and pregnant mothers, have been extensively adopted for surveillance purposes to

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monitor the epidemiological trends of blood-borne viruses and formulate national prevention strategies [11,12]. In the MENA region, viral hepatitis and HIV remain important public health issues. Even though their prevalence rate is relatively low when compared to some other parts of the world, the epidemiology of these diseases is different from one country to another and among different populations within each country due to various reasons [13,14].

The results from national surveys carried out in Libya indicate an approximate prevalence rate of hepatitis B surface antigen (HBsAg) was 2.2%, and a prevalence rate of hepatitis C virus infection was 1.2%, with marked geographical variations in the two diseases [15]. A study done in Bani Waleed in Libya between the years 2014–2020 showed differences in the prevalence of HBV and HCV infections, where HBV (67.36%) compared to HCV (32.64%), [16]. In addition, there were slightly higher infection rates among male individuals in both HBV and HCV. Unfortunately, the epidemiological information available concerning viral hepatitis in Libya is still inadequate and lacking, especially when it comes to identifying the prevalence of the disease in particular population groups. The importance of the epidemiologic behavior of HBV and HIV infections among individuals who undergo health certification examinations cannot be overstated. This group may consist of apparently healthy people from different occupations and demographics. Health examination screenings could serve as an important source of information that would help to identify the prevalence of infections and support disease surveillance and prevention [1]. While research in the field of viral hepatitis and HIV epidemiology is growing worldwide, there is no evidence available concerning the prevalence and trends of these diseases among individuals undergoing health certificates in Libya, especially those living in the central area of Al-Jufra. Accordingly, this paper will try to investigate the sero-prevalence and epidemiologic trends of HBV, HCV, and HIV infections among individuals undergoing health certification tests in Al-Afia Hospital of Houn in Libya, with special attention paid to their overall prevalence rates and temporal trends between 2018 and 2024, as well as their distribution by gender.

Methods

The current study is an analytical cross-sectional study carried out in Al-Afia Hospital in Houn, Libya. The study sample consists of all people who were tested during the required health screening from January 2018 to December 2025. Information was gathered from hospital records concerning gender, year of screening, number of people who underwent the test, and positive diagnoses for HBV, HCV, and HIV infections. All statistical analyses were conducted using IBM SPSS Statistics (version 25.0).

Annual data aggregation was done for the statistical analyses that were based on descriptive statistics and the calculation of prevalence rates. The Chi-square and Fisher's exact tests were used to evaluate possible associations between gender and infection, along with reporting odds ratios (OR) and 95% confidence intervals (CI). Trends over time were analyzed using the Chi-square test for trend. Analyses were completed using SPSS version 25.0 with a significance level of $p < 0.05$.

Results

Overall prevalence of hepatitis and HIV

A total number of 10 703 indevisulsed were subjected to health certificate screening between 2018 and 2025, at Al-Afia Hospital in Houn, Libya. Our results illustrated that hepatitis prevalence was 1.02% to 4.89% of the tested samples. The highest rate was 4.89% in 2019, and the confidence interval for that year (95% CI: 2.68–7.10). HIV stayed at low levels across the same period, with yearly proportions between 0.10% and 1.90%. Because only a few HIV cases were found, the confidence intervals around those figures are wide. In contrast, the intervals for hepatitis became tighter in the later years, as (Table 1) shows.

Table 1. Prevalence of hepatitis and HIV infections with 95% confidence intervals (2018–2025)

Year	Screened	Hepatitis cases	Hepatitis %	95% CI	HIV cases	HIV %	95% CI
2018	1663	38	2.28%	1.57–2.99	2	0.12%	0.00–0.28
2019	368	18	4.89%	2.68–7.10	7	1.90%	0.51–3.29
2020	1333	31	2.33%	1.52–3.14	6	0.45%	0.09–0.81
2021	964	13	1.34%	0.61–2.07	2	0.20%	0.00–0.49
2022	1153	17	1.47%	0.77–2.17	3	0.26%	0.00–0.56
2023	973	10	1.02%	0.39–1.65	1	0.10%	0.00–0.30
2024	2148	40	1.86%	1.29–2.43	5	0.23%	0.03–0.43
2025	2101	25	1.18%	0.72–1.64	4	0.19%	0.00–0.37

Date in (Table 2) demonstrated temporal trend analysis, which indicated that there is a significant decrease in hepatitis prevalence during the study period (x^2 for trend = 6.2, p = 0.013). Hepatitis prevalence rate changed from a maximum level of 4.89% in 2019 to the lowest one of 1.18% in 2025, thus indicating improvements in the epidemiological situation. However, no significant temporal trend has been

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detected for HIV infections (x^2 for trend = 1.1, p = 0.29). Changes in the prevalence rate for this infection type can be considered accidental due to a small number of positive cases.

Table (2). Temporal trends in hepatitis and HIV prevalence with Chi-square test for trend (2018–2025)

Infection	Chi-square trend	P-value	Interpretation
Hepatitis	6.2	0.013	Significant ↓
HIV	1.1	0.29	Not significant

The prevalence of hepatitis and HIV among males and females

The frequency of hepatitis cases was significantly higher among males than among females in most years during the study. The frequency reached its peak in 2019 for males at 5.55% (95% CI: 2.51-8.59) and 3.94% (95% CI: 0.86-7.02) among females. HIV infections were recorded to be minimal among males and females in all years during the study, showing no significant trend over time, as shown in (Table 3).

Table 3. Annual prevalence of hepatitis and HIV infections by gender with 95% confidence intervals at Al-Afia Hospital, Houn, Libya (2018–2025)

Year	Gender	Screened	Hepatitis cases	Hepatitis %	95% CI	HIV cases	HIV %	95% CI
2018	Male	1170	31	2.64	1.72–3.56	1	0.08	0.00–0.25
	Female	493	7	1.41	0.37–2.45	1	0.20	0.00–0.59
2019	Male	216	12	5.55	2.51–8.59	5	2.31	0.32–4.30
	Female	152	6	3.94	0.86–7.02	2	1.31	0.00–3.11
2020	Male	1072	25	2.33	1.42–3.24	4	0.37	0.01–0.73
	Female	261	6	2.29	0.46–4.12	2	0.76	0.00–1.80
2021	Male	731	10	1.36	0.52–2.20	1	0.13	0.00–0.40
	Female	233	3	1.28	0.00–2.72	1	0.42	0.00–1.24
2022	Male	692	13	1.87	0.86–2.88	2	0.28	0.00–0.67
	Female	461	4	0.86	0.02–1.70	1	0.20	0.00–0.59
2023	Male	541	7	1.29	0.34–2.24	0	0.00	0.00–0.55
	Female	432	3	0.69	0.00–1.47	1	0.23	0.00–0.68
2024	Male	1380	30	2.17	1.40–2.94	2	0.14	0.00–0.34
	Female	768	9	1.17	0.41–1.93	3	0.39	0.00–0.83
2025	Male	1329	25	1.88	1.15–2.61	4	0.30	0.01–0.59
	Female	772	1	0.12	0.00–0.36	0	0.00	0.00–0.48

Temporal trends (Table 4) showed that there was a statistically significant reduction in hepatitis cases in males (x^2 for trend = 5.9; p = 0.015) and females (x^2 for trend = 4.3; p = 0.038). The decline was more noticeable after 2019, suggesting that there may have been some progress in managing the disease. However, no temporal trends were detected regarding the HIV prevalence in males (x^2 for trend = 1.2; p = 0.27) and females (x^2 for trend = 0.9; p = 0.34). This variability is possibly due to low patient numbers.

Table 4. Temporal trends in hepatitis and HIV prevalence by gender using the Chi-square test for trend (2018–2025)

Infection	Gender	x^2 trend	P-value	Interpretation
Hepatitis	Male	5.9	0.015	Significant ↓
Hepatitis	Female	4.3	0.038	Significant ↓
HIV	Male	1.2	0.27	Not significant
HIV	Female	0.9	0.34	Not significant

Distribution of HBV and HCV infections

Summary of the distribution of cases of HBV and HCV with 95% Confidence Intervals (CI) and P-values from Fisher's Exact Test based on gender type during the study period is presented in (Table 5). Generally, HBV had a significantly higher frequency among both male and female participants across all years in the study. Our results illustrated that HBV among the males was 71.4% (95% CI: 38.0-100) in 2023, 90% (95% CI: 71.4-100) in 2021, and in 2019 was 100% (95% CI: 73.5-100). While the HBV prevalence among females was 16.6% (95% CI: 0.0-46.5) in 2019, and 100% across several years (2020-2025). HCV represented a much lower percentage of the total number of cases compared to HBV in both genders during the study period, as illustrated in (Table 5). The comparative test with Fisher's Exact Test showed no significant differences between the genders regarding the distribution of HBV and HCV infections, except for 2019, when females had significantly higher proportions of HCV infections (p = 0.01). It can be

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seen that even though HBV is prevalent, gender disparities in the distribution of infections are subject to small sample sizes each year, especially for females.

Table (5). Gender-specific distribution of HBV and HCV infections with 95% confidence intervals and P-values (2018–2025)

Year	Sex	Total cases	HBV (n)	HBV %	95% CI	HCV (n)	HCV %	95% CI	P-value (Fisher)
2018	Male	31	24	77.4	62.7–92.1	7	22.5	7.9–37.1	0.34
	Female	7	4	57.1	20.4–93.8	3	42.8	6.2–79.6	
2019	Male	12	12	100	73.5–100	0	0.0	0.0–26.5	0.01
	Female	6	1	16.6	0.0–46.5	5	83.3	53.5–100	
2020	Male	25	20	80.0	64.3–95.7	5	20.0	4.3–35.7	0.07
	Female	6	6	100	54.1–100	0	0.0	0.0–45.9	
2021	Male	10	9	90.0	71.4–100	1	10.0	0.0–28.6	0.25
	Female	3	3	100	29.2–100	0	0.0	0.0–70.8	
2022	Male	13	11	84.6	65.0–100	2	15.3	0.0–34.9	0.49
	Female	4	4	100	39.6–100	0	0.0	0.0–60.4	
2023	Male	7	5	71.4	38.0–100	2	28.5	0.0–61.9	1.00
	Female	3	2	66.6	13.4–100	1	33.3	0.0–86.6	
2024	Male	31	27	87.0	75.1–98.9	4	12.9	1.1–24.7	0.88
	Female	9	8	88.8	68.3–100	1	11.1	0.0–31.7	
2025	Male	25	21	84.0	69.6–98.4	4	16.0	1.6–30.4	1.00
	Female	1	1	100	2.5–100	0	0.0	0.0–97.5	

Distribution of HIV infections by gender

There was a relatively low number of cases of HIV infection reported during the entire study period, with a range of 1 to 7 cases per year (Table 6). The ratio between male and female patients was highly variable, with no observable trend through time. Most of the cases of HIV infection were presented among males compared to females. There is no statistically significant relationship between the gender of the patient and their HIV infection ($x^2 = 2.13$, $p = 0.14$; Fisher's exact test, $p = 0.18$).

Table 6. Distribution of HIV infections by gender with 95% confidence intervals (2018–2025)

Year	Total cases	Male	Male %	95% CI	Female	Female %	95% CI
2018	2	1	50.0	0.0–100	1	50.0	0.0–100
2019	7	5	71.4	38.0–100	2	28.5	0.0–62.0
2020	6	4	66.6	28.9–100	2	33.3	0.0–71.1
2021	2	1	50.0	0.0–100	1	50.0	0.0–100
2022	3	2	66.6	13.3–100	1	33.3	0.0–86.7
2023	1	0	0.0	0.0–97.5	1	100	2.5–100
2024	5	2	40.0	0.0–82.9	3	60.0	17.1–100
2025	4	4	100	39.6–100	0	0.0	0.0–60.4

Discussion

This study provides important information on the epidemiology of infection with the hepatitis B virus, hepatitis C virus, and HIV among individuals going through the process of health certification in Houn, Libya. In general, it is clear from the results obtained that infection with hepatitis viruses is decreasing, and HIV infections remain at a fairly constant low level over time, with no significant differences according to gender. The prevalence of hepatitis infections in the current study (1–4.89%) is comparable to results obtained in other studies conducted among populations in North African and Middle Eastern countries, where HBV is classified as having medium-endemicity. According to earlier studies from Libya and the surrounding region, the prevalence rate of HBV infection has ranged from 2% to 7% [17].

In contrast, higher prevalence rates have been observed in some sub-Saharan African countries. One meta-analysis conducted in Nigeria indicated a prevalence of 9.5% [18], while other studies have noted even higher percentages of up to 19% [19]. Such disparities can be attributed to disparities in vaccination rates, availability of healthcare facilities, and the general organization of the public health sector. One of the more interesting results from this research is the decreasing trend in the prevalence of hepatitis cases, especially since 2019. The reason for this trend may lie in better coverage with vaccines for the hepatitis B virus, as well as the higher awareness of preventive methods against the infection. Such a trend was seen worldwide after implementing universal vaccination programs [4]. Nevertheless, since this particular study lacks information about participants' vaccination, it cannot yet confirm this conclusion.HBV infection was the most frequent type observed in both male and female groups, corroborating existing scientific

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literature [20,21]. This result is expected due to the fact that HBV infections are known to be endemic in many countries at lower levels of economic development.

The situation is similar in Africa, as evidenced by the fact that HBV infection is still rather frequent in specific categories of people, such as pregnant women, for whom behavioral and household transmission factors play an important role [22]. However, in this study, HCV infection rates were lower and fluctuated during the research period, which might be due to the fewer identified cases. The epidemiology of HCV also shows great variance throughout the world, with the virus's distribution affected by various factors, including health care facilities, blood handling, and others [23]. In Libya, earlier studies have also shown varied HCV prevalence estimates. For example, very low HCV prevalence was found in eastern Libya [24]. However, higher rates of the infection were noted in certain regions of Libya, for instance, southern Libya and Al Bayda [25,26]. In reference to HIV, the results show that the prevalence rates remain low and constant over time. This is in line with the epidemiological trend observed in North Africa, where HIV infections are quite rare and confined to certain at-risk groups in the population [17,27]. Results have shown similar low prevalence rates in other regions of Libya, for example, a study conducted by [28] in the City of Zawia HIV was 0.04%. Although there are variations in HIV prevalence rates, with females showing higher incidence than males in sub-Saharan Africa [29,30], this difference was not seen in the present study

However, there was no statistically significant difference in prevalence for other infections between genders, with men having slightly higher prevalence rates than women in some cases. This observation is in line with earlier findings indicating that gender is not a reliable predictor of infection, despite potential differences in exposure to risk factors [17, 31]. Year-to-year variability was seen, especially with HIV and HCV. Such fluctuations may have arisen from the smaller sample size involved, and they need to be taken into consideration when interpreting results. With respect to public health, it is apparent that there have been gains achieved in the fight against hepatitis infections, though much more needs to be done. With regard to HBV, for example, the need for sustained campaigns in vaccination and screening cannot be overemphasized. On the other hand, due to the low occurrence rate of HIV, prevention should be concentrated among risk groups only.

One limitation of this research is the fact that only applicants for mandatory health certificates participated in this research, and thus, they cannot necessarily be considered representative of the larger population. There is a possibility of selection bias within screening-based samples due to the fact that respondents may differ from the general population with respect to their health condition and accessibility to medical care [32,33]. Additionally, there are limitations in estimating the epidemiology of disease in populations based on data collected through non-representative samples [34]. The strength of this research is that it involved a relatively long follow-up period and an equal number of male and female subjects. Nevertheless, there were certain disadvantages which need to be taken into account. First, this study involved only one institution, while data about specific risk factors for HIV were not provided. Second, the small number of HIV cases precluded any detailed analysis of its dynamics.

Conclusion

The study demonstrates that hepatitis (particularly HBV) continues to be the most prevalent viral disease among the research participants, although its incidence seems to be declining. On the contrary, HIV still persists at very low levels, remaining relatively constant. The absence of any gender-specific disparities implies the same tendencies in both male and female populations. These results can serve as a good point of reference for further policy making.

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Conflicts of Interest. *Nil*

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