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RESEARCH ARTICLE **MICROBIOLOGY**

Demographic Patterns and Clinical Outcomes of Viral Hepatitis B and C among Hospitalized and Outpatient Cohorts in Southern Libya

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ABSTRACT

Hepatitis B and C are viral infections that can cause severe liver damage. Although they share certain clinical similarities, they are caused by entirely distinct viruses and require different strategies for prevention and treatment. This study investigated the epidemiological burden and demographic distribution of viral hepatitis infections in southern Libya over recent years. A cohort of 176 randomly selected patients diagnosed with HBV and/or HCV was evaluated across two primary healthcare centers. The study population was predominantly Libyan (78.4%), with the remaining population comprising migrants from Niger, Egypt, Sudan, Chad, and Senegal. Hepatitis B (HBV) constituted the vast majority of infections, representing 80.1% of all cases. Overall, viral hepatitis was more frequent in males (51.7%, n=91) than in females (48.3%, n=85). While HBV infection rates were higher in males (53.9%) than females (46.1%), HCV showed a notably higher frequency among female participants (57.5%) than males (42.5%). Although infections spanned all age groups, they were heavily concentrated between 30 and 50 years of age (53.4%). Geographically, Sabha city recorded the highest overall infection frequency (59.7%). Additionally, HIV coinfection was rare, identified in only two patients within the study group. Liver cirrhosis was observed in 21 patients (11.93%). Ultimately, this study demonstrates that HBV and HCV are deeply entrenched among both residents and migrants in southern Libya

الأنماط الديموغرافية والنتائج السريرية لالتهاب الكبد الفيروسي (ب) و (ج) بين مجموعات المرضى الداخليين والعيادات الخارجية في جنوب ليبيا

خديجة محمد احمد إبراهيم [1,*]، فدوى عبدالسلام سعد [2]، مشكاة إبراهيم محمد [2] ، عبدالنبي الخير مسعود [2]، صالحة خميس محمد علي [3]

الملخص

التهاب الكبد ب وج هو عدوى فيروسية قد تُلحق الضرر بالكبد. ورغم تشابههما في بعض الجوانب، إلا أنهما ناتجان عن فيروسات مختلفة، ولكل منهما طرق وقاية وعلاج متباينة. هدفت هذه الدراسة إلى بحث التوزيع الديموغرافي لعدوى التهاب الكبد الفيروسي في جنوب ليبيا خلال السنوات القليلة الماضية. قيّمت هذه الدراسة 176 مريضًا في جنوب ليبيا تم تشخيص إصابتهم بالتهاب الكبد ب و/أو ج. أوضحت الدراسة ان غالبية المرضى كانوا من الليبيين (78.4%)، بينما شملت النسبة المتبقية جنسيات مختلفة، بما في ذلك أفراد من النيجر ومصر والسودان وتشاد والسنغال. كان التهاب الكبد ب هو العدوى الأكثر شيوعًا، حيث مثّل 80.1% من إجمالي الحالات. وبشكل عام، كان التهاب الكبد الفيروسي أكثر شيوعًا بين الذكور (51.7%، ن=91) منه بين الإناث (48.3%، ن=85). كانت معدلات الإصابة بفيروس التهاب الكبد ب أعلى لدى الذكور (53.9%) مقارنةً بالإناث (46.1%). في المقابل، كان فيروس التهاب الكبد ج أكثر انتشارًا بين المشاركات الإناث (57.5%) مقارنةً بالذكور (42.5%). وبينما شملت الإصابات جميع الفئات العمرية، إلا أنها كانت أكثر تركيزًا في الفئة العمرية بين 30 و50 عامًا (53.4%). جغرافيًا، سجلت مدينة سبها أعلى معدل إصابة (59.7%). بالإضافة إلى ذلك، كانت الإصابة المشتركة بفيروس نقص المناعة البشرية نادرة، حيث تم تشخيصها لدى مريضين فقط ضمن المجموعة. ولوحظ تليف الكبد لدى 21 مريضًا مصابًا بالتهاب الكبد (11.93%). في النهاية، تثبت الدراسة أن فيروسي التهاب الكبد ب و ج منتشران على نطاق واسع بين السكان والمهاجرين في جنوب ليبيا.

الكلمات المفتاحية

ليبيا
فيروس التهاب الكبد ب
فيروس التهاب الكبد ج
تليف الكبد
الاختبار المصلي
العدوى المصاحبة

Introduction

Hepatitis B and C infections are considered as most significant contributors to chronic liver disease that frequently progressing to cirrhosis and hepatocellular carcinoma [1-3]. The latest WHO data from 2022 shows that about 254 million people have chronic hepatitis B and 50 million have chronic hepatitis C worldwide 60% of liver cirrhosis and 80% of hepatocellular carcinoma (HCC) caused

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by HBV and HCV with 1 million deaths each year. [4-5]. According to the WHO Regional Office for Eastern Mediterranean (EMRO), the chronic HBV and HCV infections have affected 18 million and 12 million respectively. These silent infections pose a serious public health threat, as often going undetected until they progress to liver cirrhosis and hepatocellular carcinoma [6].

Although HBV and HCV share common modes of transmission, yet HBV is much more easily transmitted through sexual contact and from mother to child during birth, whereas HCV is predominantly spread through blood-to-blood contact [7].

In Libya several studies were conducted to detect HBV and HCV infection. A large-scale study of over 65,000 people across Libya revealed that the rate of HBV and HCV infections in general population was 2.2% of and a 1.3% respectively [8]. Based on a significant, retrospective study published regarding hepatitis C virus (HCV) In Libya, a total of 1,008,214 healthy blood donors were screened between 2008 and 2013 in Tripoli and it was found that the overall HCV infection among these blood donors was 1.8% [9]. In a 2019 study at Al Kufra City Hospital in Libya, researchers screened 3,248 sub-Saharan African migrants for viral hepatitis. The results revealed remarkably high infection rates 23.4% tested positive for HBV and 31.2% for HCV [10]**.** A Surveillance of HBV and HCV infections among the general population in the southern region of Libya was also been conducted. Ghudduwah village in south of Libya was selected to assess the occurrence of HBV and HCV infections among 352 individuals. This study showed ta high infection rate of hepatitis C infection among studied people [11]. Additionally, a screening of 420 adult serum samples in Sabratha, Western Libya, revealed frequency rates of 4.0% for HBV and 2.9% for HCV [12]. 239 cases were examined In Bani Waleed City, for HBV and HCV during the period from 2014 to 2020 and the frequency of HBV and HCV was 67.36% and 32.64% respectively [13]. Despite the establishment of the Libyan immunization program in 1989, universal neonatal HBV vaccination was not formally adopted until 1993 [14]. This has left a significant immunity gap among the adult population born before the program's inception. Although several studies have investigated infectious diseases in Sebha and southern Libya data remains insufficient to fully map the endemicity of HBV and HCV. This knowledge gap is further widened by heavy migration through the region, which significantly increases the transmission and local spread of these infections. For this reason, Focusing on Sebha and the surrounding southern regions is crucial, especially given how migration patterns can shift the epidemiological landscape. The primary aim of this study is to map the current epidemiological burden, demographic distribution, and clinical outcomes of Hepatitis B (HBV) and Hepatitis C (HCV) within the Fezzan region. Additionally, the study aims to provide actionable baseline data to improve localized public health strategies, optimize resource allocation, and enhance clinical management for viral hepatitis in southern Libya

Methodology

This study evaluated the demographic distribution and clinical outcomes of Hepatitis B virus (HBV) and Hepatitis C virus (HCV) infections among 176 participants in Sebha, Libya, collected between July 2025 and January 2026. The study population comprised two cohorts: 97 inpatients from Sebha Medical Center (the Obstetrics and Gynecology, Surgery, Hemodialysis, and Infectious Diseases departments) and 79 outpatients from the National Center for Disease Control, Sebha (NCDC). All reactive Demographic variables, including age, gender, residence, marital status, and nationality, were recorded. Ethical approval was obtained from the Research Ethics Committee of Sebha Medical Center.

Serological Screening and Diagnostic Confirmation

Serum samples were collected from all participating patients to screen for viral infection. A microplate-based enzyme-linked immunosorbent assay (ELISA) (Autobio Diagnostics Co., Ltd., Zhengzhou, China) was performed for the qualitative detection of Hepatitis B surface antigen (HBsAg) and Hepatitis B core antibody (HBcAb). The assays were conducted strictly according to the manufacturer's protocol, which specifies a diagnostic sensitivity of 100% and a specificity of 99.5%. Samples with an absorbance value equal to or greater than the designated cut-off threshold were classified as reactive.

Quantification of viral nucleic acids was performed via real-time automated polymerase chain reaction (PCR) utilizing the Cepheid GeneXpert XVI system (16 module) (Cepheid, Sunnyvale, CA, USA). For Hepatitis C evaluation, viral RNA extraction and amplification targeted the highly conserved 5' non-coding region (5' NCR). For Hepatitis B evaluation, viral DNA quantification targeted the conserved preC-C core gene region. The procedure was followed as described by manufacture instruction. The low Ct value (<25 to 30) reflecting strong positive reading with high concentration of target DNA or RNA in the sample. While high Ct value (>30 to 45) indicated very low viral load. Patients with laboratory-confirmed reactive results were included in the study, with no further inclusion or exclusion restrictions applied.

Statistical analysis

The collected data were compiled using Microsoft Excel 2016 and subsequently analyzed using the Statistical Package for the Social Sciences (SPSS**)** software. Continuous quantitative variables were expressed as mean ± standard deviation (SD)**,** while categorical variables were presented as frequencies and percentages**.** Pearson's Chi-square **(**X^2**)** test was utilized to evaluate associations between categorical variables and determine p-values. Statistical significance was defined as a p-value <0.05.

Results

Among the 176 study samples, Hepatitis B virus (HBV) exhibited a significantly higher distribution patterns than Hepatitis C virus (HCV), with 141 and 40 cases respectively. Dual infection with both viruses was identified in 5 patients (2 males and 3 females), as detailed in Table 1 and 2. Overall, viral hepatitis was more frequent in males (51.7%, n=91) than in females (48.3%, n=85), according to Table 3 and Figure 1. Gender-specific analyses revealed that HBV infection rates were higher in males (53.9%) than females (46.1%). Conversely, within the HCV patients, HCV was more prevalent among female participants (57.5%) than male participants (42.5%) (Table 4 and Figure 2). As shown in Table 4, there is no statistically significant difference in gender distribution between the groups ($p = 0.126$) and ($p = 0.163$), respectively, indicating no statistically significant association between gender and the frequency of either viral infection in this study. The highest case densities emerged in Sebha (59.7%) and Ubari (10.8%), followed sequentially by Ghudduwah (8%), Qatrun (6.8%), Ghat (4%), and both Murzuq and Wadi Al Shatti (2.85% each). Lower endemicity

was recorded in Umm Al Aranib (2.3%), while the minimum baseline infection (0.6% each) was uniform across Al-Zighan, Traghan, Samno, Wadan, and Wadi Atba **(**Fig. 3). The mean age of the cohort was 43.5 +_15.6. Age-specific demographic analysis indicated that over 50% of infected individuals were clustered between 30 and 50 years of age. The next highest infection rate occurred in group above 50 years, which accounted for 27.8% of cases, while the lowest incidence of infection was observed in the youngest demographic under 30 years (Table 5 and Figure 4). Out data showed that the highest rate of infection was detected among Libyan nationals at 78.4%. This was followed by individuals of Chadian (8.5% (8 female and 7 male), Nigeriens (5.1% (1 female and 8 males)), and Sudanese (4.5% (8males)). Egyptian nationals accounted for 2.8% (1 female and 4 males), of the infected population, while the lowest infection rate was recorded among Senegalese individuals at 0.6% (1 male), as detailed in Table 6. Given that marital status potentially influences viral transmission dynamics, the cohort was evaluated accordingly; 116 of the total participants were married, while the remaining 60 individuals were unmarried. This sample included 24 pregnant women who had Hepatitis (20 HBV (83.3%) and 4 HCV (16.7%)) infections were incidentally detected during routine third-trimester prenatal screenings for HBV, HCV, and HIV. The most prevalent comorbidities among the viral hepatitis patients were chronic kidney disease (n = 22), Type 2 diabetes mellitus (n = 14), and hypertension (n = 11), Notably, four patients with chronic kidney disease undergoing haemodialysis presented with HBV and HCV coinfection. Furthermore, HIV coinfection was documented in two African nationals originating from Chad and Niger**.** Regarding clinical outcomes, liver cirrhosis was observed in 21 cases (11 HBV and 10 HCV). In terms of age distribution, 52.38% (n = 11) of these cases occurred in patients older than 50 years, 33.33% (n = 7) were between 30 and 50 years, and the remaining 14.29% (n = 3) were younger than 30 years (Table 7). A statistically significant association was found between age and the presence of liver cirrhosis among viral patients (*p = 0.015*), indicating that the differences across age cohorts are highly meaningful. Additionally, hepatocellular carcinoma was detected in a single patient of Chadian nationality**.**

Table 1: Frequency of HBV among the collected samples

HBV		
	Frequency	**Percentage**
Positive	141	80.1%
Negative	35	19.9%
Total	176	100.0%

Table 2: Frequency of HCV among the collected samples

HCV		
	Frequency	**Percentage %**
Positive	40	22.7%
Negative	136	77.3%
Total	176	100.0%

Table 3: Gender Distribution of Viral Hepatitis Cases

Gender	Frequency	Percentage
Male	91	51.7%
Female	85	48.3%
Total	176	100.0

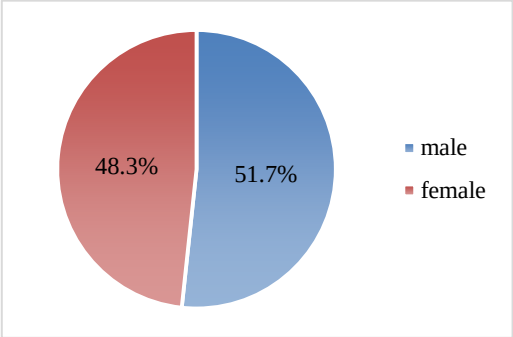

Figure 1: Gender distribution and percentage of viral hepatitis infection among the study participants.

Table 4: Distribution of HBV and HCV between male and Female

HCV- HBV * Gender Crosstabulation					
			Gender		
			Male	**Female**	**P value**
HCV	Positive	Count	17	23	
		%	42.5%	57.5%	0.126
HBV	Positive	Count	76	65	
		% HBV	53.9%	46.1%	0.163

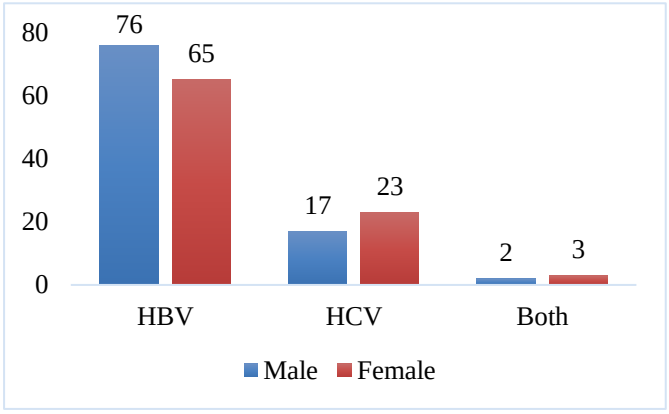

Figure 2: Distribution of HBV- HCV viral infection among both gender in southern Libya

Table 5: Distribution hepatitis B and C according to the age groups

	Age	**Frequency**	**Percent**
Valid	<30 years	33	18.8%
	30-50 years	94	53.4%
	> 50 years	49	27.8%
	Total	176	100.0

Table 6: Distribution of Viral Hepatitis among different nationalities

Nationality	**Frequency**	**Percent**
Libyan	138	78.4%
Nigeriens	9	5.1%
Egyptian	5	2.8%
Sudanese	8	4.5%
Chadian	15	8.5%
Senegalese	1	0.6%
Total	176	100.0

Discussion

The detection of hepatitis B virus (HBV) and hepatitis C virus (HCV) infections has been widely documented across various regions of Libya, reflecting a sustained research interest in monitoring viral hepatitis rates and transmission dynamics. In 2014, Daw et al. reported a nationwide rate of occurrence 2.2% for HBV and 1.3% for HCV [8]. This higher burden of HBV aligns with the findings of the current study.

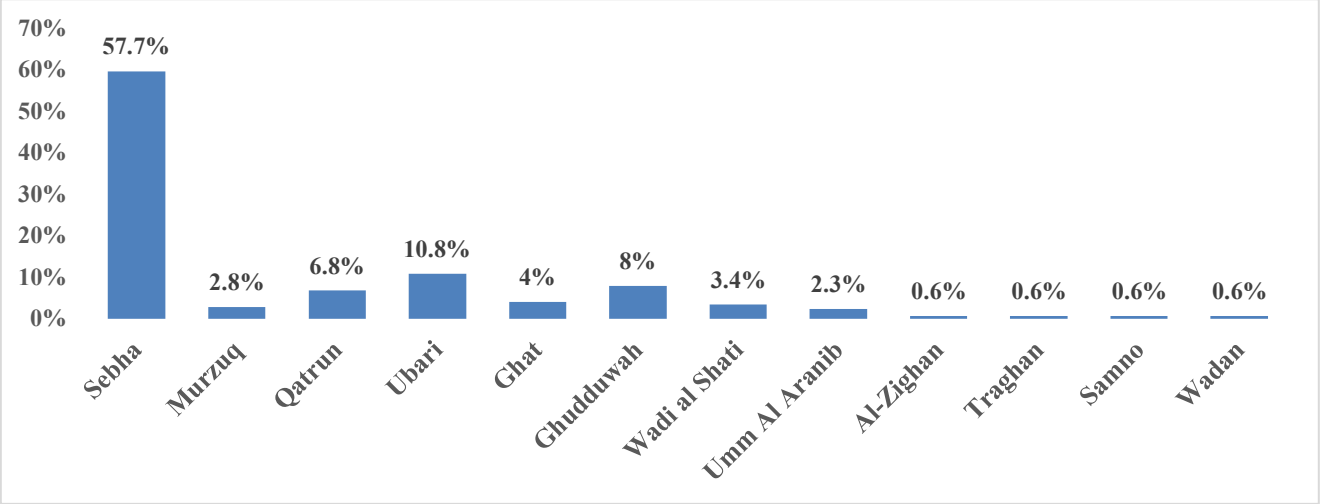

Figure 3: Distribution of HBV- HCV viral diseases among Fezzan region in southern Libya

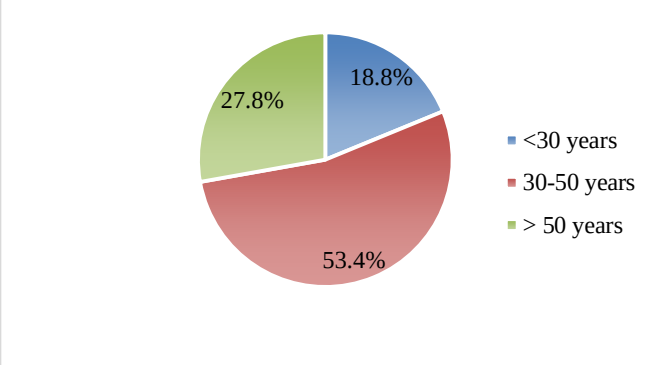

Figure 4: Age wise distribution of viral hepatitis infected patients

Table 7: Distribution of liver cirrhosis among age groups of hepatitis patients

		Age			p-value
		<30 years	30-50 years	> 50 years	
Liver cirrhosis among viral patients	Suffering/ 21	3 14.29%	7 33.33%	11 52.38%	0.027
	Not suffering /155	30 19.4%	87 56.1%	38 24.5%	

Demographic analysis reveals that viral hepatitis is more frequent in males (51.7%) than in females (48.3%). Specifically, HBV infection was higher in males (53.9%) than females (46.1%), a trend consistent with a large-scale nationwide cross-sectional study of 65,761 individuals that reported an HBV of 2.2% and a male-to-female ratio of 1.4:1 [15]. This also accords with regional data from Tripoli, which showed a higher percentage of HBV (3.7%) relative to HCV (0.9%) [16]. Similarly, a study in Bani Waleed involving 239 cases documented a high rate of HBV (67.36%), followed by HCV (32.64%) and co-infection (3.77%). However, our study found that HCV disproportionately affects females (57.5%) over males (42.5%). This female predominance is reinforced by some published data [17-18] but contradicts research showing higher rates in males [19-21]. Five Libyan participants had dual HBV/HCV infections; notably, four were hemodialysis patients. These cases underscore the risk of viral transmission associated with shared hemodialysis machinery. It was reported that the Patients receiving maintenance hemodialysis (HD) are at higher risk for acquiring HBV and HCV infections compared general population [22-23].

In terms of age distribution, the most frequently affected group was individuals aged 30 to 50 years (53.4%), followed by those over 50. This corresponds with prior literature indicating that the vast majority of HBV infections (91.08%) occur within the 21–60 years [24]. Analysis of participant nationality revealed that non-Libyan individuals comprised 21.6% of the total sample. Within this migrant subpopulation, 32 individuals tested positive for hepatitis B virus (HBV) and 6 for hepatitis C virus (HCV). These results are in Consistent with previous literature indicating that migration from sub-Saharan Africa potentially accelerates hepatitis virus transmission within Libya [10,25]. The study identified five patients from Egypt: four with HBV and one with HCV. Because Egypt is one of six HCV-endemic countries bordering Libya, it acts as a primary pathway for the introduction of the virus into Libyan territory. [26-27]. This study also noted viral hepatitis cases in other nationalities. Sharing borders with Niger, Chad, and Sudan render Libya highly vulnerable to viral introduction. This geographic proximity makes migration a primary risk factor for accelerated infection rates. Such finding has also been documented by other researchers [10,12]. Geographically, infection rates varied across southern Libya, peaking in Sebha City due to its higher population density compared to surrounding smaller towns. In this study, the largest concentration of hepatitis patients was identified in Sebha (59.7%), followed by smaller clusters in Ubari (10.8%), Ghudduwah (8.0%), and Qatrun (6.8%). This distribution is anticipated, given that these four regions constitute a major transit route through the southern desert. Within Ghudduwah, 14 cases of viral hepatitis were identified, consisting of 10 HCV and 4 HBV infections. The high percentage of HCV in Ghudduwah aligns with expectations, as multiple regional investigations have consistently documented the high endemicity of hepatitis C in this locality [11 and 28]. In this study we focused also on chronic disease that could accelerates progression in patients with chronic hepatitis and intensifies liver damage as it has been reported [29-30]. Our data found that 14 hepatitis patients had diabetes, yet only one presented with liver cirrhosis. This low incidence (1/14) suggests these individuals may be in the early stages of hepatic injury before fibrosis advances to cirrhosis, or their chronic condition has not persisted long enough to cause severe liver damage.

Several Researches indicate that HBV and HCV infection is significantly higher in chronic kidney disease (CKD) patients particularly those on maintained hemodialysis than in the general population. This vulnerability is further exacerbated by improper implementation of infection prevention and control strategies (IPC) [31-32]. In addition, a significant correlation exists between the duration of hemodialysis and HCV seropositivity. A study examining 1,250 chronic hemodialysis patients in 10 Libyan cities (Tripoli, Benghazi, Misurata, Zawiya, Zintan, Sabha, Zliten, Alkhoms, Sirte, and Derna) identified Sabha as having the highest regional burden of HCV. Nevertheless, conflicting data from alternative Libyan studies demonstrate notable disparities in viral hepatitis frequency rates. Among the nation's end-stage renal disease population [33]. Within our study, 22 cases of chronic kidney disease (CKD) were identified among the total hepatitis patients, all of whom were undergoing maintenance hemodialysis. The exact timing of viral acquisition specifically whether infection occurred prior to or following the initiation of hemodialysis was not evaluated, as nosocomial transmission via shared, contaminated medical devices remains a distinct possibility.

In this study, the clinical outcomes of viral hepatitis were also evaluated with specific consideration given to the risk of chronic liver damage and cirrhosis. While literature establishes that fibrotic acceleration is driven by advanced age, alcohol intake, comorbidities, and HIV coinfection [34-36]. A study in Wadi Alshatti confirmed that diabetic patients have a higher rate of Hepatitis C Virus (HCV) infection**,** demonstrating a strong correlation between the virus and the development of diabetes [37]. our data revealed that 21 patients presented with confirmed liver cirrhosis. Because the majority of these individuals were over 50 years old, these findings confirm that an extended infection duration increases the risk of hepatic cirrhosis.

Given that marriage represents a distinct risk factor for viral transmission, recently Libya mandates routine premarital screening for HBV, HCV, and HIV, alongside mandatory third-trimester testing for pregnant women approaching labor prevent transmission to their newborn during delivery. While this study sample included 116 married patients, the precise modes of transmission were not evaluated; however, multiple risk factors exist, with sexual transmission being a strong possibility. Notably, routine third-trimester screening identified 24 pregnant women (13.64%) with previously undiagnosed viral hepatitis. Among these individuals, 20 were positive for HBV, while the remaining 4 were diagnosed with HCV. These findings contribute to a broader regional context, as maternal HBV infection has been extensively investigated in neighbouring countries, including Tunisia, Sudan, and Egypt [38-39]. The education and early investigation of babies of infected mothers is necessary since If babies were infected, more than 90% of them will be chronic carriers [40]. Early detection and routine vaccination are vital to prevent the progression of chronic HBV and HCV into severe liver complications. Libya established its national immunization program in 1989, later adding universal newborn HBV vaccination in 1993 [41]. Notably, the program also implemented retrospective to cover those born between 1989 and 1992. Our data demonstrated that over 61.3% of Libyan patients with HBV were older than 35 years; consequently, it is highly probable that this majority missed the opportunity for routine infant HBV vaccination. Those Libyan patients with HVB and below 35 years most likely the immunity getting low because they either not vaccinated or their immunity decreased with long duration. A study at Shiraz University of Medical Sciences revealed that many vaccinated freshmen had anti-HBs levels below the protective threshold. Moreover, studies in Libya indicate that anti-HBs antibody levels can remain low despite complete vaccination. Globally, it is well-established that while immune memory persists, anti-HBs titers often decline below protective thresholds 10–20 years after the primary series [42-44]. In short, while several studies have examined infectious disease including influenza and the COVID-19 pandemic both within the Fezzan region and across Libya [45-49], further research is critical to fully map their epidemiology and establish robust control strategies.

Conclusion

This study highlights a substantial and potentially overlooked immunity gap among the population of southern Libya. These findings underscore an urgent need for active serological surveillance targeting both immigrants and Libyan national regardless of prior vaccination status to effectively control viral hepatitis transmission. Immunization of High-risk groups for example Migrants, Haemodialysis patients and Booster doses vaccination of HBV might decrease the infection rate. Maximizing early detection and public awareness will safeguard national health security and lower healthcare spending.

Authors' contributions: Khadija Mohamed Ahmad: Conceptualization, analysis and interpretation, writing original draft, review and editing. Fadwa Abdulsalam Mishkat Ibrahim and Abdulnabi Alkair Masoud data acquisition. Salha Khames Mohamed Ali did the statistical analysis. The manuscript was revised and agreed by all authors.

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