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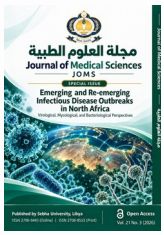

Seropositivity of Hepatitis B Virus, Hepatitis C Virus and Human Immunodeficiency Virus among Attendees of the Brak Al-Shati Primary Health Care Center, Southern Libya, 2020–2025: A Retrospective Record-Based Study

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Keywords:
Hepatitis B virus
Hepatitis C virus
Human immunodeficiency virus
Seroprevalence
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ABSTRACT

Background: Hepatitis B virus (HBV), hepatitis C virus (HCV) and human immunodeficiency virus (HIV) remain major public health challenges in Libya, but facility-level data from southern Libya are limited. This study described recorded seropositivity of these viruses among attendees of the Brak Al-Shati Primary Health Care Center and their distribution by demographic and temporal characteristics.

Methods: This retrospective record-based descriptive study reviewed the serological testing records (HBsAg, anti-HCV and HIV antigen/antibody) of 15,973 attendees screened between January 2020 and November 2025. Positivity rates were calculated with exact 95% confidence intervals (CIs), and distributions were compared using chi-square, Fisher's exact and Cochran–Armitage tests, with significance set at $p < 0.05$.

Results: Overall, 370 attendees (2.32%) tested positive for at least one virus. HBV was the most frequent (300 positive results; 1.88%, 95% CI 1.67–2.10), followed by HCV (48; 0.30%) and HIV (30; 0.19%), and seven attendees (1.9% of positive cases) had co-infections. Positivity for each virus was significantly higher among non-Libyan than among Libyan attendees (all $p < 0.05$). Males accounted for 92.4% and non-Libyans for 75.4% of positive cases. Annual positivity ranged from 1.60% in 2020 to 3.62% in 2021, and the number of positive cases peaked in 2025 (n = 88).

Conclusions: HBV was the predominant bloodborne viral infection among screened attendees, and positivity differed by nationality and year. Continued laboratory screening, linkage of positive cases to care and improved record-keeping are needed. Because these are facility-based positivity rates, they should not be interpreted as estimates of population prevalence.

الإيجابية المصلية لفيروسات التهاب الكبد البائي والتهاب الكبد الجيمي والعوز المناعي البشري بين المترددين على مركز الرعاية الصحية الأولية ببراك الشاطئ، جنوب ليبيا، 2020–2025: دراسة استعادية قائمة على السجلات

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الكلمات المفتاحية:
فيروس التهاب الكبد البائي
فيروس التهاب الكبد الجيمي
فيروس العوز المناعي البشري
الانتشار المصلي
الرعاية الصحية الأولية
ليبيا

الملخص

الخلفية: لا تزال فيروسات التهاب الكبد البائي والتهاب الكبد الجيمي والعوز المناعي البشري تمثل تحديات مهمة للصحة العامة في ليبيا، غير أن بيانات المرافق الصحية في جنوب البلاد محدودة. هدفت هذه الدراسة إلى وصف الإيجابية المصلية المسجلة لهذه الفيروسات بين المترددين على مركز الرعاية الصحية الأولية ببراك الشاطئ، وتوزيعها وفق الخصائص الديموغرافية والزمنية.

الطرائق: أُجريت دراسة وصفية استعادية قائمة على السجلات، رُوجعت فيها سجلات الفحوصات المصلية (HBsAg وAnti-HCV وHIV Ag/Ab) لـ 15,973 مترددًا فُحصوا بين يناير 2020 ونوفمبر 2025. وحُسبت نسب الإيجابية مع فترات ثقة دقيقة بنسبة 95%، وقورنت التوزيعات باستخدام اختبار مربع كاي واختبار فيشر الدقيق واختبار كوكران–أرميتاج، مع اعتماد مستوى دلالة 0.05.

النتائج: كانت نتائج 370 مترددًا (2.32%) إيجابية لفيروس واحد على الأقل. وكان فيروس التهاب الكبد البائي الأكثر تسجيلًا (300 نتيجة إيجابية؛ 1.88%، فترة الثقة 95%: 1.67–2.10)، يليه فيروس التهاب الكبد الجيمي (48؛ 0.30%) ثم فيروس العوز المناعي البشري (30؛ 0.19%)، وسُجلت عدوى مشتركة لدى سبعة مترددين (1.9% من الحالات الإيجابية). وكانت الإيجابية لكل فيروس أعلى بدلالة إحصائية لدى غير الليبيين مقارنة بالليبيين ($p < 0.001$ لجميع المقارنات). وشكّل الذكور 92.4% وغير الليبيين 75.4% من الحالات الإيجابية. وتراوحت الإيجابية السنوية بين 1.60% عام 2020 و3.62% عام 2021، وسُجل أكبر عدد من الحالات الإيجابية عام 2025 (88 حالة).

الاستنتاجات: كان فيروس التهاب الكبد البائي العدوى الفيروسية المنقولة بالدم الأكثر تسجيلًا بين المترددين المفحوصين، واختلفت الإيجابية بحسب الجنسية والسنة. وتبرز الحاجة لاستمرار الفحص المخبري، وربط الحالات الإيجابية بخدمات الرعاية، وتحسين التوثيق في السجلات. ولأن هذه النسب تمثل الإيجابية بين مراجعي المرفق، فلا ينبغي تفسيرها تقديرات لانتشار العدوى بين السكان.

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1. Introduction

Bloodborne viral infections, particularly hepatitis B virus (HBV), hepatitis C virus (HCV) and human immunodeficiency virus (HIV), remain a persistent public health problem because they can cause chronic infection and serious complications, and many infections remain undiagnosed for long periods. Hepatitis B is one of the leading causes of chronic liver disease worldwide: the World Health Organization (WHO) estimates that 240 million people were living with chronic HBV infection in 2024, with about 0.9 million new infections each year and an estimated 1.1 million deaths in 2024, mostly from cirrhosis and hepatocellular carcinoma [1]. HBV infection is preventable with a safe and effective vaccine, which makes vaccination and early detection the cornerstones of efforts to reduce the burden of disease [1].

Hepatitis C is likewise an important global health burden. WHO estimates that about 47 million people are living with chronic HCV infection, with approximately 0.9 million new infections each year and about 239,000 deaths in 2024 [2]. HCV infection can progress to chronic hepatitis, cirrhosis and liver cancer, and no effective vaccine is yet available. About 30% of people with acute infection clear the virus spontaneously, whereas the remainder develop chronic infection; a positive antibody test therefore requires confirmation of active infection by detection of HCV ribonucleic acid (RNA) [2].

HIV also remains an infection of global public health importance despite major advances in diagnosis, treatment and prevention. According to the Joint United Nations Programme on HIV/AIDS (UNAIDS), about 41.0 million people were living with HIV in 2025, 1.2 million people newly acquired HIV and around 570,000 people died from AIDS-related illnesses in the same year [3]. These figures underline the importance of continued surveillance, screening and early diagnosis, together with access to treatment and care for people living with HIV [3].

In Libya, a large national survey of more than 65,000 people from different age groups and administrative regions reported a hepatitis B surface antigen (HBsAg) positivity of 2.2% and an antibody to hepatitis C virus (anti-HCV) positivity of about 1.3%, with variation by age and other risk factors [4]. A study in Kufra reported high HBV and HCV positivity among migrants from sub-Saharan Africa: among 3,248 migrants screened in 2019, HBV positivity was 23.4% and HCV positivity was 31.2% [5].

Although local and regional studies have examined HBV and HCV infection in Libya, published data on temporal changes in HBV, HCV and HIV test results at primary health care facilities remain limited, particularly in the Brak Al-Shati area. Laboratory records at primary health care facilities are a valuable source of local epidemiological data, because they can be analyzed to identify changes in positive results over time and their distribution by the available demographic characteristics, thereby supporting surveillance and guiding prevention and early detection.

This study therefore aimed to describe the recorded positivity rates of HBV, HCV and HIV tests among attendees of the Brak Al-Shati Primary Health Care Center between January 2020 and November 2025, and to examine the distribution of positive results across the study years according to the available demographic and temporal characteristics, in order to provide local epidemiological data to support surveillance, prevention and early detection of these infections in the region.

2. Materials and Methods

2.1. Study design and setting

This retrospective record-based descriptive study examined the serological test results recorded for HBV, HCV and HIV among attendees of the Brak Al-Shati Primary Health Care Center in the Wadi Al-Shati district of southern Libya between January 2020 and November 2025. Data were extracted from the center's paper and electronic records of routine laboratory screening tests, which were requested for several purposes, including employment, study, marriage contracts and general medical examination.

2.2. Study population and data collection

The study population comprised all attendees who underwent serological screening for all three markers during the study period, in accordance with the center's routine practice: HBsAg, anti-HCV antibodies and HIV antigen/antibody (Ag/Ab). In total, 15,973 attendees were tested, of whom all those positive for one or more viruses (n = 370) were included in the analysis of positive cases. Incomplete records, records without laboratory results and duplicate records of the same person across years were excluded; duplicates were identified and removed by the center's data officers using the available identifier, so that each person was included only once. The available records did not contain details of the analytical techniques, manufacturers and test kits used, the consistency of testing methods during the study period, quality-control procedures or the results of confirmatory testing of reactive samples.

Available demographic, occupational and geographic data were collected, including age, sex, nationality, place of residence, occupation and reason for testing. Because these characteristics were analyzed only for attendees with positive results, they were used to describe the distribution of positive cases and not to estimate the probability of positivity or the risk of infection across groups of attendees.

2.3. Ethical considerations

Administrative permission for the study was obtained through an official letter from the Dean of the Faculty of Medical Technology, Wadi Alshatti University (ref. 25/315, dated 1 October 2025), to the Director of the Primary Health Care Office, Wadi Al-Shati, which approved the study and granted access to the relevant records of the Brak Al-Shati Primary Health Care Center. The confidentiality of attendees' data was maintained throughout data handling, and the information was used solely for scientific research.

2.4. Statistical analysis

Data were entered and organized in Microsoft Excel 2010 (Microsoft Corp., Redmond, WA, USA) and analyzed using IBM SPSS Statistics, version 26 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to present frequencies and percentages for categorical variables and means with standard deviations (SD) for continuous variables. The apparent prevalence of each virus over the whole study period was calculated as the percentage of positive results: positivity (%) = (number of positive cases ÷ total number tested) × 100. Positivity was also calculated for each virus in each year from 2020 to 2025 to describe annual variation. Ninety-five percent confidence intervals (CIs) for positivity rates were calculated using the exact Clopper–Pearson binomial method. The chi-square (χ^2) test was used to examine associations between the type of viral infection and age group, sex and nationality, and to compare positivity between groups; Fisher's exact test was used when the assumptions of the chi-square test were not met. The Cochran–Armitage test was used to assess linear trends. A p value < 0.05 was considered statistically significant.

3. Results

3.1. Characteristics of attendees and positive cases

After application of the inclusion and exclusion criteria, 15,973 attendees were tested at the Brak Al-Shati Primary Health Care Center between January 2020 and November 2025, of whom 7,431 (46.5%) were Libyan and 8,542 (53.5%) were non-Libyan (Fig. 1). Of these, 370 (2.32%) tested positive for one or more of the viruses studied. The age of positive attendees ranged from 12 to 75 years, with a mean of 31.95 ± 10.89 years and a median of 30 years (interquartile range 24–38 years), indicating that most positive cases were young or early-middle-aged adults.

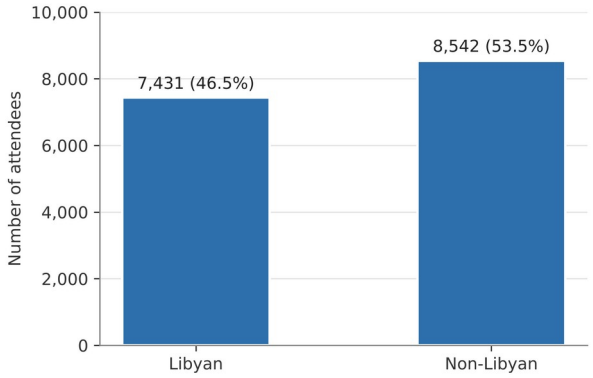

Fig. 1. Distribution of attendees tested at the Brak Al-Shati Primary Health Care Center by nationality, January 2020–November 2025 (N = 15,973).

No specific reason for testing (such as routine follow-up, an employment check or another defined purpose) was documented for 287 positive cases (77.6%), whereas testing was linked to employment in 72 cases (19.5%), to a marriage contract in 8 cases (2.2%) and to study in 3 cases (0.8%).

3.2. Distribution of positive cases by type of infection

HBV mono-infection accounted for most positive cases (294 cases, 79.5%; 1.84% of all attendees), followed by HCV mono-infection (43 cases, 11.6%; 0.27%) and HIV mono-infection (26 cases, 7.0%; 0.16%). Co-infections were uncommon (7 cases, 1.9% of positive cases): three were HBV and HCV, two were HBV and HIV, one was HCV and HIV, and one was a triple infection with HBV, HCV and HIV (Table 1).

Table 1. Distribution of positive cases by type of viral infection

Category	Virus	Positive cases, n (%)	% of all attendees
Mono-infection	HBV	294 (79.5)	1.84
	HCV	43 (11.6)	0.27
	HIV	26 (7.0)	0.16
Co-infection	HBV + HCV	3 (0.8)	0.02
	HBV + HIV	2 (0.5)	0.01
	HCV + HIV	1 (0.3)	0.006
	HBV + HCV + HIV	1 (0.3)	0.006
Total		**370 (100)**	**2.32**

Percentages of all attendees are based on 15,973 attendees tested. HBV, hepatitis B virus; HCV, hepatitis C virus; HIV, human immunodeficiency virus.

3.3. Positivity by nationality

The distribution of infection types among positive cases was not significantly associated with nationality (χ^2 = 4.444, df = 3, p = 0.217), although HBV mono-infection was slightly more frequent among Libyan than among non-Libyan positive cases (86.8% vs. 77.1%; Table 2).

Table 2. Distribution of positive cases by type of infection and nationality

Type of infection	All positive cases, n (%)	Libyan, n (%)	Non-Libyan, n (%)
HBV mono-infection	294 (79.5)	79 (86.8)	215 (77.1)
HCV mono-infection	43 (11.6)	8 (8.8)	35 (12.5)
HIV mono-infection	26 (7.0)	3 (3.3)	23 (8.2)
Co-infection	7 (1.9)	1 (1.1)	6 (2.2)
Total	**370 (100)**	**91 (100)**	**279 (100)**

$\chi^2 = 4.444$, df = 3, $p = 0.217$. Abbreviations as in Table 1.

Overall seropositivity among all attendees tested, including co-infections, was 1.88% (95% CI 1.67–2.10) for HBV, 0.30% (0.22–0.40) for HCV and 0.19% (0.13–0.27) for HIV. Non-Libyan attendees had significantly higher positivity than Libyan attendees for all three viruses: HBV (2.58% vs. 1.08%), HCV (0.46% vs. 0.12%) and HIV (0.32% vs. 0.04%; all $p < 0.001$; Table 3).

Table 3. Overall positivity for each virus among all attendees tested, by nationality

Virus	Overall, % (95% CI)	Libyan, % (95% CI)	Non-Libyan, % (95% CI)	*p* value
HBV	1.88 (1.67–2.10)	1.08 (0.85–1.34)	2.58 (2.25–2.93)	< 0.001
HCV	0.30 (0.22–0.40)	0.12 (0.06–0.23)	0.46 (0.32–0.62)	< 0.001
HIV	0.19 (0.13–0.27)	0.04 (0.01–0.12)	0.32 (0.21–0.46)	< 0.001

Positivity includes co-infections; denominators are all attendees tested (overall 15,973; Libyan 7,431; non-Libyan 8,542). 95% CIs were calculated by the exact Clopper–Pearson method. CI, confidence interval; other abbreviations as in Table 1.

3.4. Distribution by residence and occupation

Most positive cases were resident in the town of Brak (238 cases, 64.3%), followed by Qirah (23 cases, 6.2%) and Tamzawa (14 cases, 3.8%), whereas 64 cases (17.3%) were distributed across other localities with small individual counts, which were combined into a single category (Table 4). By occupation, workers and technicians accounted for the largest share of positive cases (239 cases, 64.6%), followed by employees (55 cases, 14.9%), whereas the remaining occupational groups (self-employment, students and job seekers, housewives and domestic workers, and agricultural and livestock occupations) contributed smaller proportions (Table 5).

Table 4. Distribution of positive cases by place of residence and type of infection

Place of residence	HBV, n (%)	HCV, n (%)	HIV, n (%)	Co-infection, n (%)	Total, n (%)
Brak	182 (49.2)	30 (8.1)	20 (5.4)	6 (1.6)	238 (64.3)
Qirah	20 (5.4)	1 (0.3)	2 (0.5)	0 (0.0)	23 (6.2)
Tamzawa	14 (3.8)	0 (0.0)	0 (0.0)	0 (0.0)	14 (3.8)
Sebha	6 (1.6)	2 (0.5)	0 (0.0)	0 (0.0)	8 (2.2)
Ubari	6 (1.6)	0 (0.0)	0 (0.0)	1 (0.3)	7 (1.9)
Tarout	4 (1.1)	0 (0.0)	2 (0.5)	0 (0.0)	6 (1.6)
Aqar	3 (0.8)	1 (0.3)	0 (0.0)	0 (0.0)	4 (1.1)
Ashkidah	3 (0.8)	0 (0.0)	1 (0.3)	0 (0.0)	4 (1.1)
Abu Gharduqah	1 (0.3)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.3)
Benghazi	0 (0.0)	1 (0.3)	0 (0.0)	0 (0.0)	1 (0.3)
Other localities (combined)	55 (14.9)	8 (2.2)	1 (0.3)	0 (0.0)	64 (17.3)
Total	**294 (79.5)**	**43 (11.6)**	**26 (7.0)**	**7 (1.9)**	**370 (100)**

Percentages are of all 370 positive cases. HBV, HCV and HIV columns refer to mono-infections. Abbreviations as in Table 1.

Table 5. Distribution of positive cases by occupation and type of infection

Occupation	HBV, n (%)	HCV, n (%)	HIV, n (%)	Co-infection, n (%)	Total, n (%)
Workers and technicians	193 (52.2)	20 (5.4)	21 (5.7)	5 (1.4)	239 (64.6)
Employees	50 (13.5)	3 (0.8)	2 (0.5)	0 (0.0)	55 (14.9)
Self-employed	16 (4.3)	1 (0.3)	1 (0.3)	1 (0.3)	19 (5.1)
Agricultural and livestock occupations	4 (1.1)	7 (1.9)	0 (0.0)	0 (0.0)	11 (3.0)
Students and job seekers	7 (1.9)	2 (0.5)	0 (0.0)	0 (0.0)	9 (2.4)
Housewives and domestic workers	6 (1.6)	1 (0.3)	1 (0.3)	0 (0.0)	8 (2.2)
Other occupations	18 (4.9)	9 (2.4)	1 (0.3)	1 (0.3)	29 (7.8)
Total	**294 (79.5)**	**43 (11.6)**	**26 (7.0)**	**7 (1.9)**	**370 (100)**

Percentages are of all 370 positive cases. HBV, HCV and HIV columns refer to mono-infections. Abbreviations as in Table 1.

3.5. Distribution by sex and nationality

Males accounted for the great majority of positive cases (92.4%), compared with 7.6% for females, a pattern observed across most nationalities. The most represented nationalities among positive cases were Nigerien (30.5%), Libyan (24.6%), Nigerian (22.7%) and Sudanese (7.8%), whereas the remaining nationalities each contributed small numbers. The chi-square test showed no significant association between sex and type of infection when all nationalities were analyzed together ($\chi^2 = 3.421$, df = 3, $p = 0.331$), although significant associations were observed within two

nationalities, Niger ($p = 0.010$) and Mali ($p = 0.030$); these subgroup results should be interpreted with caution because of their small sample sizes (Table 6).

Table 6. Distribution of positive cases by nationality, sex and type of infection

Nationality	Sex	HBV, n (%)	HCV, n (%)	HIV, n (%)	Co-infection, n (%)	Total, n	Nationality total, n (%)
Niger	Female	2 (66.7)	0 (0.0)	0 (0.0)	1 (33.3)	3	113 (30.5)
	Male	94 (85.5)	3 (2.7)	11 (10.0)	2 (1.8)	110	
Libya	Female	12 (70.6)	3 (17.6)	2 (11.8)	0 (0.0)	17	91 (24.6)
	Male	67 (90.5)	5 (6.8)	1 (1.4)	1 (1.4)	74	
Nigeria	Female	5 (71.4)	1 (14.3)	1 (14.3)	0 (0.0)	7	84 (22.7)
	Male	69 (89.6)	3 (3.9)	5 (6.5)	0 (0.0)	77	
Sudan	Male	22 (75.9)	4 (13.8)	2 (6.9)	1 (3.4)	29	29 (7.8)
Egypt	Male	4 (18.2)	18 (81.8)	0 (0.0)	0 (0.0)	22	22 (5.9)
Burkina Faso	Male	4 (50.0)	0 (0.0)	2 (25.0)	2 (25.0)	8	8 (2.1)
Mali	Female	0 (0.0)	0 (0.0)	1 (100)	0 (0.0)	1	7 (1.9)
	Male	5 (83.3)	1 (16.7)	0 (0.0)	0 (0.0)	6	
Pakistan	Male	2 (40.0)	3 (60.0)	0 (0.0)	0 (0.0)	5	5 (1.4)
Chad	Male	3 (100)	0 (0.0)	0 (0.0)	0 (0.0)	3	3 (0.8)
Bangladesh	Male	1 (50.0)	1 (50.0)	0 (0.0)	0 (0.0)	2	2 (0.5)
Côte d'Ivoire	Male	1 (100)	0 (0.0)	0 (0.0)	0 (0.0)	1	1 (0.3)
Ghana	Male	0 (0.0)	0 (0.0)	1 (100)	0 (0.0)	1	1 (0.3)
India	Male	1 (100)	0 (0.0)	0 (0.0)	0 (0.0)	1	1 (0.3)
Togo	Male	1 (100)	0 (0.0)	0 (0.0)	0 (0.0)	1	1 (0.3)
Tunisia	Male	0 (0.0)	1 (100)	0 (0.0)	0 (0.0)	1	1 (0.3)
Returnee from Chad	Male	1 (100)	0 (0.0)	0 (0.0)	0 (0.0)	1	1 (0.3)
All nationalities	**Female**	**19 (67.9)**	**4 (14.3)**	**4 (14.3)**	**1 (3.6)**	**28**	**28 (7.6)**
	Male	**275 (80.4)**	**39 (11.4)**	**22 (6.4)**	**6 (1.8)**	**342**	**342 (92.4)**

Row percentages are within each sex and nationality; the last column gives the percentage of all 370 positive cases. Sex and type of infection, all nationalities: $\chi^2 = 3.421$, df = 3, $p = 0.331$; within Niger, $p = 0.010$; within Mali, $p = 0.030$. HBV, HCV and HIV columns refer to mono-infections. Abbreviations as in Table 1.

3.6. Distribution by age

HBV mono-infection was the most frequently recorded infection in every age group, whereas relatively higher proportions of HCV and HIV were observed in the older age groups. Fisher's exact test showed no significant association between age group and type of infection in the sample as a whole ($p = 0.284$; Table 7). However, the association was significant when Libyan ($\chi^2 = 43.315$, df = 27, $p = 0.024$) and non-Libyan ($\chi^2 = 49.713$, df = 33, $p = 0.031$) positive cases were analyzed separately; these subgroup results should be interpreted with caution because several categories had low expected frequencies. Because the analysis was restricted to positive cases and the number of attendees tested in each age group was not available, no age group can be identified as being at highest risk of infection in the community.

Nationality was strongly associated with the age distribution of positive cases ($\chi^2 = 57.931$, df = 12, $p < 0.001$). Non-Libyans predominated among positive cases in the younger age groups (90.2% and 97.3% of cases aged 16–20 and 21–25 years, respectively), whereas the proportion of Libyans increased progressively with age and exceeded 50% from the 51–55-year group onward (Table 8).

Table 7. Distribution of positive cases by age group and type of infection

Age group (years)	HBV, n (%)	HCV, n (%)	HIV, n (%)	Co-infection, n (%)	Total, n (%)
≤ 15	5 (100)	0 (0.0)	0 (0.0)	0 (0.0)	5 (1.4)
16–20	34 (82.9)	4 (9.8)	2 (4.9)	1 (2.4)	41 (11.1)
21–25	64 (85.3)	7 (9.3)	4 (5.3)	0 (0.0)	75 (20.3)
26–30	58 (81.7)	6 (8.5)	5 (7.0)	2 (2.8)	71 (19.2)
31–35	48 (82.8)	3 (5.2)	6 (10.3)	1 (1.7)	58 (15.7)
36–40	36 (66.7)	11 (20.4)	5 (9.3)	2 (3.7)	54 (14.6)
41–45	19 (82.6)	3 (13.0)	0 (0.0)	1 (4.3)	23 (6.2)
46–50	13 (72.2)	2 (11.1)	3 (16.7)	0 (0.0)	18 (4.9)
51–55	9 (81.8)	2 (18.2)	0 (0.0)	0 (0.0)	11 (3.0)
56–60	3 (50.0)	2 (33.3)	1 (16.7)	0 (0.0)	6 (1.6)
61–65	3 (75.0)	1 (25.0)	0 (0.0)	0 (0.0)	4 (1.1)
66–70	1 (33.3)	2 (66.7)	0 (0.0)	0 (0.0)	3 (0.8)
71–75	1 (100)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.3)
Total	**294 (79.5)**	**43 (11.6)**	**26 (7.0)**	**7 (1.9)**	**370 (100)**

Row percentages within each age group; the last column gives the percentage of all positive cases. Fisher's exact test, $p = 0.284$ ($\chi^2 = 35.029$, df = 36). HBV, HCV and HIV columns refer to mono-infections. Abbreviations as in Table 1.

Table 8. Distribution of positive cases by age group and nationality

Age group (years)	Libyan, n (%)	Non-Libyan, n (%)	Total, n (%)
≤ 15	0 (0.0)	5 (100)	5 (1.4)
16–20	4 (9.8)	37 (90.2)	41 (11.1)
21–25	2 (2.7)	73 (97.3)	75 (20.3)
26–30	17 (23.9)	54 (76.1)	71 (19.2)
31–35	21 (36.2)	37 (63.8)	58 (15.7)
36–40	22 (40.7)	32 (59.3)	54 (14.6)
41–45	7 (30.4)	16 (69.6)	23 (6.2)
46–50	7 (38.9)	11 (61.1)	18 (4.9)
51–55	6 (54.5)	5 (45.5)	11 (3.0)
56–60	0 (0.0)	6 (100)	6 (1.6)
61–65	3 (75.0)	1 (25.0)	4 (1.1)
66–70	1 (33.3)	2 (66.7)	3 (0.8)
71–75	1 (100)	0 (0.0)	1 (0.3)
Total	**91 (24.6)**	**279 (75.4)**	**370 (100)**

Row percentages within each age group. $\chi^2 = 57.931$, df = 12, $p < 0.001$.

3.7. Annual distribution of positive results

The annual number of positive results for HBV, HCV and HIV varied over 2020–2025, with notable differences between Libyan and non-Libyan attendees (Table 9). Annual positivity among all attendees was 1.60% in 2020, 3.62% in 2021, 2.59% in 2022, 1.97% in 2023, 2.53% in 2024 and 1.89% in 2025. Each person with a co-infection was counted only once when calculating the total number of positive attendees each year, but was included under each relevant virus when results were presented by virus. The highest HBV positivity among Libyans was recorded in 2021 (4.15%), whereas the highest among non-Libyans was recorded in 2022 (4.79%). Non-Libyans had higher positivity than Libyans in most years, particularly for HBV, with year-to-year variation in HCV and HIV. HBV positivity differed significantly between study years ($\chi^2 = 21.502$, df = 5, $p < 0.001$), whereas no significant annual differences were observed for HCV ($p = 0.242$) or HIV ($p = 0.186$). The test for linear trend showed a significant decrease in HBV positivity when all years were included ($z = -2.590$, $p = 0.010$), but this trend was no longer significant when 2025 was excluded.

Table 9. Annual number of attendees tested and positivity for each virus, by nationality

Year	Attendees tested, n	Nationality	Tested, n	HBV, n (%)	HCV, n (%)	HIV, n (%)	Positive attendees, n (%)
2020	876	Libyan	453	6 (1.32)	0 (0.00)	0 (0.00)	14 (1.60)
		Non-Libyan	423	8 (1.89)	0 (0.00)	0 (0.00)	
2021	1,603	Libyan	1,060	44 (4.15)	4 (0.38)	0 (0.00)	58 (3.62)
		Non-Libyan	543	8 (1.47)	2 (0.37)	0 (0.00)	
2022	3,167	Libyan	2,060	8 (0.39)	0 (0.00)	0 (0.00)	82 (2.59)
		Non-Libyan	1,107	53 (4.79)	15 (1.36)	7 (0.63)	
2023	2,792	Libyan	1,144	6 (0.52)	2 (0.17)	1 (0.09)	55 (1.97)
		Non-Libyan	1,648	39 (2.37)	5 (0.30)	5 (0.30)	
2024	2,884	Libyan	745	8 (1.07)	1 (0.13)	1 (0.13)	73 (2.53)
		Non-Libyan	2,139	50 (2.34)	7 (0.33)	8 (0.37)	
2025	4,651	Libyan	1,969	8 (0.41)	2 (0.10)	1 (0.05)	88 (1.89)
		Non-Libyan	2,682	62 (2.31)	10 (0.37)	7 (0.26)	
Total	**15,973**			**300 (1.88)**	**48 (0.30)**	**30 (0.19)**	**370 (2.32)**

Virus-specific counts include co-infections, so each co-infected attendee is counted under every relevant virus; positive attendees are counted once per year. Percentages for each virus are of attendees tested in the same nationality group and year; positive attendees are a percentage of all attendees tested that year. 2025 covers January–November. HBV by year: $\chi^2 = 21.502$, df = 5, $p < 0.001$; HCV, $p = 0.242$; HIV, $p = 0.186$. Abbreviations as in Table 1.

4. Discussion

In this study, 370 of 15,973 attendees of the Brak Al-Shati Primary Health Care Center (2.32%) tested positive for at least one of the viruses studied between January 2020 and November 2025. HBV was the most frequent (1.88%), followed by HCV (0.30%) and HIV (0.19%). These figures represent test positivity among attendees of the center; they may indicate, but cannot accurately estimate, the prevalence of infection in the general population of the region, because the characteristics of attendees and their reasons for testing may differ from those of the population as a whole.

In Tripoli, Daw et al. reported HBsAg positivity of 3.7%, anti-HCV

positivity of about 0.9% and HIV positivity of 0.15% among 9,170 participants from nine districts [6]. Numerically, HBV and HCV positivity in the present study were lower than those reported in Tripoli, whereas HIV positivity was slightly higher. The Libyan national survey, whose data were collected in 2005, reported HBsAg positivity of 2.2% and anti-HCV positivity of 1.3% [4], and a population-based study conducted in Ghudduwah, southern Libya, in 2018 reported HBsAg positivity of 2.8% and anti-HCV positivity of 22.4% among 352 participants [7]. In Sebha, screening of 2,239 male blood donors at Sebha Medical Centre in 2006 found HBsAg in 3.17% and anti-HCV in 1.34% of donors, with no HIV-positive donors [8]. HBsAg positivity in the present study (1.88%) was numerically lower than in all four studies, and anti-HCV positivity (0.30%) was lower than in the national, Tripoli and Sebha blood-donor surveys and well below the high rate reported in Ghudduwah. These differences do not demonstrate a temporal change in infection prevalence and should be interpreted with caution in view of differences in study periods, geographic locations and population characteristics. Moreover, anti-HCV positivity alone does not establish active infection unless it is followed by confirmatory testing for viral RNA.

Higher rates have been reported in groups at increased risk of infection. Ziglam et al. found positivity rates of 6.9% for HBV, 23.7% for HCV and 18.2% for HIV among 6,371 male prisoners in western Libya [9], which are clearly higher than those in the present study. This difference does not imply a contradiction between the two studies, because the earlier study examined a different population whose exposures and risk factors probably differ from those of primary health care attendees. Occupational exposure may also increase the risk of infection: Franka et al. reported HBV positivity of 2.3% among medical waste handlers in Tripoli compared with 0.3% in a comparison group, and HCV positivity of 2.7% compared with no positive cases, with statistically significant differences between the groups [10]. These findings highlight the importance of assessing occupational exposure, although the present study could not evaluate it directly because information on risk factors and reasons for testing was limited. In his review of HBV, HCV and HIV among high-risk and vulnerable populations in Libya, Khalaf likewise noted that these infections remain a public health concern and that epidemiological data on vulnerable groups, including migrants, are still limited [11].

The predominance of HBV among the three viruses in this study is consistent with the continuing importance of HBV infection as a public health problem in Libya [6]. It also agrees with the study by Ahmad et al. on the demographic patterns of viral hepatitis in southern Libya, in which HBV accounted for 80.1% of 176 patients attending health care facilities [12]. However, overall rates cannot be compared directly, because that study was restricted to patients already diagnosed with hepatitis B and/or C in inpatient and outpatient settings, whereas the present study analyzed screening results for three viruses among primary health care attendees [12]. Similarly, Eisay et al. found that 67.36% of cases recorded at Bani Walid General Hospital during 2014–2020 were HBV infections and 32.64% were HCV infections, with co-infection in 3.77% [13].

The higher positivity among non-Libyans is consistent with Libyan studies of viral infections among nationals and foreign workers, including the study by Almlyan et al. in Al-Rujban, which recorded higher positivity for all three viruses among migrant workers than among Libyans, although the differences were not statistically significant [14], and the study by Abubaker et al. in Tarhuna [15]. Nevertheless, nationality should not be assumed to be a direct cause of higher positivity, because other factors may contribute, including differences in age and occupational structure, previous exposure, access to screening services and the groups required to undergo testing. Furthermore, the large number of non-Libyan attendees does not necessarily indicate a higher risk among all non-Libyans in the region, because the study was based on attendee records rather than a representative population sample. The most appropriate interpretation is that the records showed different positivity rates between nationality groups within the study sample, which calls for further studies with more detailed data on risk factors, health history and reasons for testing.

Non-Libyans accounted for 75.4% of all positive cases, most of whom were from African countries, particularly Niger, Nigeria and Sudan. This finding is noteworthy when compared with the study by Saaed and Ongerth among migrants in Kufra, which reported HBsAg positivity of 23.4% [5], whereas HBV positivity among non-Libyans in the present study was 2.58%. Differences in study populations, testing settings and participant selection call for caution when interpreting this gap. These results underline the importance of providing evaluation and follow-up for people with positive results, including measurement of HBV DNA, hepatitis B e antigen (HBeAg) and alanine aminotransferase (ALT), together with screening of contacts and vaccination of those who are uninfected and non-immune.

Co-infections were infrequent in this study. Although few in number, they are clinically important, because infection with more than one virus may complicate clinical assessment and follow-up, depending on the type of infection and the clinical condition of the patient. A previous study in Tripoli examined the seroprevalence of co-infection with these viruses and its associated risk factors [6]. The low frequency of co-infection is consistent with the findings of Ahmad et al. [12]. Although differences in testing methods, definitions of co-infection and participant characteristics make

precise comparison difficult, these studies suggest a similar epidemiological pattern in southern Libya, in which HBV is the main burden of disease [12].

Most positive cases in this study were male, but this alone does not show that males are at greater risk of infection; the distribution of occupational groups, the reasons for testing and access to testing should be examined to explain this imbalance. Likewise, workers and technicians were the most represented occupational group among positive cases, and Brak was the locality with the largest number of cases. These findings describe the distribution of recorded cases by occupation and residence and do not demonstrate a higher infection rate in any occupational group or locality unless the number of people tested in each category is known. They may help to identify groups and areas that require better documentation and follow-up, but they do not justify labelling any population group as a source of infection.

The ages of positive cases ranged from 12 to 75 years, with a mean of 31.95 ± 10.89 years, indicating that recorded cases spanned several age groups but were concentrated among relatively young adults. This agrees with the study by Ahmad et al., in which cases were concentrated in the 30–50-year age group (53.4%) and Sebha was the most frequent location (59.7%) [12]. However, the highest-risk age group cannot be identified from the ages of positive cases alone, because this requires comparison of positive cases with the number tested in each age group. The significant difference in age distribution by nationality may reflect differences in the age structure of the two groups.

HCV positivity in the present study was lower than that reported in the Libyan national survey [4] and in some published local studies from southern Libya [11], and a previous study showed spatial and temporal variation in the distribution of HCV infection in Libya during 2007–2016 [16]. Notably, 18 of the 22 positive cases among Egyptian attendees (81.8%) were HCV infections, and the remaining four were HBV infections. This observation is consistent with the historical burden of HCV in Egypt, where community studies reported high positivity in Upper Egypt and linked it partly to past parenteral antischistosomal therapy [17,18], and molecular studies documented the predominance of HCV genotype 4 [19]; genotype 4 was likewise the most common genotype (60%) among 75 HCV-positive samples genotyped in Benghazi, Libya [20]. Nevertheless, this finding should be interpreted with caution because of the small number of cases, and because it reflects the relative distribution of infection types among positive cases rather than positivity among all Egyptian attendees tested.

The annual distribution of HBV-positive results differed between Libyans and non-Libyans. Positivity among Libyans was highest in 2021 (4.15%) and fell to 0.39% in 2022, whereas among non-Libyans it rose from 1.47% in 2021 to 4.79% in 2022. The available data do not allow this variation to be attributed to a specific factor, because the study lacked sufficient information on the reasons for testing and on the demographic and clinical characteristics of those tested each year. These results should therefore be interpreted as the annual distribution of seropositivity among attendees who underwent testing, rather than as direct evidence of real changes in infection prevalence in either group. Overall, annual case numbers fluctuated without a consistent upward or downward trend, in agreement with previous studies [11,21]. This fluctuation probably reflects changes in the number of people tested and in the reasons for testing rather than true changes in prevalence, consistent with the global observation by Blach et al. that changes in HCV diagnosis rates are often linked to the expansion or contraction of screening programmes rather than to real changes in infection rates [21]. It is also consistent in principle with the temporal and spatial variation in HIV cases reported by Daw et al. in Libya during 1993–2017 [22].

This study has several limitations. It relied on retrospective data from the records of a single primary health care center; the reason for testing was not documented for 77.6% of positive cases; and information on individual risk factors and outcomes after diagnosis was lacking. Limited demographic, occupational and geographic data restricted some detailed comparisons. No documented information was available on testing techniques, test kits, quality-control procedures or confirmatory testing, so the results reflect recorded serological reactivity and do not necessarily indicate active infection. Results for categories with small numbers should be interpreted with caution because of limited statistical power. Accordingly, the findings should be interpreted with a clear distinction between test positivity and population prevalence.

5. Conclusion

HBV was the most frequently recorded bloodborne viral infection among attendees of the Brak Al-Shati Primary Health Care Center during 2020–2025, followed by HCV and HIV, and positivity was higher among non-Libyan than among Libyan attendees. Laboratory screening for HBV, HCV and HIV should continue according to approved protocols, with confidentiality of results and linkage of positive cases to appropriate evaluation and follow-up. Laboratory records should be made more complete and standardized, including demographic and geographic characteristics, the reason for testing, and monthly and annual numbers of people tested and positive results, so that positivity can be calculated accurately. Hepatitis B awareness and prevention programmes, verification of vaccination status with referral for vaccination according to national guidelines, and multicenter studies that include risk-factor data and confirmatory

results are also recommended, together with future time-series analyses to assess possible monthly and seasonal variation.

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Declarations

Author contributions: All authors made a substantial, direct and intellectual contribution to the work. S.A. designed the study, developed the overall research plan and performed the statistical analysis. E.O. and R.A.A. contributed to the practical work and data collection. S.A. and A.A. prepared the first draft of the manuscript. All authors reviewed and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

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Data availability: The data supporting the findings of this study are available from the corresponding author on reasonable request, subject to applicable ethical and institutional restrictions.

Supplementary material: Not applicable.

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