Prevalence of hepatitis B and C virus infections and their related risk factors in Libya: a national seroepidemiological survey

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معدل انتشار العدوى بفيروسات الالتهاب الكبدي "بي" و"سي" وعوامل الاختطار ذات الصلة بها في ليبيا: مسح وطني مصلي وبائي

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الخلاصة: أشارت التقارير إلى وجود معدلات انتشار مرتفعة للعدوى بفيروسات الالتهاب الكبدي "بي" و"سي" بين مجموعات معينة من المرضى في ليبيا، فأجرى الباحثون مسحاً تم تصميمه للتعرف على مدى اتساع نطاق المشكلة على المستوى الوطني. وقد طبق الباحثون تصميماً للعينة المتعددة المراحل التي تغطي جميع المناطق الإدارية في ليبيا، وشملت العينة أكثر من 65000 فرد من جميع المجموعات العمرية. وقد أخذت عينات الدم من جميع المرضى، مع استكمال الاستبيان حول المعطيات لعوامل الاختطار الديموغرافية والسلوكية. واتضح أن معدل انتشار المستضد السطحي للالتهاب الكبدي "بي" 2.2٪، ومعدل انتشار الضد المضاد لفيروس الالتهاب الكبدي "سي" 1.3٪، وأن معدل انتشار الضد المضاد للالتهاب الكبدي "سي" يزداد بتقدم العمر، وأنه يزداد تدريجياً بعد عمر الثلاثين عاماً، وفي المقابل فإن المستضد السطحي للالتهاب الكبدي "بي" ثابت في جميع المجموعات العمرية التي تزيد على العاشرة من العمر. أما عوامل الاختطار المعدَّلة حسب العمر للعدوى بفيروس الالتهاب الكبدي "سي" فهي الإدخال السابق إلى المستشفى، والعمليات الجراحية، ونقل الدم السابق، وتعاطي المخدرات بالحقن، ولم يتعرف الباحثون على عوامل الاختطار المرافقة للعدوى بفيروس الالتهاب الكبدي "بي" سوى التعرض الأسري أو مخالطة حالة مصابة بالعدوى بفيروس الالتهاب الكبدي "بي".

ABSTRACT A high prevalence of hepatitis B (HBV) and C virus (HCV) infections has been reported among specific patient groups in Libya; a survey was thus designed to determine the extent of the problem at the national level. A multi-stage sampling design covering all administrative areas of Libya was applied, covering > 65 000 individuals of all age groups. All subjects gave a blood sample and completed a questionnaire on demographic and risk behaviour data. The prevalence of HBV surface antigen (HBsAg) and anti-HCV were 2.2% and 1.3% respectively. The prevalence of anti-HCV increased with age, rising gradually after age 30 years, in contrast to a stable prevalence of HBsAg in all age groups 10+ years. Age-adjusted risk factors for HCV infection were previous hospitalization, surgical operations, previous blood transfusions and intravenous drug use; for HBV infection only family exposure or contact with HBV case were identified.

Prévalence des infections par les virus de l'hépatite B et C et des facteurs de risque associés en Libye : enquête séro-épidémiologique nationale

RÉSUMÉ Une forte prévalence des infections par les virus de l'hépatite B et C a été signalée dans des groupes de patients spécifiques en Libye et une enquête a par conséquent été préparée pour évaluer l'étendue du problème à l'échelle nationale. Un plan d'échantillonnage à plusieurs degrés couvrant toutes les zones administratives de Libye a été appliqué, impliquant plus de 65 000 personnes de tous les groupes d'âge. Tous les sujets ont fourni un échantillon de sang et rempli un questionnaire concernant leurs données démographiques et leur comportement à risque. La prévalence de l'antigène de surface du virus de l'hépatite B (AgHBs) et des anticorps anti-hépatite C était de 2,2 % et 1,3 % respectivement. La prévalence des anticorps anti-hépatite C augmentait progressivement avec l'âge, enregistrant une progression à partir de 30 ans contrairement à la prévalence de l'AgHBs qui restait stable dans tous les groupes d'âge de plus de dix ans. Les antécédents d'hospitalisation, d'interventions chirurgicales, de transfusions sanguines et de consommation de drogue par voie intraveineuse étaient les facteurs de risque corrigés selon l'âge pour une infection par le virus de l'hépatite C, alors que pour l'infection par le virus de l'hépatite B, une exposition familiale ou le contact avec un cas infecté étaient les seuls facteurs identifiés.

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Introduction

Hepatitis B virus (HBV) and C virus (HCV) infections are a major global public health problem warranting high priority efforts for prevention, control and treatment [1,2]. In developing countries the mode of transmission of these 2 bloodborne viruses tends to be from perinatal transmission or household contacts, while in developed countries sexual contact, shared needles among intravenous drug users and contaminated blood or organ transplants are more likely to be responsible for transmission. However, screening tests have reduced dramatically the risk of transmission worldwide [3–5].

Libya, a developing country of approximately 6 million people, belongs to the intermediate endemicity countries with a wide variance of seropositivity among different regions and populations. Previous studies of blood donors from serum screening in Libya revealed prevalence rates varying between 1.9%–5.8% for HBV and 1.2%–7.9% for HCV [6–11]. In one of these studies, a high prevalence of HCV infection in the apparently healthy Libyan population was reported (7.9%) [9]. Nosocomial outbreaks of multiple bloodborne viral infections was reported in 2001 by Yerly et al. involving approximately 400 children. While all were infected with HIV, coinfection with HCV or HBV was found in 47% and 33% respectively after testing a subgroup of 148 children [10]. The prevalence of HCV antibodies among different populations in 1999–2001 was found to be 1.6% among healthy adults, 1.2% among blood donors, 2.0% among hospital health care workers, 10.8% in multiple blood transfusion patients and 20.5% among renal dialysis patients [11]. Furthermore, in Benghazi city the prevalence of anti-HCV in 153 chronic renal dialysis patients was found to be 21% [12]. It is well known that such a high prevalence of HCV infection could lead to a substantial increase in future morbidity and mortality from HCV-related diseases such as liver cirrhosis and hepatocellular carcinoma.

These high figures of HBV and HCV infection among different patients groups in Libya have raised questions about whether the general population has a similar high prevalence from sources as exposure to blood during the period before initiation of routine testing for blood units for anti-HCV in 1997. We conducted the present national seroepidemiological investigation to determine the prevalence and risk factors of HBV and HCV infection among the general population in Libya.

Methods

Sample

Sample size calculations were based on the prevalence of hepatitis B surface antigen (HBsAg) and HCV infection in previous studies in Libya. To detect a 2-fold increase in prevalence among the lowest prevalence expected for HCV (1/1000) in each age group as compared with the next age one a sample size of 25 476 has a power of 80% (i.e. beta error of < 0.2) to detect this difference at the alpha = 0.05 level (1-sided). This sample size allows for estimating a prevalence of 2/10 000 for HBsAg with a power of > 96%. A total sample of 51 000 would allow estimation of these parameters independently for males and females.

A multi-stage sampling technique was applied in the year 2005 to select a large, representative sample of sex and age groups from all administrative regions of Libya and to minimize refusals. The following age strata were targeted in each administrative region for both males and females:

- Pre-school children (< 6 years) at maternal and child care centres as well as other health facilities and child care centres.
- School-age children below university levels (6–18 years) at schools of the 3 levels (primary, preparatory and high schools).
- University age group for graduate and postgraduate students (19–45 years) at university health service centres.
- Employment age (20–62 years), and above retired age (> 62 years) at schools for teachers, outpatient clinics at public sector facilities, outpatient clinics at general hospitals, work places at government facilities and inpatient health care facilities.

For regional representativeness, Libya was classified into 12 regions including all 32 administrative sections with a cluster sampling technique with population proportional to all age groups and both sexes. Several sampling frames were established in all targeted sectors in the 12 regions. The sampling units for schools were the class level in a frame including all schools and classes in each region. In health care facilities the unit was the health care centre in a frame including all health care facilities in the region. In administrative and employment places the unit was an office in a frame including all administrative buildings and offices in the region. The sample size for males and females and age strata was determined in each region proportional to regional population according to the latest national census in 2003–04. The target cluster sample was calculated for each sampling age and sex group in each region in proportion to its size within the region based on the national census.

The total sample in each region was set ahead of the survey and recruitment continued till the sampling teams fulfilled the required sample according to Table 1. Sample weighting was later performed and a weight was calculated according to age and sex within each region.

Table 1 Geographical sample allocation

Province	Total sample	
	No.	%
Derna	4 996	7.6
Aljabal Al-Akhdar	5 944	9.0
Benghazi	6 938	10.6
Ijdabia	4 963	7.5
Sirt	3 871	5.9
Misrata	4 966	7.6
Almergeb	4 913	7.5
Tarhouna	5 023	7.6
Tripoli	8 013	12.2
Alzawia	5 022	7.6
Aljabal Al-Garbi (Nafosa)	5 752	8.7
Fezan	5 360	8.2
Total	65 761	100.0

Data collection

An anonymous questionnaire was filled out for each participant, including information on age, sex, education, residence and occupation. It also included lifetime history of major invasive exposures, use of recreational intravenous drugs and multiple sexual partners.

A 5–10 mL blood was collected on site and transported within a few hours to the local laboratory in a general hospital in the region for separating serum aliquots and stored in a –20 °C deep freezer until testing. Serum samples were tested for anti-HCV antibodies by using a 3rd-generation microparticle enzyme immunoassay (Axsym System) (i.e. HCV EIA 3.0, Abbott Laboratories) and HBsAg (Axsym). Samples that initially gave a positive HBsAg and anti-HCV antibodies result were repeatedly tested for confirmation. Only cases that tested repeatedly positive were considered as positive for HBsAg and anti-HCV antibodies.

The study protocol and a questionnaire were approved by the Libyan National Center for Disease Control ethics committee and an informed consent was prepared to be signed by the individual or a witness from the local health office before initiating collection of data or blood samples. Serum samples and associated demographic data were coded so that data were collected without any need for personal identifiers.

Statistical analysis

Data were coded and using a computer data entry program the database was cleaned and verified. Data were analysed by using the chi-squared test with Yates' correction or Student *t*-test for univariate analysis. Multivariate analysis was conducted using logistic regression, with anti-HCV serologic results as the dependent variable, using *SPSS*, version 17. Prevalence estimates were reported with 95% confidence intervals (CI) by using the Poisson distribution approximation. A type I error of alpha = 0.05 was assumed.

There was a good agreement between sample structure after weighting and population structure at all age groups for both males and females (data on request).

Results

The overall unweighted prevalence of anti-HCV was 1.2% (95% CI: 1.1%–1.3%), which rose to 1.3% after weighting. The overall prevalence of HBsAg for the whole sample was 2.2% (95% CI: 2.1%–2.3%), with a significantly higher rate among males (2.6%; 95% CI: 2.4%–2.7%) than females (1.8%; 95% CI: 1.6%–1.9%). The risk for being HBsAg positive was 1.4 times higher among males than females (Table 2). The prevalence of anti-HCV increased with age rising gradually after the age of 30 years (from 0.7%–0.9% < 30 years up to 3.7% ≥ 30 years) in contrast to a stable prevalence of HBsAg in all age groups 10+ years (2.3%–2.7%) with a reduced prevalence probably due to vaccination of children among those < 10 years (0.8%–0.9%).

The mean age of anti-HCV-positive individuals was 31.7 (SD 18.4) years and 35.6 (SD 20.9) years among females and males respectively, which

Table 2 Weighted hepatitis B surface antigen (HBsAg) and anti-hepatitis C virus (HCV) prevalence among males and females

Sex	Total sample	Prevalence			
		HBsAg +ve		Anti-HCV +ve	
	No.	No.	% (95% CI)	No.	% (95% CI)
Total	65 671	1 431	2.2 (2.1–2.3)	780	1.2 (1.1–1.3)
Female	32 996	591	1.8 (1.6–1.9)	413	1.3 (1.1–1.4)
Male	32 765	840	2.6 (2.4–2.7)[b]	367	1.1 (1.0–1.2)[a]

[a]P > 0.05 males vs females; [b]P < 0.001 males vs females (OR 1.4; 95% CI: 1.3–1.6).
CI = confidence interval.

Table 3 Mean age of hepatitis B surface antigen (HBsAg) and anti-hepatitis C virus (HCV) positive groups among males and females

Sex	Age (years)					
	Total sample		HBsAg +ve		Anti-HCV +ve	
	Median	Mean (SD)	Median	Mean (SD)	Median	Mean (SD)
Total	22	25.3 (16.4)	25	28.5 (17.4)	32	33.5 (19.7)
Female	22	24.7 (15.5)	23	26.3 (16.8)	30	31.7 (18.4)
Male	23	25.9 (17.2)[a]	27	30.0 (17.6)[a]	36	35.6 (20.9)

[a] *P < 0.001, t-test for mean age.*
SD = standard deviation.

was higher than for HBsAg-positive individuals, 26.3 (SD 16.8) years and 30.0 (SD 17.6) years among females and males respectively ($P < 0.001$) (Table 3). The mean age of anti-HCV-positive individuals was significantly higher than that for anti-HCV-negative individuals for both males (by almost 10 years) and females (by 7 years). The mean age of HBsAg-positive individuals was also significantly higher but to a lesser degree among females (by < 2 years) and males (by < 4 years).

Table 4 summarizes the seroprevalence of HBsAg and anti-HCV antibodies among the general population according to demographic characteristics and risk factors. Although there was no significant difference between males and females in the prevalence of anti-HCV positivity, HBsAg was significantly higher in males than females ($P < 0.001$). The frequency of HBsAg and anti-HCV antibodies significantly increased with increasing age group ($P < 0.001$), and significantly decreased with increasing the level of education ($P < 0.001$). Among known risk factors, previous history of jaundice and history of contact with infected patients were significantly higher in both HBsAg and anti-HCV positives (P <0.001 respectively). In contrast, history of blood transfusion, previous hospital admission, previous surgical operation and history of skin piercing were the major risk factors for transmission of anti-HCV ($P < 0.001$, for all comparisons).

As shown in Table 5, there was little difference in the estimated proportions of cases between males and females for HCV but more than 60% of the estimated HBsAg cases were among males. More than 50% of the estimated HBsAg were < 30 years and around 40% of HCV cases were also below that age. In terms of educational level and HBV and HCV, the highest level of infection by both viruses was among illiterate individuals (weighted prevalence 2.6% for HBsAg representing 12.3% of all estimated cases and 3.0% for anti-HCV antibodies representing 21.8% of all estimated cases).

There was a very clear-cut difference in the age distribution of HBsAg-positive cases at the 10-years age cut-off and of anti-HCV positive at the 30-years age cut-off. The estimated numbers of anti-HCV positive cases aged 30+ years were > 40 000 and for HBsAg positive age 10+ years were > 100 000 (Table 6).

Regional variations in HBsAg and HCV prevalence

As for regional differences in the prevalence of HBsAg and anti-HCV, there were significant variations from 0.6% in Misrata, up to 2.1% in Fezan for anti-HCV and from 1.0% in Benghazi and Aljabal Al-Akhdar to 6.6% in Sirt for HBsAg (Table 7).

Risk factors for HCV infection

Data from the present national survey were analysed by logistic binary regression analysis for HCV seropositivity to determine which risk factors were significantly associated with risk of infection. All invasive exposures were entered into the regression equation including dental treatment, traditional exposures such as tattooing and bloodletting or skin piercing. However, these were not significantly associated with increased risk of HCV infection. Similarly there was no significant difference of risk of infection according to sex. An increased risk was associated with increasing age for all subjects and among males and females (a significant risk for all age groups 50+ years compared with < 5 years (data not presented). Among all subjects, hospitalization and surgical operation, blood transfusion, intravenous drug use and haemodialysis were all significantly associated with an increased age-adjusted risk compared with those not exposed. The increased risk for hospitalization and surgical operation and blood transfusion were modest (an increase of 29%, 32% and 48% respectively) with proportion of exposed in the community of 26%, 14.8% and 5.5% of all subjects respectively. The risk associated with intravenous drug use and haemodialysis were much higher (5.9 times and 3.5 times respectively), but their exposure frequency was only 0.1% of all subjects (Table 8).

Among males, similar increased risks were found but these were only statistically significant for intravenous hospitalization and diabetes treatment. Male drug abusers had an 9.4 times increased risk with an exposure frequency of 0.2% of all males. Hospitalization was significantly associated with increased risk of HCV infection of 39% with an exposure rate of 24.3%, and diabetes treatment was associated with an increased risk of 53% with an exposure frequency of 3.7% among all males. The

Table 4 Seroprevalence of hepatitis B surface antigen (HBsAg) and anti-hepatitis C virus (HCV) antibodies among Libyans according to demographic characteristics and risk exposures

Variable	Total sample	HBsAg +ve			Anti-HCV +ve			*P*-values	
				Weighted			Weighted	HBsAg	Anti-HCV
	No.	No.	%	%	No.	%	%		
Total	65 761	1 431	2.2	2.0	780	1.2	1.3		
Sex									
Female	32 996	591	1.8	1.6	413	1.3	1.3	< 0.001	0.119
Male	32 765	840	2.6	2.4	367	1.1	1.2		
Age (years)									
5	6 530	55	0.8	0.9	57	0.9	0.8		
10	4 091	38	0.9	0.8	28	0.7	0.7		
20	20 658	520	2.5	2.3	168	0.8	0.8		
30	13 883	289	2.1	2.3	119	0.9	0.9		
40	9 775	220	2.3	2.3	140	1.4	1.6		
50	5 359	150	2.8	2.4	108	2.0	2.0		
60	3 427	91	2.7	2.7	86	2.5	2.6		
70	1 344	35	2.6	2.1	50	3.7	3.7		
75	694	33	4.8	3.1	24	3.5	2.7	< 0.001	< 0.001
Education									
Below age	6 485	56	0.9	0.9	60	0.9	0.9		
Illiterate	5 084	146	2.9	2.6	156	3.1	3.0		
Preparatory	22 431	520	2.3	2.0	236	1.1	1.2		
High school	20 646	458	2.2	2.3	212	1.0	1.1		
University	8 592	184	2.1	2.2	90	1.0	1.0		
Postgraduate	1 007	16	1.6	1.9	13	1.3	1.0		
Unknown	1 516	51	3.4	2.0	13	0.9	1.3	< 0.001	< 0.001
Marital status									
Married	17 862	472	2.6	2.5	351	2.0	2.1		
Single	26 634	576	2.2	2.2	230	0.9	0.9		
Widowed	808	15	1.9	1.4	26	3.2	3.4		
Divorced	337	6	1.8	2.9	6	1.8	1.5		
Below age	18 994	330	1.7	1.4	156	0.8	0.8		
Unknown	1 126	32	2.8	2.1	11	1.0	1.4	< 0.001	< 0.001
Type of dwelling									
Villa	9 998	218	2.2	2.2	96	1.0	1.2		
Apartment	7 350	135	1.8	1.6	103	1.4	1.6		
Rural house	46 088	1 035	2.2	2.1	567	1.2	1.3		
Other	120	1	0.8	1.1	1	0.8	1.0		
Unknown	2 205	42	1.9	1.6	13	0.6	0.7	0.078	0.011

increased risk associated with surgical operation and blood transfusion did not reach statistical significance (P = 0.071 and P = 0.068 respectively). Among females, similar increased risks were found, but only blood transfusion was statistically significantly associated with increased risk of HCV (69%). It was also clear that married women had a 69% increased risk of acquiring HCV (Table 8).

Risk factors for HBV transmission

Unlike HCV, there were no invasive risk factors associated with being HBsAg-positive. The age-adjusted risk factors for HBV infection included only family exposure to HBV case or contact with HBV case with an increased risk of 2.1 (2.0 among females and 2.4 among males). Being vaccinated against HBV was protective and those who

Table 4 Seroprevalence of hepatitis B surface antigen (HBsAg) and anti-hepatitis C virus (HCV) antibodies among Libyans according to demographic characteristics and risk exposures (*concluded*)

Variable	Total sample	HBsAg +ve			Anti-HCV +ve			*P*-values	
				Weighted			Weighted	HBsAg	Anti-HCV
	No.	No.	%	%	No.	%	%		
Clinical history									
Hospital admissions	16 946	395	2.3	2.3	326	1.9	2.1	0.115	< 0.001
Surgical operations	9 586	233	2.4	2.3	218	2.3	2.6	0.077	< 0.001
Blood transfusion	3 557	74	2.1	2.0	96	2.7	2.8	0.681	< 0.001
Dental procedures	23 220	500	2.2	2.1	299	1.3	1.4	0.767	0.089
Skin piercing	7 451	189	2.5	2.4	130	1.7	1.9	0.073	< 0.001
Skin tattoo	1 243	36	2.9	2.5	22	1.8	2.3	0.532	0.283
IV drug use	54	0	0.0	0.0	4	7.4	15.4	0.266	< 0.001
Illegal sex	193	3	1.6	1.3	3	1.6	2.6	0.464	0.814
HBV vaccination	13 242	167	1.3	1.1	147	1.1	1.0	< 0.001	0.376
HBV contact	1 423	57	4.0	3.8	26	1.8	2.6	< 0.001	0.006
History of jaundice	2 421	88	3.6	3.6	51	2.1	2.5	< 0.001	< 0.001

IV = intravenous.

were vaccinated had a 44% lower risk of being infected (38% among females and 49% among males) (Table 9).

Discussion

The present study reports the results of a national seroepidemiologic study in Libya on the prevalence of HBV and HCV infections and the related risk factors. Previous studies in Libya were based on selected populations such as hospitalized patients, health care workers and blood donors. Blood donor groups are usually young male adults, hence the seroprevalence in females and other age groups such as children and elderly people have not previously been estimated. The present study is the first survey of a representative, random, community-based sample of the general population of Libya. It is unique because a large sample size was tested (65 761), the evaluation was conducted in 12 distinct administrative regions of the country, the study comprised all age groups of both sexes in the Libyan general population and the risk factors for transmission for both HBV and HCV infections were identified. A multi-stage sampling technique was applied and the high participation rate from all age groups of both sexes in all administrative regions of Libya suggests the absence of selection bias and may provide an accurate assessment of HBsAg and anti-HCV prevalence and their associated risk factors in this developing country.

Since 1997 blood units were routinely examined for anti-HCV in all blood banks in Libya, which should reduce the transmission through blood transfusion. The relatively low overall prevalence of anti-HCV antibodies (1.3%) among Libyans is still higher than Canada (0.8%), Australia (1.1%) and some western European countries including France (1.1%) and Germany (0.6%) [13–17] and is close to that reported from large studies of the general population in the United States of America (1.8%–2.2%) [18–21] and much lower than the figures reported for Pakistan (5%–7%) [22,23] and Egypt (22%) [24], a neighbouring country with a high movement of workers every year. The results of this study also are consistent with previously published studies of selected Libyan populations [6–11]. The relatively low level of HCV infection among the general population in this country can be contrasted with the high prevalence among those who reported use of intravenous drugs (15.4%) and may suggest that this route of transmission is potentially an important risk factor for future transmission of HCV in Libya, as in the USA where it is the major mode of HCV transmission [25–28].

The prevalence of anti-HCV antibodies increased with age, rising gradually after the age of 30 years (from 0.7%–0.9% at age < 30 years up to 3.7% at 30+ years). This suggests that HCV

Table 5 Weighted hepatitis B surface antigen (HBsAg) and anti-hepatitis C virus (HCV) antibodies prevalence and population estimates of hepatitis B virus (HBV) and C virus (HCV) infections

Variable	Estimated national HBSAg +ve		Estimated national HCV +ve	
	No.	%	No.	%
Total	107 848	100.0	68 275	100.0
Sex				
Female	42 297	39.2	34 845	51.0
Male	65 551	60.8	33 430	49.0
Age (years)				
5	4 861	4.5	4 699	6.9
10	4 110	3.8	3 881	5.7
20	26 148	24.2	8 889	13.0
30	26 153	24.2	10 147	14.9
40	20 139	18.7	13 966	20.5
50	11 436	10.6	9 738	14.3
60	6 856	6.4	6 633	9.7
70	3 613	3.4	6 415	9.4
75	4 532	4.2	3 907	5.7
Education				
Below age	4 957	4.6	5 235	7.7
Illiterate	13 318	12.3	14 850	21.8
Preparatory	34 927	32.4	20 685	30.3
High school	34 389	31.9	17 214	25.2
University	16 118	14.9	7 544	11.0
Postgraduate	1 769	1.6	981	1.4
Unknown	2 370	2.2	1 766	2.6
Marital status				
Married	39 844	36.9	32 605	47.8
Single	42 551	39.5	17 845	26.1
Widowed	1 425	1.3	3 403	5.0
Divorced	913	0.8	470	0.7
Below age	21 434	19.9	12 828	18.8
Unknown	1 681	1.6	1 124	1.6
Type of dwelling				
Villa	13 545	12.6	6 944	10.2
Apartment	10 491	9.7	10 480	15.3
Rural house	80 646	74.8	49 398	72.4
Other	118	0.1	104	0.2
Unknown	3 048	2.8	1 349	2.0

screening needs to be targeted on people aged 35+ years old.

Although the results of the present study did not show a significant difference in the prevalence of anti-HCV antibodies according to sex, a higher prevalence of HBsAg in males and older ages was detected. The infection rate was higher in individuals aged 10+ years and was more obvious at age 75+ years, with a prevalence of 3.1%. Individuals in the older age groups were most likely to have been exposed to HBV infection before the risks were well recognized, through hospital care, exposure to blood transfusion and blood products or family contacts. On the other hand, the lower HBsAg prevalence in individuals aged < 20 years (0.8%–0.9%) was probably due to the universal vaccination programme of newborns and adolescents against hepatitis B in Libya since 1992 according to World Health Organization criteria.

The present study showed that close contact with infected family members, particularly the mother, was probably

Table 6 Weighted hepatitis B virus (HBV) and C virus (HCV) population prevalence estimates according to age strata

Variable	Sample	Total	Estimated in population	Weighted +ve	OR (95% CI)
	No.	No.	No.	%	
HCV estimated national caseload					2.5 (2.5–2.6)
Age < 30 yrs	43 240	352	25 786	0.8	
Age 30+ yrs	22 521	428	42 489	2.0	
Total	65 761	780	68 275	1.3	
HBV estimated national caseload					3.3 (3.2–3.3)
Age < 10 yrs	76	9 459	7 006	0.7	
Age 10+ yrs	1 355	56 302	100 842	2.3	
Total	1 431	65 761	107 848	2.0	

OR = odds ratio; CI = confidence interval.

a major source of HBV infection, suggesting that intrafamiliar transmission is a significant risk factor. Screening of family members in direct contact with infected patients and subsequent vaccination is needed to minimize intrafamiliar transmission of HBV.

Comparison of invasive exposures between HBsAg-positive and -negative individuals did not reveal any factors that were significantly associated with HBV infection, except having family contact with an HBV-infected person and previous history of jaundice. In addition, this study did not find dental procedures or tattooing to be associated with transmission of HCV. However, body piercing was a statistically significant risk factor for HCV but not for HBV transmission. HCV was significantly associated with a history of hospital admissions, surgical operations and blood transfusions, with prevalence rates among exposed individuals of at least twice the general population rate. Haemodialysis was reported among a very small number of individuals, which did not allow for a sufficient power for detecting its risk. The above findings may suggest that nosocomial infection may have an important role in transmission of HCV infection in a considerable number of individuals in Libya. Contaminated injection equipment seems to be the major risk factor for HCV infection in many developing countries. In Egypt, the country with the highest reported prevalence of HCV in the world, transmission has been attributed to contaminated glass syringes used in nationwide schistosomiasis treatment campaigns from 1960 to 1987 [23]. A high prevalence of HCV (31.1%) has been also reported from India among patients receiving multiple injections to treat leishmaniasis [29] and among

Table 7 Regional anti-hepatitis C virus (HCV) and hepatitis B surface antigen (HBsAg) prevalence

Province	Total sample	HCV		HBsAg	
		Weighted	Estimated +ve	Weighted	Estimated +ve
	No.	%	No.	%	No.
Derna	308 178	1.77	5 467	1.59	4 904
Aljabal Al-Akhdar	335 025	0.86	2 877	1.00	3 364
Benghazi	656 083	1.32	8 686	1.04	6 810
Igdabia	208 044	1.30	2 703	1.35	2 811
Sirt	132 174	0.99	1 314	6.61	8 743
Misrata	512 532	0.59	3 042	1.73	8 870
Almergeb	203 320	1.36	2 759	1.43	2 914
Tarhouna	200 523	1.20	2 397	3.42	6 858
Tripoli	1 422 204	1.40	19 854	2.27	32 316
Alzawia	541 136	1.32	7 150	2.42	13 089
Aljabal Al-Garbi	434 406	1.10	4 768	2.25	9 760
Fezan	348 606	2.08	7 258	2.13	7 409
Total	5 302 231	1.29	68 275	2.03	107 848

Table 8 Regression analysis for risk factors of hepatitis C virus (HCV) infection

Variable	Total sample (*n* = 65 761)				Females (*n* = 32 780)				Males (*n* = 32 391)			
	Exposed %	Exp(B)	95% CI for ExpB	*P*-value	Exposed %	ExpB	95% CI for ExpB	*P*-value	Exposed %	ExpB	95% CI for ExpB	*P*-value
Age		1.02	1.01–1.02	< 0.001		1.01	1.00–1.02	0.014		1.02	1.02–1.03	< 0.001
Married vs single	29.0	1.25	1.02–1.54	0.031	26.4	1.69	1.26–2.25	< 0.001	32.0	0.96	0.71–1.28	0.756
Hospitalization	26.0	1.29	1.06–1.56	0.011	27.0	1.12	0.86–1.47	0.404	24.3	1.39	1.04–1.84	0.024
Surgical operation	14.8	1.32	1.06–1.63	0.011	15.5	1.28	0.96–1.72	0.094	14.1	1.34	0.98–1.84	0.071
Blood transfusion	5.5	1.48	1.17–1.87	< 0.001	4.5	1.69	1.21–2.36	0.002	6.4	1.36	0.98–1.90	0.068
IV drug abuse	0.1	5.94	2.12–16.7	0.001		0.00	0.00–0.00	0.999	0.2	9.36	3.29–26.7	0.000
Haemodialysis	0.1	3.54	1.25–10.0	0.017	0.1	3.64	0.84–15.8	0.084	0.1	3.43	0.78–15.1	0.104
Diabetes treatment	0.4	1.25	0.95–1.64	0.107	0.4	1.03	0.70–1.52	0.876	0.37	1.53	1.05–2.23	0.028
Constant		0.055		0.000		0.009		0.000		0.056		< 0.001

CI = confidence interval.

Table 9 Regression analysis for risk factors of hepatitis B virus (HBV) infection

Variable	Total sample (*n* = 65 761)				Females (*n* = 32 780)				Males (*n* = 32 391)			
	Exposed %	Exp(B)	95% CI for Exp(B)	*P*-value	Exposed %	Exp(B)	95% CI for Exp(B)	*P*-value	Exposed %	Exp(B)	95% CI for Exp(B)	*P*-value
Age		1.01	(1.00–1.01)	< 0.001		1.00	(0.99–1.01)	0.665		1.01	1.01–1.02	< 0.001
Hospitalization	26.0	0.98	(0.84–1.14)	0.756	27.0	1.11	(0.88–1.40)	0.394	24.3	0.94	0.76–1.15	0.543
Surgical operation	14.8	1.02	(0.84–1.23)	0.868	15.5	1.02	(0.77–1.35)	0.887	14.1	1.04	0.81–1.34	0.745
Blood transfusion	5.5	0.81	(0.63–1.05)	0.107	4.5	0.86	(0.56–1.32)	0.485	6.4	0.74	0.54–1.01	0.054
IV drug use	0.1	0.00	–	0.997		0.00	–	0.999	0.2	0.00	0.00–	0.998
Haemodialysis	0.1	1.50	(0.36–6.23)	0.578	0.1	1.72	(0.23–12.9)	0.599	0.1	1.35	0.18–10.2	0.769
Diabetes treatment	3.8	1.02	(0.79–1.33)	0.869	3.9	1.11	(0.73–1.68)	0.629	3.7	1.02	0.73–1.43	0.907
Family hepatitis B cases	2.0	2.10	(1.70–2.61)	< 0.001	2.2	1.99	(1.45–2.73)	< 0.001	1.6	2.43	1.80–3.26	< 0.001
HBV vaccination	20.4	0.56	(0.47–0.66)	< 0.001	28.4	0.62	(0.48–0.80)	< 0.001	24.1	0.50	0.40–0.63	< 0.001

IV = intravenous.

individuals with frequent visits to unlicensed practitioners [30] as well as among those with history of therapeutic injections using reusable syringes [31].

Sexual contact could also be a source of infection, although this was not detected in this national survey data analysis. However, HCV infections in some population groups may be due to high-risk sexual activity (e.g. multiple partners) similar to the findings of studies other countries [32–34].

In conclusion, the results of this general population-based survey suggest the need for continuous implementation of stringent measures for prevention and control of these infections in Libya, including screening and vaccination focused on high-risk groups, such as contacts for HBV cases. The higher prevalence of HCV infection in older age groups suggests that the Center for Disease Control of Libya needs to implement a targeted risk-based HCV screening programme for persons who are 35+ years of age for early detection and specific treatment of this insidious infection. Even though the risk of HCV infection was relatively low compared with that of HBV, the future health care burden of prior HCV infections in Libya could be substantial in the general community.

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