

Original Article

Seroprevalence of hepatitis viruses and risk factors in blood donors of Veracruz, Mexico

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Abstract

Introduction: Hepatitis B and C are among the most important transfusion-transmitted infections and sources of liver diseases worldwide. In Veracruz, Mexico, liver diseases are important causes of mortality, and the prevalence reports of these viruses are scarce. This study sought to determine the prevalence of these infections in blood donors, in order to increase the safety of blood products in this region.

Methodology: A retrospective study was performed on blood donors who attended the Veracruz State Blood Transfusion Center from 2006 to 2010. All samples were screened for transfusion-transmitted infections. The prevalence rates of hepatitis B virus (HBV) and hepatitis C virus (HCV) were determined, and demographic data obtained from clinical records were used to evaluate risk factors.

Results: A total of 56,377 donors were serologically screened; of them, 403 were seropositive for HCV (357 men and 46 women), and 61 were positive for HBsAg (52 men and 9 women). The overall prevalence rates were 0.72% (0.63%–0.76%) for HCV and 0.11% (0.08%–0.14%) for HBsAg. The risk factors for HBsAg positivity were being a cattleman and living in the Huasteca Baja region, whereas those for HCV were being a fisherman, living in the Papaloapan region, and having an elementary-level or lower education.

Conclusions: This is the first study to show that being a fisherman is a risk factor for HCV. The implementation of nucleic acid test technology will help to identify the real risks for transfusion-transmitted hepatitis C in Veracruz.

Key words: HCV; HVB; prevalence; HBsAg; blood donors.

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Introduction

Hepatitis B (HBV) and hepatitis C (HCV) viruses are among the most important transfusion-transmitted infections (TTIs) and worldwide causes of liver disease [1,2]. Transmission can occur via parenteral (exposure to infected blood, serum, and body fluids) and non-parenteral (perinatal and sexual) routes, with the latter being more common for HBV than for HCV [3,4]. Both viruses may induce an acute phase and chronic liver disease. Chronic carriers may be symptom-free, but they can act as sources of new infections and have significant risks for developing hepatic dysfunction, cirrhosis, and/or hepatocellular carcinoma (HCC) [3–5].

HBV and HCV infections have had significant impacts on health systems worldwide. Countries with high prevalence rates of HBV usually also have high incidences of HCC. About 80% of HCC cases worldwide occur in developing countries, and nearly half of these are associated with chronic HBV infection. In Western countries, in contrast, there is a

relatively low prevalence of HBV, and the main causes of HCC are HCV infection or alcoholic cirrhosis [6,7].

HBV is a highly infectious DNA virus from the Hepadnaviridae family that comprises eight genotypes (A to H). It has recently been reported that about 240 million people live with chronic infection, and it is estimated that 600,000 people die each year due to acute or chronic infection consequences [4]. The virus is broadly distributed, with the highest prevalence rates (5% to 10%) observed in sub-Saharan Africa and East Asia, and rates of 2%–5% observed in South America and the Middle East [4,5]. The progression to chronic phase depends on the age at which the infection is acquired; 90% of patients with perinatal transmission become chronically infected, while only 5% of adults progress to the chronic phase [4].

HCV, in contrast, is an enveloped positive-strand RNA virus from the genus *Hepacivirus* and family *Flaviviridae*. It is highly heterogeneous, with 6 genotypes and 52 subtypes. Every year, 3–4 million

people are infected with the hepatitis C virus and about 150 million people are chronically infected [1,3]. Lower incidence rates (approximately 2%) are seen in North America, Australia, and Europe, while a very high rate (> 15%) is found in Egypt. About 80% of infected individuals progress to the chronic phase, and 20% of these develop cirrhosis after 20–30 years [3,5].

Historically, blood transfusion was a significant transmission route for HBV and HCV. Over the past 60 years, however, researchers have urgently sought to diminish the transmission of pathogens by blood components through the development of specific and sensitive serological tests and (more recently) nucleic acid amplification technology (NAT) [2]. Nevertheless, these technologies are costly and not easily accessible in developing countries. Indeed, there is still a great difference in the safety of blood transfusions in developed versus developing countries, as the latter typically rank lower in donations, facilities, equipment, training, and supplies [8,9].

Mexico is a low-prevalence area for both infections. Two previous studies found rates of < 2% for HBV and 1%–2.5% for HCV [5,10]. The National Health Survey in the general Mexican population found a prevalence for hepatitis B surface antigen (HBsAg) of 0.21% (0.11–0.37) [11] and 1%–1.9% for HCV [12]. According to a report from the National Blood Transfusion Center (CNTS), the Pan American Health Organization (PAHO) reported overall prevalence rates in Mexican blood donors of 0.20% for HBsAg and 0.68% for HCV [13]. However, there are relatively few reports of hepatitis prevalence rates in Mexico, and the existing data come from only a few states, making it difficult to assess the true scope of such infections [10].

The state of Veracruz, located in eastern Mexico, is the country's third-most populated state. It has 212 municipalities, and 38.9% of its inhabitants live in rural areas [14]. The Veracruz State Blood Transfusion Center (CETS-Veracruz) is located in the center of the state and receives blood donors from almost all municipalities. It is the largest blood bank in the Social Health Protection System of the state, and has associated blood collection centers distributed throughout the south-central territory.

Hepatic diseases, along with diabetes mellitus and ischemic heart disease, are among the leading causes of death in Mexico, and this trend is expected to increase in the coming years [15]. There are few reports on the prevalence of HBV and HCV in Veracruz, but some evidence shows that mortality

related to hepatic diseases such as cirrhosis, fibrosis, and hepatic tumors has increased in this region in the last 20 years, mainly in men over 25 years of age [15,16]. The most recent report on the prevalence of hepatitis infection among blood donors in Veracruz, which was published in 2005, found prevalence rates of 0.057% for HBsAg and 1.1% for HCV [17].

In the present study, we aimed to examine the prevalence rates of HBV and HCV among blood donors who attended CETS-Veracruz from 2006 to 2010, and to identify risk factors and high-prevalence regions.

Methodology

The Veracruz State Blood Transfusion Center (CETS-Veracruz) is the largest blood bank in the Social Health Protection System of the state. A retrospective study was performed on blood donors enrolled at CETS-Veracruz from 2006 to 2010. The donors were selected as candidates for blood donation, and the blood units were screened for transfusion-transmitted infections (TTIs) according to the official Mexican health regulations [18]. Anti-HCV and HBsAg screens were carried out using a VITROS 3600 ECi/ECiQ Immunodiagnostic System (Ortho-Clinical Diagnosis, Rochester, USA) according to the provided instructions. The reactive samples were run in duplicate, and a third run was made with the implicated plasma unit.

In order to collect a greater number of blood units through the state, a program was created to establish blood collection centers (entities that only collect blood units and send them to the central blood bank for immunological and serologic assays). Since 2009, CETS-Veracruz has been responsible of eight blood collection centers that are located in the municipalities of Ciudad Isla, Cosamaloapan, and Tierra Blanca in the Papaloapan region; San Andrés in the Tuxtla region; Cordoba and Huatusco in the Mountain region; Oluta-Acayucan in the Olmeca region; and Panuco in the Huasteca Alta region (Figure 1).

Additionally, other blood banks of the state Social Health Protection System report the blood units collected and have been reporting seropositive units to CETS-Veracruz since 2010. These blood banks are located in the regional hospitals of Xalapa (RH-LFN), Poza Rica (RH-PR), Coatzacoalcos (RH-C), and Río Blanco (RH-RB), and at the Center of Medical Specialties Doctor Rafael Lucio (CEM-RL) and the Doctor Miguel Dorantes Mesa Cancerology Center of the Veracruz State (CECAN-MD) (Figure 1).

To evaluate the potential risk factors associated with HCV and HBV infection, a representative sample of healthy donors was selected by systematic random sampling based on the number of units assigned from the years 2009 and 2010. This period was selected because CETS-Veracruz obtained blood units from the greatest number of blood collection centers in the study period, so the sample is more representative of the state population (Figure 1). The sample size was calculated based on the highest prevalence (2.5%) reported previously for HCV [10], with a confidence level of 95.5% and error of 1%.

The demographic variables analyzed in seropositive and healthy donors (from 2009 and 2010) were obtained from medical records; these are shown in Table 1. The prevalence rates at the eight blood collection centers were also calculated for the same period, but the prevalence rates for the other six blood banks in the Social Health Protection System of Veracruz were only available for 2010.

Occupations were grouped as employee (blue-collar workers), farmer, bricklayer, store clerk, trade (technician, craft, or works by himself; did not require university study; includes bakers, taxi drivers, electricians, etc.), fisherman, cattleman, housewife, student, professional (white-collar workers and those who have bachelor degrees), and unemployed (including pensioners).

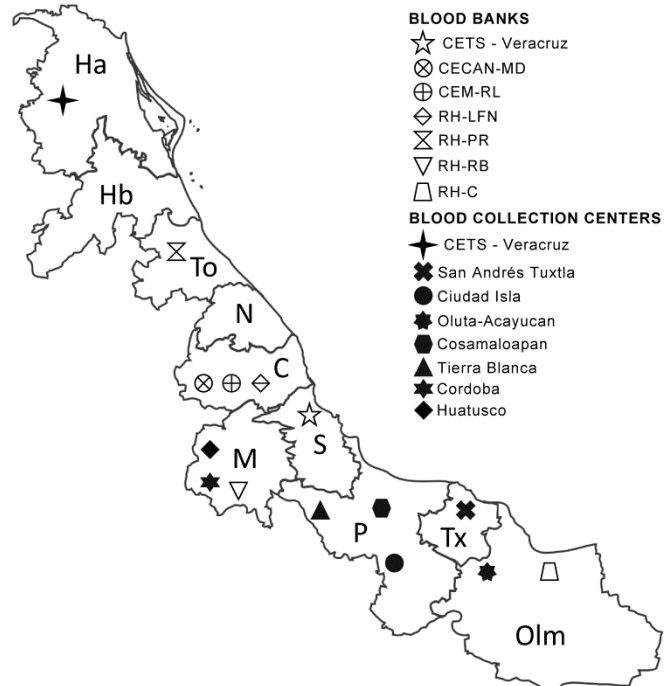
The data were analyzed using SPSS version 21.0. Student’s *t*-test and the Pearson Chi-square test were used in the analysis to assess the comparison of the frequency of seropositive and healthy donors. A *p* value < 0.05 was taken as indicating a significant difference. Odds ratios (ORs) with 95% confidence intervals (CI) were calculated to identify risk factors. Prevalence rates are shown as percentages. The Veracruz State Commission of Research, Bioethics, and Biosafety approved this study in January 2011.

Results

A total of 56,377 donors were admitted to CETS-Veracruz and serologically screened between 2006 and 2010 (89% male and 11% female). The total number of donors increased annually from 9,153 in 2006 to 13,585 in 2010. The number of blood collection center also increased, from four in 2008 to eight in 2010, covering the central, southeast, and north regions.

During this period (2006 to 2010), 403 donors were seropositive for HCV (357 men and 46 women), and 61 were positive for HBsAg (52 men and 9 women). Among the three assessed transfusion-transmitted viruses, the prevalence of HCV was the

Figure 1. Economic regions of Veracruz state: **Ha:** Huasteca alta; **Hb:** Huasteca baja; **To:** Totonaca; **N:** Nautla; **C:** Capital; **M:** Montañas; **S:** Sotavento; **P:** Papaloapan; **Tx:** Tuxtlas; **Olm:** Olmeca. The location of the seven blood banks of the Social Health Protection System and blood collection centers of Veracruz are illustrated.



(Modified from Hernandez-Romano *et al.*; accepted transfusion doi:10.1111/trf.12860).

highest, with an overall prevalence rate of 0.72%, followed by HIV with 0.4%, and HBsAg with 0.11%. The prevalence of HBsAg remained stably below 0.2% during the study period, whereas the prevalence of HCV increased from 0.6% to 0.82% between 2006 and 2008, and then decreased to 0.63% by 2010.

The average prevalence of HCV in first-time donors was 0.83%, 2.7 times higher than in recurring donors (0.31%). This difference was observed throughout the study period, while in hepatitis B, both were very similar – 0.12% in first-time and 0.10% in recurring donors in the study period.

There was a single case of coinfection of hepatitis B and C (HBV-HCV); two cases of Chagas-HBV and one of Chagas-HCV; two of HIV-HCV; and two cases of coinfection with three pathogens – one HBV-HIV-HCV and one Chagas-HIV-HCV.

Risk factors were analyzed from donors who were enrolled in 2009 and 2010. During this period, 27 and 182 cases were HBsAg and HCV seropositive, respectively.

Table 1. Demographic data for healthy donors and donors who were seropositive for *HBsAg* and HCV in Veracruz, Mexico, between 2009 and 2010

	Healthy (n = 1,786)		<i>HBsAg</i> (n = 27)		HCV (n = 182)	
	n	%	n	%	n	%
Sex						
Men	1,589	89.0	24	88.9	164	90.1
Women	197	11.0	3	11.1	18	9.9
Marital status						
Couple	1,299	72.7	23	85.2	141	77.5
Single	487	27.3	4	14.8	41	22.5
Community						
Rural	479	26.8	8	29.6	66	36.3
Urban	1,053	59.0	15	55.6	105	57.7
Missing data	254	14.2	4	14.8	11	6.0
Mean age (95% CI)	33.2	(32.8–33.7)	36.7	(33–40.4)	35.1	(33.6–35.6)
Age group						
18–24 years	427	23.9	3	11.1	33	17.7
25–34 years	610	34.2	7	25.9	58	32
35–49 years	618	34.6	14	51.9	75	41.4
≥ 50 years	131	7.3	3	11.1	16	8.8
Education						
Elementary or less	590	33.0	8	29.6	74	40.7
Middle school (secondary)	549	30.7	7	25.9	54	29.7
High school/technician	380	21.3	7	25.9	34	18.7
Bachelors/postgraduate	267	14.9	5	18.6	20	11.0
Occupation						
Employee	547	30.6	12	44.4	67	37.0
Farmer	376	21.1	7	25.9	37	20.4
Trade	215	12.0	1	3.7	16	8.8
Bricklayer	133	7.4	0	0	14	7.7
Student	116	6.5	0	0	8	4.4
Housewife	104	5.8	2	7.4	11	6.1
Store clerk	85	4.8	0	0	8	4.4
Professional	84	4.7	2	7.4	1	0.6
Police/military	73	4.1	2	7.4	5	2.8
Unemployed/pensioner	33	1.8	0	0	3	1.7
Fisherman	18	1	0	0	11	6.1
Cattleman	2	0.1	1	3.7	0	0
Missing data	0	0	0	0	1	0.6
Residence region						
Sotavento	946	53.0	13	48.1	89	48.9
Papaloapan	363	20.3	3	11.1	58	31.9
Mountain	152	8.5	2	7.4	8	4.4
Tuxtla	106	5.9	2	7.4	9	4.9
Olmeca	69	3.9	1	3.7	5	5.0
Capital	56	3.1	2	7.4	3	1.6
Huasteca Alta	14	0.8	0	0	1	0.5
Nautla	12	0.7	1	3.7	2	1.1
Huasteca Baja	2	0.1	1	3.7	0	0
Totonaca	0	0	0	0	1	0.5
Foreign	66	3.5	2	7.4	6	3.3

Analysis (Table 1) revealed that 88.9% of the HBsAg-seropositive and 90.1% of the HCV cases were men, that most of the seropositive cases lived as part of a couple (85.2% for HBV and 77.5% for HCV), and that nearly a third of the cases came from rural communities (29.6% for HBV and 36.3% for HCV). There was no significant difference between healthy and seropositive donors with respect to sex, marital status, or type of community.

The mean ages of seropositive individuals (Table 1) were 36.7 years for HBsAg and 35.1 years for HCV; both groups were older than the healthy donors (33.2 years), but this was only significant for HCV ($p = 0.019$). A comparison across different age groups showed a higher rate of 35–49 year-olds in both infected groups (Table 1). However, the odds ratios (ORs) for this group were not significant, at 2.035 (CI: 0.951–4.357) for HBsAg and 1.337 (CI: 0.979–1.826) for HCV.

Analysis of education level revealed that an elementary-level or lower education was a risk factor for HCV seropositivity, with an OR of 1.57 (CI: 1.15–2.12). No significant association was found with respect to education level and HBsAg seropositivity.

Significant associations were found between HBsAg seropositivity and HCV infection and the occupation variables assessed in the Pearson Chi-square analysis ($p = 0.001$ and 0.0001 , respectively). The most common occupations among both seropositive and healthy donors were employee and farmer (Table 1). There was no case of HBsAg seropositivity among individuals occupied as store clerks, bricklayers, fishermen, and students, nor were

there any cases of HCV seropositivity among cattlemen. However, being a cattleman was significantly associated with HBsAg seropositivity (OR = 34.308 [CI: 3.016–390.274]); being a fisherman was significantly associated with HCV (OR = 6.356 [CI: 2.953–13.678]); being a professional tended to protect against HCV infection (OR = 0.113 [CI: 0.016–0.813]).

Regarding the place of residence, significant associations were also found between HBsAg seropositivity and HCV infection ($p = 0.0001$ and 0.002 , respectively). CETS-Veracruz receives blood donors from all regions of Veracruz (Table 1). Most of them come from the Sotavento region, where CETS-Veracruz is located, followed by Papaloapan, both of which are in the central region of the state (Figure 1). The regions identified with increased infection risk were Huasteca Baja (OR = 34.308 [CI: 3.016–390.274]) for HBsAg seropositivity and Papaloapan region (OR = 1.834 [CI: 1.315–2.557]) for HCV infection.

The prevalence rates at CETS-Veracruz, at each blood collection center, and at the others blood banks were obtained (Table 2). The highest prevalence of HBsAg was observed at the Tierra Blanca blood collection center, which sent a total of 792 blood units during the two years under investigation. The highest prevalence for HCV was observed for the Cosamaloapan blood collection center, which sent 875 blood units during this period. Both are located in the Papaloapan region (Figure 1).

Table 2. Prevalence of HBsAg and HCV seropositivity in blood banks and blood collection center from Veracruz state

Blood bank	Blood units	HBsAg (%)	HCV (%)
CETS-Veracruz*	19,862	0.10	0.71
CECAN-MD†	2,310	0.17	0.61
CEM-RL†	4,799	0.17	0.58
RH-LFN†	1,361	0.29	0.44
RH-RB†	4,849	0.08	0.47
RH-C†	3,531	0.08	0.59
RH-PR†	5,255	0.02	0.93
Blood collection center associated with CETS-Veracruz	Blood units	HBsAg (%)	HCV (%)
Ciudad Isla*	938	0.00	0.32
Cosamaloapan*	875	0.00	2.06
Tierra Blanca*	792	0.51	0.63
San Andrés*	1,018	0.20	0.79
Oluta-Acayucan*	900	0.22	0.22
Córdoba*	1,298	0.08	0.31
Huatusco*	181	0.00	0.00
Panuco*	161	0.00	0.00

*Units from 2009 and 2010; †units from 2010

Discussion

Recent modifications to the official Mexican regulations relating to transfusion medicine have ensured the adequate monitoring of blood banks and the safety of blood units [18]. During the study period, CETS-Veracruz transitioned from being a local blood bank to becoming the reference institution of the Social Health Protection System in Veracruz. This change was associated with improvements in the physical facilities, equipment, training, and donation campaigns. The number of blood units collected increased from 9,153 in 2006 to 13,585 in 2010 and 16,154 in 2012, making CETS-Veracruz one of the few blood banks in Mexico to process more than 15,000 blood units annually [19].

In Mexico and Latin American countries, the main causes of HCC are HCV infection and alcoholism, with the exception of Peru and Brazil, where HBV infection is the major etiology [6]. In Mexico, hepatic diseases are among the leading causes of death [15]. Particularly in Veracruz, there is evidence that hepatic disease has increased over the last 20 years. In this region, it is the fourth leading cause of death in men 25–34 years of age, the second in men 35–44 years of age, and the first in men 45–64 years of age. Although 50%–60% of the reported cases were associated with alcoholism, the remaining causes were not specified [16]. Thus, it is likely that many cases of liver disease in Veracruz are caused by HCV (alone or associated with alcoholism), and, to a lesser extent, HBV.

The present study analyzed a low-risk population (blood donors) from 2006 to 2010. A comparison to the results from previous studies in the general populations and blood donors from Mexico and Veracruz revealed that the HBsAg prevalence in Veracruz blood donors (0.11%) was lower than that found by a national health survey of the general population (0.21%) [11], lower than the range reported by other national blood banks (0.13%–1.12%) [20-24], and below the average prevalence in Mexican blood donors reported by the PAHO (0.2%) [13]. During the 1998–2003 period, the National Blood Transfusion Center (CNTS) reported an HBsAg prevalence of 0.31% for the state of Veracruz [9]. Therefore, our findings suggest that the prevalence of HBsAg decreased since the previous report, even though it remained stable during the study period.

The HCV prevalence rate found herein for Veracruz was 0.72%. This is lower than that previously reported in a national health survey in the general population (1.4%) [12], and in the range of reports from other blood banks in Mexico (0.31%–

1.14%) [20-24], but higher than the average prevalence in Mexican blood donors reported by the PAHO (0.64%) [13]. Furthermore, our prevalence rate is higher than that previously reported for the state in 2003 (0.57%) [9]. However, the annual average has fluctuated over time.

Our analysis of the prevalence of HBsAg at each blood collection center (Table 2) indicates that the Tierra Blanca blood collection center, located in Papaloapan region (Figure 1), had a higher prevalence than that found in the general population (0.5% versus 0.21% [11], respectively). In contrast, the two other blood collection centers in this region (Ciudad Isla and Cosamaloapan) did not have any seropositive blood units, even though they both collected more blood units than Tierra Blanca. This indicates that chronic HBV carriers are not scattered throughout the Papaloapan region, but rather are located in communities near the blood collection centers of Tierra Blanca. The second-highest prevalence was observed in the Capital region, in the blood bank of the Regional Hospital Luis F. Nachon in the city of Xalapa (RH-LFN) (Table 2).

A similar analysis of HCV revealed that the highest prevalence rate was also found in the Papaloapan region, at the Cosamaloapan blood collection center, where the prevalence was higher than that reported for the general population (2.06% versus 1.4% [12], respectively). Notably, above-average prevalence rates were also observed in the Poza Rica blood bank (0.93%) in the north of the state, in the CETS-Veracruz blood bank (0.71%) in the central region, and in the San Andrés blood collection center (0.79%) in the southern part of the state, as compared to the average prevalence among Mexican blood donors reported by the PAHO (0.67%) [13]. Thus, it appears that most of the state shows an increased prevalence of HCV compared with the population of blood donors in the country.

Our findings indicate that living in the Papaloapan region is a risk factor for HCV infection (OR = 1.83 [CI: 1.32–2.56]). Valerio-Ureña *et al.* previously reported that the municipality of Alvarado, also located in the Papaloapan region, had the highest prevalence (2.96%) compared with metropolitan area Veracruz-Boca del Rio [17]. Thus, our findings together with the previous reports suggest that epidemiological studies and confirmatory testing should be performed in the Papaloapan population, in an effort to determine the prevalence of chronic HCV carriers, evaluate additional risk factors, and prevent the spread of HCV in these communities.

The World Health Organization has reported that regular voluntary donations have lower prevalence of TTIs, although in developing countries the percentage of altruistic donations is very low [8]. In CETS-Veracruz during the study period, 25.6% were recurring donors; of these, 96.7% were family donations, and only 0.4% were altruistic donations. Most of Veracruz's blood donors donate blood repeatedly if a family member needs it.

The prevalence of hepatitis C in first-time donors was 2.7 higher than in recurring donors. Differences could exist in the risk factors between first-time donors and people who donate frequently, even for family reasons. This may be because recurring donors tend to have a better lifestyle, with lower risk practices; furthermore, they may take steps to prevent diseases that are transmitted via blood transfusion. By contrast, in hepatitis B prevalence, this behavior is not observed, because the prevalence is low in both populations of donors.

In the National Health Survey done in Mexico in 2000, the anti-HBc (antibody vs. hepatitis B core antigen) prevalence was higher in men, and it was directly proportional to age; the risk factors among chronic carriers (HBsAg-positive) were female gender, widower status, age 60 years or more, and illiteracy [11]. In the present study, the risk factors found to be significantly associated with HBsAg seropositivity were living in Huasteca Baja and being a cattleman. However, these results should be interpreted with some caution, since relatively few donors live in this region, and relatively few healthy donors listed cattleman as their occupation.

Despite these limitations, some characteristics may be identified from our HBsAg-seropositive population. They were primarily adults between 35 and 49 years of age (mean age, 36.7 years), which was similar to the results from Irapuato, Mexico, where the highest prevalence was observed in the 31-40 year age group [20]. The HBsAg-positive group in the present study had a higher education level compared to the HCV-positive group (Table 1) and to other blood banks in the country [23].

The risk factors identified herein for HCV seropositivity showed some similarities to those reported by Mexican national blood banks and in other countries. For example, we observed no difference in gender or marital status [23,25], and found the highest prevalence rates among adults between 35 and 59 years of age [25-27] and among those with a low level of education (including illiterates) [17,25,27,28]. We also found that being a professional was a protective

factor for HCV, reflecting the increased risk of HCV infection among people with low education levels.

The most frequent occupations among the HCV-seropositive group (Table 1) were employee, farmer, trade, bricklayer, housewife, fisherman, and store clerk. These findings were similar to those previously reported from a blood bank in Mexico City (employee, store clerk, worker, and housewife) [22]. The preponderance of farmers and fishermen in the present study likely reflects that 36.3% of the blood donors were from rural areas; Veracruz has a wide seacoast. Indeed, the occupation of fisherman yielded the only significant OR for HCV infection (OR = 6.36 [CI: 2.95–13.68]). Most of the studied fishermen came from the Papaloapan region (77% of fishermen in healthy donors), and living in this region was found to be a risk factor for HCV infection. Thus, we calculated an adjusted OR (Mantel-Haenszel) to assess whether this occupation was directly associated with HCV seropositivity. The adjusted OR was 3.8 (CI: 1.64–8.86), which was lower but remained statistically significant.

The occupation of fisherman is considered a risk factor for HIV infection due to lifestyle factors, such as long absences from home and alcohol intake, which can lead to high-risk sexual activities [29,30]. Although sexual transmission is not considered to be an efficient route for the transmission of HCV, multiple sex partners and sexually transmitted diseases have been identified as risk factors in several studies [27,31]. This suggests that additional investigations are needed to understand how the customs and activities of Papaloapan fishermen may increase the risk of HCV infection, because in the donor selection interview, those who used intravenous drugs or had high-risk sex were excluded, but not those who had tattoos, piercings, and practiced acupuncture, since Mexican regulations did not consider these practices causes for exclusion.

Adults 35–45 years of age are more highly affected by HBV and HCV, probably because unsafe blood transfusion practices existed prior to 1992 in many countries, including Mexico [12,25,27]. Other practices that confer risks for HCV and HBV infections include tattooing, piercing, acupuncture, multiple sex partners, and surgeries [12,25-28,31]. Additionally, HCV has been associated with intravenous drug use (IDU), sex with someone who uses intravenous drugs, or sex with an HCV-seropositive partner [27,28,31]. In Mexico, 56.5% of cirrhosis patients from two hospitals in Mexico City had records of blood transfusions, and 32.3% received

blood transfusions prior to being diagnosed with cirrhosis [32]; however, this report did not specify whether patients were infected before or after 1992. Most of the risk factors identified so far have been associated in the past with the economically active adult population, but they are now present even in teenagers; consequently, the appearance of the aftermath of a chronic hepatitis infection as cirrhosis or HCC could appear at earlier ages.

The implementation of a nucleic acid test (NAT) in the blood banks of developing countries requires known prevalence rates, pilot testing, and cost-benefit studies. It has been reported that NAT can detect hidden cases of hepatitis B (HBsAg-negative, NAT-positive), but it does not greatly reduce the window period (time from infection to first reactive test) compared to serological testing [2]. Thus, the blood banks should consider the prevalence in each region. As the prevalence of HBV in Veracruz is relatively low and has decreased over time, the potential impact of NAT may not justify the cost. With respect to HCV infection, the use of NAT can significantly reduce the window period [2], and the prevalence of this infection in Veracruz appears to be increasing. The introduction of NAT could potentially identify cases during the window period, suggesting that a pilot study of NAT in blood donors in Veracruz could be highly useful.

Conclusions

Important advances have been made in Veracruz with respect to reducing TTIs, perhaps explaining why the prevalence rate of HBsAg-positive blood donors obtained in the present study was lower even when compared to other national blood banks. This was reflected in all studied regions of the state except for Tierra Blanca, which had a prevalence higher than that reported in the general Mexican population. Meanwhile, the HCV prevalence in blood donors of Veracruz appears to be on the rise. We therefore recommend confirmatory studies of Papaloapan fishermen to determine the prevalence of active HCV infections and a pilot study using NAT to reduce the risk of transfusion-transmitted HCV.

As hepatic diseases are already among the principal mortality causes in the Veracruz population, future research should also examine additional risk factors and seek to develop methods for early detection of HCV and HBV infections.

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