RESEARCH COMMUNICATION

Hepatitis B and Liver Cancer Knowledge and Preventive Practices among Asian Americans in the San Francisco Bay Area, California

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Abstract

Chronic hepatitis B virus (HBV) infection causes liver cancer and disproportionately affects the Asian community in the U.S. In order to advance HBV and liver cancer awareness and prevention, it is important to identify existing gaps in knowledge and preventive practices among Asian Americans. Therefore, the authors administered a written questionnaire to 199 adults in the Asian-American community of the San Francisco Bay Area, California. Although the majority of adults had at least a college education, knowledge regarding HBV transmission, prevention, symptoms, risks, and occurrence was low. Fewer than 60% reported having been tested for HBV, only 31% reported having been vaccinated against HBV, and only 44% reported having had their children vaccinated. Asians, especially those born in China or Southeast Asia, had significantly poorer knowledge regarding HBV and liver cancer than non-Asians. Those with higher knowledge levels were significantly more likely to have been tested for HBV and to have had their children vaccinated. Younger adults, women, Caucasians, more highly educated individuals, those not born in China or Hong Kong, and those with a personal or family history of liver disease were more likely to have taken preventive action against HBV. Our results suggest that HBV and liver cancer knowledge among Asian Americans, especially Chinese Americans, is poor, and that better knowledge is associated with increased preventive practices. Thus, there is a need for increased HBV education and improved community-based interventions to prevent HBV-related liver disease in the high-risk Asian-American community.

Key Words: Hepatitis B - liver cancer - Asian Americans - knowledge - vaccination - screening

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Introduction

Eliminating racial/ethnic health disparities is a top priority in the U.S. (U.S. Department of Health and Human Services, 2000) where one of the greatest health disparities is the disproportionately high incidence rate of liver cancer in Asian Americans (Surveillance, Epidemiology, and End Results (SEER) Program, 2006). This inequality can be largely attributed to the high prevalence of chronic hepatitis B virus (HBV) infection in Asians and Asian immigrants (Lang, 2006) among whom the prevalence of chronic HBV infection ranges between 10-15%, compared with less than 0.5% in the general U.S. population (Custer et al., 2004; Centers for Disease Control and Prevention, 2005). Chronic HBV infection confers a 200-fold increased risk of liver cancer (Beasley et al., 1981; Jenkins et al., 2001) and, if it is not properly monitored and treated, a one-in-four probability of death from HBV-related liver cancer or cirrhosis (World Health Organization, 2000). Liver cancer, although relatively uncommon in the overall U.S. population, is the second most common cause of cancer death in Asian/Pacific Islander (API) men and the seventh leading cause of cancer death in API women (United States Cancer Statistics Working Group, 2005).

Because chronic HBV infection is usually asymptomatic until advanced liver disease has developed (Wright, 2006), HBV screening is necessary in order to identify both individuals who are infected and those who remain susceptible to infection. In the high-risk Asian-American community, preventive action against HBV and liver cancer must be undertaken at three levels: (i) serological testing of HBV infection and antibody status, (ii) vaccination of unprotected children and adults, and (iii) routine liver cancer screening in patients chronically infected with HBV. However, the lack of knowledge and awareness about HBV and liver cancer in the Asian-American community is a major barrier to preventing HBV-related morbidity and mortality in this population (Taylor et al., 2000; 2002; 2004; 2005a/b; 2006; Thompson et al., 2002; Chen et al., 2006; Choe et al., 2005; 2006; Ma et al.,

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Culturally sensitive health initiatives should be implemented in the Asian-American community to reduce the burden of chronic HBV infection and eliminate the racial/ethnic disparity in liver cancer incidence and mortality. In order to spotlight the need for such interventions, as well as to inform their design and identify key target groups for education and intervention, we conducted a study to assess the level of knowledge and preventive practices against HBV and liver cancer in the high-risk Asian-American community. Our focus was on Chinese Americans, who comprise the largest group of Asians in the U.S. (United States Census Bureau, 2002).

Materials and Methods

Study population

The San Francisco Bay Area of California has the highest percentage, and one of the largest populations, of Asians in the continental U.S. (United States Census Bureau, 2002). Over 30% of the Bay Area population is of Asian background, compared with 4% of the overall U.S. population (United States Census Bureau, 2005). Between April 2000 and August 2000, adults (≥18 years old) at various Chinese community gatherings in the Bay Area were invited to complete a written questionnaire assessing HBV and liver cancer knowledge and preventive practices. Locations from which subjects were recruited included cultural events, a community business association meeting, community centers, and Chinese language schools. Non-Asians were eligible because they can be considered members of the Asian-American community. Of 200 adults asked to complete the survey, 199 agreed and granted written consent to participate in the study. The study protocol was approved by the Stanford University Institutional Review Board.

Questionnaire

Questionnaires and consent forms were available in English, traditional Chinese, and simplified Chinese. Chinese-language translations were performed and cross-verified by collaborators at Shantao University Medical School and Hong Kong University Medical School. Throughout the questionnaire, we referred to 'hepatitis B' instead of 'HBV' in order to avoid confusion among participants. Therefore, in the methods and results below, we refer to 'hepatitis B' in order to correspond with the actual survey questions asked.

The questionnaire included sections on hepatitis B knowledge, preventive practices, and demographics. The knowledge assessment section measured understanding about modes of hepatitis B transmission, ways to prevent hepatitis B, symptoms and risks of hepatitis B, and the occurrence of hepatitis B and liver cancer in Asians compared with Caucasians. Specifically, participants were first asked whether they had heard of viral hepatitis and hepatitis B. The questions about transmission asked whether one could get hepatitis B from eating contaminated food, coming into contact with contaminated blood, sharing a toothbrush or razor blade with an infected person, sharing needles during intravenous drug use, having unprotected sex with an infected person, or being born to an infected mother. The questions about prevention asked whether hepatitis B could be prevented by vaccination, using proper cooking methods, avoiding contaminated water, or avoiding infected needles. The questions about symptoms and risks of hepatitis B asked whether hepatitis B always, usually, or rarely causes symptoms; whether hepatitis B can be cured; and whether hepatitis B can impair liver function, cause liver failure, increase the risk of liver cancer, or cause premature death. The questions about occurrence asked whether hepatitis B and liver cancer are more common in Asians, more common in Caucasians, or equally common in both.

The section on preventive practices asked whether participants had ever been tested for, vaccinated against, or had their children vaccinated against hepatitis B. Specifically, participants were asked whether they had ever been tested for hepatitis B; whether they had been vaccinated against viral hepatitis and, if so, whether it was against hepatitis A, hepatitis B, or both. If participants had children, they were asked whether their children had been vaccinated against viral hepatitis and, if so, whether it was against hepatitis A, hepatitis B, or both. Participants were also asked whether they had ever been screened for liver cancer and, if so, whether they were screened at least once a year, a couple of times, or once. In this study, liver cancer screening was not considered as a preventive action because it is not necessarily appropriate for the general population.

The questionnaire also assessed several demographic and health-related characteristics, including age, sex, birthplace, immigrant generation if born in the U.S., race/ethnicity, level of education, preferred source(s) of health information, preferred language(s) of health information, personal or family history of hepatitis B or liver cancer, and health insurance status.

Statistical methods

An overall knowledge score was calculated as the sum of correct answers to the 18 knowledge-based questions. Correct responses received a score of one point each; incorrect, uncertain ('don't know'), or missing responses received no points. Preventive practices were categorized as 'yes' if the participant reported having taken the action, and 'no' if the participant's answer was 'no', 'don't know', or missing.

Univariate associations of demographic and health-related covariates and preventive actions with knowledge score were assessed using linear regression to estimate the difference in knowledge score (in continuous points, with corresponding 95% confidence interval [CI]) between groups. Demographic covariates were categorized to maximize inter-group differences, if any, in knowledge score. Missing values for demographic covariates were excluded because they were considered to be uninformative. Missing values for health-related covariates and preventive actions were grouped with uncertain ('don't know') values, which were included because they were considered to be informative. For example, a missing value for age or sex was judged not to be meaningful, whereas a missing value for family history of liver disease was

interpreted as indicating a lack of awareness about such a history. Demographic covariates that were at least marginally ($p<0.10$) associated with knowledge score were included in multivariate linear regression models for knowledge score.

Table 1. Distribution of Demographic Characteristics and Hepatitis B Preventive Actions in the San Francisco Bay Area Asian-American Community

Characteristic/action	
Age group (years)	
<30	22 (11.1)
30-39	35 (17.6)
40-49	59 (29.6)
50-59	51 (25.6)
≥60	20 (10.1)
Missing	12 (6.0)
Sex	
Male	88 (44.2)
Female	105 (52.8)
Missing	6 (3.0)
Race/ethnicity	
Taiwanese	100 (50.3)
Chinese	71 (35.7)
Other Asian	5 (2.5)
Caucasian	8 (4.0)
Other	3 (1.5)
Missing	12 (6.0)
Birthplace	
Taiwan	121 (60.8)
China	26 (13.1)
Hong Kong	14 (7.0)
Other Asian	10 (5.0)
United States	21 (10.6)
2nd gen	9 (4.5)
≥ 3rd gen	10 (5.0)
Missing	2 (1.0)
UK	1 (0.5)
Missing	6 (3.0)
Level of education	
High school	6 (3.0)
College#	15 (7.5)
4-Year College/University	77 (38.7)
Graduate/professional school	85 (42.7)
Missing	16 (8.0)
Health insurance coverage	
Yes	166 (83.4)
No	21 (10.6)
Don't know	7 (3.5)
Missing	5 (2.5)
Preferred source of health information*	
Newspapers/magazines	111 (55.8)
Television/radio	99 (49.7)
Doctor	90 (45.2)
Brochures	79 (39.7)
Internet	72 (36.2)
Herbalist	11 (5.5)
Other (e.g.drug store, nurse)	8 (4.0)
Missing	21 (10.6)
Preferred language of health information*	
Chinese	123 (61.8)
English	124 (62.3)
Japanese	5 (2.5)
Korean	1 (0.5)
Other	1 (0.5)
Missing	16 (8.0)
Ever heard of hepatitis B	
Yes	179 (89.9)
No	13 (6.5)
Don't know	4 (2.0)
Missing	3 (1.5)
Personal or family history of hepatitis B or liver cancer	
Yes	48 (24.1)
No	125 (62.8)
Don't know	21 (10.6)
Missing	5 (2.5)
Ever tested for hepatitis B	
Yes	119 (59.8)
No	58 (29.1)
Don't know	16 (8.0)
Missing	6 (3.0)
Ever vaccinated against hepatitis	
Yes	74 (37.2)
Against A	8 (4.0)
Against B	43 (21.6)
Both	19 (9.5)
Missing	4 (2.0)
No	79 (39.7)
Don't know	30 (15.1)
Missing	16 (8.0)
Ever screened for liver cancer	
Yes	29 (14.6)
At least once a year	8 (4.0)
A couple of times	4 (2.0)
Once	10 (5.0)
Missing	7 (3.5)
No	154 (77.4)
Don't know	8 (4.0)
Missing	8 (4.0)
(If have children [N=142]:)	
Children ever vaccinated against hepatitis	
Yes	82 (57.7)
Against A	5 (3.5)
Against B	35 (24.6)
Both	27 (19.0)
Missing	15 (10.6)
No	35 (24.6)
Don't know	20 (14.1)
Missing	5 (3.5)

* (more than one possible response) #Community College

Univariate associations of demographic covariates and knowledge score with preventive practices were assessed using logistic regression to estimate the relative risk (RR, approximated by the prevalence odds ratio, with corresponding 95% CI) of having taken a preventive action (yes versus no/unknown/missing). The hepatitis B knowledge score was analyzed in 5-point increments; that is, we estimated the RR of having taken a preventive action associated with each 5-point increase in knowledge score. As before, demographic covariates were categorized to maximize any differences in the RR between groups. Missing demographic values were excluded, while missing and uncertain values for health-related information and preventive actions were combined. Demographic covariates that were at least marginally (p,â§0.10) associated with the RR of having taken a particular preventive action were included in multivariate linear regression models for that action. Data were analyzed using SAS version 9.1.3 (SAS Institute, Cary, NC).

Results

The study population comprised predominantly college-educated, first-generation Chinese immigrants from mainland China and Taiwan; most individuals were between ages 40 and 59 years (Table 1).

Hepatitis B knowledge level

Although 90% of adults had heard of hepatitis B and 24% reported that they or a family member had a history of hepatitis B or liver cancer (Table 1), knowledge regarding hepatitis B transmission, prevention, symptoms, risks, and patterns of occurrence was poor (Table 2). Out of a possible knowledge score of 18, the median number of correct answers was 10 (56%); only four individuals (2%) answered all questions correctly. The majority (53%) of adults had the misconception that hepatitis B can be acquired through contaminated food, while 37-49% were unaware that hepatitis B can be transmitted through contaminated blood, shared needles, unprotected sex, or from mother to child at birth.One-fourth of individuals did not know that hepatitis B can be prevented by vaccination, 61% did not know that hepatitis B rarely causes symptoms, and 61% were unaware that there is no cure for hepatitis B.

After adjusting for age group and birthplace, Caucasians and other non-Asians, on average, scored 4.4 points higher (95% CI: 0.9, 7.8 points) than Asians on the hepatitis B knowledge questions (Table 3).Compared to those born in Taiwan or Hong Kong, individuals born in China or another Asian country (mostly in Southeast Asia) scored 1.8 points lower (95% CI: -3.3, -0.2 points), whereas those born in the U.S. or U.K. did not score significantly differently, after controlling for age group and race/ethnicity. Likewise, there were no significant differences in hepatitis B knowledge by age group, sex, or level of education.As expected, adults who had not previously heard of hepatitis B had significantly poorer knowledge than those who had, and those who had never been screened for liver cancer or had not had their children vaccinated against hepatitis B also had lower scores than those who

Table 2. Distribution of Responses to Knowledge Questions about Hepatitis B and Liver Cancer in the San Francisco Bay Area Asian-American Community

Hepatitis B awareness	
Heard of viral hepatitis	
Yes	138 (69.3)
No	41 (20.6)
Unclear#	20 (10.1)
Heard of hepatitis B	
Yes	179 (89.9)
No	13 (6.5)
Unclear#	7 (3.5)
Hepatitis B transmission	
Contaminated food	
Yes	106 (53.3)
No*	50 (25.1)
Unclear#	43 (21.6)
Contaminated blood	
Yes*	126 (63.3)
No	29 (14.6)
Unclear#	44 (22.1)
Shared razors/toothbrushes	
Yes*	112 (56.3)
No	40 (20.1)
Unclear#	47 (23.6)
Intravenous drug use	
Yes*	118 (59.3)
No	30 (15.1)
Unclear#	51 (25.6)
Unprotected sex	
Yes*	101 (50.8)
No	44 (22.1)
Unclear#	54 (27.1)
Birth to infected mother	
Yes*	117 (58.8)
No	29 (14.6)
Unclear#	53 (26.6)
Hepatitis B prevention	
Vaccination	
Yes*	147 (73.9)
No	17 (8.5)
Unclear#	35 (17.6)
Proper cooking methods	
Yes	93 (46.7)
No*	51 (25.6)
Unclear#	55 (27.6)
Avoid contaminated water	
Yes	96 (48.2)
No*	44 (22.1)
Unclear#	59 (29.6)
Avoid infected needles	
Yes*	140 (70.4)
No	15 (7.5)
Unclear#	44 (22.1)
Hepatitis B symptoms/cure	
Occurrence of symptoms	
Always	15 (7.5)
Usually	50 (25.1)
Rarely*	77 (38.7)
Never	6 (3.0)
Unclear*	51 (25.6)
Availability of cure	
Yes	92 (46.2)
No*	61 (30.7)
Unclear#	46 (23.1)
Risks of hepatitis B	
Impaired liver function	
Yes*	166 (83.4)
No	5 (2.5)
Unclear#	28 (14.1)
Liver failure	
Yes*	139 (69.8)
No	14 (7.0)
Unclear#	46 (23.1)
Liver cancer	
Yes*	155 (77.9)
No	8 (4.0)
Unclear#	36 (18.1)
Premature death	
Yes*	127 (63.8)
No	9 (4.5)
Unclear#	63 (31.7)
Occurrence in Asians relative to Caucasians	
Hepatitis B	
Lower	5 (2.5)
Equal	9 (4.5)
Higher*	146 (73.4)
Unclear#	39 (19.6)
Liver cancer	
Lower	3 (1.5)
Equal	9 (4.5)
Higher*	127 (63.8)
Unclear#	60 (30.2)

*Correct answer
#Don't know/missing

had. Surprisingly, individuals without insurance, on average, scored 3.2 points higher (95% CI: 0.9, 5.5) than those who were insured.

Hepatitis B preventive practices

Sixty percent of adults reported having been tested for hepatitis B, 31% reported having been vaccinated against hepatitis B, and 44% of those with children reported that their children had been vaccinated (Table 1). In addition, 15% of adults reported having been screened for liver cancer, including 4% who stated that they were routinely screened at least once a year. In the latter group, however, only 2 of 8 reported having a personal history of hepatitis B, and two others reported having been vaccinated against hepatitis B, suggesting some degree of misreporting.

Table 3. Differences in Hepatitis B Knowledge Scores in the San Francisco Bay Area Asian-American Community

Characteristic /action	Point Difference Unadjusted (95% CI)	Adjusted (95% CI)*
Age group (years)		
<50	0.0 (reference)	0.0 (reference)
≥50	-1.9 (-3.8, 0.1)	-1.3 (-3.2, 0.7)
Sex Male	0.0 (reference)	0.0 (reference)
Female	0.4 (-0.8, 1.6)	0.4 (-0.8, 1.6)
Race/ethnicity		
Asian	0.0 (reference)	0.0 (reference)
Non-Asian	3.9 (1.4, 6.4)	4.4 (0.9, 7.8)
Birthplace		
Taiwan/Hong Kong	0.0 (reference)	0.0 (reference)
China/other Asian	-2.2 (-3.8, -0.7)	-1.8 (-3.3, -0.2)
USA/UK	1.4 (-0.5, 3.3)	-1.0 (-3.5, 1.5)
Level of education completed		
High school/community college	0.0 (reference)	0.0 (reference)
Four-year college/university	1.2 (-0.9, 3.2)	1.0 (-1.0, 3.0)
Graduate/professional school	1.1 (-1.0, 3.1)	1.2 (-0.9, 3.2)
Health insurance coverage		
Yes	0.0 (reference)	0.0 (reference)
No	-0.1 (-2.0, 1.9)	3.2 (0.9, 5.5)
Unclear#	-2.4 (-4.9, 0.1)	-1.0 (-3.6, 1.5)
Ever heard of hepatitis B		
Yes	0.0 (reference)	0.0 (reference)
No	-4.5 (-6.8, -2.3)	-4.1 (-6.3, -1.9)
Unclear#	-7.0 (-10.0, -4.0)	-6.9 (-9.8, -4.0)
Personal or family history of hepatitis B or liver cancer		
Yes	0.0 (reference)	0.0 (reference)
No	-0.6 (-2.0, 0.8)	-0.6 (-2.0, 0.9)
Unclear#	-2.3 (-4.3, -0.3)	-2.0 (-4.0, 0.1)
Ever tested for hepatitis B		
Yes	0.0 (reference)	0.0 (reference)
No	-1.6 (-2.9, -0.3)	-1.0 (-2.3, 0.3)
Unclear#	-2.0 (-4.0, -0.1)	-1.6 (-3.6, 0.4)
Ever vaccinated against hepatitis B		
Yes	0.0 (reference)	0.0 (reference)
No	-0.8 (-2.2, 0.6)	-0.2 (-1.6, 1.2)
Unclear#	-2.0 (-3.6, -0.4)	-1.4 (-3.0, 0.2)
Ever screened for liver cancer		
Yes	0.0 (reference)	0.0 (reference)
No	-1.9 (-3.6, -0.2)	-1.7 (-3.3, 0.0)
Unclear#	-3.0 (-5.6, -0.4)	-2.3 (-5.0, 0.5)
(If have children): Children ever vaccinated against hepatitis B		
Yes	0.0 (reference)	0.0 (reference)
No	-3.0 (-4.6, -1.5)	-2.2 (-3.9, -0.6)
Unclear#	-2.7 (-4.2, -1.2)	-2.4 (-4.0, -0.9)

*Adjusted for age group (<50 or ≥50 years), race/ethnicity (Asian or Caucasian/other), and birthplace (Taiwan/Hong Kong, China/other Asian country, or USA/UK) #Don't know/missing

Individuals born in China or Hong Kong were half as likely as those born in Taiwan to have been tested for hepatitis B (RR=0.5, 95% CI: 0.2, 1.0). After controlling for birthplace, there were no differences in the odds of hepatitis B testing by age, sex, race/ethnicity, or level of education (Table 4). Those who had never heard of hepatitis B, had no personal or family history of hepatitis B or liver cancer, had never been vaccinated against hepatitis B, had never been screened for liver cancer, or had not had their

Table 4. Associations with Having Taken Any Preventive Actions against Hepatitis B, Estimated by Relative Risks (RRs) with 95% Confidence Intervals (CIs), in the San Francisco Bay Area Asian-American Community

Characteristic/action		Tested for Hepatitis B*	Vaccinated [$]	Children Vaccinated[$$]	Preventive Action**
Age group	<30	1.0 (reference)	1.0 (reference)		
	30-39	2.0 (0.6, 7.1)	0.5 (0.1, 1.7)	1.0[@] (reference)	1.0[@] (reference)
	40-49	0.9 (0.3, 3.2)	0.4 (0.1, 1.2)	1.2 (0.4, 3.4)	0.4 (0.1, 1.1)
	50-59	0.6 (0.2, 2.2)	0.3 (0.1, 0.8)	0.5 (0.2, 1.6)	0.3 (0.1, 0.9)
	≥60	0.8 (0.2, 3.6)	0.2 (0.04, 0.9)	0.4 (0.1, 1.7)	0.3 (0.1, 1.1)
Sex	Male	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
	Female	1.1 (0.6, 2.0)	3.2 (1.5, 6.5)	1.7 (0.8, 3.3)	1.1 (0.5, 2.1)
Race/ethnicity	Taiwanese	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
	Chinese	1.4 (0.6, 3.2)	1.3 (0.6, 2.7)	0.6 (0.2, 1.5)	1.0 (0.4, 2.6)
	Other Asian	0.1 (0.01,1.8)	0.4 (0.05, 4.5)	undefined	0.3 (0.03, 2.7)
	Caucasian	1.0 (0.1, 6.4)	21.3 (2.0, 223.4)	3.0 (0.2, 35.0)	1.9 (0.1, 24.6)
	Other	1.2 (0.1,17.3)	undefined	undefined	0.5 (0.03, 9.8)
Birthplace	Taiwan	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
	China	0.6 (0.3, 1.5)	0.6 (0.2, 2.1)	0.5 (0.2, 1.3)	0.4 (0.1, 1.0)
	Hong Kong	0.3 (0.1, 1.0)	1.9 (0.6, 6.7)	0.5 (0.1, 1.6)	0.3 (0.1, 0.8)
	Other Asian	0.8 (0.2, 3.1)	2.1 (0.4, 9.6)	0.3 (0.04, 3.2)	0.7 (0.1, 3.7)
	USA/UK	0.8 (0.3, 2.0)	0.5 (0.1, 2.6)	1.0 (0.2, 3.9)	0.5 (0.2, 1.9)
Level of education completed					
High school/Community college		1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
4-year college/University		1.0 (0.4, 2.9)	3.7 (1.0, 14.1)	1.7 (0.4, 6.3)	1.3 (0.4, 4.0)
Grad/Professional school		1.0 (0.4, 2.8)	3.6 (0.9, 14.2)	2.9 (0.7, 11.2)	1.1 (0.4, 3.3)
Health insurance	Yes	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
	No	0.8 (0.3, 2.3)	0.8 (0.2, 3.2)	1.3 (0.4, 4.1)	2.5 (0.5, 12.1)
	Unclear[#]	0.2 (0.05, 1.3)	0.5 (0.1, 2.4)	0.3 (0.1, 1.7)	0.3 (0.1, 1.3)
Heard of hepatitis B	Yes	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
	No	0.1 (0.02, 0.5)	0.2 (0.03, 1.9)	undefined	0.1 (0.03, 0.5)
	Unclear[#]	0.8 (0.2, 3.7)	0.4 (0.05, 3.9)	1.1 (0.2, 7.0)	0.4 (0.1, 1.9)
Personal or family history of hepatitis B or liver cancer					
	Yes	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
	No	0.5 (0.2, 1.0)	1.7 (0.7, 3.9)	0.9 (0.4, 1.9)	0.5 (0.2, 1.3)
	Unclear[#]	0.2 (0.1, 0.7)	0.8 (0.2, 3.2)	0.7 (0.2, 2.5)	0.2 (0.1, 0.7)
Tested for hepatitis B	Yes	---	---	1.0 (reference)	1.0 (reference)
	No	---	---	0.4 (0.2, 0.9)	0.2 (0.1, 0.5)
	Unclear[#]	---	---	undefined	0.2 (0.03, 0.7)
Ever vaccinated against hepatitis B					
	Yes	1.0 (reference)	---	---	1.0 (reference)
	No	0.3 (0.1, 0.7)	---	---	0.3 (0.2, 0.8)
	Unclear[#]	0.2 (0.1, 0.5)	---	---	0.1 (0.02, 0.2)
Ever screened for liver cancer					
	Yes	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
	No	0.4 (0.1, 1.0)	0.4 (0.2, 1.0)	0.6 (0.2, 1.4)	0.1 (0.01, 0.5)
	Unclear[#]	0.1 (0.01, 0.5)	0.1 (0.01, 0.8)	0.2 (0.03, 1.1)	0.01 (0.001, 0.2)
(If have children): Children ever vaccinated against hepatitis B					
	Yes	1.0 (reference)	1.0 (reference)	---	---
	No	0.2 (0.1, 0.6)	0.3 (0.1, 0.9)	---	---
	Unclear[#]	0.2 (0.1, 0.5)	0.3 (0.1, 0.7)	---	---
Hepatitis B knowledge score					
	5-point increase	1.5 (1.1, 2.2)	1.2 (0.8, 1.8)	2.5 (1.5, 4.2)	1.7 (1.1, 2.6)

*Adjusted for birthplace (Taiwan, China/Hong Kong, or other Asian country/USA/UK), [$]Adjusted for age group (<30, 30-49, or ≥50 years), sex, and race/ethnicity (Asian/other or Caucasian), [$$]Adjusted for sex and birthplace (Taiwan/USA/UK or China/Hong Kong/ other Asian country), **Adjusted for age group (<40 or ,≥40 years) and birthplace (Taiwan, China/Hong Kong, or other Asian country/USA/UK), [@]Age group <40 years [#]Don't know/missing

children vaccinated against hepatitis B were significantly less likely to have been tested for hepatitis B.

Adults aged 30 years or above, males, and Asians (compared to Caucasians) were less likely to have been vaccinated against hepatitis B (Table 4).Compared with those under age 30 years, older individuals were one third as likely to have been vaccinated (RR=0.3, 95% CI: 0.1, 0.9), after controlling for sex and race/ethnicity. Conversely, compared to Asians, Caucasians were 20 times more likely to have been vaccinated (RR=20.3, 95% CI: 2.0, 203.3). After adjusting for age, sex, and race/ethnicity, adults who had completed college or graduate/professional school were over three times more likely than those less educated to have been vaccinated against hepatitis B.Those who had never been tested for hepatitis B, had never been screened for liver cancer, or had not had their children

vaccinated against hepatitis B were significantly less likely to have been vaccinated.

Among individuals with children, mothers were more likely than fathers to report that their children had been vaccinated against hepatitis B (Table 4).Those born in an Asian country other than Taiwan were less likely than those born elsewhere to have had their children vaccinated (RR=0.5, 95% CI: 0.2, 1.0, controlling for sex).After adjusting for sex and birthplace, the odds of having children vaccinated against hepatitis B did not vary significantly by age, race/ethnicity, or level of education. However, individuals who had not been tested for or vaccinated against hepatitis B were also less likely to have had their children vaccinated.

When we considered whether individuals had taken any of the three preventive actions, those aged 40 years or above (RR=0.3, 95% CI: 0.1, 0.9, compared with those under 40 years) and those born in China or Hong Kong (RR=0.3, 95% CI: 0.1, 0.7, compared with those born in Taiwan) were less likely to have taken any action against hepatitis B.In addition, after adjusting for age and birthplace, those who had not previously heard of hepatitis B, were uncertain about their own or family history of hepatitis B or liver cancer or had not been screened for liver cancer, were less likely to have taken any preventive action (Table 4).

Relationships between hepatitis B knowledge and preventive practices

Adults with higher knowledge levels were significantly more likely to have been tested for hepatitis B, to have had their children vaccinated against hepatitis B, and to have taken any preventive action against hepatitis B.In particular, those who knew that hepatitis B is more common in Asians than Caucasians were over two times more likely to have taken any preventive action against hepatitis B. Similarly, those who recognized that Asians are at higher risk of liver cancer than Caucasians were more likely to have been tested for hepatitis B, to have had their children vaccinated, or to have taken any preventive action (RR=3.8, 95% CI: 1.8, 8.0), after adjusting for confounders (listed in Table 4 footnotes).Adults who knew that hepatitis B can be prevented by vaccination were over 14 times more likely to have been vaccinated (RR=14.2, 95% CI: 3.1, 66.2), and five times more likely to have had their children vaccinated (RR=5.4, 95% CI: 1.9, 15.2).

Discussion

Even in this highly-educated sample of predominantly Chinese-American adults, our results reveal low levels of HBV- and liver-cancer-related knowledge and preventive practices, despite the high prevalence of chronic HBV infection in this population (Centers for Disease Control and Prevention, 2005; Lang, 2006). To our knowledge, our study is the first to describe HBV knowledge and prevention in the large Asian-American community of the San Francisco Bay Area. We found that individuals with higher knowledge levels were significantly more likely to have taken preventive action. Thus, our results suggest that improved education and awareness among Asian Americans may help to increase HBV testing and vaccination, reducing the disproportionate burden of liver cancer, cirrhosis, and premature death in this high-risk population.

Lack of knowledge

According our results, a disparity exists between having heard of hepatitis B or liver cancer and understanding the important health implications of these diseases in the Asian-American community. Within our surveyed population, while 90% had heard of hepatitis B, only 2% were able to answer all of the knowledge questions correctly. Our results are consistent with similar studies in other Asian populations in North America, including Vietnamese, Cambodian, Korean, and Chinese communities (Taylor et al., 2000; 2002; 2004; 2005a/b; 2006; Thompson et al., 2002; 2003; Choe et al., 2005; 2006; Cheung et al., 2005; Chen et al., 2006; Ma et al., 2007a/b). These studies consistently demonstrate a low level of HBV-related knowledge in Asian immigrants, revealing the pervasiveness of ignorance about this life-threatening disease in the population at highest risk of dying from HBV-associated liver cancer.

Effective dissemination of HBV and liver cancer information is needed to dispel current misinformation existing in the Asian-American community. One essential topic for education is the difference between HBV and hepatitis A virus, which, unlike HBV, can be transmitted through food and water, but does not cause chronic infection and very seldom leads to death (WHO, 2000). In addition, educational efforts should correct the misconception that people with chronic HBV infection often exhibit overt symptoms, since such a belief could deter people who feel healthy from taking preventive action. This false sense of security could be compounded by the widespread, but erroneous, belief that a cure for hepatitis B exists.

The lower level of HBV knowledge among Asians (88% of our study population) compared with non-Asians may reflect poorer access to health education, particularly culturally sensitive and linguistically appropriate information, in the former group. Likewise, among participants born overseas, the poorer level of knowledge among those born in China or Southeast Asia, compared with those born in Hong Kong or Taiwan, may be due in part to cultural differences or more effective public health education in the latter regions.

Lack of preventive practices

Reported levels of HBV preventive action, especially vaccination, were low in our study population, as in other Asian-American populations (Vryheid, 2001; Taylor et al., 2002; 2004; 2005a/b; 2006; Thompson et al., 2002; Choe et al., 2006; Ma et al., 2007a/b). Given that we observed an association between higher education and increased vaccination, the actual rate of vaccination in the general Asian-American community is likely even lower than in our sample of predominantly college-educated participants. The low (44%) prevalence of pediatric vaccination in our study is consistent with a recent study showing low HBV vaccine coverage among Vietnamese-American children,

with only 10-38% of those aged 3-18 years completing all three shots (Jenkins et al., 2000). Of particular concern was our finding that a sizable proportion of participants did not know whether they had been tested for or vaccinated against HBV. Given that over 10% of Asians living in the U.S. are chronically infected with HBV (Centers for Disease Control and Prevention, 2006), it is likely that many of these individuals are unidentified chronic HBV carriers who are not being properly monitored and treated for their infection, thereby increasing their risk of fatal liver disease (WHO, 2000).

We found that younger age, female sex, personal or family history of hepatitis B or liver cancer, and country of origin were associated with certain preventive practices. Older adults were less likely than younger adults to have taken preventive actions. To target the older population, providing linguistically appropriate information and improving access to testing, vaccination, and other health services should be a priority.The higher reported vaccination coverage among women may be related to the recommendation for HBV testing among all pregnant women in the U.S. beginning in 1991 (Advisory Committee on Immunization Practices, 1991). Our finding that females were more likely than males to have been vaccinated also suggests that future interventions should be targeted towards Asian males, who have a higher prevalence of chronic HBV infection and a higher incidence of liver cancer than females (Centers for Disease Control and Prevention, 2006; Surveillance, Epidemiology, and End Results (SEER) Program, 2006) Although individuals who reported a personal or family history of HBV or liver cancer were more likely to have been screened, they did not have better HBV knowledge and were less likely to have been vaccinated or have had their children vaccinated against HBV. Since family members of individuals with chronic HBV infection are at particularly high risk of being infected, it is important that they understand the importance of HBV prevention (Immunization Practices Advisory Committee, 1991). The higher frequency of HBV testing and vaccination among individuals born in Taiwan may reflect the successful efforts of a nationwide HBV vaccination program launched in 1984 (Chen et al., 1987).

Study limitations

Our results should be interpreted in light of several limitations. We collected self-reported data only, which could not be verified. Furthermore, some inconsistencies in our data (for example, three participants reported that they had never heard of hepatitis B, yet also stated that they had been tested for or vaccinated against hepatitis B) indicate that some information was unreliable. Another limitation of our study is its cross-sectional nature, which precludes inference regarding whether HBV knowledge precedes preventive action, or vice versa. Thus, although our results show that better HBV knowledge is associated with increased preventive practices, we cannot conclude with certainty that better knowledge leads to subsequent action. Finally, the generalizability of our study is limited by its non-random sampling of participants, who were older, more highly-educated, and more likely to be female than the general population of Asian-American adults, and were mostly of Chinese-American background. However, our results revealed that even highly educated members of the Asian-American community have low levels of HBV knowledge and preventive practice, suggesting that all Asian Americans are in need of improved HBV and liver cancer education and preventive outreach.

Implications for future interventions

Despite these limitations, our study also has several strengths. For the first time, this study reveals levels of HBV knowledge and preventive practice among Asian Americans in the San Francisco Bay Area, which has the densest population of Asians in the continental U.S. This study also offers important information for the design of culturally sensitive and targeted educational initiatives in this high-risk population. Nearly all participants reported that they desired additional information about HBV and liver cancer, further reinforcing the necessity for better education in this community.

Given the current low levels of hepatitis B knowledge and preventive action in our study population, along with the strong associations between the two, it is clearly important to increase both knowledge and prevention in Asian Americans. We also found that individuals who had taken one preventive measure were significantly more likely to have taken another, suggesting that preventive actions tend to go hand-in-hand. Taken together, this growing body of data highlights the importance of HBV and liver cancer prevention in the high-risk Asian-American population. The new data gathered from this study can be used toward the design of more effective community-based health interventions. Eliminating the racial/ethnic health disparity in HBV and liver cancer incidence and mortality in the U.S. is a vital and worthy goal that requires the will and cooperation of health care providers, policy makers, scientists, legislators, and the broader community.

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