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ORIGINAL PAPER

What Made a Successful Hepatitis B Program for Reducing Liver Cancer Disparities: An Examination of Baseline Characteristics and Educational Intervention, Infection Status, and Missing Responses of At-Risk Asian Americans

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Abstract Asian Americans, compared with other racial/ethnic groups, are disproportionately affected by Hepatitis B disease. The literature suggests that knowledge and awareness of prevention strategies such as receiving hepatitis B screening and vaccination are potential factors associated with occurrence of hepatitis B and liver cancer, while it is unclear how baseline characteristics relate to these effective hepatitis B prevention strategies. In the study, five Asian–American groups in the state of Maryland completed self-administered pre- and post-test after receiving lectures on hepatitis B prevention, and participated in blood screening for Hepatitis B. *T*-test and one-way ANOVA were used to explore the differences of baseline characteristics among these participants. Logistic regression was employed to study the baseline factors and association with completion of tests. All groups were significantly different in socioeconomic characteristics except for gender and immunization status, and only marginally different in infection status ($P = 0.089$). The mean pre- and post-test scores were different by group ($P < 0.01$). All groups had significantly improved knowledge of prevention ($F = 7.65$, $P < 0.01$). Age and race were positively related to immunization status, with older participants are more likely to get vaccinated (OR = 1.02, CI = 1.00–1.03). Chinese, Korean and Vietnamese were more likely to receive vaccination. For infection, only gender was correlated with infection status, with odds of being HBV carriers for females being 74% less than that for males (OR = 0.26, CI = 0.07–0.90). Participants who had only high school or lower education, retired, self-employed, higher income level, and married were less likely to complete surveys. The study found correlations of gender, infection status, age and race with immunization status. Males are more likely to be HBV carriers. It reveals new findings on the relationship between baseline characteristics and the completion of pre- and post-tests and missing responses. The information may provide potential directions for improve preventive program for at-risk communities.

Keywords Health disparities · Hepatitis B · Liver cancer · Minority health

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Introduction

Compared to other racial/ethnic groups, Asian Americans (AA) are facing unprecedented health challenges in this

century, characterized by both being the fastest growing minority racial group in the U.S. [1], and being at risk of widening health disparities due to specific diseases adversely affecting this group. In terms of population growth, The U.S. Census Bureau projects that AA is among the fastest growth of all racial communities. Recent U.S. Census estimated that AA account for 4.9% of US population with steady, exponential growth at the rate of 3.4% in 2004. The increase of Asian Americans between 2000 and 2050 is 213%, compared to a 49% increase in the population as a whole in the same period [1]. On the other hand, this community of a diverse ethnic mark-up is confronting widened health disparities attributable to infectious or chronic diseases, such as Hepatitis B and liver cancer. A report in 1999 revealed that AAPI were 3–13 times more likely to die from HCC than Caucasians, with Vietnamese Americans at 13 times higher risk, Korean Americans at 8 times, and Chinese Americans at 6 times [2]. Several community-based screening studies conducted in the U.S. consistently confirmed that there existed substantially higher HBV infection, ranging from 4.3 to 15% of infection rates, in many Asian communities compared with those of non-Asian counterparts [2–6]. This excess risk may be attributable to a high prevalence of HBV infection (particularly among first generation immigrants), in combination with low of hepatitis B vaccination due to either cultural, linguistic, or financial barriers, such as the lack of insurance coverage and educational awareness.

Given the documented health disparities, there is a pressing need for developing and evaluating the effectiveness of community-based Hepatitis B education and prevention program to reduce cancer health disparities of Asian Americans. The purpose of this study was to evaluate the baseline characteristics of participants of a culturally integrated Hepatitis B program for Asian Americans that included education, screening and vaccination in the state of Maryland. The preliminary results of the study on infection status among at-risk Asian subgroups were reported elsewhere [3]. The present article specifically focuses on other important dimensions of the study, including a comparison and contrast of the baseline measurements, evaluating what baseline factors might be associated with the effectiveness of educational intervention, and the potential correlations of these with the probability of not responding to the pre or post-test questions among five major racial groups.

Literature Review

The literature suggested that there is a link among knowledge of prevention, level of educational attainment against Hepatitis B virus infection, with healthy behaviour and the decision of receiving vaccination to protect against the disease. Study found that those with higher knowledge levels were significantly more likely to have been tested for HBV and to have had their children vaccinated [7], and those with at least a high school diploma were more likely to have been tested for HBV. In addition, participants who were born in the US, younger individuals, and those with at least some college education were more likely to have been vaccinated against hepatitis B [8]. A study on Cambodian immigrants identified that this community generally had low levels of HBV knowledge, serologic testing, and vaccination. The study identified a need for targeted educational interventions aimed at reducing HBV-related liver cancer mortality among Southeast Asian communities [9]. On the other hand, some studies also pointed out that although some Asian community members has college education, knowledge regarding HBV transmission, prevention, symptoms, risks, and occurrence was low. One study suggests that less than 60% reported having been tested for HBV, only 31% reported having been vaccinated against HBV. 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 [7]. The lack of awareness in Hepatitis B prevention is pervasive in Asian community. Important knowledge deficits about routes of hepatitis B transmission were identified in a community-based, in-person survey of Vietnamese [10]. Another study focused on the screening of Asian residents in the San Francisco Bay Area found that among those screened 8.9% were chronically infected with HBV. Notably, before their screening nearly two-thirds (65.4%) of the chronically infected adults were unaware that they were infected. Of those who were not chronically infected, 44.8% lacked protective antibodies against HBV and were likely susceptible to future infection [5]. The literature also indicated that HBV testing and vaccination remain suboptimal among members of Vietnamese- and Cambodian-Americans, culturally sensitive efforts will be needed for these populations [10]. Culturally integrated liver cancer prevention program will reduce cancer health disparities in high risk immigrant Asian Americans [11]. The study indicated a culturally targeted, community-based outreach program to promote prevention, early detection, and management of HBV infection and liver cancer would be more effective for protecting Asian Americans against the diseases [4]. The intervention program to improve HBV screening rates should include strategies to improve knowledge about the risk of HBV and encourage effective communication with health care providers about HBV testing [12].

Evidence abounds in the support of potential association of HBV screening behaviour and baseline characteristics. One study found that known factors associated with HBV testing in bivariate comparisons include older age, short US

residence history, low English fluency, private health insurance, identifying a regular source of medical care, reporting no long waits for medical appointments, and having access to interpreter services. A HBV interview of Chinese Americans identified factors which are associated with ever having tested: knowing that Chinese are more likely to be infected with HBV than Whites; individuals can be infected with HBV for life; HBV infection can cause liver cancer; not believing that HBV can be prevented by having a positive attitude; having a family member, friend, or medical doctor recommend testing; asking for testing from a medical doctor; and not needing interpreter services [12]. In addition, the following were independently associated with HBV testing in multiple logistic regression analysis: older age, college education, low English fluency, private health insurance, having a regular medical provider, and reporting no long waits for medical appointments. Younger and less educated men, and those with difficulty accessing medical care may be at particular risk for never having had HBV testing [13]. In addition, in terms of factors associated with completing the questionnaire, a study suggested that the lay health worker interventions had a very limited impact on hepatitis B testing completion [14]. However, there is a lack of the literature clarifying what factors may influence successful educational delivery, screening status, as well as missing responses of the at-risk Asian community. The present article addresses these questions.

Research Questions

The present study seeks to evaluate the effectiveness of education and screening intervention, and analyze the potential association among baseline demographic characteristics and (1) infection, (2) immunization status, along with (3) the completion of post tests.

Materials and Methods

Materials

Eight Asian communities in Maryland enrolled in the Hepatitis B prevention program conducted by the University of Maryland School of Public Health between the year 2005 and 2006. They attended lectures on prevention of the disease, completed self-administered pre- and post-tests, and had their blood drawn to receive screening of Hepatitis B. Research instruments and protocols associated with human subjects of this project, including informed consent, pre-and post-test instruments of education intervention, and procedures of data analysis and reporting were approved by the institutional review board of the University of Maryland to ensure their full compliance with relevant federal guidelines governing treatment of human subjects.

The subjects in this study were selected from Asian faith-based organizations or community faith-based organizations in Montgomery Country, Maryland. The education program was provided for all age groups. "One-group pre-test/post-test" was chosen to evaluate the effect of HBV educational intervention. The HIV educational materials were adopted from the Asian Liver Center of Stanford University (http://liver.stanford.edu) and were translated in the participants' native languages. The same survey questionnaires including demographics, social economic status, health and insurance status, and Hepatitis B knowledge were used for pre-test and post-test. However, our limited funding resource allowed us provide Hepatitis B screening and vaccination to at-risk Asians aged between 18 and 35 who attended events at FBOs or CBOs regularly. Blood specimen was drawn from each selected participant at either the education location or clinics and was analyzed for HBsAg and HBsAb at the local lab office. Participants' physicians were noticed their Hepatitis B status. All participants were received informed consent and were not provided monetary incentives for participation.

To analyze the potential association among baseline demographic characteristics and infection, immunization status, along with the completion of post tests, we first evaluated the successful delivery of Hepatitis B prevention education. We studied what groups have either the lowest pre or post test scores that are significantly different from other groups. In particular, what (demographic) factors are correlated with the effectiveness of educational delivery as measured by the change of test scores? Moreover, are there statistically significant differences among different racial groups in terms of demographic characteristics? Second, we analyzed the outcomes of blood screening. Specific interests were directed at examining what demographic factors are correlated with screening status. Third, we investigated the differences between subjects who completed the test questions and subjects who failed to answer the test questions by examining the demographic measurements. Such information may potentially provide insight for improving completion rates and realign cultural appropriateness of the pre-and-post tests for respondents. In addition, we evaluated the correlation of the baseline factors and the probability of not answering the pre or post-test questions to understand their potential association.

Methods: Statistical Analysis

The pre- and post-test scores were given a 0.1 point for each correct answer and ranged from 0 if no correct answer to 1 for all 10 correct answers. Paired t-test was used to

evaluate the change of test scores (post-test–pre-test) by each sub-group.

Not all subjects who completed preventive education received blood screening to test for infection. The statistical analyses only included subjects who received the blood screening service ($n = 807$). To contrast the differences of baseline measurements and to aggregate the results of some groups with a small sample, originally eight Asian subgroups were collapsed to five groups for analysis due to their small number of subjects: among the 807 subjects, 294 (36.4%) (241 from mainland China and 53 from Taiwan) were Chinese, 200 (24.8%) were Koreans, 89 (11.0%) were Indians, 108 (13.4%) were Vietnamese and 116 (14.4%) were from Southeast Asian (Cambodian, Filipino, Thai and Others). To test baseline differences among the five groups, we applied t-test and one-way ANOVA for the continuous covariates (including age, pre-test score, post-test score) and chi-square test for the categorical variables (including education, gender, employment, insurance status, marriage, how long have been in U.S., and income level). Tukey adjustment was used for multiple comparisons. A linear regression model was fit to examine whether the effectiveness of educational delivery, as measured by the change of the test scores, was different across different racial groups while adjusting for the pre-test scores and the baseline covariates. We used logistic regression models to test (1) the correlation of baseline characteristics and the immunization status, and (2) the correlation of baseline characteristics and the HBV infection status.

The data contain missing information for some of the baseline covariates as well as responses for the pre and post-test questions. When missing data exist, we focused on the complete cases for the analyses. The differences between subjects who completed the test questions and subjects who failed to answer the test questions were examined in terms of the baseline measurements. Logistic regression models were used to study which baseline factors correlate the unwillingness to answer pre or post test questions. All statistical procedures were conducted using SAS (Version 9). A significance level of alpha = 0.05 was set for all statistical tests.

Results

Demographic Characteristics of the Sample

Complete demographic information is presented on Table 1. The sample consisted of 807 subjects who completed screening for HBV in Montgomery County between October 2005 and July 2006. Ninety-four (11.6%) participants were excluded from analysis because they either failed to complete all demographic information fields and have substantially incomplete responses.

The between-group differences in terms of the baseline characteristics were analyzed by using one-way analysis of variance. Comparisons revealed that the five Asian-American groups were significantly different in most baseline sociodemographic characteristics measured ($P < 0.01$), except for gender. Chinese and Vietnamese participants were the youngest with an average age of 38.4 (SD = 18.12) and 38.5 (SD = 14.46), respectively, and Asian Indian participants were the oldest with the mean age of 52.2 (SD = 19.13). The mean pre- and post-test scores were different ($P < 0.0001$) among five groups. The percentages of female participants were similar to those of males across five groups ($P = 0.42$). About half (49.7%) of Koreans reported having bachelor degree, followed by 36.1% Asian Indians and 32.2% Chinese. In terms of income level, Asian Indians (29.7%) were three times as many as Vietnamese (9.8%) to report an annual income of 70 k or more, while the Asian Indian group also has the highest percentage (33.8%) of participants with an income of lower than 10 k, followed by Vietnamese (27.9%) and Koreans (19.8%). More than half of all participants across groups have lived in the US for 10 years or more. Over half of the participants were married, ranging from 55.7% (Chinese) to 85% (Indian). As for insurance coverage, the Vietnamese group has the highest participants (47.6%) who were uninsured, while Koreans and Chinese have relatively high insurance status of 38.6% and 33.3%, respectively.

Factors Associated with Program Effectiveness

We selected the change in post-test score and pre-test score as an indicator of program effectiveness. The results suggest that all of the five Asian groups had statistically significant differences in terms of improvements of knowledge of prevention against the disease ($F = 7.65$, $P < 0.001$). Table 2 summarized the results of the analysis. The Tukey's test for multiple comparisons show that the Korea, Indian and Vietnamese have lower improvement of knowledge ($P < 0.01$) compared with other southeast Asian group, while the Chinese group has similar improvement of knowledge compared to southeast Asian group. (Note: Data is available upon request).

Table 3 shows the parameter estimates of the above factors using multiple linear regression analysis with age, gender, education, income level, marriage, and insurance status adjusted.

Among baseline characteristic factors examined, the results of pre-test score were inversely associated with the study effectiveness. Chinese have the highest improvement of test scores and Indians have the lowest. The education program is less effective for part-time employees. Subjects

Table 1 Comparisons of baseline characteristics by subgroups ($n = 807$)

	Asian Indian $N = 89$	Chinese $N = 294$	Korean $N = 200$	Other $N = 116$	Vietnamese $N = 108$	*P*-value
Age (year) mean (SD)	52.24 (19.13)	38.43 (18.12)	50.43 (17.21)	43.31 (17.04)	38.51 (14.46)	<0.0001
Pretest score mean (SD)	0.54 (0.19)	0.68 (0.17)	0.67 (0.16)	0.57 (0.16)	0.63 (0.20)	<0.0001
Posttest score mean (SD)	0.71 (0.16)	0.93 (0.10)	0.86 (0.13)	0.86 (0.19)	0.77 (0.20)	
Education						
Bachelor degree	31 (36.05)	66 (32.20)	93 (49.73)	37 (35.58)	14 (21.54)	<0.0001
High school or lower	31 (36.05)	70 (34.15)	58 (31.02)	46 (44.23)	41 (63.08)	
Master or higher	23 (26.74)	52 (25.37)	23 (12.30)	13 (12.50)	4 (6.15)	
Vocational training	1 (1.16)	17 (8.29)	13 (6.95)	6 (9.23)	8 (7.69)	
Employment						
Full time	38 (46.91)	95 (47.26)	69 (35.75)	58 (55.77)	41 (65.08)	<0.0001
Part time	5 (6.17)	22 (10.95)	11 (5.70)	13 (12.50)	7 (11.11)	
Retired	16 (19.75)	27 (13.43)	38 (19.69)	10 (9.62)	5 (7.94)	
Self-employed	4 (4.94)	20 (9.95)	35 (18.13)	6 (5.77)	0.00	
Student	5 (6.17)	23 (11.44)	24 (12.44)	6 (5.77)	6 (9.52)	
Unemployed	13 (16.05)	14 (6.97)	16 (8.29)	4 (6.35)	11 (10.58)	
Gender						
Female	40 (45.98)	140 (56.45)	103 (54.50)	60 (56.07)	49 (59.76)	0.42
Male	47 (54.02)	108 (43.55)	86 (45.50)	47 (43.93)	33 (40.24)	
Income						
$10,000–30,000	9 (12.16)	42 (22.22)	35 (19.23)	22 (25.00)	19 (31.15)	0.0003
$30,000–$50,000	10 (13.51)	40 (21.16)	59 (32.42)	15 (17.05)	17 (27.87)	
$50,000–$70,000	8 (10.81)	28 (14.81)	20 (10.99)	16 (18.18)	2 (3.28)	
$70,000 or more	22 (29.73)	46 (24.34)	32 (17.58)	19 (21.59)	6 (9.84)	
<$10,000	25 (33.78)	33 (17.46)	36 (19.78)	16 (18.18)	17 (27.87)	
Residence history						
10 Years or more	44 (51.16)	132 (63.77)	148 (75.51)	73 (69.52)	40 (61.54)	<0.0001
1–4 Years	9 (10.47)	18 (8.70)	9 (4.59)	7 (6.67)	9 (13.85)	
5–9 Years	24 (27.91)	30 (14.49)	26 (13.27)	10 (9.52)	12 (18.46)	
<1 Year	7 (8.14)	3 (1.45)	7 (3.57)	6 (5.71)	0.00	
Born in US	2 (2.33)	24 (11.59)	6 (3.06)	4 (6.15)	9 (8.57)	
Marriage						
Divorced	0.00	4 (2.19)	5 (2.75)	3 (3.45)	1 (1.89)	0.0004
Married	68 (85.00)	102 (55.74)	132 (72.53)	60 (68.97)	32 (60.38)	
Separated	0.00	1 (0.55)	3 (1.65)	0.00	2 (3.77)	
Single	12 (15.00)	76 (41.53)	42 (23.08)	18 (33.96)	24 (27.59)	
Insurance						
Not insured	17 (21.52)	65 (33.33)	73 (38.62)	25 (24.75)	30 (47.62)	0.0025
Insured	62 (78.48)	196 (66.67)	116 (61.38)	76 (75.25)	33 (52.38)	

Data are by frequencies (percentages) unless indicated as means (SD). *P*-values by chi-square or analysis of variance (ANOVA)

who have been in the US for 1–4 years have the least improvement of test scores compared to others.

Factors Associated with Outcomes of Blood Screening and Infection Status

Table 4 compared the baseline characteristics of those protected versus non-protected. The five Asian-American groups were significantly different in terms of immunization status ($F_{4,\ 802} = 21.032$, $P < 0.001$). As reported elsewhere [3] the overall un-immunization rate was 48.4%, several Southeast Asian groups (referred to the other in the table) were the most likely not to have received immunization, namely Thai (56.1%) and Cambodian (51.2%) communities. For infection status the group difference was marginally significant ($F_{4,\ 802} = 8.072$, $P = 0.089$). Two

Table 2 Improvements of knowledge of prevention by subgroup

Race comparison		Difference		
		Between means	Simultaneous confidence	95% Limits
Other	–Chinese	0.04787	−0.02563	0.12136
Other	**–Korean**	**0.09880**	**0.00363**	**0.19397***
Other	**–Asian Indian**	**0.12863**	**0.03621**	**0.22104***
Other	**–Vietnamese**	**0.15879**	**0.06637**	**0.25120***
Chinese	**–Vietnamese**	**0.11092**	**0.02924**	**0.19260***

* Statistically significant improvement

Bold values indicate statistically significant

Table 3 Parameter estimate for factors associated with study effectiveness

Parameter	Estimate	SE	*P* value
Pretest score race	−0.8244	0.0471	**<0.0001**
Asian Indian	**−0.1304**	0.028	**<0.0001**
Chinese	0.0318	0.0233	0.1717
Korean	−0.0177	0.0289	0.5418
Vietnamese	**−0.0769**	0.0291	**0.0081**
Other[a]	0		
Employment			
Full time	−0.0049	0.0277	0.8611
Part time	**−0.0876**	0.0343	**0.0106**
Retired	0.0271	0.0381	0.4776
Self-employed	0.0088	0.0384	0.8184
Student	−0.0413	0.0355	0.2451
Unemployed[a]	0		
Years of living			
10 Years or more	−0.0136	0.0297	0.6458
1–4 Years	**−0.1072**	0.0371	**0.0038**
5–9 Years	−0.0302	0.0328	0.3568
<1 Year	0.0048	0.0528	0.9282
Born in US[a]	0		

Note. Adjusted for age, education, gender, income level, marriage, and insurance status

[a] Served as reference

Bold values indicate statistically significant

factors were associated with immunization status: age and race (see Table 5). Age is positively related to the immunization status with the elder subjects are more likely to get immunized (OR = 1.02, CI = 1.00–1.03). When compared to the other (Southeast Asian group), Chinese (OR = 1.88, CI = 1.13–3.15), Korean (OR = 1.92, CI = 1.13–3.26) and Vietnamese (OR = 2.12, CI = 1.05–4.25) are more likely to receive vaccination, while Asian Indians are less likely to get immunized (OR = 0.69, CI = 0.36–1.33). In terms of infection status, only gender was correlated to the infection status. Females were less likely to be HBV carrier than their male counterparts (OR = 0.26, CI = 0.07–0.90). Other factors were not statistically associated with infection status.

Factors Associated with Completing the Questionnaire (Missing Data)

Table 6 compare subjects who answered pre (and post-) test questions with those who did not. Demographic factors, such as education level, employment status, years of living in the United States, marriage status, and race are associated with participants' willingness to complete both pre- and post- test subjects with higher education (master or higher), subjects that are full time or students are more likely to complete both pre-test and post-test.

Furthermore, Table 7 presented the results of the adjusted odds ratios for multivariate logistic regression, which identified those unique contribution of demographic factors associated with failing to complete post-test ($P < 0.05$). Participants who reported having high school or lower educational level had greater odds (OR = 4.66, CI = 1.38–15.73) of failing to complete the post-test questionnaire when compared to their counterparts who had reported having vocational training. Participants who were retired (OR = 3.44, CI = 1.05–11.22) and who were self-employed (OR = 3.83, CI = 1.17–12.51) were less likely to complete the post-test questionnaire. Participants whose annual income was 10–30 k or those whose annual income was 30–50 k were less likely to fail to complete the post-test questionnaire (OR = 0.37 (0.16–0.85), and OR = 0.27 (0.11–0.66), respectively). In addition, married people were more likely not to complete the questionnaire (OR = 2.95, CI = 1.36–6.40). Koreans were more likely to not complete the post-test questionnaire when compared to their Southeast Asian counterparts.

Discussion

The present study evaluated potential effectiveness of education and screening intervention of a hepatitis B

Table 4 Chi square comparing protected versus non-protected (immunization status) comparing infected versus non-infected

Row %	Unprotected	Antibody exists	*F*	Prob	Sig	Non-carrier	Carrier	*F*	Prob	Sig
Race										
Asian Indian	62 (69.66)	27 (30.34)	**21.03**	**0.0003**	**	62 (100)	0 (0)	8.07	0.089	NS
Chinese	146 (49.66)	148 (50.34)				132 (90.41)	14 (9.59)			
Korean	95 (47.50)	105 (52.50)				87 (91.58)	8 (8.42)			
Vietnamese	50 (46.30)	58 (53.70)				43 (86.00)	7 (14.00)			
Other	74 (63.79)	42 (36.21)				67 (90.54)	7 (9.46)			
Education										
Bachelor degree	130 (53.94)	111 (46.06)	4.17	0.2439	NS	123 (94.62)	7 (5.38)	3.83	0.2805	NS
High school or lower	126 (51.22)	120 (48.78)				111 (88.108)	15 (11.90)			
Master or higher	72 (62.61)	43 (37.39)				66 (91.67)	6 (8.33)			
Vocational training	24 (53.33)	21 (46.67)				21 (87.50)	3 (12.50)			
Employment										
Full time	167 (55.48)	134 (44.52)	6.16	0.2908	NS	151 (90.42)	16 (9.58)	2.42	0.7885	NS
Part time	33 (56.90)	25 (43.10)				30 (90.91)	3 (9.09)			
Retired	54 (56.25)	42 (43.75)				48 (88.89)	6 (11.11)			
Self-employed	38 (58.46)	27 (41.54)				34 (89.47)	4 (10.53)			
Student	26 (40.63)	38 (59.38)				25 (96.15)	1 (3.85)			
Unemployed	29 (50.00)	29 (50.00)				28 (96.55)	1 (3.45)			
Gender										
Female	198 (50.51)	194 (49.49)	1.73	0.1885	NS	188 (94.95)	10 (5.05)	3.48	0.0619	
Male	178 (55.45)	143 (44.55)				160 (89.89)	18 (10.11)			
Income										
$10,000–30,000	73 (57.48)	54 (42.52)	2.41	0.6605	NS	65 (89.04)	8 (10.96)	6.41	0.1705	NS
$30,000–$50,000	75 (53.19)	66 (46.81)				65 (86.67)	10 (13.33)			
$50,000–$70,000	38 (51.35)	36 (48.65)				38 (100)	0 (0)			
$70,000 or more	75 (60.00)	50 (40.00)				70 (100)	0 (0)			
<$10,000	67 (52.76)	60 (47.24)				61 (91.04)	6 (8.96)			
US residency										
10 Years or more	242 (55.38)	195 (44.62)	2.37	0.6679	NS	216 (89.26)	26 (10.74)	5.39	0.2497	NS
1–4 Years	23 (44.23)	29 (55.77)				22 (95.65)	1 (4.35)			
5–9 Years	55 (53.92)	47 (46.08)				51 (92.73)	4 (7.27)			
<1 Year	12 (52.17)	11 (47.83)				12 (100)	0 (0)			
Born in US	24 (53.33)	21 (46.67)				24 (100)	0 (0)			
Marriage										
Divorced	6 (46.15)	7 (53.85)	2.16	0.5389	NS	5 (83.33)	1 (16.67)	3.05	0.3844	NS
Married	218 (55.33)	176 (44.67)				201 (92.20)	17 (7.80)			
Separated	2 (33.33)	4 (66.67)				2 (100)	0 (0)			
Single	88 (51.16)	84 (48.84)				85 (96.59)	3 (3.41)			
Insurance										
Not insured	106 (50.48)	104 (49.52)	1.79	0.181	NS	94 (88.68)	12 (11.32)	1.94	0.1636	NS
Insured	234 (56.12)	183 (43.88)				218 (93.16)	16 (6.84)			

Bold values indicate statistically significant

program, and analyzed baseline characteristics associated with infection, immunization status, and the completion of pre and post tests. Our results revealed findings that are either consistent with or contradictory to the literature, and some original findings that were not previously reported.

Consistent with the literature includes that males are more at-risk of HBV infection [4, 5], females were less likely to be HBV carriers than their male counterparts. In terms of receiving hepatitis B testing, given the higher risk of hepatitis B infection found in our studies, several

Table 5 Adjusted odds ratio for immune and infection status (factors associated with immune and infection status)

	Protected		Infected	
	OR	95% CI	OR	95% CI
Age	**1.015**	**1.00–1.03***	NS	
Race				
Asian Indian	**0.689**	**0.36–1.33**	NS	
Chinese	**1.888**	**1.13–3.15***	NS	
Korean	**1.921**	**1.13–3.26***	NS	
Vietnamese	**2.115**		NS	
Other	1		NS	
Education				
Bachelor degree	NS		NS	
High school or lower	NS		NS	
Master or higher	NS		NS	
Vocational training	NS		NS	
Employment				
Full time	NS		NS	
Part time	NS		NS	
Retired	NS		NS	
Self-employed	NS		NS	
Student	NS		NS	
Unemployed	NS		NS	
Gender				
Female	NS		**0.256**	**0.07–0.90***
Male	NS		1	
Income				
$10,000–30,000	NS		NS	
$30,000–$50,000	NS		NS	
$50,000–$70,000	NS		NS	
$70,000 or more	NS		NS	
<$10,000	NS		NS	
US residency				
10 Years or more	NS		NS	
1–4 Years	NS		NS	
5–9 Years	NS		NS	
<1 Year	NS		NS	
Born in US	NS		NS	
Marriage				
Divorced	NS		NS	
Married	NS		NS	
Separated	NS		NS	
Single	NS		NS	
Insurance				
Not insured	NS		NS	
Insured	NS		NS	

Bold values indicate statistically significant

subgroups will benefit from receiving the screening tests, including Cambodian, Vietnamese [8] and Chinese [12, 15].

In terms of infection, our finding suggested that 4.5% of the 800 subjects are infected, consistent with the literature, low immunization have been seen in several subgroups, notably Southeast Asian (such as Cambodian and Vietnamese) and Chinese groups [8, 12]. Literature has indicated that as many as 10% of Asian and Pacific Islander adults in the United States are chronically infected with hepatitis B virus (HBV), and up to two-thirds are unaware that they are infected. Without proper medical management and antiviral therapy, up to 25% of Asian and Pacific Islander persons with chronic HBV infection will die of liver disease [16]. The community HBV screening reported 6–15% of HBV infection in Asian and Pacific Islander Americans in the United States [17]. Chinese immigrants to North America have substantially higher rates of chronic hepatitis B infection than the general population [15]. Sixty-seventy percent among 38% of Cambodian who had been serologically tested for HBV had not been vaccinated [9] Asian Americans and Pacific Islanders (AAPIs) account for over half of the 1.3 million chronic hepatitis B cases and for over half of the deaths resulting from chronic hepatitis B infection in United States [11]. Also consistent with literature [11, 18] American-born Asian groups have much lower infection than foreign-born ones.

In terms of factors associated with the increase of HBV test and vaccination rate, we found that educational attainment and knowledge of hepatitis B prevention are associated with willingness to receive screening and vaccination. Our study also found that Korean group has lower post test scores. This is parallel to what the literature indicated that there exists a need to integrate culturally sensitive approach to develop Hepatitis B intervention programs [8, 11]. We also found that several groups, including Chinese (OR = 1.88, CI = 1.13–3.15), Korean (OR = 1.92, CI = 1.13–3.26) and Vietnamese (OR = 2.12, CI = 1.05–4.25) are more likely to receive vaccination than other groups. However, Asian Indians are less likely to get immunized (OR = 0.69, CI = 0.36–1.33). We also found that Asian Indians did not have any infection, and had the lowest immunization rate.

In this study we also report several new findings from this analysis were not previously reported in studies. These include the analysis of the relationship between demographic characteristics and un-immunization rates, and the completion of pre- and post-test questionnaire. In previous studies, there are very few studies about screening completion rate. In a community-based survey of Chinese in North American, the lay health worker interventions had a very limited impact on hepatitis B testing completion [14]. This is new information warrant further study to corroborate the results. Un-immunization rates are higher in some Southeast Asian groups, particularly in Thai and Cambodian groups that have shown higher infection rates. The

Table 6 Baseline characteristics between subjects with observed and missing on pretest score and posttest score ($n = 807$)

	Prettest			Posttest		
	Observed ($n = 493$)	Missing ($N = 314$)	*P*-value	Observed ($n = 459$)	Missing ($N = 348$)	*P*-value
Age (year) mean (SD)	43.87 (17.48)	43.27 (19.53)	0.03	43.86 (17.34)	43.35 (19.51)	0.70
Education						
Bachelor degree	34.77	44.72	0.02	34.37	43.88	0.0015
High school or lower	37.65	39.13		36.59	41.33	
Master or higher	20.16	10.56		21.06	10.20	
Vocational training	7.41	5.59		7.98	4.59	
Employment						
Full time	49.37	39.76	<0.0001	50.23	39.50	<0.0001
Part time	10.29	5.42		9.05	9.00	
Retired	11.76	24.10		11.09	23.50	
Self-employed	6.93	19.28		7.47	16.00	
Student	11.76	4.82		12.22	5.00	
Unemployed	9.87	6.63		9.95	7.00	
Gender						
Female	57.47	50.00	0.06	56.69	52.21	0.24
Male	42.53	50.00		43.31	47.79	
Income						
$10,000–30,000	21.06	22.22	0.80	21.89	20.31	0.41
$30,000–$50,000	23.15	25.31		23.88	23.44	
$50,000–$70,000	12.73	11.73		12.94	11.46	
$70,000 or more	22.22	17.90		22.14	18.75	
<$10,000	20.83	22.84		19.15	26.04	
Residence history						
10 Years or more	60.82	82.25	<0.0001	63.16	73.40	0.01
1–4 Years	8.78	5.33		8.99	5.42	
5–9 Years	17.35	10.06		15.35	15.76	
<1 Year	4.29	1.18		3.51	3.45	
Born in US	8.78	1.18		8.99	1.97	
Marriage						
Divorced	2.29	2.01	<0.0001	2.22	2.23	<0.0001
Married	61.70	83.89		61.08	81.56	
Separated	0.69	2.01		0.74	1.68	
Single	35.32	35.32		35.96	14.53	
Insurance						
Not insured	32.54	36.20	0.40	31.32	38.27	0.09
Insured	67.46	63.80		68.68	61.73	
Race						
Asian Indian	16.63	2.22	<0.0001	14.60	6.32	<0.0001
Chinese	39.15	32.17		38.56	33.62	
Korean	11.56	45.54		12.85	40.52	
Vietnamese	12.98	14.01		14.16	12.36	
Other	19.68	6.05		19.83	7.18	

analysis of completion of pre/post tests and demographic characteristics may be helpful for other programs to improve Hepatitis B program in Asian communities.

Limitation of the study includes that fact that other factors were not statistically associated with infectious status because the infection case was rather small in each

Table 7 Adjusted odds ratios for missing on posttest score ($N = 348$)

	Odds ratio (95% CI)
Educational level	
Bachelor degree	2.07 (0.64–6.69)
High school or lower	**4.66 (1.38–15.73)***
Master or higher	0.77 (0.21–2.88)
Vocational training	1.00
Employment status	
Full time	2.14 (0.79–5.83)
Part time	1.76 (0.52–5.94)
Retired	**3.44 (1.05–11.22)***
Self-employed	**3.83 (1.17–12.51)***
Student	0.94 (0.23–3.86)
Unemployed	1.00
Income level	
$10,000–30,000	**0.37 (0.16–0.85)***
$30,000–$50,000	**0.27 (0.11–0.66)***
$50,000–$70,000	0.51 (0.18–1.43)
$70,000 or more	0.59 (0.21–1.60)
<$10,000	1.00
Marriage status	
Divorced	1.56 (0.27–9.19)
Married	**2.95 (1.36–6.40)***
Separated	6.00 (0.16–221.08)
Single	1.00
Race	
Asian Indian	1.45 (0.52–4.05)
Chinese	1.54 (0.63–3.75)
Korean	**21.05 (8.54–51.88)***
Vietnamese	0.12 (0.01–1.10)
Other	1.00

Note. Adjusted for gender, length of living, and insurance status

* Indicates statistically significant difference

Bold values indicate statistically significant

group—with Chinese the highest (14 cases) and Indian the lowest (0 cases); and that many subjects did not complete both pre and post tests an as such their incomplete responses were excluded from analysis, additional effort should be directed to introduce incentive to improve their completion rate. The literature also reported several important protective factors against hepatitis B infection, including effective communication with healthcare providers [12], and use ESL education model [8] warrant inclusion in further study.

Conclusions

In demographic characteristics, only gender was correlated to the infection status. We found that males are more likely to be HBV carriers, which is consistent with the literature. Age and race are related to immunization status. The study present additional findings about the relationship between demographic characteristics and the completion of pre- and post-test questionnaire and missing responses, which were not reported before. The findings provide potential directions for focusing preventive interventions on at-risk Asian communities to reduce liver cancer disparities.

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