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Health Within Reach—a Patient-Centered Intervention to Increase Hepatitis B Screening Among Asian Americans: a Randomized Clinical Trial



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BACKGROUND: There are few studies to date of interventions to increase viral hepatitis screening among Asian Americans, who have high rates of chronic hepatitis B (HBV) infection.

OBJECTIVE: To develop, implement, and test the efficacy of a mobile application (Hepatitis App) delivered in four languages to increase HBV screening among Asian Americans.

DESIGN: Cluster-randomized clinical trial.

PARTICIPANTS: Four hundred fifty-two Asian American patients ≥ 18 years of age, who had no prior HBV testing, and received primary care within two healthcare systems in San Francisco, CA.

INTERVENTIONS: The intervention group received the Hepatitis App, delivering interactive video education on viral hepatitis in English, Cantonese, Mandarin, or Vietnamese and a provider printout (Provider Alert) and Provider Panel Notification. The comparison group received a mobile application delivering nutrition and physical activity education and Provider Panel Notification.

MAIN MEASURES: Primary outcomes were patient-provider discussion about HBV and documentation of a HBV screening test within 3 months post-intervention. Secondary outcome was documentation of an order for a HBV screening test.

KEY RESULTS: Participants had a mean age of 57 years and were 64% female, 80% foreign-born, and 44% with limited English fluency. At post-visit, over 80% of intervention participants reported they liked using the Hepatitis App. At 3-month follow-up, the intervention group was more likely than the comparison group (all $P < 0.001$) to have discussed HBV with their provider (70% vs. 16%), have a HBV test ordered (44% vs. 10%), and receive a HBV test (38% vs. 8%). In multivariable analyses, the intervention odds ratio for HBV test ordering was 7.6 (95% CI: 3.9, 14.8) and test receipt was 7.5 (95% CI: 3.6, 15.5).

Prior Presentations This manuscript has not been previously published or presented elsewhere.

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CONCLUSIONS: A multi-lingual educational intervention using a mobile application in primary care clinics was well received by Asian American patients, enhanced patient-provider communication about HBV, and increased HBV screening. Technology can improve healthcare quality among Asian Americans.

TRIAL REGISTRATION: ClinicalTrials.gov NCT02139722 (<https://clinicaltrials.gov/ct2/show/NCT02139722>).

KEY WORDS: Viral hepatitis; Primary care; Mobile technology; Healthcare disparities; Language.

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About 250 million worldwide¹ and 0.84 million US adults² have chronic hepatitis B (HBV) infection. HBV screening is recommended in at-risk individuals, including those from endemic regions such as Asia.^{3,4} In 2016, the National Academy of Medicine noted that addressing patient-, provider-, and system-level barriers to HBV screening is needed.^{5,6} Moreover, the World Health Organization (WHO) announced a global strategy for HBV elimination by 2030 and highlighted rapid scaling up of HBV testing and treatment as critical to meeting this WHO HBV elimination goal.⁷

In the USA, among all racial groups, Asian Americans have the highest chronic HBV prevalence, at 3.85% and 0.79% for foreign-born and US-born Asians, respectively.² Importantly, reported HBV awareness is low at 15–32%.^{2,8} Certain Asian subgroups, including Chinese and Vietnamese Americans, have even higher rates of HBV ranging from 5.6 to 17%.^{9–14} Chronic HBV is a risk factor for liver cancer, and thus, foreign-born Asian Americans are twice as likely as non-Hispanic Whites to die from liver cancer.¹⁵ HBV screening

and treatment are cost-effective,^{16,17} but despite community campaigns to increase screening,^{18–20} screening rates among Asian Americans remain suboptimal.^{21–24} Patient, provider, and practice factors have contributed to suboptimal rates of hepatitis B screening in primary care settings.^{21,25,26} We showed previously that the most common barriers to HBV screening among primary care providers (PCP) across diverse settings were lack of clarity of screening guidelines, uncertainty and unawareness of guidelines, and patient financial barriers.^{25,26} Additional factors influencing HBV screening among Asian Americans in the primary care setting include patient gender, favorable provider attitudes toward screening, patient-provider Asian language concordance, number of patients seen in clinic, proportion of Asian patients in the practice, and whether providers offer hepatitis B treatment in practice.^{21,25}

There are limited intervention studies on HBV screening among Asian Americans in clinical settings.²⁷ In our “Health Within Reach” study, we aimed to evaluate whether a mobile application delivering an interactive multi-lingual video patient education in the primary care setting increases HBV testing among Asian Americans.

METHODS

Study Design

A cluster-randomized clinical trial design was used to evaluate the efficacy of a mobile application (Hepatitis App) consisting of interactive video education combined with a printout (Provider Alert) and a Provider Panel Notification [intervention] compared to a Provider Panel Notification alone with a mobile application on nutrition and physical activity [comparison] to promote HBV screening. The study also assessed the intervention effect of the Hepatitis App and Provider Alert versus usual care for hepatitis C screening (data not shown). Participating PCPs, stratified by healthcare system (academic or safety net) and provider type (attending physician, resident, or nurse practitioner), were randomized to the intervention or comparison arm in a 1:1 ratio within each stratum using a computer-generated random number table.²⁸ Eligible enrolled patients received the intervention assigned to their PCP (cluster) (Fig. 1). Investigators who participated in the data analysis and interpretation were blinded to participant and provider assignments. The study was approved by the University of California San Francisco (UCSF) Institutional Review Board and registered at ClinicalTrials.gov (NCT02139722).

Participants and Settings

The study was conducted from January 2015 to December 2017 in 5 primary care clinics at the UCSF Medical Center, an academic medical center, and Zuckerberg San Francisco General Hospital (ZSFG), a safety net hospital. PCPs were aged 18 or older, had an MD or NP degree, and employed and

designated as a PCP by the health system. Participants self-identified as Asian, Chinese, or Vietnamese American; were aged 18 or older; had no HBV screening test (hepatitis B surface antigen [HBsAg]) in the electronic health record (EHR) lab section; were an Asian immigrant or a child of one; spoke English, Cantonese, Mandarin, or Vietnamese; and had an upcoming PCP appointment at one of the clinics. Patients whose PCP excluded them due to medically related reasons or inability to provide consent due to cognitive or other health reasons were ineligible.

Recruitment

Eligible PCPs received up to 3 e-mails over 2 months describing the study as a way to improve health education and viral hepatitis screening among Asian Americans. After consent, PCPs were randomized. Providers received \$100 for answering a pre-trial survey and a post-trial survey. Research staff generated a list of eligible patients from the EHR and sent it to the PCP every 6 months. The list served 3 functions: (1) provider exclusion of patients; (2) provider permission to recruit patients; and (3) Provider Panel Notification for HBV testing. Eligible patients received a letter from the PCP describing the study and the option of notifying the research staff if they did not want to be contacted. Research staff then contacted patients who had an upcoming PCP appointment by telephone prior to or in-person at the visit for their interest in study participation. Participants received \$50 for participation.

Intervention

Development of the Intervention (Hepatitis App). Guided by guidelines, the literature, and input from community members, health and social service providers, and community organizations that focus on hepatitis prevention and Asian American health, the research team developed video contents, scripts, and an intervention algorithm. Five focus groups were conducted in 4 languages (English, Cantonese, Mandarin, and Vietnamese) to assess knowledge about HBV, barriers to screening, and responses to a mock-up of the intervention. Focus groups and interviews were also conducted with clinic staff and PCPs to assist in the design of the intervention and its delivery to fit with clinic flow.

The team worked with the UCSF Information System Unit to build the intervention as an iOS App for the iPad. The intervention included branching logics integrating a brief assessment, data storage, in-language video messages from a Video Doctor according to patients' responses, and a summary printout (Provider Alert) to be given to the PCP. The program assessed HBV screening barriers about fatalism, stigma, and competing medical priorities. The scripts responding to these questions incorporated focus group and interview findings and were developed in English and then translated to the Asian language, with review by two bilingual staff. The Video Doctor was played by an Asian male physician (English),

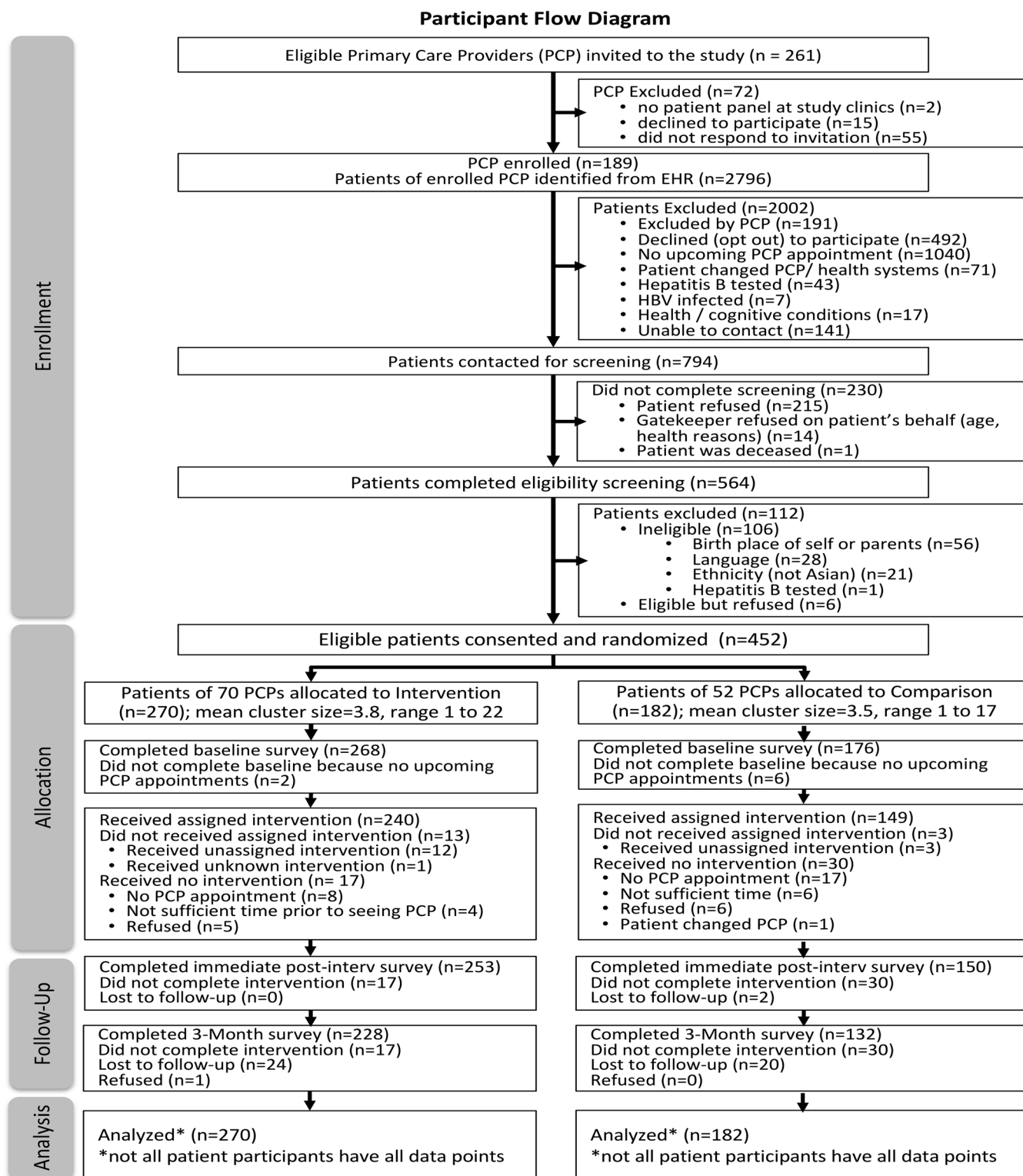


Fig. 1 Consort flow diagram.

Asian female PhDs (Chinese), and an Asian female actress (Vietnamese).

Intervention Group. Participating providers received a list of eligible patients every 6 months (Provider Panel Notification). On the day of the PCP clinic visit, prior to their appointment

time, participating patients received the Hepatitis App, which consisted of brief interactive patient education videos delivered via a tablet computer, and a summary printout (Provider Alert) to be given to the PCP. Participants watched a collection of video clips simulating a conversation with a provider (Video Doctor), individually tailored to their answers about

sociodemographics, HBV, and beliefs about/barriers to hepatitis screening in their preferred language (English, Cantonese, Mandarin, or Vietnamese). All participants received a message from the Video Doctor to ask their provider for HBV screening. Those who expressed hesitation about screening would get a message to discuss the test with the provider. A participant could watch up to 10 video clips (30–90 s each) lasting a total of 8–10 min. The Hepatitis App produced two copies of a printout (Provider Alert), which included a participant section (description of the participant's self-reported HBV screening status and risk factors, a message stating they may be at risk for HBV, a recommendation to discuss and ask for screening, and the topics reviewed during the intervention) and a provider section (description of the participant's self-reported screening status, recommended screening tests, US Preventive Services Task Force recommendation on hepatitis screening, and a list of hepatitis risk factors). Participants were instructed to give the printout to their provider at their clinic visit.

Comparison Group. Providers received a list of eligible patients every 6 months (Provider Panel Notification). On the day of the PCP clinic visit, prior to the appointment, comparison participants received a tablet-delivered video education focused on healthy weight, healthy nutrition, and physical activity in their preferred language. Participants received a printout, which summarized the topics presented, the participant's self-reported weight, and healthy weight range computed based on self-reported height and a body mass index of 18.5–22.9 kg/m² as recommended for Asian Americans.²⁹ Participants were instructed to give the printout to their provider during their visit. The printout suggested providers advise participants of their healthy weight range and discuss appropriate nutrition and physical activity recommendations based on Centers for Disease Control and Prevention guidelines.

Data Collection

Participant Measures. Participants completed surveys pre-intervention, post-visit, and 3 months post-intervention. Age, sex, and comorbid medical conditions were obtained from the EHR. The surveys assessed demographics, language preference and fluency, a Single-Item Literacy Screener^{30,31} for health literacy, and need for medical interpretation. Perceived general health, family history of hepatitis or liver cancer, and HBV were assessed. At pre-intervention and 3 months, participants self-reported HBV testing, intention to obtain screening in 6 months, knowledge (ever heard of HBV, modes of transmission), and self-efficacy (comfort level in asking providers for a test). At 3 months, we asked about perceived risk of liver cancer, HBV, perceived severity; perceived benefits of screening (early detection of HBV screening helped to prevent spreading); barriers to screening (fatalism, fear of blood draws, stigma or anxiety associated with diagnosis); and social support for screening. Participants had the choice of skipping questions if they felt uncomfortable.

Outcomes. We assessed two primary outcomes: (1) patient-provider discussion about HBV and (2) EHR documentation of a hepatitis B surface antigen (HBsAg) test done within 3 months post-intervention. Pre-intervention, all participants were asked if they had ever asked a PCP to test them for hepatitis. At post-visit and 3 months, participants were asked if they had asked a PCP for HBV testing, discussed screening with their PCP, and whether their PCP recommended screening. The secondary outcome was EHR documentation of an order for a HBV screening test.

Intervention Feedback. At post-visit, patients were asked how much they liked or disliked the Hepatitis App and how helpful the printout was. They were also asked if they gave the printout to their provider and helpfulness of the printout in talking with the provider.

Sample Size Calculation

We performed sample size calculations to test our primary hypothesis at $\alpha = 0.05$ significance level (2-sided) and 80% power, for the primary outcome of getting an HBsAg test within 3 months post-intervention. Based on a pilot study,³² we assumed an intraclass correlation of 0.14. With 450 patients, we would be able to detect a 20% difference between intervention and comparison groups.

Statistical Analysis

Statistical analyses were performed using SAS (version 9.4; SAS Institute, Cary, NC, USA). We calculated descriptive statistics including frequency distribution, means, and standard deviation as appropriate for the subgroups and time points. Analyses were conducted using an intent-to-treat approach, including all randomized providers and their participants, regardless of participation in treatment. PCP clusters were accounted for in bivariate and multivariate analyses. For the bivariate analyses of the differences between intervention and comparison groups within each time period (pre-intervention or 3 months), we used generalized linear mixed models that control for correlations in outcomes associated with the clustering of patients within providers and accommodate normally and non-normally distributed data. Dichotomous indicators were analyzed using a logistic model with a logit link. Using generalized linear mixed-effects models to test our primary hypotheses, we then constructed multivariate regression models. The HBV models were adjusted for provider clusters. Odds ratio with 95% confidence intervals is reported. For the bivariate comparisons of provider data at the pre-intervention time point, the intervention and comparison groups were compared using chi-square tests for categorical data and Student's *t*-tests for continuous data. We used linear models to test the hypotheses of significant differences in the change from pre- to post-intervention between the groups. A significance level of 0.05 was used for all statistical tests.

RESULTS

Participants

Table 1 shows the sociodemographic and health characteristics of the 452 enrolled patients, with mean age of 57 years, 64% female, 47% married, and 61% with some college education. Most (80%) were foreign-born, with a majority speaking English well or fluently. Only 18% reported ever asking a doctor for a hepatitis test. About one-third reported an annual household income less than \$20,000. There were no significant differences in these characteristics between the intervention and comparison groups.

Among all participants, baseline hepatitis-related risk factors included surgery outside of the USA (19%), having worked in a hospital or as a healthcare worker (21.5%), receiving acupuncture (33%), having tattoos or ear piercing (33%), and having multiple sexual partners (23%). Only 8.9% reported history of a blood transfusion, 9.5% having lived with someone with hepatitis or liver cancer, 0.7% an exposure to injection drug use, and 3.5% an exposure to intranasal drug use. There were no significant differences between intervention and comparison groups.

Hepatitis Knowledge, Barriers, and Self-Reported Behaviors

Table 2 shows the hepatitis-related knowledge, barriers, and self-reported behaviors assessed via the baseline and

3 months post-intervention surveys. Awareness and knowledge about HBV transmission increased in both groups, but only awareness was significantly different between the two groups at 3 months post-intervention ($P=0.02$). A higher proportion of intervention participants strongly agreed that they felt more comfortable asking their provider for a hepatitis test (45% vs. 33% comparison group). Intervention participants were more likely to report a significant increase in ever receiving a hepatitis blood test at 3 months post-intervention (72% intervention vs. 44% comparison at 3 months; $P<0.001$; $P<0.001$ for pre-post comparison).

Patient-Provider Discussion About HBV and Receipt of HBV Screening

Table 3 shows that the intervention group was much more likely than the comparison group to report having discussed HBV with their provider, asked their provider for a HBV test, and had the provider recommend a HBV test. At 3 months post-intervention, the intervention group was more likely to have had a HBV test ordered (44% vs. 10%, $P<0.001$) and done (38% vs. 8%, $P<0.001$) in the EHR.

Multivariable models showed that the intervention group was much more likely to have discussed HBV than the comparison group (odds ratio [OR] 8.33; 95% confidence interval [CI]: 4.08, 17.01). The intervention was effective in EHR-documented HBV test order (OR 7.60; CI: 3.91, 14.79) and

Table 1 Baseline Characteristics of Participants Enrolled in the Randomized Clinical Trial

	Total N=452	Comparison n=182	Intervention n=270	P-value*
Site, academic (%)	271 (60.0)	109 (59.9)	162 (60.0)	0.99
Age (mean $\pm$ SD)	56.8 $\pm$ 16.8	55.8 $\pm$ 17.0	57.5 $\pm$ 16.8	0.45
Sex, female (%)	289 (64.0)	127 (69.8)	162 (60.0)	0.07
Marital status, married (%)	213 (47.1)	79 (43.4)	134 (49.6)	0.56
Education (%)				
Less than high school	50 (11.1)	14 (7.8)	36 (13.3)	0.49
Completed high school	78 (17.3)	29 (16.1)	49 (18.2)	
College or higher	276 (61.1)	107 (58.8)	169 (62.6)	
Others/missing	48 (10.6)	32 (17.6)	16 (5.9)	
Employment, employed (%)	167 (37.0)	61 (33.5)	106 (39.3)	0.28
Foreign-born, %	79.7	77.5	81.1	0.61
Years in the USA, 20 years or more (%)	316 (74.1)	117 (64.3)	199 (78.4)	0.46
Language (%)				
English	311 (68.8)	134 (73.6)	177 (65.6)	0.19
Cantonese	88 (19.5)	28 (15.4)	60 (22.2)	
Mandarin	33 (7.3)	16 (8.8)	17 (6.3)	
Vietnamese	20 (4.4)	4 (2.2)	16 (5.9)	
Spoken English fluency, fluent or well (%)	254 (56.2)	101 (55.5)	153 (56.7)	0.78
Need a translator at doctor's office (%)	105 (23.2)	39 (21.4)	66 (24.4)	0.59
Need help to read material from doctor, always/often/sometimes (%)	134 (29.7)	51 (28.0)	83 (30.7)	0.76
Self-reported health, excellent/very good (%)	124 (27.4)	45 (24.7)	79 (29.3)	0.56
Family has hepatitis or liver cancer (%)	57 (12.6)	21 (11.5)	36 (13.3)	0.55
Ever asked doctor to get hepatitis B or C test (%)	81 (17.9)	31 (17.0)	50 (18.5)	0.66
Annual household income (%)				
Less than \$10,000	65 (14.4)	22 (12.1)	43 (15.9)	0.96
\$10–20,000	72 (15.9)	30 (16.5)	42 (15.6)	
\$20–50,000	69 (15.3)	25 (13.7)	44 (16.3)	
\$50,000–\$100,000	66 (14.6)	24 (13.2)	42 (15.6)	
More than \$100,000	85 (18.8)	33 (18.1)	52 (19.3)	
Don't know	34 (7.5)	12 (6.6)	22 (8.2)	
Missing	61 (13.5)	36 (19.8)	25 (9.3)	

*P-value for comparison vs. intervention group controlled for provider clusters

Table 2 Hepatitis Knowledge, Barriers, and Self-Reported Behaviors at Baseline and 3 Months Post-intervention

	Baseline				3 months post-intervention				Post-pre
	Total N = 452	Comparison n = 182	Intervention n = 270	P-value*	Total N = 360	Comparison n = 132	Intervention n = 228	P-value*	P-value
Ever heard of hepatitis B (%)									
Yes	336 (74.3)	130 (71.4)	206 (76.3)	0.62	312 (86.7)	106 (80.3)	206 (90.4)	0.02	0.13
No	90 (19.9)	37 (20.3)	53 (19.6)		44 (12.2)	24 (18.2)	20 (8.8)		
Don't know	16 (3.4)	8 (4.4)	8 (3.0)		4 (1.1)	2 (1.5)	2 (0.9)		
Missing	10 (2.2)	7 (3.9)	3 (1.1)		0 (0.0)	0 (0.0)	0 (0.0)		
Hepatitis B or C transmitted by sharing food, drink, or eating utensils (%)									
Yes	174 (38.5)	63 (34.6)	111 (41.1)	0.16	176 (48.9)	66 (50.0)	110 (48.3)	0.72	0.24
No (correct)	131 (29.0)	59 (32.4)	72 (26.7)		127 (35.3)	45 (34.1)	82 (36.0)		
Don't know	134 (29.7)	51 (28.0)	83 (30.7)		57 (15.8)	21 (15.9)	36 (15.8)		
Missing	13 (2.9)	9 (5.0)	4 (1.5)		0 (0.0)	0 (0.0)	0 (0.0)		
Hepatitis B or C transmitted from mother to baby during childbirth (%)									
Yes (correct)	222 (49.1)	88 (48.4)	134 (49.6)	0.77	269 (74.7)	95 (72.0)	174 (76.3)	0.36	0.57
No	50 (11.1)	9 (10.4)	31 (11.5)		16 (4.4)	7 (5.3)	9 (4.0)		
Don't know	167 (37.0)	67 (36.8)	100 (37.0)		74 (20.6)	29 (22.0)	45 (19.7)		
Missing	13 (2.9)	8 (4.4)	5 (1.9)		1 (0.3)	1 (0.8)	0 (0.0)		
Concerned about blood draw for hepatitis test (%)									
Very concerned	42 (9.3)	17 (9.3)	25 (9.3)	0.50	39 (10.8)	18 (13.6)	21 (9.2)	0.08	0.90
Somewhat concerned	72 (15.9)	32 (17.6)	40 (14.8)		75 (20.8)	30 (22.7)	45 (19.7)		
Not at all concerned	277 (61.3)	96 (52.8)	181 (67.0)		229 (63.6)	79 (59.9)	150 (65.8)		
Don't know	14 (3.1)	6 (3.3)	8 (3.0)		15 (4.2)	5 (3.8)	10 (4.4)		
Missing	47 (10.4)	31 (17.0)	16 (5.9)		2 (0.6)	0 (0.0)	2 (0.9)		
Afraid of finding out that respondent had hepatitis (%)									
Very afraid	50 (11.1)	26 (14.3)	24 (8.9)	0.03	52 (14.4)	22 (16.7)	30 (13.2)	0.79	0.51
Somewhat afraid	98 (21.7)	27 (14.8)	71 (26.3)		130 (36.1)	43 (32.6)	87 (38.2)		
Not at all afraid	232 (51.3)	88 (48.4)	144 (53.3)		160 (44.4)	59 (44.7)	101 (44.3)		
Don't know	26 (5.8)	10 (5.5)	16 (5.9)		17 (4.7)	8 (6.1)	9 (4.0)		
Missing	46 (10.2)	31 (17.0)	15 (5.6)		1 (0.3)	0 (0.0)	1 (0.4)		
Feel comfortable asking doctor for hepatitis test (%)									
Strongly agree	133 (29.4)	50 (27.5)	83 (30.7)	0.85	146 (40.6)	44 (33.3)	102 (44.7)	0.16	0.38
Agree	241 (53.3)	97 (53.3)	144 (53.3)		178 (49.4)	71 (53.8)	107 (46.9)		
Disagree	28 (6.2)	12 (6.6)	16 (5.9)		20 (5.6)	11 (8.3)	9 (4.0)		
Strongly disagree	10 (2.2)	3 (1.7)	7 (2.6)		7 (1.9)	1 (0.8)	6 (2.6)		
Don't know	26 (5.8)	11 (6.6)	14 (5.2)		9 (2.5)	5 (3.8)	4 (1.8)		
Missing	14 (3.1)	8 (4.4)	6 (2.2)		0 (0)	0 (0)	0 (0)		
Had vaccination for hepatitis B (%)									
Yes	123 (27.2)	42 (23.1)	81 (30.0)	0.08	119 (33.1)	41 (31.1)	78 (34.2)	0.78	0.51
No	191 (42.3)	82 (45.1)	109 (40.4)		155 (43.1)	59 (44.7)	96 (42.1)		
Don't know	93 (20.6)	28 (15.4)	65 (24.1)		80 (22.2)	31 (23.5)	49 (21.5)		
Missing	45 (10.0)	30 (16.5)	15 (5.6)		6 (1.7)	1 (0.8)	5 (2.2)		
Ever had a hepatitis blood test (%)									
Yes	200 (44.3)	77 (42.3)	123 (45.6)	0.68	223 (61.9)	58 (43.9)	165 (72.4)	<0.001	<0.001
No/don't know	252 (55.7)	105 (57.7)	147 (54.4)		137 (38.1)	74 (56.1)	63 (27.6)		
Planning to get a hepatitis blood test in the next 6 months (%)									
Yes	102 (22.6)	41 (22.5)	61 (22.6)	0.88	110 (30.6)	35 (26.5)	75 (32.9)	0.22	0.36
No/don't know	350 (77.4)	141 (77.5)	209 (77.4)		250 (69.4)	97 (73.5)	153 (67.1)		

* P-value for comparison group vs intervention group controlling for provider clusters

receipt (OR 7.49; CI: 3.63, 15.48). These results were independent of certain patient factors, including birthplace (US- vs. foreign-born) (Table 4).

Intervention Feedback

At the post-visit survey, 84% of the intervention group reported that they liked the Hepatitis App either very much or somewhat. Over half (59%) of the participants gave the printout to their providers, with 95% reporting that it was helpful for talking with their provider.

DISCUSSION

To our knowledge, this is the first randomized clinical trial using a multi-lingual tablet application to promote HBV screening among Asian Americans. Our intervention was effective in improving HBV awareness, patient-provider discussion about HBV, and receipt of HBV screening. The majority of intervention participants shared the summary printout following education with their provider and 70% discussed HBV with their provider during their clinic visit. This provides evidence that well-designed, interac-

Table 3 Patient-Provider Discussion About Hepatitis B and Receipt of Hepatitis B Screening, Intention to Treat

Immediate post-visit survey	Total(N=452)	Comparison(n=182)	Intervention(n=270)	P-value*
Discussed hepatitis B with healthcare provider	220 (48.7)	30 (16.5)	190 (70.4)	<0.001
Asked healthcare provider for hepatitis B test	176 (38.9)	17 (9.3)	159 (58.9)	<0.001
Healthcare provider recommended hepatitis B test	162 (35.8)	24 (13.2)	138 (51.1)	<0.001
Electronic health record 3 months post-intervention	Total(N=452)	Comparison(n=182)	Intervention(n=270)	
Hepatitis B surface antigen test ordered	137 (30.3)	18 (9.9)	119 (44.1)	<0.001
Hepatitis B surface antigen test done	116 (25.7)	14 (7.7)	102 (37.8)	<0.001

*P-value for comparison group vs intervention group controlling for provider clusters

tive, and in-language mobile applications can increase patient-centered care and enhance patient-provider communication among Asian American patients, regardless of age or language ability, and can readily be integrated into the primary care setting.

The only prior clinic-based intervention to increase HBV testing among Asian Americans used an EHR prompt and found a screening rate of 34%.³² The HBV screening rate in our comparison group was 8%, which may be due to the Provider Panel Notification or from secular changes, although there were no other HBV-related interventions at the time. The large intervention effect (OR of 7.5 compared to Provider Panel Notification alone) indicates that the Hepatitis App is effective and should be considered a tool to better address viral hepatitis and liver cancer disparities among Asian Americans. This combined patient-provider approach encouraged real-time discussions about HBV to address barriers to testing and can be used as part of a comprehensive approach to improving patient care for Asian American patients.

Prior studies have reported that patients who are older, less educated, or racial minorities have more difficulty using a tablet computer compared to other groups.^{33,34} In our sample, one-third of Asian American patients were 65 years of age and older, four out of five were

immigrants, and about half spoke English well. Nevertheless, the majority of our patients (84%) reported that the Hepatitis App was easy to use, that they liked it very much, and that there was little they would do to change it. The prevalent perception that some populations have trouble using technology may be a result of not using patient-centered design that takes into consideration age, ethnicity, culture, language, and health literacy. It is critical that technology design take these considerations into account in order to avoid the worsening of healthcare disparities.³⁵

Our study has some limitations. The PCPs had relatively small panel sizes (mean 173 patients per panel). The patients were drawn from one geographic area with a large number of racially concordant physicians (30% Asian). However, the study sample reflects the US Asian population; for example, the proportion of Asian Americans aged 25 and older who completed college or higher in the US Census was 55%, similar to our participants [61%].³⁶ It is also possible that HBV screening done outside of their health system was accessible to PCPs and was not documented in the patient's EHR. Nevertheless, the randomized design of our study would have led to a similar distribution of this factor across intervention and comparison groups. Furthermore, it should be noted that this study was an

Table 4 Factor Associated with Hepatitis B Test Ordering and Receipt: Results of Multivariable Models*

	Hepatitis B test ordered(N=452)		Hepatitis B test receipt(N=452)	
	Odds ratio	95% confidence interval	Odds ratio	95% confidence interval
Hepatitis App intervention (ref control)	7.60	3.91, 14.79	7.49	3.63, 15.48
Safety net hospital (ref academic)	0.93	0.48, 1.80	0.82	0.41, 1.63
Age	1.01	0.99, 1.03	1.01	0.98, 1.03
Male (ref female)	0.80	0.49, 1.32	0.70	0.42, 1.17
U.S. birthplace (ref foreign-born)	1.34	0.64, 2.82	1.04	0.50, 2.18
Lived in the U.S. >20 or more years (ref <20 years)	1.25	0.73, 2.13	1.17	0.67, 2.06
College graduate or higher (ref <high school)	0.30	0.14, 0.67	0.50	0.21, 1.19
High school graduate (ref <high school)	0.82	0.44, 1.53	1.09	0.51, 2.35
Other education (ref <high school)	0.06	0.01, 0.99	0.08	0.01, 2.19
Employed (ref not employed)	1.59	0.86, 2.96	1.34	0.72, 2.51
Spoke English very well or fluently (ref <very well)	1.71	0.69, 4.21	1.43	0.57, 3.61
Self-reported health very good or excellent (ref <very good)	1.30	0.82, 2.06	0.97	0.58, 1.61
Annual income \$10–50,000 (ref <\$10,000)	1.99	0.96, 4.16	3.20	1.59, 6.46
Annual income \$50,000 or more (ref <\$10,000)	1.07	0.47, 2.43	1.73	0.75, 4.00
Annual income unknown/missing (ref <\$10,000)	1.30	0.52, 3.22	2.09	0.83, 5.28
Need help reading health materials (ref does not need help)	0.79	0.21, 3.57	0.83	0.22, 3.17
Speaks Mandarin (ref English)	0.86	0.21, 3.57	0.83	0.22, 3.17
Speaks Cantonese (ref English)	1.51	0.57, 3.98	1.46	0.48, 4.45
Speaks Vietnamese (ref English)	1.35	0.41, 4.48	1.53	0.41, 5.73

*Adjusted for provider clusters

efficacy trial and that additional studies are needed in order to evaluate the effectiveness of the intervention in the real-world setting. Even so, the strengths of the study are numerous and include the patient-centered approach, the randomized clinical trial design, and EHR-validated outcomes.

CONCLUSION

A multi-lingual mobile application for patient education was well received by Asian American patients and led to enhanced patient-provider discussion about hepatitis B, increase in ordering of hepatitis B screening tests, and receipt of those tests. Technology designed via a patient-centered approach can be easily used by minority patients, even among older and those with limited English proficiency, to improve the quality of care delivered to Asian Americans.

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Declarations:

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