Jun-Yu Fan, PhD
Tung-Jung Huang, MD, PhD
Sui-Whi Jane, PhD
Mei-Yen Chen, PhD

Prevention of Liver Cancer Through the Early Detection of Risk-Related Behavior Among Hepatitis B or C Carriers

K E Y W O R D S
Health-related behaviors
Hepatitis B carrier
Hepatitis C carrier
Infection

Background: Hepatitis B virus (HBV) and hepatitis C virus (HCV) infections are the leading causes of liver cirrhosis and hepatocellular carcinoma. Little is known about the relationship between health-related behaviors and health status among HBV or HCV carriers. **Objective:** The purpose of this study was to explore the relationship between health status (eg, specific biomarkers) and health-related behaviors (eg, alcohol consumption) in individuals with or without HBV or HCV infection. **Methods:** A cross-sectional descriptive design was used, and a community-based health screening survey was conducted between August 2011 and July 2012 in Taiwan. **Results:** In total, 6 805 community residents 20 years or older participated in the study. The HBV and HCV infection rate was 18.7% and 20.8%, respectively, and HBV/HCV infections were significantly associated with current alcohol use, smoking, and self-medication. Multivariate analysis indicated that HBV/HCV infection, overweight status, higher fasting blood sugar level, higher systolic blood pressure, and 3 unhealthy habits were independent risk factors for abnormal liver function. **Conclusion:** Our findings suggest that both HBV and HCV carriers are more likely to have unhealthy habits and a poor health status. In addition to some factors that cannot be modified, being overweight, drinking alcohol, betel nut chewing, smoking, and self-medication are all risk factors for poor liver health among both hepatitis carriers. **Implications for Practice:** For clinicians, the results could be applied by providing more education to help the

Author Affiliations: Department of Nursing, Chang Gung University of Science and Technology, Chiayi County (Drs Fan and Jane); Department of Internal Medicine, Gung Memorial Hospital (Dr Huang); and College of Nursing, Chang Gung University of Science and Technology, Taoyuan, Taiwan (Dr Chen).

This study was funded by a grant from the Taiwan Formosa Plastic Company (FCRPF 690011).

The authors have no conflicts of interest to disclose.

Correspondence: Mei-Yen Chen, PhD, College of Nursing, Chang Gung University of Science and Technology, 261 Wen-Hwa 1st Road, Kweishan, Taoyuan, Taiwan, ROC 33333 (meiyen@gw.cgust.edu.tw).

Accepted for publication February 28, 2014.
DOI: 10.1097/NCC.0000000000000153

community better understand the relationships between specific risk factors and liver health, encouraging hepatitis carriers in rural areas to undergo annual physical check-ups.

Liver cancer is 1 of the most common cancers worldwide, particularly in Asia.[1] According to the Taiwan health report,[2,3] cancer is a leading cause of death, with a standardized mortality rate of 131 in 100 000, and on the basis of *International Classification of Diseases, 10th Edition,* data, liver cirrhosis and hepatocellular carcinoma (HCC) are the second most common causes of cancer-related death in Taiwan, accounting for 34.9 deaths per 100 000 persons.[3] Evidence indicates that hepatitis B virus (HBV) and hepatitis C virus (HCV) infections are the leading causes of liver cirrhosis and HCC, and an estimated 620 000 persons die annually from hepatitis virus-related liver disease.[1,4] Hepatitis B virus and HCV infections and their sequelae remain a major health problem affecting billions of people globally.[1,7] The mechanism by which hepatitis virus infection leads to liver cancer might involve the chronic inflammation caused by the former. Chronic HBV infection is present in approximately 60% to 90% of adult HCC cases and nearly 100% of childhood HCC cases in areas endemic for HBV infection.[5] Taiwan has been an HBV-endemic area, and, previously, as many as 15% to 20% of the adult population were chronic HBV carriers, compared with only 0.5% in North America.[6] However, its prevalence declined to 9.6% in 2007 after 20 years of a large-scale vaccination program.[6] The prevalence of infection is greater in rural areas; for example, the crude death rate in Yunlin County is 84 of 100 000 men and 20 of 10^5 women, which is higher than that in most cities in Taiwan.[6]

In recent decades, the nursing profession has improved the quality of liver-related cancer care in clinics. However, little has been done to enhance cancer prevention strategies among HBV or HCV carriers in rural areas and only a few studies have explored the relationships between health-related behavior and health status among these individuals.

Hepatitis B virus infection occurs mainly during early childhood, and mother-to-infant transmission accounts for approximately 50% of chronic infection cases. Conversely, the incidence of mother-to-infant HCV transmission is less than 5%.[6] Most HCV infection is transmitted through contact with the blood of an infected person or with contaminated materials.[1] The first evidence of cancer prevention by vaccination in humans emerged from a history of HBV vaccination in infants.[1,5] The world's first nationwide HBV universal vaccination program for infants was launched in Taiwan in July 1984.[5,8,9] Three doses of HBV vaccine were given to all infants starting from the first week of life. Encouragingly, long-term studies have demonstrated that after the mass HBV vaccination program was implemented, the incidence of HBV infection declined significantly.[10–12]

Although the number of newly acquired HBV infections has declined substantially since the implementation of this national immunization program, the prevalence of chronic HBV and HCV infection remains high in some disadvantaged areas.[11] There is still no vaccination to prevent HCV infection or to treat HCV carriers. Hepatitis C virus infection causes chronic hepatitis in 70% to 80% of cases, 20% of which develop into liver cirrhosis, and a further 5% develop into HCC.[10] Hepatitis C virus is spread primarily by blood-to-blood contact associated with intravenous drug use, poorly sterilized medical equipment, and transfusions. Therefore, with the increasing prevalence of drug abuse and tattoos among young adults and an increasing need for dialysis in adult patients, preventing HCV infection is becoming even more important.[10] A previous study indicated that both overall and nonalcoholic liver disease–related morbidity in hospitals is considerably higher among patients infected with HCV compared with those infected with HBV.[13] In Taiwan, the prevalence of HBV and HCV infection is 15% to 20% and 2% to 3%, respectively. An estimated 2.5 million to 3.0 million people are HBV carriers, and 60% to 90% of them are at risk of liver cirrhosis and HCC. Correspondingly, almost 90% of HCC patients were found to be infected with HBV.[5,10]

Although there is currently no vaccine for HCV, there is evidence that some antiviral drug treatments are effective, reducing the incidence of hepatic cancer by 78% and liver cirrhosis by 47%.[1] However, many adults still get chronic virus infections because there is limited information on and limited availability of efficient treatments for HBV and HCV carriers, especially in disadvantaged areas. Although it has been found that many HBV and HCV carriers remain healthy (inactive carriers), others go on to have liver cancer. Why only some infected individuals go on to develop HCC and what the underlying mechanism for this is remain unclear. It also remains to be determined whether specific health-related behaviors are a risk factor for these individuals.

Many studies have demonstrated that HCC is associated not only with HBV or HCV infection but also with former or current smoking, obesity, and heavy alcohol intake.[14–16] Previous findings have indicated that HBV and HCV carriers should undertake at least 5 important health-related checks and modifications[1,15,17,18]; regular monitoring (eg, every 3–6 months) for the early diagnosis of chronic liver disease; adopting appropriate therapies and avoiding self-medication; and avoiding the overuse of alcohol, betel nuts, and tobacco.[10,15] Medical experts in Taiwan have drawn attention to the fact that certain behaviors considered to be unhealthy, such as consuming alcohol, chewing betel nuts, and smoking, appear to have negative effects on liver function and liver health, as indicated by evaluations including serum glutamate-pyruvate transaminase (SGPT), serum glutamic oxaloacetic transaminase (SGOT), and gamma-glutamyl transpeptidace.[19,20] It has also been shown that obesity has a negative impact on liver function, which likewise results in, for example, increasing SGPT and SGOT.[6] A more sedentary lifestyle is a risk factor for obesity, and obesity, in turn, can increase fasting glucose levels and negatively affect an individual's general health.[21]

■ Conceptual Framework

The conceptual framework for this study was based on part of the Health Belief Model (HBM), concepts of health promotion, and on previous studies of liver cancer prevention. The HBM was originally proposed by Rosenstock and was subsequently modified by Becker.[22] It has been used to predict protective health behaviors, such as screening or vaccination uptake and compliance with medical advice.[23] The HBM is based on the assumption that an individual's preventive health behaviors are modified by his/her beliefs as to the severity of the disease, his/her demographic characteristics, and cues to action. The model suggests that whether people change their behavior will be influenced by an evaluation of its feasibility and benefits weighed against the costs. The World Health Organization defined health promotion, in part, as enabling people to gain control over their lives. Based on the previously identified factors associated with liver function,[24] many predictors of poor liver function have been identified. These include sociodemographics such as gender, age, economic status, and education. Biological and personal factors included viral infection, blood pressure, alcohol consumption, betel nut chewing, smoking, obesity, and self-care behaviors.[10,15,19,20] On the basis of these concepts, we assumed that individual perceptions of the barriers and facilitators to having regular check-ups were associated with health-related behaviors. In addition, unhealthy habits, a sedentary lifestyle, and hepatitis infection could be important risk factors associated with liver health. Therefore, we designed this study to evaluate the relationship between health status (as measured, eg, by using biomarkers) and health-related behaviors (eg, alcohol consumption, chewing betel nuts and smoking) in individuals with or without HBV or HCV infection.

■ Methods

Study Population and Design

This work was part of a longitudinal study of health promotion for community health development led by community health nursing faculties around areas of endemic liver and oral cancer in Yunlin County, which is a coastal region of southwestern Taiwan. A cross-sectional descriptive design and community-based health screening survey was conducted between August 2011 and July 2012. The survey participants were selected by convenience samples from the southwestern coastal area. The inclusion criteria for this project were that subjects should be (1) 20 years or older, (2) fully independent in managing daily life, (3) able to complete the questionnaire in Mandarin or Taiwanese dialects either by self-administration or at interview and not have any serious learning difficulty, (4) able to walk to the community hospital, and (5) able to provide signed, informed consent before being enrolled in the study. Exclusion criteria were (1) a serious learning difficulty and (2) inability to answer questionnaires. In total, 6805 participants enrolled for the full statistical analysis.

Procedures and Ethical Considerations

This study was approved by the institutional review board of Chang Gung Memorial Hospital Ethics Committee No. 100-3726-B. The purpose of the health screening survey was explained to all invited participants, as was the need to fast from midnight on the day of the assessment. Subjects were recruited by district leaders from 27 rural villages. The interview was conducted after informed consent had been obtained. All participants were interviewed in a local contract hospital that participated in health screening before the blood sample was taken and the patient was examined by a physician.

Less than 10% of the data were collected using a self-administered questionnaire, and the rest were obtained through interviews conducted by 12 research assistants. Research staff read the questions in Taiwanese or Mandarin to participants who were unable to read the questions themselves. To check for possible measurement error, the research assistants were separated into 6 pairs before the start of the project and were asked to interview an elder in the community activity center, which allowed us to confirm a 90% correct response rate of interrater reliability among these 6 pairs. There are 22 self-report items in the health survey, and it took each participant 10 to 15 minutes to complete the questionnaire. To make the questionnaire easy to understand, most of the behaviors were recorded as 1 response from 2 or 3 categories.

Data Collection

HEALTH STATUS

Health status was measured using biomarkers of liver function, biochemical and physiological tests, and self-reported health parameters among adults with or without HBV or HCV infection.

1. Specific biomarkers of liver function, including detection of HBV and HCV and SGPT (normal liver function defined by SGPT <40 mU/mL), were recorded in the medical record of each subject by the hospital during the physical examination (PE). The presence of hepatitis B surface antigen and antibody against HCV in serum samples were determined using enzyme-linked immunoassays.
2. General biochemistry and physiological parameters. These included (*a*) fasting blood glucose (normal range, <110 mg/dL), (*b*) systolic and diastolic blood pressure measured on-site by standard procedures during the study (normal range, <140/90 mm Hg), and (*c*) body mass index (BMI), calculated using the standard formula (weight in kilograms divided by square of the height in meters). According to the nationwide standard set by MOHW,[3] participants with BMI greater than 24 kg/m^2 and those with BMI greater than 27 kg/m^2 were classified as being overweight and obese, respectively.
3. Self-report of health status. Participants were asked to self-rate using a scale of 1 of 4 their response to the question "How do you feel about your health compared with your friends? Feel good/feel ok (so-so)/don't feel good/feel bad." These 4 levels of self-perception of health status were recorded as 3 categories: feel good, feel fair, and feel bad.

HEALTH-RELATED BEHAVIORS

Six habits, including alcohol consumption, betel nut chewing, smoking, taking regular exercise, undergoing an annual PE check-up, and self-medication, were examined. The responses were collected during a standardized personal interview according to a structured questionnaire. Regarding the 3 current behaviors of alcohol use, betel nut chewing, and smoking, participants were classified as being in the "less consumption" category if they had never consumed alcohol or had not consumed it for 1 year or the "regular consumption" category if they were currently consuming alcohol. Regarding regular exercise, participants were classified as being in the "not often" category if their answer was never or sometimes or the "often" category if they usually exercised for more than 30 minutes per day, 3 times per week, or 150 minutes per week. The participants were asked "during the past 5 years, have you undergone an annual PE check-up at any health agency or hospital" and "do you buy drugs or medication for your health without medical prescription?"

DEMOGRAPHICS

Participants' characteristics were obtained through structured questions relating to age (year of birth), gender, economic status (3 levels categorized as good, fair/not bad, and poor/bad), and educational attainment (years of education received or school level graduated).

Statistical Analysis

SPSS (version 17.0) was used for data analyses. All tests were 2 sided, and P values <.05 were considered statistically significant. The demographics and health-related behaviors of the participants were summarized using descriptive statistics. To compare demographics, health status, or health-related behaviors between individuals with and individuals without HBV or HCV infection, the χ^2 statistic for testing equality of proportions or rates was used. As discussed in the "Conceptual Framework" section, a biomarker of liver function (SGPT) was chosen as an outcome variable of health status to investigate the factors associated with health-related behaviors and demographics among individuals with or without HBV or HCV infection. Multivariate regression was used to analyze the determinant factors associated with liver function that were chosen on the basis of likely and relevant confounders after univariate analysis.

■ Results

Participant Characteristics and Health-Related Behaviors

Of the 7495 community residents who participated in this project, 6805 completed most of the PE items at the local hospital and were older than 20 years. The mean (SD) age of the study cohort was 49.8 (16.4) years (range, 20–95 years). Most of the participants (3836; 56.4%) were women, and nearly half (49.9%) were not educated past middle and high school level. Many of the subjects were infected with HBV (1265, 18.7%) or HCV (1372, 20.8%). Among the HBV carriers, 28.9% (365) reported that they were current alcohol drinkers, 14.2% (179) were betel nut chewers, and 21.8% (276) were smokers. Among the HCV carriers, 14.7% (202), 9.5% (130), and 14.6% (200) were current drinkers, betel nut chewers, and smokers, respectively. Around half (56.1%) of HBV and 57.3% of HCV carriers did not exercise regularly, and 75.6% of HBV and 75.1% of HCV carriers had not undergone annual physical check-ups during the previous 5 years. Twenty-three percent of HCV and 13.4% of HBV carriers reported that they had self-medicated over the previous year (Table 1).

There was a high proportion of HBV carriers among men (χ^2 = 26.6, P < .001) and of HCV carriers among women (χ^2 = 8.6, P < .01). Carriers of HBV tended to be younger than 65 years (χ^2 = 26.1, P < .001), to have received less education (χ^2 = 17.7, P < .001), and to be more likely to currently consume alcohol (χ^2 = 14.8, P < .001), chew betel nuts (χ^2 = 21.5, P < .001), and smoke (χ^2 = 17.6, P < .001) than the HBV-negative group (Table 1). Carriers of HCV were significantly more likely to be older (χ^2 = 933.5, P < .001), have a lower educational level (χ^2 = 803.8, P < .001), be in economic difficulties (χ^2 = 168.1, P < .001), and be self-medicating (χ^2 = 46.5, P < .001) than the HCV-negative group. Carriers of HCV tended to have lower incidences of alcohol consumption (χ^2 = 92.7, P < .001) and smoking habits (χ^2 = 12.2, P < .001) than the HCV-negative group.

Health Status Among Individuals With or Without HBV or HCV Infection

Levels of the specific biomarker of liver function, SGPT, were significantly higher in HBV (χ^2 = 24.7, P < .001) and HCV (χ^2 = 388.4, P < .001) carriers than in the noncarrier groups. Carriers of HCV also showed a significant tendency to self-report their health status as "feel bad" (χ^2 = 167.6, P < .001) (Table 2). The proportions of individuals either overweight or obese were 53% among HBV carriers and 62% among HCV carriers, significantly higher than in the HCV-negative group (χ^2 = 38.8, P < .001). Carriers of HCV had significantly higher systolic blood pressure (χ^2 = 205.2, P < .001), diastolic blood pressure (χ^2 = 25.8, P < .001), and fasting blood sugar levels (χ^2 = 145.4, P < .001) than the HCV-negative group did. There were similar differences in systolic blood pressure, diastolic blood pressure, and fasting blood sugar levels between HBV-positive and HBV-negative participants.

Determinant Factors Associated With Health Status

Multivariate regression analysis (Table 3) demonstrated that the determinant risk factors of poor liver function were HCV infection (β = .22, P < .001), HBV infection (β = .09, P < .001), being overweight (β = .14, P < .001), fasting blood sugar levels greater than 110 mg/dL (β = .06, P < .001), systolic blood pressure greater than 140 mm Hg (β = .06, P < .001), smoking (β = .05, P < .01), betel nut chewing (β = .04, P < .01), and alcohol consumption (β = .04, P < .01) after adjusting for other potential

Table 1 • Characteristics and Health-Related Behavior of Study Participants With or Without Hepatitis B or C Infection (n = 6805)

Variable	Hepatitis B Infection Negative		Hepatitis B Infection Positive	Hepatitis C Infection Negative		Hepatitis C Infection Positive
Gender		χ^2 = 26.6[a]			χ^2 = 8.6[b]	
Female	3205 (57.9)		631 (49.9)	2902 (55.3)		820 (59.8)
Male	2335 (42.1)		634 (50.1)	2341 (44.7)		552 (40.2)
Age, y		χ^2 = 26.1[a]			χ^2 = 933.5[a]	
20–39	1951 (35.2)		428 (33.8)	2225 (42.4)		79 (5.7)
40–64	2330 (42.1)		619 (48.9)	2222 (42.4)		647 (47.2)
≥65	1259 (22.7)		218 (17.2)	796 (15.2)		646 (47.1)
Education		χ^2 = 17.7[a]			χ^2 = 803.8[a]	
≤Primary	2811 (50.7)		587 (46.4)	2153 (41.1)		1145 (83.5)
Middle-high	1586 (28.6)		438 (34.6)	1785 (34.0)		189 (13.8)
≥College	1143 (20.6)		240 (19.0)	1305 (24.9)		38 (2.8)
Economic status		χ^2 = 0.7			χ^2 = 168.1[a]	
Good	98 (1.8)		19 (1.5)	99 (1.9)		15 (1.1)
Average	3934 (71.0)		910 (71.9)	3920 (74.8)		798 (58.2)
Difficult/bad	1508 (27.2)		336 (26.6)	1224 (23.3)		559 (40.7)
Alcohol use		χ^2 = 14.8[a]			χ^2 = 92.7[a]	
Current drinkers	1312 (23.7)		365 (28.9)	1432 (27.3)		202 (14.7)
Nondrinkers	4228 (76.3)		900 (71.1)	3811 (72.7)		1170 (85.3)
Betel nut habit		χ^2 = 21.5[a]			χ^2 = 2.5	
Current users	538 (9.7)		179 (14.2)	574 (10.9)		130 (9.5)
Nonusers	5002 (90.3)		1086 (85.8)	4669 (89.1)		1242 (90.5)
Smoking habit		χ^2 = 17.6[a]			χ^2 = 12.2[a]	
Current smokers	932 (16.8)		276 (21.8)	977 (18.6)		200 (14.6)
Nonsmokers	4608 (83.2)		989 (78.2)	4266 (81.4)		1172 (85.4)
Regular exercise		χ^2 = 4.8			χ^2 = 1.1	
Yes	2440 (44.0)		555 (43.9)	2325 (44.3)		586 (42.7)
No	3100 (56.0)		710 (56.1)	2918 (55.7)		786 (57.3)
PE check-up		χ^2 = 0.1			χ^2 = 0.1	
Never	4168 (75.2)		956 (75.6)	3957 (75.5)		1030 (75.1)
Regular	1372 (24.8)		309 (24.4)	1286 (24.5)		342 (24.9)
Self-medication		χ^2 = 8.7[b]			χ^2 = 46.5[a]	
Yes	832 (17.1)		148 (13.4)	688 (14.7)		264 (23.0)
No	4042 (82.9)		954 (86.6)	3985 (85.3)		882 (77.0)

Data are presented as n (%).
Abbreviation: PE, physical examination.
[a]$P < .001$.
[b]$P < .01$.

confounding variables (eg, age, gender, education, economic status, and self-medication) associated with liver function.

Discussion

Taiwan launched the universal HBV vaccination program for infants about 28 years ago, and there is accumulating evidence that the incidence of HBV infection has declined significantly since then.[10–12] According to the study by Ni and Chen[9] and Lu et al,[6] the seroprevalence of hepatitis B surface antigen declined from 9.8% (prevaccination period) to 0.6% and the seroprevalence of the antibody to hepatitis C antigen was 3.7% after 20 years of mass vaccination. However, the prevalence of chronic HBV (18.7%) and HCV (20.8%) infection was still high among the study cohort that we report here. Although HCV carriers tend to be older (94% were >40 years old), HBV carriers were generally either young or middle aged (Table 1). Furthermore, HBV and HCV carriers had significantly elevated levels of the liver function biomarker SGPT (Table 2). These results might reflect the findings in the official report that liver cirrhosis and HCC are the most common causes of death in Yunlin County.[3] This might be attributable to the lack of health education, poverty, illiteracy, lack of hepatitis B vaccination, and lack information about HCV treatments for adults in rural areas until a few decades ago. According to the HBM, the adoption of health-related behaviors associated with individual perceptions of the sensitivity and severity of disease, together with an insufficient health service in rural areas, might reduce the uptake of annual physical check-ups among both carriers of HBV and of HCV. It is striking that most of the hepatitis virus–infected participants were socioeconomically disadvantaged,

Table 2 • Liver Function Biomarker Levels and General Physiological Parameters Among Individuals With or Without Hepatitis B or C Virus Infection

Variables	Hepatitis B Infection			Hepatitis C Infection		
	Negative		Positive	Negative		Positive
SGPT, mu/mL		χ^2 = 24.7[a]			χ^2 = 388.4[a]	
<40	4460 (81.6)		915 (75.4)	4412 (85.4)		834 (61.5)
≥40	1004 (18.4)		299 (24.6)	756 (14.6)		522 (38.5)
Self-rated health status		χ^2 = 2.9			χ^2 = 167.6[a]	
Good	651 (13.0)		131 (11.6)	663 (13.8)		100 (8.5)
Fair	3246 (64.9)		764 (67.4)	3247 (67.7)		662 (56.1)
Poor	1105 (22.1)		238 (21.0)	883 (18.4)		419 (35.5)
BMI, kg/m^2		χ^2 = 0.3			χ^2 = 38.8[a]	
Not overweight	2503 (46.0)		578 (46.9)	2478 (48.0)		517 (38.5)
Overweight/obese	2934 (54.0)		655 (53.1)	2680 (52.0)		825 (61.5)
SBP, mm Hg		χ^2 = 1.0			χ^2 = 205.2[a]	
<140	3286 (60.5)		764 (62.1)	3355 (65.1)		586 (43.7)
≥140	2143 (39.5)		467 (37.9)	1795 (34.9)		755 (56.3)
DBP, mm Hg		χ^2 = 0.1			χ^2 = 25.8[a]	
<90	3955 (72.8)		902 (73.3)	3828 (74.3)		904 (67.4)
≥90	1474 (27.2)		329 (26.7)	1322 (25.7)		437 (32.6)
Fasting glucose, mg/dL		χ^2 = 3.3			χ^2 = 145.4[a]	
<109	4696 (85.2)		1077 (87.2)	4602 (88.2)		1034 (75.4)
≥110	816 (14.8)		158 (12.8)	614 (11.8)		338 (24.6)

Data are presented as n (%).
Abbreviations: BMI, body mass index; DBP, diastolic blood pressure; SBP, systolic blood pressure; SGPT, serum glutamic pyruvic transaminase.
[a]$P < .001$.

often being less well educated, less likely to undergo regular physical check-ups, and more likely to be in economic difficulties. Therefore, further study is required to evaluate the effectiveness of behavioral changes in the present cohort study.

Previous studies have shown that alcohol consumption, betel nut chewing, and smoking are risk factors for HCC, especially for HBV and HCV carriers,[17,18,20] and current smoking was found to be associated with an increased risk of mortality from HCC in men.[17,18] Furthermore, the relative risk of mortality from HCC for HBV carriers was 24 times that in HBV-negative men.[14] In a Europe-wide study,[16] smoking, alcohol consumption, and obesity contributed to HCC more than chronic HBV and HCV infections did. Although the present study did not focus on HCC, many HBV and HCV carriers, especially HBV carriers, still regularly consumed alcohol, betel nuts, and cigarettes (Table 1). Therefore, further study is needed to assess the health knowledge, attitude, and skills that could help HBV and HCV carriers give up these high-risk habits. In terms of the conceptual framework of this study, creating health literature that acts as a cue to action for people to adopt more healthy behaviors is also an important goal.

In a case control study, Tsai et al[17] found an additive interaction between betel nut chewing and the presence of either HBV or HCV infection in HCC patients. Moreover, a higher risk of HCC was associated with a longer duration of betel nut chewing,[17,18] and there was a significant dose-response relationship between the risk of HCC and the number of substance use habits.[20,25] Wang et al[18] found that habitual alcohol

Table 3 • Factors Associated With Impaired Liver Function (Serum Glutamic Pyruvic Transaminase [SGPT])

Variables	Unstandardized					
	B	SE	*β*	*t*	*P*	95% CI
Constant	17.03	0.69		24.70	<.001	15.68–18.39
HCV (1 = infected)	17.71	0.98	.22	18.11	<.001	15.79–19.63
BMI (1 = overweight)	8.98	0.81	.14	11.05	<.001	7.39–10.58
HBV (1 = infected)	7.33	1.00	.09	7.34	<.001	5.37–9.28
Fasting glucose (1 = ≧110 mg/dL)	5.41	1.13	.06	4.79	<.001	3.19–7.62
SBP (1 = ≧140 mm Hg)	4.15	0.84	.06	4.94	<.001	2.50–5.79
Betel nut (1 = current user)	4.12	1.45	.04	2.85	<.01	1.28–6.97
Smoking (1 = current smoker)	4.08	1.21	.05	3.38	<.01	1.71–6.45
Alcohol (1 = current drinker)	2.69	1.01	.04	2.66	<.01	0.71–4.67

Abbreviations: BMI, body mass index; CI, confidence interval; HBV, hepatitis B virus; HCV, hepatitis C virus; SBP, systolic blood pressure.

drinking, betel nut chewing, and smoking are associated with an increased risk of HCC. Aside from the association between HBV or HCV infection and abnormal liver function, this study revealed that other determinant risk factors were being overweight or obese, smoking, betel nut chewing, alcohol consumption, fasting blood sugar levels greater than 110 mg/dL, and systolic blood pressure greater than 140 mm Hg. These findings are similar to those of Lin et al,[25] who showed that HBV or HCV carriers in an aboriginal population with a high incidence of alcohol consumption, betel nut chewing, and smoking also had the most elevated levels of biomarkers for abnormal liver function, for example, gamma-glutamyl transpeptidace, SGOT, and SGPT. Montella et al[15] also pointed out that although HBV or HCV infections are the leading causes of liver cancer, some important lifestyle factors also contribute to HCC, for example, alcohol consumption, diabetes, and obesity. The pathway by which obesity increases risk could involve its association with nonalcoholic fatty liver disease. Obesity and diabetes are also likely to be risk factors for HCC.[15] In addition, we found that nearly half of all HBV and HCV carriers did not exercise regularly. Many other studies have supported the finding that obesity is associated with an increased incidence and prevalence of type 2 diabetes and cardiovascular disease.

Unfortunately, many HBV and HCV carriers in this study did not undergo regular annual PE check-ups; 3- to 6-month assessments are recommended by medical experts.[3] Therefore, to reduce the risk of liver cirrhosis and HCC among HBV and HCV carriers in rural areas, the strategies should include a modification of unhealthy lifestyles, for example, abstaining from alcohol, smoking, and betel nut chewing and weight reduction and diabetes prevention through effective and individualized, culturally tailored health education. As a community healthcare provider, it is necessary to advocate that HBV and HCV carriers receive high-quality care through policy decision making, for instance, providing 3 doses of free HBV vaccination booster to adolescents when their antibody titer from infant vaccination has dropped to zero or free antivirus treatment for adult HCV carriers.

Limitations and Recommendations

This study has several limitations. First, the participants were recruited by nonrandom sampling and most of them apparently had received less than 6 years of education. This might limit the generalizability of the findings. Second, the use of cross-sectional data poses a limitation and precludes the inference of causal relationships. Third, self-reporting often underestimates health-related behaviors such as the true frequencies of alcohol consumption, betel nut chewing, and smoking. Finally, selection and recall bias need to be considered because the participants might have been incapacitated by various health conditions.

Conclusion and Implications for Practice

From health promotion and cancer prevention perspectives, evidences proved that HBV and HCV infections are the leading causes of liver cirrhosis and HCC.[1,4] This study provides valuable information about the prevalence of HBV/HCV infection in rural areas and the relationship between HBV infection and current alcohol consumption, betel nut chewing, and smoking. Carriers of HCV were, on average, significantly older, less well educated, had a lower economic status, and tended to self-medicate. They were also more likely to be overweight and have abnormal blood pressure and fasting blood glucose levels. Both HBV and HCV carriers frequently had a poor health status, poor liver function, and unhealthy lifestyles. Some risk factors, such as gender, age, and education status, cannot be modified. However, from the perspective of health promotion, clinicians might (1) provide more education to help the community understand the relationships between liver disease and being overweight, drinking alcohol, betel nut chewing, smoking, and self-medicating, (2) tackle HBV and HCV transmission when ethically acceptable, including the avoidance of blood donation and sexually transmitted disease, (3) link more resources from local health agencies to initiate health promotion programs including weight loss and lifestyle modification, (4) refer participants with abnormal liver biomarker levels to the teaching hospital for further diagnosis and treatment, and (5) develop a cell phone–based system to remind HBV and HCV carriers to attend regular check-ups.

ACKNOWLEDGMENTS

We thank all participants living around the western coastal region in Yunlin County who helped in the success of this study.

References

1. World Health Organization. Hepatitis B and hepatitis C. http://www.who.int/mediacentre/factsheets/fs204/en/. Accessed January 20, 2013.
2. Ministry of Health Administration (MOHA). Statistics: Taiwan health care report. http://www.mohw.gov.tw/cht/DOS/Statistic.aspx?f_list_no=312&fod_list_no=2747. Accessed December 25, 2013.
3. Ministry of Health and Welfare (MOHW). Cause of death statistics. http://www.mohw.gov.tw/cht/DOS/DisplayStatisticFile.aspx?d=13690&s=1. Accessed January 11, 2014.
4. Mohamed R, Ng CJ, Tong WT, et al. Knowledge, attitudes and practices among people with chronic hepatitis B attending a hepatology clinic in Malaysia: a cross sectional study. *BMC Public Health.* 2012;12:601.
5. Chang MH. Cancer prevention by vaccination against hepatitis B. *Recent Results Cancer Res.* 2009;181:85–94.
6. Lu SN, Chen CH, Chen TM, et al. Hepatitis B virus infection in adolescents in a rural township—15 years subsequent to mass hepatitis B vaccination in Taiwan. *Vaccine.* 2006;24(6):759–765.
7. Baha W, Foullous A, Dersi N, et al. Prevalence and risk factors of hepatitis B and C virus infections among the general population and blood donors in Morocco. *BMC Public Health.* 2013;13:50.
8. Lin CC, Yang CY, Shih CT, et al. Waning immunity and booster responses in nursing and medical technology students who had received plasma-derived or recombinant hepatitis B vaccine during infancy. *Am J Infect Control.* 2011;39(5):408–414.
9. Ni YH, Chen DS. Hepatitis B vaccination in children: Taiwan experience. *Pathol Biol (Paris).* 2012;58(4):296–300.
10. Centers for Disease Control (CDC), Taiwan. Acute hepatitis B virus infection. http://www.cdc.gov.tw/diseaseinfo.aspx?treeid=8d54c504e820735b&nowtreeid=dec84a2f0c6fac5b&tid=5CA41646EE28F677. Accessed December 20, 2013.
11. Lu JJ, Cheng CC, Chou SM, et al. Hepatitis B immunity in adolescents and necessity for boost vaccination: 23 years after nationwide hepatitis B virus vaccination program in Taiwan. *Vaccine.* 2009;27(47):6613–6618.
12. Su FH, Chen JD, Cheng SH, et al. Waning-off effect of serum hepatitis B surface antibody amongst Taiwanese university students: 18 years post-implementation

of Taiwan's national hepatitis B vaccination program. *J Viral Hepat.* 2008;15(1): 14–19.
13. Gidding HF, Dore GJ, Amin J, et al. Trends in all cause and liver-related hospitalizations in people with hepatitis B or C: a population-based linkage study. *BMC Public Health.* 2011;11:52.
14. Jee SH, Ohrr H, Sull JW, et al. Cigarette smoking, alcohol drinking, hepatitis B, and risk for hepatocellular carcinoma in Korea. *J Natl Cancer Inst.* 2004;96(24):1851–1856.
15. Montella M, Crispo A, Giudice A. HCC, diet and metabolic factors: diet and HCC. *Hepat Mon.* 2011;11(3):159–162.
16. Trichopoulos D, Bamia C, Lagiou P, et al. Hepatocellular carcinoma risk factors and disease burden in a European cohort: a nested case-control study. *J Natl Cancer Inst.* 2011;103(22):1686–1695.
17. Tsai JF, Jeng JE, Chuang LY, et al. Habitual betel quid chewing and risk for hepatocellular carcinoma complicating cirrhosis. *Medicine.* 2004;83(3): 176–187.
18. Wang LY, You SL, Lu SN, et al. Risk of hepatocellular carcinoma and habits of alcohol drinking, betel quid chewing and cigarette smoking: a cohort of 2416 HBsAg-seropositive and 9421 HBsAg-seronegative male residents in Taiwan. *Cancer Causes Control.* 2003;14(3):241–250.
19. Sheu JC. Lifestyle recommendation of hepatitis B or C carriers. http://mag.udn.com/mag/life/storypage.jsp?f_ART_ID=419718#ixzzDxOEo3z3. Accessed January 20, 2013.
20. Wu GH, Boucher BJ, Chiu YH, et al. Impact of chewing betel-nut (*Areca catechu*) on liver cirrhosis and hepatocellular carcinoma: a population-based study from an area with a high prevalence of hepatitis B and C infections. *Public Health Nutr.* 2009;12(1):129–135.
21. Guh DP, Zhang W, Bansback N, et al. The incidence of co-morbidities related to obesity and overweight: a systematic review and meta-analysis. *BMC Public Health.* 2009;9:88.
22. Becker MH. *The Health Belief Model and Personal Health Behavior.* Thorofare, NJ: Slack; 1974.
23. Naidoo J, Wills J. *Foundations for Health Promotion.* 3rd ed. New York, NY: Elsevier; 2009:140–145.
24. Lee H, Park W. Public health policy for management of hepatitis B virus infection: historical review of recommendations for immunization. *Public Health Nurs.* 2010;27(2):148–157.
25. Lin CF, Shiau TJ, Ko YC, et al. Prevalence and determinants of biochemical dysfunction of the liver in Atayal Aboriginal community of Taiwan: is betel nut chewing a risk factor? *BMC Gastroenterol.* 2008;8:13.