Factors Associated with Alcohol Consumption in Hepatitis B Carriers: A Nationwide Study in the Republic of Korea

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Abstract
This study was conducted to investigate the prevalence of alcohol consumption and identify the sociodemographic factors associated with alcohol consumption among individuals with hepatitis B virus (HBV) infection. We used data from the Korean National Health and Nutrition Examination Surveys, a nationwide survey conducted between 2007 and 2011. “Monthly alcohol consumption” was defined as having consumed alcohol at least once per month during the past year, and “high-risk alcohol consumption” was defined as having consumed alcohol twice or more per week and, for males, having consumed at least 60 g of alcohol on one occasion or, for females, having consumed at least 40 g of alcohol on more than one occasion. The prevalence of monthly alcohol consumption was 53.2%, and that of high-risk alcohol consumption was 11.8% among HBV carriers. Less education was associated with both monthly and high-risk alcohol consumption (OR = 1.75 [95% CI = 1.02–3.02] for monthly alcohol consumption among those with less than a high school education; OR = 2.48 [95% CI = 1.19–5.17] for high-risk alcohol consumption among those with less than a high school education and OR = 2.02 [95% CI = 1.12–3.64] among those with a high school education). Additionally, smoking and being male increased the risk of alcohol consumption, and older age and having a normal body mass index decreased the risk. HBV carriers who were less educated, overweight, and smokers were more likely to consume alcohol or meet criteria for high-risk drinking. Health policies and intervention programs aimed at promoting a generally healthy lifestyle in HBV carriers should consider educational inequalities and alcohol consumption.

Introduction
Hepatitis B virus (HBV) infection is a major global public health issue. It is estimated that, worldwide, more than 2 billion people are infected with HBV and that 378 million are chronic carriers. Additionally, about 4.5 million new HBV infections develop worldwide each year; about one-quarter of these progress to further liver disease and approximately 600,000 individuals die of HBV-related causes each year [1]. The disease burden of HBV infection is especially high in Asian countries. Indeed, about 75% of chronic HBV carriers reside in the Asia-Pacific region, and 15–25% die of HBV-related liver diseases [2]. People who are chronically infected with HBV are at high risk of developing life-threatening chronic diseases, such as liver cirrhosis and hepatocellular carcinoma (HCC) [3]. HCC accounts for 70–85% of primary liver cancer cases [4], which is the sixth most common cancer and the third leading cause of death from cancer worldwide [5].

The outcome of HBV infection is influenced by several viral and host factors, and alcohol consumption is one of the host factors that affects the progress of HBV infection [6]. Alcohol consumption itself is also a major cause of chronic liver diseases, such as liver cirrhosis and HCC, and it contributes to the progression of liver damage when other risk factors exist [7]. Alcohol intake independently increases the risk of liver cirrhosis and HCC in HBV carriers [8]. Some researchers have even suggested a multiplicative interactive effect between HBV infection and heavy alcohol consumption on the risk of liver cirrhosis [7]. In terms of HCC development, compared with non-viral-induced cirrhosis, cirrhosis related to viral infection, especially chronic HBV infection, is associated with a higher risk of developing HCC [9]. Several previous studies have shown that alcohol consumption and HBV infection operate synergistically [10–12] and share mechanisms of action in the development of HCC [13].

The Republic of Korea is among the regions with a high prevalence (≥8%) of HBV infection [14]. Although the prevalence of HBV infection has decreased because of the nationwide vaccination program implemented in 1995, HBV infection is still considered endemic in the Republic of Korea, which is now classified as intermediate in this regard [15].

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the population has been increasing [16]. Considering the disease burden of HBV infection, efforts to combat the development of liver disease must focus not only on the primary prevention of HBV infection through HBV vaccination but also on the modification of risk factors, such as reducing alcohol consumption in HBV carriers.

Thus, in this study, we investigated the prevalence of alcohol consumption, a major factor that operates synergistically with other factors in the development of liver disease, among HBV carriers and compared it with that among HBV non-carriers. We also identified the sociodemographic factors associated with alcohol consumption in individuals with HBV infection using a nationally representative sample of the population of the Republic of Korea.

Materials and Methods

Study population

This study used data from the Korean National Health and Nutrition Examination Surveys (KNHANES), a series of cross-sectional, population-based nationally representative surveys that relied on independent rolling survey sampling based on a complex survey design. This survey had been implemented every 3 years between 1998 and 2005; since 2007, it has been conducted annually. KNHANES uses a standardized questionnaire to examine health behavior, a health examination survey, and a nutrition survey using a food-frequency questionnaire. Details of the survey have been described fully on the KNHANES official website, and the survey data are publicly available (http://knhanes.cdc.go.kr/). The study protocol was approved by the Institutional Review Board of the Korean Centers for Disease Control and Prevention.

Our analysis included data from the KNHANES conducted between 2007 and 2011. During the period, 53,232 individuals were sampled, and 42,347 participated in the survey (response rate: 71.2% in 2007, 77.8% in 2008, 82.8% in 2009, 81.9% in 2010, and 80.4% in 2011). Individual HBV surface antigen (HBsAg) values were measured in serum with an electrochemiluminescence immunoassay (Roche Diagnostics, Switzerland) in those aged 10 years or older. Of these, we selected 28,340 individuals aged 20 years or older with complete HBsAg test results; 27,318 of this group were negative for HBsAg, and 1,022 were positive. Thus, 3.7% of the population aged 20 years or older was infected with HBV, and the weighted prevalence was 3.5%. We defined those whose serum was HBsAg-positive as HBV carriers and those whose serum was HBsAg-negative as HBV non-carriers.

Data collection

Participants’ drinking patterns, including alcohol consumption, frequency of alcohol consumption during the previous year, and amount of alcohol consumed on one occasion, were assessed by questionnaire. The World Health Organization (WHO) defines high-risk drinking as drinking 60 g of alcohol or more for males and 40 g of alcohol or more for females on a single day [17]. We defined “monthly alcohol consumption” as having consumed alcohol once or more per month during the past year, and “high-risk alcohol consumption” as having consumed alcohol twice or more per week and, for males, having consumed at least 60 g of alcohol on one occasion or, for females, having consumed at least 40 g of alcohol on one occasion [18]. Demographic data (sex, age, area of residence), socioeconomic factors (monthly household income, educational level), life style-related factors (subjective health status, recognition of HBV infection status, smoking) were collected using a standardized questionnaire. We defined “recognition of HBV infection” as being serum HBsAg-positive and diagnosed with HBV infection by a physician. Body mass index (BMI) was calculated based on the height and weight data collected during the health examination.

Statistical analyses

All analyses incorporated sampling weights, stratification, and clustering. The total proportions of baseline characteristics among HBV carriers and non-carriers were compared with the chi-square test. In addition, the annual prevalence of the monthly alcohol consumption and high-risk alcohol consumption for 2007 and 2011 was analyzed. We performed multiple logistic regression to estimate the odds ratios (ORs) and 95% confidence intervals (CIs) for the association between sociodemographic factors and monthly alcohol consumption and high-risk alcohol consumption among HBV carriers to control for the effects of other sociodemographic variables and showed the frequency and percent of each sociodemographic factor. A p-value of <0.05 was considered to indicate statistical significance. All statistical analyses were performed using the SAS software (ver. 9.1; SAS, Inc., Cary, NC, USA).

Results

Among HBV carriers, 53.2% consumed alcohol at least once per month during the previous year, but this figure did not differ significantly from that for non-carriers (56.0% for non-carriers, \( P = 0.168 \)). The prevalence of high-risk alcohol consumption was 11.8% in HBV carriers and 12.0% in HBV non-carriers. The prevalence of high-risk alcohol consumption also did not significantly differ between HBV carriers and non-carriers \( (P = 0.867) \). Figure 1 and 2 shows the annual prevalence of the monthly alcohol consumption and high-risk alcohol consumption for the years 2007 and 2011 among HBV carriers and non-carriers age 20 years or older.

Table 1 compares the baseline characteristics of HBV carriers and non-carriers in 2007–2011 in the Republic of Korea. Among HBV carriers, 52.4% were males and 47.6% were females. Most HBV carriers (79.1%) in Korea did not recognize their infection status, nearly 50% of HBV carriers considered their health status to be moderate, and 44% of HBV carriers were smokers. Compared with non-carriers, more HBV carriers tended to be male, in their 40s and 50s, and to consider their health status bad or moderate. Other baseline characteristics were not significantly different.

Table 2 presents the sociodemographic factors associated with monthly alcohol consumption in HBV carriers. Being male, smoking, and less education were significantly associated with higher rates of monthly alcohol consumption (OR = 2.56 [95% CI = 1.62–4.03, \( P < 0.001 \)) for males; OR = 2.28 [95% CI = 1.47–3.54, \( P < 0.001 \)) for smokers; and OR = 1.75 [95% CI = 1.02–3.02, \( P = 0.044 \)) for those with less than a high school education vs. those with at least some college). People older than 50 drank less than did people younger than 40 \( (P < 0.001) \), and low household income and normal BMI \((18.5–24.9)\) were significantly associated with less monthly drinking \( (OR = 0.43 [95\% CI = 0.24–0.80, \( P = 0.008 \)) for the those in the first quartile of household income vs. those in the fourth quartile, and OR = 0.69 [95% CI = 0.48–0.99, \( P = 0.045 \)) for normal BMI vs. those with BMI \( \geq 25\ m/Kg^2\). Area of residence, recognition of HBV infection, and subjective health status were not associated with monthly drinking.
Table 3 shows the associations between individual sociodemographic factors and high-risk alcohol consumption in HBV carriers. Similar to the association with monthly alcohol consumption, being male, smoking, and less education were significantly associated with a higher prevalence of high-risk alcohol consumption (OR = 3.46 [95% CI = 1.33–9.00, P<0.011] for males; OR = 4.15 [95% CI = 1.75–9.85, P = 0.001] for smokers; and OR = 2.48 [95% CI = 1.19–5.17, P = 0.016] for those with less than high school education and OR = 2.02 [95% CI = 1.12–3.64, P = 0.020] for those with a high school education.

Figure 1. The annual prevalence of monthly alcohol consumption and high-risk alcohol consumption during the year of 2007–2011 among HBV carriers and non-carriers aged 20 or older.
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Figure 2. Trends in annual prevalence of high-risk alcohol consumption during the year of 2007–2011 among hepatitis B carriers and non-carriers aged 20 or older and per capita pure alcohol consumption per year in general population. The prevalence of high-risk alcohol consumption was calculated from Korean National Health and Nutrition Examination Surveys and Korean Statistical Information Service data was applied for per capita pure alcohol consumption.
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|                          | Hepatitis B carriers |                           | Hepatitis B non-carriers |                           | P-value |
|--------------------------|----------------------|---------------------------|--------------------------|---------------------------|---------|
|                          | Sample size         | Prevalence (%)            | 95% CI                   | Sample size               | Prevalence (%)            | 95% CI   |
| Overall                  | 1022                |                          |                          | 27318                     |                       |
| Sex                      |                      |                           |                          |                           |                       |
| Male                     | 492                 | 52.4 (48.9–56.0)          |                          | 11676                     | 46.0 (45.5–46.6)        | 0.001   |
| Female                   | 530                 | 47.6 (44.0–51.1)          |                          | 15642                     | 54.0 (53.4–54.5)        |         |
| Age                      |                      |                           |                          |                           |                       |
| <40                      | 300                 | 31.2 (18.5–24.4)          |                          | 8748                      | 35.6 (34.4–36.8)        | <0.001  |
| 40–49                    | 252                 | 25.1 (19.1–25.4)          |                          | 5298                      | 20.3 (19.5–21.1)        |         |
| 50–59                    | 224                 | 22.7 (21.8–28.4)          |                          | 4935                      | 18.3 (17.5–19.0)        |         |
| ≥60                      | 246                 | 21.4 (27.8–34.6)          |                          | 8337                      | 25.9 (24.8–27.0)        |         |
| Area of residence        |                      |                           |                          |                           |                       |
| Urban                    | 768                 | 79.3 (75.4–82.2)          |                          | 20719                     | 80.1 (77.5–82.8)        | 0.610   |
| Rural                    | 254                 | 20.7 (16.8–24.6)          |                          | 6599                      | 19.9 (17.2–22.5)        |         |
| Household income         |                      |                           |                          |                           |                       |
| Low                      | 166                 | 14.3 (11.8–16.9)          |                          | 5446                      | 17.5 (16.5–18.4)        | 0.161   |
| Mid-low                  | 264                 | 26.3 (23.0–29.6)          |                          | 6757                      | 25.0 (23.9–26.0)        |         |
| Mid-high                 | 260                 | 26.9 (23.3–30.6)          |                          | 7317                      | 27.8 (26.8–28.9)        |         |
| High                     | 310                 | 30.5 (26.9–34.0)          |                          | 7248                      | 27.8 (26.4–29.2)        |         |
| Missing                  | 22                  | 1.9 (1.0–2.9)             |                          | 555                       | 1.9 (1.6–2.2)           |         |
| Education                |                      |                           |                          |                           |                       |
| Less than high school    | 376                 | 33.3 (29.7–36.8)          |                          | 10378                     | 33.1 (31.8–34.3)        | 0.319   |
| High school              | 328                 | 32.7 (29.1–36.3)          |                          | 9067                      | 35.6 (34.6–36.5)        |         |
| College or more          | 306                 | 32.0 (28.2–35.4)          |                          | 7543                      | 29.9 (28.7–31.0)        |         |
| Missing                  | 12                  | 2.1 (0.9–3.3)             |                          | 330                       | 1.5 (1.3–1.8)           |         |
| Body mass index          |                      |                           |                          |                           |                       |
| <18.5                    | 31                  | 3.2 (1.9–4.4)             |                          | 1221                      | 4.6 (4.3–5.0)           |         |
| 18.5–24.9                | 640                 | 61.8 (58.4–65.2)          |                          | 17312                     | 63.1 (62.4–63.8)        |         |
| ≥25.0                    | 347                 | 34.5 (31.1–37.8)          |                          | 8659                      | 31.8 (31.1–32.5)        |         |
| Missing                  | 4                   | 0.5 (−0.1–1.1)            |                          | 126                       | 0.4 (0.3–0.6)           |         |
| Subjective health status |                      |                           |                          |                           |                       |
| Bad                      | 246                 | 20.9 (17.9–23.8)          |                          | 5975                      | 19.2 (18.6–19.9)        | <0.001  |
| Moderate                 | 469                 | 49.6 (45.9–53.4)          |                          | 10785                     | 42.3 (41.4–43.2)        |         |
| Good                     | 295                 | 27.4 (24.1–30.7)          |                          | 10243                     | 37.0 (36.1–37.9)        |         |
| Missing                  | 12                  | 2.1 (0.9–3.3)             |                          | 315                       | 1.5 (1.2–1.7)           |         |
| Smoking                  |                      |                           |                          |                           |                       |
vs. those with at least some college). Being older, having a normal BMI, and moderate self-rated health status were associated with less high-risk alcohol consumption. Area of residence, household income, and recognition of HBV infection were unrelated to high-risk alcohol consumption.

**Discussion**

This study found that 53.2% of HBV carriers consumed alcohol on a monthly basis and that 11.8% of this group met criteria for high-risk alcohol consumption, but these figures did not significantly differ from those for HBV non-carriers. Less education, smoking, and being overweight were associated with monthly drinking and high-risk drinking in HBV carriers, and we confirmed the existence of educational inequalities in the alcohol consumption of HBV carriers. To our knowledge, this is the first published study to investigate the prevalence of alcohol consumption among HBV carriers who are at high risk for chronic liver disease.

The proportion of Korean adults who drink alcohol is among the highest in the world and is increasing [19]. The proportion of high-risk alcohol drinkers has also been increasing [18], and both the prevalence of high-risk alcohol consumption and total alcohol consumption per capita are high in the Republic of Korea compared with most other countries [16].

In the Republic of Korea, the prevalence of those with serum HBsAg-positive status has been decreasing rapidly, from 8.6% in 1980 [15] to 3.2% in 2009, due to a nationwide HBV vaccination program implemented in 1995 [20]. However, the decrease in the disease burden related to chronic liver diseases, including liver cancers, is not as dramatic as is the decrease in the prevalence of HBsAg. To further decrease the risk for developing liver disease, it has been recommended that HBV carriers stop drinking [6]. Indeed, the treatment guidelines for chronic hepatitis B developed by the Korean Association for the Study of the Liver recommend that HBV carriers avoid drinking [21]. However, more than 50% of HBV carriers drank alcohol and more than 10% were heavy drinkers. Thus, in addition to current efforts that focus on reducing high-risk groups, such as HBV carriers, through vaccination, more efforts are needed to prevent the gradual development of liver disease in general, especially in high-risk groups.

Educational attainment and alcohol use have been associated with each other in several previous studies. Several studies have suggested that less education is associated with alcohol dependence [22–24], whereas others have proposed that more education is associated with increased daily alcohol consumption or problematic drinking [25] or that there is no association between these factors [26]. In this study, we showed that lower educational levels were associated with increased monthly alcohol consumption and high-risk alcohol consumption in HBV carriers. The odds ratios of educational attainment were more significant for high-risk alcohol consumption than for monthly alcohol consumption, showing educational disparities in both alcohol consumption, in general, and heavy drinking patterns, in particular. In Korea, there are differences in mortality due to liver cancer and liver diseases according to educational attainment, and these differences reflect major inequalities [27]. Our results showing differences in drinking according to educational level in HBV carriers may, at least in part, explain the inequalities in liver cancer and liver disease mortality.

Our results showed that smokers who were HBV carriers were more likely to drink alcohol on a monthly basis and to be heavy drinkers, which is similar to previous results indicating that
### Table 2. Multivariate analysis of association between monthly alcohol consumption\(^a\) and sociodemographic factors in HBV carriers.

|                          | Monthly alcohol consumers | Non-consumers | Odds ratio | 95% CI       | P-value |
|--------------------------|---------------------------|---------------|------------|--------------|---------|
|                          | N     | %b (95% CI) | N     | %b (95% CI) | Odds ratio | 95% CI       | P-value |
| **Sex**                  |       |            |       |            |           |              |         |
| Male                     | 327   | 68.1(63.8–72.4) | 157   | 34.4(29.4–39.4) | 2.56      | (1.62–4.03) | <0.01   |
| Female                   | 175   | 31.9(27.6–36.2) | 349   | 65.6(60.6–70.6) | 1         |            |         |
| **Age**                  |       |            |       |            |           |              |         |
| <40                      | 179   | 36.9(32.3–41.4) | 166   | 29.9(25.3–34.5) | 1         |            |         |
| 40–49                    | 143   | 29.6(24.8–34.3) | 117   | 24.8(20.1–29.6) | 0.68      | (0.43–1.06) | 0.09    |
| 50–59                    | 104   | 20.0(15.9–24.1) | 108   | 20.8(16.7–24.8) | 0.31      | (0.19–0.50) | <0.01   |
| ≥60                      | 76    | 13.5(10.2–16.9) | 115   | 24.5(20.3–28.6) | 0.23      | (0.13–0.42) | <0.01   |
| **Area of residence**    |       |            |       |            |           |              |         |
| Urban                    | 383   | 79.3(74.7–83.8) | 373   | 79.3(74.8–83.9) | 0.76      | (0.50–1.18) | 0.22    |
| Rural                    | 119   | 20.7(16.2–25.3) | 133   | 20.7(16.1–25.2) | 1         |            |         |
| **Household income**     |       |            |       |            |           |              |         |
| Low                      | 55    | 8.6(6.0–11.1) | 108   | 20.6(16.3–24.8) | 0.43      | (0.24–0.80) | 0.01    |
| Mid-low                  | 138   | 28.7(24.0–33.5) | 124   | 24.2(19.6–28.7) | 1.02      | (0.66–1.59) | 0.93    |
| Mid-high                 | 133   | 27.4(22.6–32.3) | 123   | 26.5(21.7–31.4) | 0.65      | (0.42–1.01) | 0.06    |
| High                     | 167   | 33.9(29.2–38.6) | 141   | 27.1(22.7–31.6) | 1         |            |         |
| **Education**            |       |            |       |            |           |              |         |
| Less than high school    | 148   | 27.3(23.0–31.6) | 228   | 41.6(36.3–46.8) | 1.75      | (1.02–3.02) | 0.04    |
| High school              | 184   | 36.0(30.9–41.2) | 142   | 29.8(25.0–34.6) | 1.34      | (0.88–2.05) | 0.18    |
| College or more          | 169   | 36.3(31.3–41.3) | 135   | 28.3(23.6–33.0) | 1         |            |         |
| **Body mass index**      |       |            |       |            |           |              |         |
| <18.5                    | 15    | 3.4(1.6–5.2) | 15    | 2.9(1.2–4.7) | 1.12      | (0.49–2.58) | 0.79    |
| 18.5–24.9                | 302   | 58.2(53.3–63.1) | 326   | 64.8(59.8–69.7) | 0.69      | (0.48–0.99) | 0.04    |
| ≥25.0                    | 182   | 37.5(32.6–42.3) | 164   | 32.3(27.6–37.0) | 1         |            |         |
| **Awareness of HBV infection** |      |             |       |            |           |              |         |
| Unaware                  | 394   | 77.1(72.4–81.7) | 401   | 80.4(76.3–84.5) | 1.02      | (0.67–1.55) | 0.92    |
| Aware                    | 108   | 22.9(18.3–27.6) | 105   | 19.6(15.5–23.7) | 1         |            |         |
| **Subjective health status** |    |             |       |            |           |              |         |
| Bad                      | 94    | 17.5(13.8–21.1) | 151   | 25.6(21.0–30.2) | 0.75      | (0.48–1.18) | 0.21    |
| Moderate                 | 249   | 53.3(48.4–58.1) | 219   | 47.6(42.4–52.9) | 0.96      | (0.66–1.39) | 0.81    |
| Good                     | 158   | 28.9(24.4–33.4) | 135   | 26.4(21.8–31.0) | 1         |            |         |
| **Smoking**              |       |            |       |            |           |              |         |
| Smoker                   | 284   | 58.7(54.0–63.4) | 130   | 28.6(23.8–33.5) | 2.28      | (1.47–3.54) | <0.01   |
| Non–smoker               | 218   | 41.3(36.6–46.0) | 375   | 71.2(66.4–76.0) | 1         |            |         |

\(^a\)Monthly alcohol consumption was defined as having consumed alcohol at least once per month during the past year.

\(^b\)The sum of the percentage may not be 100 because the number of missing values were not presented. Missing values were treated as dummy variables in the analysis.

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Table 3. Multivariate analysis of association between high-risk alcohol consumption\(^a\) and sociodemographic factors in HBV carriers.

|                           | High-risk alcohol consumers | Non-high-risk consumers | Odds ratio | 95% CI      | P-value |
|---------------------------|----------------------------|-------------------------|------------|-------------|---------|
|                           | N %\(b\) (95% CI)          | N %\(b\) (95% CI)      |            |             |         |
| **Sex**                   |                            |                         |            |             |         |
| Male                      | 95 87.0(80.9–93.0)         | 397 47.8(44.1–51.6)    | 3.46       | (1.33–9.00) | 0.01    |
| Female                    | 12 13.0(7.0–19.1)          | 518 52.2(48.4–55.9)    | 1          |             |         |
| **Age**                   |                            |                         |            |             |         |
| <40                       | 9 8.0(3.2–12.8)            | 237 23.2(20.1–26.4)    | 1          |             |         |
| 40–49                     | 17 15.7(8.4–23.0)          | 207 23.1(19.7–26.6)    | 0.92       | (0.50–1.70) | 0.79    |
| 50–59                     | 41 38.7(29.7–47.6)         | 211 23.2(20.0–26.6)    | 0.29       | (0.13–0.64) | <0.01   |
| ≥60                       | 40 37.6(28.0–47.2)         | 260 30.3(26.7–34.0)    | 0.19       | (0.06–0.60) | <0.01   |
| **Area of residence**     |                            |                         |            |             |         |
| Urban                     | 78 81.5(75.4–87.6)         | 690 79.0(75.0–83.1)    | 1.09       | (0.61–1.93) | 0.78    |
| Rural                     | 29 18.5(12.4–24.6)         | 225 21.0(16.9–25.0)    | 1          |             |         |
| **Household income**      |                            |                         |            |             |         |
| Low                       | 9 6.1(1.3–10.8)            | 157 15.4(12.7–18.2)    | 0.49       | (0.17–1.42) | 0.19    |
| Mid-low                   | 33 29.7(21.5–37.9)         | 231 25.8(22.4–29.3)    | 1.28       | (0.67–2.44) | 0.45    |
| Mid-high                  | 31 29.4(21.3–37.5)         | 229 26.6(22.9–30.3)    | 0.84       | (0.44–1.63) | 0.61    |
| High                      | 33 34.4(25.6–43.3)         | 277 29.9(26.3–33.6)    | 1          |             |         |
| **Education**             |                            |                         |            |             |         |
| Less than high school     | 26 23.4(15.7–31.1)         | 14 2.4(1.1–3.7)        | 2.48       | (1.19–5.17) | 0.01    |
| High school               | 44 42.8(33.4–52.2)         | 395 45.7(41.6–49.7)    | 2.02       | (1.12–3.64) | 0.02    |
| College or more           | 37 33.8(24.6–42.9)         | 506 51.9(47.9–55.9)    | 1          |             |         |
| **Body mass index**       |                            |                         |            |             |         |
| <18.5                     | 3 4.2(1.5–7.0)             | 28 3.0(1.8–4.2)        | 1.23       | (0.31–4.91) | 0.77    |
| 18.5–24.9                 | 55 49.1(40.3–57.8)         | 585 63.9(60.0–67.0)    | 0.51       | (0.31–0.82) | 0.01    |
| ≥25.0                     | 49 46.7(38.0–55.4)         | 298 32.8(29.4–36.3)    | 1          |             |         |
| **Awareness of HBV infection** |                        |                         |            |             |         |
| Unaware                   | 85 76.4(67.6–85.2)         | 724 79.4(76.3–82.5)    | 1.16       | (0.63–2.13) | 0.64    |
| Aware                     | 22 23.6(14.8–32.4)         | 191 20.6(17.4–23.7)    | 1          |             |         |
| **Subjective health status** |                          |                         |            |             |         |
| Bad                       | 19 18.6(11.0–26.2)         | 227 21.2(18.0–24.3)    | 0.62       | (0.32–1.22) | 0.16    |
| Moderate                  | 47 44.1(35.2–53.1)         | 422 50.4(46.5–54.2)    | 0.49       | (0.28–0.84) | 0.01    |
| Good                      | 41 37.3(28.2–46.4)         | 254 26.1(22.8–29.4)    | 1          |             |         |
| **Smoking**               |                            |                         |            |             |         |
| Smoker                    | 88 81.1(73.5–88.7)         | 326 38.7(34.9–42.5)    | 4.15       | (1.75–9.85) | <0.01   |
| Non-smoker                | 19 18.9(11.3–26.5)         | 578 59.3(55.5–63.0)    | 1          |             |         |

\(^a\)High-risk alcohol consumption was defined as having consumed alcohol twice or more per week and, for males, having consumed at least 60 g of alcohol on one occasion or, for females, having consumed at least 40 g of alcohol on more than one occasion.

\(^b\)The sum of the percentage may not be 100 because the number of missing values were not presented. Missing values were treated as dummy variables in the analysis.

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showed no statistically significant differences in monthly drinking between obese people (BMI $\geq 25$ kg/m$^2$) and overweight people with BMI $18.5 < \text{BMI} < 25$ kg/m$^2$. Considering the synergistic effects of smoking and HBV infection and of obesity and HBV infection on the risk of HCC [12,29], the higher prevalence of smokers or overweight/obese people with HBV infection may further increase the risk of developing HCC.

To reduce the disease burden related to the morbidity and mortality of liver cancer, which is end-stage liver disease [13], Korea implemented nationwide liver cancer screening in 2003 as part of the National Cancer Screening Program for secondary prevention. Alpha-fetoprotein and ultrasonography tests are provided for men and women aged 40 years or older with chronic HBV or hepatitis C virus (HCV) infection, liver cirrhosis, or chronic liver disease of any cause [30,31]. However, there is no specific national program for the primary prevention of liver diseases that targets high-risk populations. A previous study conducted by our team suggested that sex, age, awareness of infection status, and monthly household income are associated with liver cancer screening among HBV carriers [32]. Another study also showed that HBV or HCV carriers who knew their infection status sought liver cancer screening more often than carriers unknown infection status during their lifetime [33]. Although awareness of infection status was the most important factor related to undergoing liver cancer screening among HBV carriers, we found that it was not associated with alcohol consumption among HBV carriers, suggesting that we may need a different approach to the primary and secondary prevention of liver diseases in HBV carriers.

This study has several limitations. First, the information related to demographic, socioeconomic, and lifestyle-related factors was self-reported in health surveys, and thus might be subject to information bias and/or recall bias. Although the alcohol consumption measured in household surveys might be underreported [34], it is possible to use such questions in epidemiological studies [35]. In addition, studies have shown that self-reported information regarding risk factors, including alcohol consumption and smoking, was reasonably reproducible, suggesting reasonable reliability [36,37]. Therefore, although the questions used in

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