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Prevalence of Liver Complications and Its Associated Factors Among Hepatitis B – Infected Adults in Sabah

Zainib Amirah Anwar[1], S. Muhammad Izuddin Rabbani Mohd Zali[1], Mohamad Kamal Mohamed Lazi[1], Abdul Rahman Ramdzan[1,2*], Fauzi Muh[3], Roddy Teo[4]

Faculty of Medicine & Health Sciences, Universiti Malaysia Sabah, Sabah, Malaysia[1]

Health Economic Evaluation Research (HEER) Group, Universiti Malaysia Sabah, Sabah, Malaysia[2]

Faculty of Public Health, Universitas Diponegoro, Semarang, Indonesia[3]

Public Health Division, Sabah State Department of Health, Sabah, Malaysia[4]

Corresponding Author: Abdul Rahman Ramdzan

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KEYWORDS

Hepatitis B, liver complications, cirrhosis, hepatocellular carcinoma, risk factors, Sabah

ABSTRACT:

Introduction: Hepatitis B remains a significant global public health issue, particularly in regions such as Sabah, Malaysia, where the disease burden remains high despite vaccination and treatment programs. Chronic hepatitis B can lead to serious complications including cirrhosis and hepatocellular carcinoma, creating a major strain on healthcare resources.

Objectives: This study aimed to determine the prevalence of liver complications and their associated factors among hepatitis B–infected adults in Sabah, to inform public health interventions and resource allocation.

Methods: We conducted a cross-sectional analysis of 3,110 adult hepatitis B cases reported to the Sabah State Health Department through the *e-Notifikasi* system between 2016 and 2023. Sociodemographic variables, behavioral risk factors, and comorbidities were examined. Chi-square tests and logistic regression models were used to identify predictors of liver complications.

Results: The prevalence of liver complications, including cirrhosis and hepatocellular carcinoma, was 6.7% (95% CI: 6.5–6.9). Significant predictors were older age (aOR = 3.28, 95% CI: 2.16–5.19), male gender (aOR = 0.49, 95% CI: 0.35–0.67), Malaysian nationality (aOR = 0.31, 95% CI: 0.19–0.47), hypertension (aOR = 3.84, 95% CI: 1.95–7.15), and alcohol intake (aOR = 8.46, 95% CI: 3.23–22.63). Interestingly, sharing of personal hygiene tools was associated with lower odds of complications (aOR = 0.37, 95% CI: 0.21–0.66), likely reflecting reporting or behavioral biases. A significant interaction showed that alcohol consumption had a stronger effect among younger adults, while its impact was attenuated in older individuals..

Conclusions: These findings highlight the need for targeted prevention strategies in Sabah, focusing on younger adults with high-risk alcohol use and patients with comorbidities such as hypertension. Strengthening community-based health education, early screening, and integrated care for hepatitis B patients will be critical to reducing severe liver complications and supporting Malaysia's commitment to the WHO 2030 viral hepatitis elimination goals.

1. Introduction

Hepatitis B virus (HBV) remains a major global public health concern, with an estimated 296 million people chronically infected and approximately 820,000 deaths in 2019 due to cirrhosis and hepatocellular carcinoma (HCC) [16]. Despite the availability of effective vaccines and antiviral treatments, HBV continues to cause significant morbidity and mortality, especially in low- and middle-income countries [10].

In Malaysia, the seroprevalence of hepatitis B surface antigen (HBsAg) has declined due to universal infant vaccination introduced in 1989, yet regional disparities

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persist. Sabah recorded the highest incidence of HBV cases nationwide between 2003 and 2012, with projections suggesting continued increases through 2030 [14].

Liver complications such as cirrhosis, HCC, and hepatic decompensation are major consequences of chronic HBV infection [12]. These complications are influenced not only by viral factors but also by behavioral risks like alcohol use and tattooing [9], and comorbidities such as diabetes and hypertension [18]. Co-infections with HIV and HCV further accelerate liver damage and increase HCC risk [5].

In light of the rising HBV burden and liver-related mortality in Sabah, it is essential to understand the epidemiology of hepatitis B-related liver complications and their associated risk factors. Despite Sabah's high burden of hepatitis B, few studies have examined the specific behavioral and clinical risk factors contributing to liver complications in this population.

2. Objectives

This study aims to determine the prevalence of liver complications among HBV-infected adults in Sabah and explore associations with sociodemographic characteristics, behavioral factors, and comorbidities. The findings may help guide targeted public health strategies and contribute to Malaysia's efforts in achieving the WHO's goal of eliminating HBV as a public health threat by 2030 [17].

3. Methods

This study utilized a cross-sectional design using secondary data obtained from the national *e-Notifikasi* database maintained by the Communicable Diseases Control Sector, Sabah State Health Department. The data included all confirmed hepatitis B cases reported in Sabah between 2016 and 2023.

The target population was adults aged 18 years and above with confirmed hepatitis B infection. All eligible cases reported in the *e-Notifikasi* database from 2016–2023 were included after applying exclusion criteria. Therefore, this study represents a census of reported adult HBV cases in Sabah. After excluding duplicates, individuals under 18, and incomplete clinical or behavioral data, a total of 3,110 cases were included for analysis (Figure 1). Sociodemographic variables were complete for nearly all records, as the system requires these fields to be filled. No imputation was performed.

The study's main outcome variable was the presence of liver complications, defined as documented diagnoses of cirrhosis, hepatocellular carcinoma (HCC), or fulminant hepatitis. Independent variables included sociodemographic characteristics (age, gender, ethnicity, nationality, and Sabahan status), behavioral factors (alcohol use, tattoos, piercings, multiple sexual partners, sharing personal hygiene tools, and incarceration history), and comorbidities (diabetes, hypertension, HIV, kidney disease, pulmonary tuberculosis, and other chronic conditions).

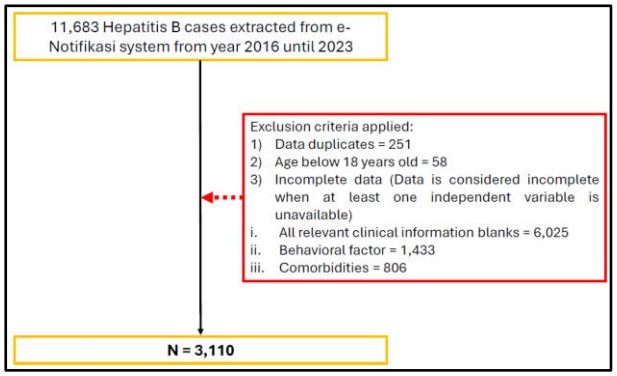

Figure 1. Data extraction flowchart

All statistical analyses were performed using IBM SPSS Statistics version 29 (IBM Corp., Armonk, NY, USA) and R version 4.4.3 (R Core Team, 2025) within RStudio version 2025.05.0+496 (Posit Software, Boston, MA). Descriptive statistics were used to summarize sample characteristics. Bivariate analyses were initially performed using the Chi-square test and Fisher's exact test to examine associations between each independent variable and the outcome, liver complication. Variables with p-values <0.05 in the Chi-square test were further assessed in univariable simple logistic regression (SLR) to estimate crude odds ratios (OR) with 95% confidence intervals (CI) and Wald statistics. Statistical significance was set at $p < 0.05$.

Multicollinearity was assessed using the variance inflation factor (VIF), with values >5 indicating potential collinearity. All variables retained for multiple logistic regression had VIF values below 3, indicating no problematic multicollinearity. To assess potential confounding, the 10% change-in-estimate criterion was applied. Variables were considered confounders if the

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adjusted odds ratio differed by 10% or more from the crude estimate.

The initial multivariable logistic regression (MLR) model included all eligible variables, followed by model reduction using backward elimination, forward selection, and stepwise selection based on Akaike Information Criterion (AIC). Final model performance was assessed using the Hosmer–Lemeshow goodness-of-fit test, receiver operating characteristic (ROC) curve analysis, and classification accuracy. Exploratory analyses for potential two-way interaction terms between selected predictors were examined to assess whether the effects of predictors varied across subgroups using likelihood ratio tests. Detailed interaction terms is as shown in Table 5. For significant interactions, stratum-specific odds ratios were derived by combining the relevant coefficients (main effect + interaction term).

This study received ethical approval from the Medical Research and Ethics Committee (MREC) of Malaysia (NMRR ID-24-00100-QHA), the university ethics board (JKEtika 1/24 (14)), and the Sabah State Health Department. All data were securely stored on encrypted, password-protected devices.

4. Results

Descriptive

A total of 3,110 adult hepatitis B cases from Sabah (2016–2023) were analyzed. The prevalence of liver complications (including cirrhosis, HCC, or fulminant hepatitis) was 6.7% (n = 209) (Table 1). Most patients were older than 35 years (63.4%), with an average age of 41.0 years (SD = 13.7). The sample had a near-equal gender distribution, and the majority were Bumiputera Sabah (59.2%) and Malaysian nationals (68.4%) (Table 2). High-risk behaviors were reported in 19.2% of participants. The most common were sharing of personal hygiene tools (14.1%) and alcohol consumption (2.8%). Tattoos, piercings, and multiple sexual partners were reported less frequently. Comorbidities were present in 6.9% of cases, with other comorbidities (2.7%), hypertension (1.9%), and diabetes mellitus (1.2%) being the most frequent.

Outcome	n (%)	(95% CI)
Liver complications		
No	2901 (93.27)	92.3, 94.1
Yes	209 (6.72)	6.5, 6.9

Table 1. Distribution of Liver Complications

Variables	Mean (SD)	n(%)
Age (years)	41.03 ± 13.68	-
18 – 35 years		1139 (36.6)
>35 years		1971 (63.4)
Gender	-	
Male		1571 (50.5)
Female		1539 (49.5)
Race/Ethnicity	-	
Malay		22 (0.7)
Chinese		195 (6.3)
Bumiputera Sabah		1840 (59.2)
Others		69 (2.2)
Foreigners		984 (31.6)
Sabahan Status	-	
Sabahan		1975 (63.5)
Non-Sabahan		1135 (36.5)
Nationality	-	
Malaysian		2126 (68.4)
Non-Malaysian		984 (31.6)
Behavioral Factors	-	
No		2512 (80.8)
Yes		598 (19.2)
Alcohol	-	
No		3022 (97.2)
Yes		88 (2.8)
Tattoo	-	
No		3094 (99.5)
Yes		16 (0.5)
Piercing	-	
No		3041 (97.8)
Yes		69 (2.2)
Multiple sexual partners	-	

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Variables	Mean (SD)	n(%)
No		3067 (98.6)
Yes		43 (1.4)
Sharing personal hygiene tools	-	
No		2671 (85.9)
Yes		439 (14.1)
Inmate	-	
No		3104 (99.8)
Yes		6 (0.2)
Comorbids	-	
No		2894 (93.1)
Yes		216 (6.9)
Diabetes mellitus	-	
No		3074 (98.8)
Yes		36 (1.2)
Hypertension	-	
No		3052 (98.1)
Yes		58 (1.9)
HIV co-infection	-	
No		3102 (99.7)
Yes		8 (0.3)
Other hepatitis co-infection	-	
No		3109 (100.0)
Yes		1 (0.0)
Kidney disease	-	
No		3097 (99.6)
Yes		13 (0.4)
PTB	-	
No		3072 (98.8)
Yes		38 (1.2)
Other comorbidities	-	
No		3026 (97.3)
Yes		84 (2.7)

Table 2. Distribution of Liver Complications

Chi-square and Fisher's exact tests

Significant associations with liver complications were found for age, gender, nationality, and Sabahan status (all $p < 0.001$). Among behavioral factors, alcohol consumption ($p = 0.002$) and sharing of personal hygiene tools ($p < 0.001$) were significantly associated, while tattooing, piercing, multiple sexual partners, and imprisonment history were not ($p > 0.05$). Regarding comorbidities, hypertension, diabetes, pulmonary tuberculosis, and other chronic illnesses showed significant associations ($p < 0.05$). However, HIV, kidney disease, and co-infection with other hepatitis viruses were not significantly associated ($p > 0.05$). All observed effect sizes were small.

Simple Logistic Regression

Individuals aged >35 years had significantly higher odds of liver complications compared to those ≤35 (OR = 3.85, 95% CI: 2.58,5.74, $p < 0.001$). Females had lower odds compared to males (OR = 0.39, 95% CI: 0.25,0.53, $p < 0.001$). Foreigners were less likely to develop liver complications compared to Malaysian nationals (OR = 0.28, 95% CI: 0.18,0.42, $p < 0.001$), as were non-Sabahans compared to Sabahans (OR = 0.35, 95% CI: 0.25,0.51, $p < 0.001$).

Among behavioral risk factors, heavy alcohol use was associated with increased odds of complications (OR = 2.49, 95% CI: 1.36,4.58, $p = 0.003$). Interestingly, sharing personal hygiene tools was associated with lower odds (OR = 0.39, 95% CI: 0.22,0.68, $p = 0.001$).

For comorbidities, significant associations were observed for diabetes mellitus (OR = 3.43, 95% CI: 1.48,7.93, $p = 0.004$), hypertension (OR = 5.64, 95% CI: 3.12,10.22, $p < 0.001$), pulmonary tuberculosis (OR = 2.65, 95% CI: 1.10,6.41, $p = 0.031$), and other chronic illnesses (OR = 2.39, 95% CI: 1.28,4.49, $p = 0.006$). These variables were selected for further analysis in the multivariable logistic regression model.

Variables	Crude OR (95% CI)	*p*-value
Age		
18 – 35 years old	1.00	
>35 years old	3.85 (2.58,5.74)	**< 0.001**
Gender		
Male	1.00	
Female	0.39 (0.28,0.53)	**< 0.001**
Race / Ethnicity		
Sabahan	1.00	
Non-Sabahan	0.35 (0.25,0.51)	**< 0.001**

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Variables	Crude OR (95% CI)	*p*-value
Nationality		
Malaysian	1.00	
Non-Malaysian	0.28 (0.18,0.42)	**< 0.001**
Heavy Alcohol Intake		
No	1.00	
Yes	2.49 (1.36,4.58)	**0.003**
Tattoo		
No	1.00	
Yes	3.24 (0.92,11.44)	0.069
Piercing		
No	1.00	
Yes	0.41 (0.10,1.68)	0.215
Multiple sexual partners		
No	1.00	
Yes	0.33 (0.05,2.39)	0.271
Sharing of personal hygiene tools		
No	1.00	
Yes	0.39 (0.22,0.68)	**0.001**
Inmates		
No	1.00	
Yes	0.00 (0.00,0.00)	1.000
Diabetes mellitus		
No	1.00	
Yes	3.43 (1.48,7.93)	**0.004**
Hypertension		
No	1.00	
Yes	5.64 (3.12,10.22)	**<0.001**
Co-infection with HIV		
No	1.00	
Yes	-	1.000
Co-infection with other hepatitis		
No	1.00	
Yes	-	1.000
Kidney diseases		
No	1.00	
Yes	2.54 (0.56,11.53)	0.228
PTB		
No	1.00	
Yes	2.65 (1.10,6.41)	**0.031**
Other diseases		
No	1.00	
Yes	2.39 (1.28,4.49)	**0.006**

Table 3. Simple Logistic Regression

Multiple Logistic Regression

After adjusting for other factors, several variables remain significantly associated with liver complications among hepatitis B-infected individuals.

Two models were compared: one without interaction terms (Table 4) and one including the interaction between age and alcohol intake. In the model without interactions, being older than 35 years (aOR = 2.89, 95% CI: 1.92,4.37, p<0.001), male gender (p<0.001), Malaysian nationality (p<0.001), alcohol intake (aOR = 2.17, 95% CI: 1.15,4.10, p=0.017), and hypertension (aOR = 3.80, 95% CI: 2.04,7.07, p<0.001) were identified as significant predictors. On the other hand, sharing personal hygiene tools was associated with significantly lower odds of liver complications (aOR = 0.37, 95% CI: 0.21,0.66, p<0.001). This model suggests that older age, alcohol use, and hypertension are strong independent predictors of hepatitis B liver complications, with hypertension increased the odds by nearly four-fold.

In contrast, the model with the interaction (Age × Alcohol Intake) revealed a different pattern (Table 6). A significant interaction between age and alcohol intake was observed (p for interaction = 0.016). Stratified analysis (Table 7) revealed that alcohol intake was strongly associated with liver complications among participants younger than 35 years (OR = 8.46, 95% CI: 2.62,27.29, p < 0.001). In contrast, among participants older than 35 years, alcohol intake was not significantly associated with liver complications (OR = 1.54, 95% CI: 0.73–3.24, p = 0.255). These findings suggest that alcohol consumption confers substantially greater risk of liver complications in younger individuals, while its effect is attenuated in older participants. Other covariates (female gender, non-Malaysian nationality, sharing of personal hygiene tools, and hypertension) remained consistent in both models.

Variables	Adjusted OR (95% CI)	*p*-value
Age		
18 – 35 years old	1.00	
>35 years old	2.89 (1.92,4.37)	**< 0.001**
Gender		
Male	1.00	
Female	0.49 (0.35,0.67)	**< 0.001**
Nationality		

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Variables	Adjusted OR (95% CI)	*p*-value
Malaysian	1.00	
Non-Malaysian	0.31 (0.19,0.47)	**< 0.001**
Alcohol Intake		
No	1.00	
Yes	2.17 (1.15,4.10)	**0.017**
Sharing of Personal Hygiene Tools		
No	1.00	
Yes	0.37 (0.21,0.66)	**< 0.001**
Hypertension		
No	1.00	
Yes	3.80 (2.04,7.07)	**< 0.001**

Table 4. Multiple Logistic Regression without Interaction Terms

2-way Interactions	Adjusted OR (95% CI)	p-value
Age by Alcohol Intake	0.18 (0.05,0.79)	**0.016**
Gender by Alcohol Intake	0.63 (0.09,2.77)	0.582
Gender by Sharing of Personal Hygiene Tools	0.47 (0.07,1.90)	0.350
Nationality by Sharing of Personal Hygiene Tools	7.06 (0, 0.0001)	0.977
Age by Hypertension	0.32 (0.06,1.84)	0.218

Table 5. Interaction Terms

Variables	Adjusted OR (95% CI)	*p*-value
Age		
18 – 35 years old	1.00	
>35 years old	3.28 (2.16,5.19)	**< 0.001**
Gender		
Male	1.00	
Female	0.49 (0.35,0.67)	**< 0.001**
Nationality		
Malaysian	1.00	
Non-Malaysian	0.31 (0.19,0.47)	**< 0.001**
Alcohol Intake		
No	1.00	
Yes	8.46 (3.23,22.63)	**< 0.001**
Sharing of Personal Hygiene Tools		
No	1.00	
Yes	0.37 (0.21,0.66)	**< 0.001**
Hypertension		
No	1.00	
Yes	3.84 (1.95,7.15)	**< 0.001**
Age > 35 years * Alcohol Intake	0.18 (0.05,0.79)	**0.016**

Table 6. Multiple Logistic Regression with Interaction Terms

Stratum	OR (95% CI)	*p*-value
<35 years	8.46 (2.62,27.29)	**<0.001**
>35 years	1.54 (0.73,3.24)	0.255

Table 7. Stratum-specific OR

Confounding assessment showed that age group, sex, nationality, alcohol intake, and hypertension each changed the crude odds ratios by more than 10%, indicating confounding. Sharing of personal hygiene tools did not meet this threshold (4.4% change), and therefore was not considered a confounder. These confounders were retained in the final multivariable model to ensure unbiased estimates.

The final multivariable logistic regression model with interaction terms showed better model fit compared to the model without interactions (AIC = 1389.1 vs. 1391.7) (Table 8). The discriminatory ability of the model was acceptable (AUC = 0.75). Pseudo R^2 values were modest (McFadden R^2 = 0.11). The Hosmer–Lemeshow test indicated lack of perfect calibration (χ^2 = 11.5, df = 3, p = 0.009). Influence plots identified several observations with higher leverage, but none with excessive influence on model estimates.

Diagnostic Test	Final Model (without interaction term)	Final Model (with interaction term)
AIC	1391.7	1389.1
Area under ROC curve (AUC)	0.74	0.75
McFadden's R^2	0.10	0.11
Hosmer-Lemeshow test	χ^2 = 16.708, df = 3, p < 0.001	χ^2 = 11.479, df = 3, p = 0.009

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Influence diagnostics	No major influential cases	No major influential cases

Table 8. Model Diagnostics

5. Discussion

Our study found that 6.7% of hepatitis B-infected adults in Sabah developed liver complications, closely mirroring global estimates indicating 10-15% of HCC cases are attributed to HBV [2,6]. The observed complication rate highlights the need for continuous surveillance and early intervention, especially in high-risk populations.

Older age, heavy alcohol use, and hypertension were significantly associated with hepatitis B liver complications. Alcohol consumption alone was strongly associated with higher odds of liver complications, although the wide confidence interval (95% CI: 3.23,22.63) suggests some uncertainty in the estimate, likely due to small subgroup size and potential underreporting. Nonetheless, the direction and strength of the association are consistent with biological plausibility and prior literature as seen in previous studies[1, 8]. Older age has an increased risk of liver fibrosis among hepatitis B individuals, especially in the presence of metabolic syndrome [3]. These findings also align with previous studies showing that metabolic conditions and alcohol exacerbate liver damage and accelerate the progression of liver damage and HCC [4, 13].

The significant interaction observed between age and alcohol intake in this study suggests that the effect of alcohol on liver complications is not uniform across age groups. Interestingly in our study, when stratified by age the effect appeared attenuated in individuals over 35 years. This may be partly explained by findings from Xie et al. (2019), who reported that younger patients with liver disease were more likely to engage in hazardous or harmful alcohol consumption compared to older individuals. Similar pattern seen in a global study where older adults have a higher prevalence of alcohol-associated liver disease, but lower prevalence of alcohol use disorder compared to younger individuals [7].

The observed protective association between sharing hygiene tools and liver complications is likely spurious. Confounding assessment indicated that this variable did not alter other associations. The unexpected protective direction may instead reflect reporting bias or misclassification in secondary data. The lower odds of complications among non-Malaysians may reflect selective reporting or limited access to diagnostic services that detect complications, thus underestimating their true burden in foreign populations. Nevertheless, evidence from European surveillance indicates that infectious disease reporting in migrants can sometimes be more complete than in natives, due to screening practices and heightened clinical suspicion, so this interpretation should be made with caution [15].

Analytically, while the non-interaction model is more parsimonious and easier to interpret, the interaction model provides a more nuanced explanation, highlighting effect modification by age. The choice between the two depends on whether the aim is simplicity for general interpretability or precision in capturing subgroup effects. For this analysis, the inclusion of the significant interaction suggests that alcohol's impact on liver complications is age-dependent and should not be assumed uniform across age groups.

From a clinical and public health perspective, this interaction underscores the importance of targeted interventions. Our study shows that older age, heavy alcohol use, and hypertension significantly increase the risk of hepatitis B-related liver complications. For older adults with hepatitis B, the combination of alcohol use and comorbid conditions such as hypertension appears to drive risk, emphasizing that clinical management cannot focus solely on viral suppression.

These findings carry broader public health implications. While global elimination strategies such as WHO's 2030 framework, and Malaysia's National Strategic Plan for Hepatitis B and C (NSPHBC) 2019–2023 have rightly emphasized vaccination, testing, and treatment, our findings suggest that greater integration of modifiable co-factors such as alcohol use and hypertension management could further strengthen these frameworks and accelerate progress toward elimination goals. The observed interaction between HBV infection, alcohol use, and NCDs suggests that elimination strategies must evolve into comprehensive liver health programs.

In the Malaysian context, embedding alcohol harm reduction and hypertension control into HBV care pathways would strengthen the NSPHBC and help close the gap between policy ambitions and outcomes.

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Framing HBV elimination as not only a biomedical agenda but as an integrated public health approach is essential if the global target of a 65% reduction in HBV-related mortality by 2030 is to be achieved.

Importantly, our findings are also relevant in high-burden, resource-limited settings, where access to antivirals and specialist care is constrained. Integrating alcohol harm reduction and hypertension control into HBV programs offers a practical and cost-saving way to prevent complications. Such an approach can ease strain on health systems while making elimination strategies more equitable and achievable.

This study has several strengths. The large sample size and the use of real-world patient data enhanced the statistical power and precision of the findings. A rigorous analytical approach was undertaken, applying multiple logistic regression with careful adjustment for key confounders. Model diagnostics were reported to support the robustness of the analysis. Importantly, the study also examined potential interaction effects, allowing a more nuanced understanding of how demographic and clinical factors may jointly influence the outcome. To our knowledge, this is among the few studies in Malaysia that comprehensively explored predictors of liver complications among hepatitis B patients, filling a significant gap in local evidence.

Nevertheless, several limitations should be acknowledged. The cross-sectional design prevents causal inference, as associations do not establish temporal relationships between exposures and outcomes. While major confounders were adjusted, the possibility of residual confounding from unmeasured factors, such as detailed lifestyle variables or genetic predispositions, cannot be excluded. Although the inclusion of interaction terms improved overall model performance, the Hosmer–Lemeshow test indicated areas of misfit, suggesting that the model predictions may not fully align with the observed data. In addition, some predictors relied on self-reported information, especially high-risk behaviours which are susceptible to underreporting due to social desirability bias. Finally, the findings may not be generalizable to populations outside the study setting, particularly in regions with different demographic or healthcare characteristics.

6. Conclusion

This study investigated the prevalence and associated factors of liver complications among hepatitis B-infected adults in Sabah between 2016 and 2023. A prevalence of 6.7% was observed, with several significant associations identified. Older age, male gender, Malaysian nationality, hypertension, and alcohol consumption were independently linked to increased odds of developing liver complications. These findings demonstrate associations between liver complications and sociodemographic factors, high-risk behaviors, and comorbid conditions. In addition, the effect of alcohol on liver complications varied by age group, with a stronger association observed in younger individuals.

Our findings underscore the need to integrate alcohol harm reduction and NCD control into HBV care pathways to prevent progression to severe liver disease. Embedding these co-factor interventions within national programs not only aligns with the global elimination goal of reducing HBV-related mortality, but also offers a pragmatic approach for regions of high disease burden with limited resources where prevention of complications can reduce both clinical and economic strain.

7. Conflict of Interest

The principal investigator is currently a graduate student at Universiti Malaysia Sabah (UMS) and also employed under the Sabah State Health Department, Ministry of Health Malaysia. Access to the *e-Notifikasi* database was granted through official institutional procedures. The authors declare no financial or personal conflict of interest in the conduct or reporting of this research.

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References

1. Abassa, K. K., Wu, X. Y., Xiao, X. P., Zhou, H. X., Guo, Y. W., & Wu, B. (2022). Effect of alcohol on clinical complications of hepatitis virus-induced liver cirrhosis: A consecutive ten-year study. *BMC Gastroenterology, 22*, Article 130. https://doi.org/10.1186/s12876-022-02198-w
2. Blachier, M., Leleu, H., Peck-Radosavljevic, M., Valla, D.-C., & Roudot-Thoraval, F. (n.d.). The burden of liver disease in Europe: A review of available epidemiological data. http://data.euro.who.int
3. Cai, S., Ou, Z., Liu, D., Liu, L., Liu, Y., Wu, X., Yu, T., & Peng, J. (2018). Risk factors associated with liver steatosis and fibrosis in chronic hepatitis B patients with component of metabolic syndrome. *United European Gastroenterology Journal, 6*(4), 558–566. https://doi.org/10.1177/2050640617751152
4. Chalasani, N., Younossi, Z., Lavine, J. E., Charlton, M., Cusi, K., Rinella, M., ... & Sanyal, A. J. (2018). The diagnosis and management of nonalcoholic fatty liver disease: Practice guidance from the American Association for the Study of Liver Diseases. Hepatology, 67(1), 328-357. https://doi.org/10.1002/hep.29367
5. Cheng, Z., & Lin, P. (2021). HBV/HIV Coinfection: Impact on the Development and Clinical Treatment of Liver Diseases. Frontiers in Medicine. https://www.frontiersin.org/articles/10.3389/fmed.2021.713981/full
6. Hatzakis, A., Wait, S., Bruix, J., Buti, M., Carballo, M., Cavaleri, M., Colombo, M., Delarocque-Astagneau, E., Dusheiko, G., Esmat, G., Esteban, R., Goldberg, D., Gore, C., Lok, A. S. F., Manns, M., Marcellin, P., Papatheodoridis, G., Peterle, A., Prati, D., … Janssen, H. L. A. (2011). The state of hepatitis B and C in Europe: Report from the hepatitis B and C summit conference. Journal of Viral Hepatitis, 18(SUPPL. 1), 1–16. https://doi.org/10.1111/j.1365-2893.2011.01499.x
7. Danpanichkul, P., Suparan, K., Ng, C. H., Dejvaara, D., Kongarin, S., Panpradist, N., Chaiyakunapruk, N., Muthiah, M. D., Chen, V. L., Huang, D. Q., Antonio Díaz, L., Noureddin, M., Arab, J. P., & Wijarnpreecha, K. (2024). Global and regional burden of alcohol-associated liver disease and alcohol use disorder in the elderly. *JHEP Reports, 6*(2), 101020. https://doi.org/10.1016/j.jhepr.2024.101020
8. Lin, C.-W., Lin, C.-C., Mo, L.-R., Chang, C.-Y., Perng, D.-S., Hsu, C.-C., Lo, G.-H., Chen, Y.-S., Chen, Y.-C., Yen, Y.-C., Hu, J.-T., Yu, M.-L., Lee, P.-H., Lin, J.-T., & Yang, S.-S. (2013). Heavy alcohol consumption increases the incidence of hepatocellular carcinoma in hepatitis B virus-related cirrhosis. *Journal of Hepatology, 58*(4), 706–711. https://doi.org/10.1016/j.jhep.2012.11.045
9. Lo Re, V., Newcomb, C. W., Carbonari, D. M., Roy, J. A., Althoff, K. N., Kitahata, M. M., Reddy, K. R., Lim, J. K., Silverberg, M. J., Mayor, A. M., Horberg, M. A., Cachay, E. R., Kirk, G. D., Hull, M., Gill, J., Sterling, T. R., Kostman, J. R., Peters, M. G., Moore, R. D., … Kim, H. N. (2019). Determinants of Liver Complications among HIV/Hepatitis B Virus-Coinfected Patients. Journal of Acquired Immune Deficiency Syndromes, 82(1), 71–80. https://doi.org/10.1097/QAI.0000000000002094
10. MacLachlan, J. H., & Cowie, B. C. (2015). Hepatitis B virus epidemiology. Cold Spring Harbor Perspectives in Medicine, 5(5), a021410. https://doi.org/10.1101/cshperspect.a021410
11. National Strategic Plan for Hepatitis B and C 2019-2023. Ministry of Health Malaysia (MoH). 2019
12. Nayagam, S., Thursz, M., Sicuri, E., Conteh, L., Wiktor, S., Low-Beer, D., ... & Hallett, T. B. (2016). Requirements for global elimination of hepatitis B: A modelling study. The Lancet Infectious Diseases, 16(12), 1399-1408. https://doi.org/10.1016/S1473-3099(16)30204-3
13. Patmore, L. A., Katwaroe, W. K., van der Spek, D., Choi, H. S. J., Patel, K., Brakenhoff, S., van der Meer, A. J., Brouwer, W. P., van Kleef, L. A., de Knegt, R. J., Hansen, B. E., de Man, R. A., Feld, J. J., Janssen, H. L. A., & Sonneveld, M. J. (2023). Association Between the Presence of Metabolic Comorbidities and Liver-Related Events in Patients With Chronic Hepatitis B. Clinical

Gastroenterology and Hepatology, 21(12), 3089-3096.e1. https://doi.org/10.1016/j.cgh.2023.03.024

14. Rajamoorthy, Y., Mohd Taib, N., Abdul Rahim, K., & Munusamy, S. (2016). Trends and estimation of hepatitis B infection cases in Malaysia, 2003–2030. *Malaysian Journal of Public Health Medicine, 16*(1), 113–120.
15. Giorgi Rossi, P., Riccardo, F., Pezzarossi, A., Ballotari, P., Dente, M. G., Napoli, C., Chiarenza, A., Velasco Munoz, C., Noori, T., & Declich, S. (2017). Factors influencing the accuracy of infectious disease reporting in migrants: A scoping review. *International Journal of Environmental Research and Public Health, 14*(7), 720. https://doi.org/10.3390/ijerph14070720
16. World Health Organization. (2021). Hepatitis B. https://www.who.int/news-room/fact-sheets/detail/hepatitis-b
17. World Health Organization. (2016). Global health sector strategy on viral hepatitis 2016-2021: Towards ending viral hepatitis. https://apps.who.int/iris/handle/10665/246177
18. Xie, Y.-D., Zhao, C.-Q., Wang, J.-P., Cheng, C.-S., Zhou, J.-Y., Zhang, Y., Xia, H., & Wei, L. (2019). Alcohol consumption analysis among patients with liver disease in China. *Chinese Medical Journal, 132*(4), 420–426. https://doi.org/10.1097/CM9.0000000000000067
19. Xie, J., Wang, X., Wang, X., Li, J., Jie, Y., Hao, Y., & Gu, J. (2024). Assessing the impact of comorbid type 2 diabetes mellitus on the disease burden of chronic hepatitis B virus infection and its complications in China from 2006 to 2030: a modeling study. Global Health Research and Policy, 9(1). https://doi.org/10.1186/s41256-024-00345-2