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ORIGINAL ARTICLE

Contextual and individual factors associated with knowledge, awareness and attitude on liver diseases: A large-scale Asian study

Mei Hsuan Lee[1] | Sang Hoon Ahn[2] | Henry L. Y. Chan[3] | Asad Choudhry[4] | Rino Alvani Gani[5] | Rosmawati Mohamed[6] | Janus P. Ong[7] | Akash Shukla[8] | Chee Kiat Tan[9] | Tawesak Tanwandee[10] | Pham Thi Thu Thuy[11] | Boon Leong Neo[12] | Venus Tsang[12] | Jin Youn[12] | Shikha Singh[13]

[1]Institute of Clinical Medicine, National Yang Ming Chiao Tung University, Taipei, Taiwan (ROC)

[2]Yonsei University College of Medicine, Yonsei University, Seodaemun-gu, South Korea

[3]Institute of Digestive Diseases, The Chinese University of Hong Kong, Hong Kong SAR, China

[4]Chaudhry Hospital, Ghulam Dastagir Khan Rd, Gujranwala, Pakistan

[5]Hepatobiliary Division, Department of Internal Medicine, Faculty of Medicine, University of Indonesia, Jakarta, Indonesia

[6]Department of Medicine, Faculty of Medicine, University of Malaya, Kuala Lumpur, Malaysia

[7]College of Medicine, University of the Philippines, Manila, Philippines

[8]King Edward Memorial Hospital, Global Hospital, Mumbai, India

[9]Department of Gastroenterology & Hepatology, Singapore General Hospital, Singapore, Singapore

[10]Department of Medicine, Siriraj Hospital, Mahidol University, Nakhon Salaya, Thailand

[11]Hepatology Department in Ho Chi Minh Medic Medical Center, City Ho Chi Minh, Vietnam

[12]Gilead Sciences, Hong Kong, China

[13]Kantar Health, Singapore, Singapore

Correspondence
Mei Hsuan Lee, Institute of Clinical Medicine, National Yang Ming Chiao Tung University, No.155, Sec.2, Linong Street, Taipei 11221, Taiwan (ROC).
Email: meihlee@ntu.edu.tw

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Abstract

There are limited data to provide better understanding of the knowledge/awareness of general population towards liver health in Asia. We sought to identify the knowledge gaps and attitudes towards liver health and liver diseases as well as evaluate associated individual-level and macro-level factors based on contextual analysis. An online survey assessing knowledge, awareness and attitudes towards liver health and disease was conducted among 7500 respondents across 11 countries/territories in Asia. A liver index was created to measure the respondents' knowledge level and the degree of awareness and attitudes. Multilevel logistic regression was performed to identify individual factors and contextual effects that were associated with liver index. The overall liver index (0–100-point scale) was 62.4 with 6 countries/territories' liver indices greater than this. In the multilevel model, the inclusion of geographical information could explain for 9.6% of the variation. Residing in a country/territory with higher HBV prevalence (80% IOR: 1.20–2.79) or higher HCV death rate (80% IOR: 1.35–3.13) increased the individual probability of obtaining a high overall liver index. Individual factors like age, gender, education, household income, disease history and health screening behaviour were also associated with liver index (all p-values<0.001).

The overall liver index was positively associated with the two macro-level factors viz. HBV prevalence and HCV death rate. There is a need to formulate policies especially in regions of lower HBV prevalence and HCV death rate to further improve the knowledge, awareness and attitudes of the general public towards liver diseases.

KEYWORDS
Asia, liver health, policy, public health, viral hepatitis

1 | INTRODUCTION

Liver diseases account for approximately 2 million deaths per year worldwide, with 1 million deaths due to viral hepatitis and 1 million due to complications of cirrhosis and liver cancer.[1] Almost two-thirds of global deaths due to liver diseases occur in the Asia-Pacific region,[2] with approximately 75% of liver cancer cases from Asia.[3] Hepatitis B virus (HBV) and hepatitis C virus (HCV) remain the most common causes of cirrhosis,[4] accounting for approximately 90% of liver cancer cases,[5] highlighting viral hepatitis as an international public health challenge. The World Health Organization's (WHO) global hepatitis strategy implemented in 2016 aims to reduce new hepatitis infections and hepatitis-related deaths by 90% and 65%, respectively, as well as achieve 80% treatment target of eligible persons with chronic hepatitis B and C infections by 2030.[6] Access to medical services in Asia is hindered by lack of public awareness, inadequate treatment and varied priorities on policy agendas among countries/territories.[7]

Knowledge and awareness of liver diseases such as viral hepatitis are vital steps in preventing the disease and seeking early intervention. Having said that, knowledge and awareness of factors contributing towards liver diseases including but not limited to viral hepatitis, have not been well studied among the general population in Asia.

Few studies and limited information have been published on the knowledge and awareness regarding liver diseases. In a survey conducted among the general population, patients and guardians in South Korea, 35% of healthy subjects and 45% of patients and their guardians misunderstood hepatitis B as hereditary diseases.[8] Another survey in North West India showed that among the general population, 24.2%, 29.2% and 46.6% respondents, respectively, had good, fair and poor level of awareness of hepatitis C infection.[9] In Vietnam, a survey conducted among pregnant women and mothers examined their knowledge, attitudes and practices concerning HBV prevention and immunization. When compared to previous studies in endemic countries, participants in this survey were more knowledgeable about HBV transmission routes. However, the study also revealed a significant stigma associated with people having chronic HBV infections.[10]

To date, there is no comprehensive regional study conducted in Asia, which could provide a better understanding of the knowledge gaps and attitudes towards liver health and liver diseases such as viral hepatitis collectively across countries/territories.

This large-scale Asian study conducted among the general population across 11 countries/territories aimed to identify knowledge gaps and attitudes towards liver-related health and diseases in Asia as well as evaluate associated individual-level factors (eg the respondents' demographic and liver health characteristics) and macro-level factors (country/territory level characteristics eg HBV/HCV prevalence and HBV/HCV death rate) based on contextual analysis.

2 | MATERIALS AND METHODS

2.1 | Study population

Across Asia in 11 countries/territories, eligible respondents, aged 18 years old or older with informed consent were invited by email to answer a web survey through an existing, general purpose web-based consumer panel between February and March 2020 until sample quotas were achieved. There were in total 7500 respondents, including Singapore (500), Hong Kong (500), Malaysia (500), Thailand (500), Philippines (500), Pakistan (500), Indonesia (750), Vietnam (750), South Korea (1000), Taiwan (1000) and India (1000).

With a 95% confidence interval and 50% response, the sample sizes (500, 750 and 1,000) were able to provide descriptive estimates with 4.33%, 3.51% or 3.02% margins of error, respectively, which fall within the acceptable range (<5%) for large-scale survey study.[11,12] With 500 respondents, a difference in the effect size of at least 0.177 can be detected, given 80% power and 95% confidence interval.[13]

2.2 | Survey design and questionnaire

The full questionnaire (Appendices) consisted of 25 questions in two sections, with 14 questions in section 1 on knowledge and awareness of liver health and disease, and 11 questions in section 2 on attitudes towards liver screening, diagnosis and treatment. The internal consistency of the section construct was assessed by Cronbach's alpha (alpha>0.7).[14]

The questionnaire was developed, reviewed and finalized based on the expert opinions of a steering committee comprising of gastroenterologists or hepatologists from the 11 countries/territories. The survey questionnaire was developed in English and translated into different local languages: traditional Chinese (Hong

Kong; Taiwan), Indonesian (Indonesia), Malay, simplified Chinese (Malaysia), Urdu (Pakistan), Tagalog (Philippines), Korean (South Korea), Thai (Thailand) and Vietnamese (Vietnam). The translations were validated by linguists who are native speakers of the languages. All respondents completed the questionnaires in their first language and only de-identified data were collected. The protocol and questionnaire for the survey were reviewed for exemption by the Pearl Institutional Review Board (IRB) and determined to be exempt from IRB review for the periods the data used in the current study.

2.3 | Knowledge, awareness and attitude measures

A liver index on a 0–100-point scale was created to measure the respondents' knowledge level and the degree of awareness and attitude. A higher liver index indicates better knowledge, awareness and attitude. Responses to the 25 questions were first scored and normalized by min-max feature scaling to a 0–100-point scale for each respondent. The section liver index was a weighted mean of the normalized question scores, with the same weight on each answered question (no-response question carrying zero weight). Next, the overall liver index was a weighted mean of the section liver indices with the weights on the number of questions in each section (section 1: 56%, section 2: 44%). The overall liver index or section liver index for a country/territory is an arithmetic mean of the overall liver index or section liver index of each respondent in that country/territory.

2.4 | Statistical analysis

The respondents' sociodemographic variables were summarized by frequencies and percentages. One-way ANOVA tests were used for bivariate comparison of liver indices among subgroups. The continuous macro-level variables and the outcome variable overall liver index were dichotomized as high or low using their medians.

A three-step multilevel regression analysis was performed[15] to:

(i) Examine the association between the overall liver index and individual-level factors including
   - Sociodemographic factors: age, gender, education level, monthly household income
   - Liver-related health characteristics: attendance status of recent 2 years health screening, previous diagnosis with liver disease(s)
(ii) Investigate whether macro-level factors (contextual effect)[16] were attributed to the variation in the overall liver index
(iii) Quantify the relevance of contextual effect for understanding general population's overall liver index

The three-step approach started with a single-level logistic regression with sociodemographic factors (model 1). Collinearity was assessed by variance inflation factor (VIF) of 5. Model 2 is two level, with respondents as level 1 and countries/territories as level 2. It added a random effect (general contextual effect) to model 1 with an assumption that the effect is normally distributed with zero mean. The general contextual effect was evaluated by intra-class correlation coefficient (ICC) or variance partition coefficient (VPC), mean odds ratios (MORs) and area under the receiver operating characteristic curve (AUC).[15-18] ICC/VPC, estimated by latent variable formulation, measures the percentage of variance in the overall liver index due to the contextual effect and larger ICC/VPC indicates more relevance of the inclusion of the contextual effect. MOR quantifies the effect of clustering or heterogeneity; large MOR means the contextual effect is of more relevance. A large AUC measures discriminatory accuracy and informs the relevance of contextual effect.

Lastly, model 3 extended model 2 to include macro-level factors of interest (specific contextual effect). There were 12 macro-level variables included in model 3: human development index (HDI),[19,20] gross domestic product (GDP),[21,22] HBV/HCV prevalence,[23–25] diagnosed HBV/HCV percentage,[26] HBV/HCV death rate,[26–28] HBV/HCV infection treated percentage,[26] and if meet the HBV/HCV elimination target in each region.[26,29] The 11 countries/territories were dichotomized into countries/territories having high or low HBV/HCV prevalence, diagnosed percentage, death rate or infections treated percentage by the median values of these indicators of the 11 countries/territories. The specific contextual effect was evaluated by the 80% interval odds ratio (IOR-80%) and the proportion of opposed odds ratio (POOR).[15–17,30] Both IOR-80% and POOR measure the effect of macro-level variables, with IOR-80% excluding 1 or POOR closing to 0 indicating that the macro-level variable is of importance in the comparison of variance. The proportional change in variance (PCV) defined as the proportion of variance in model 2 explained by adding the specific contextual effect in model 3 was also reported to inform how much general context effect was mediated by adding the macro-level variables. The model selections followed stepwise Akaike Information Criterion (AIC) with backward eliminations.

Statistical significance was assessed at 0.05. Data analyses were conducted by R version 3.6.1.

3 | RESULTS

3.1 | Characteristics of the population

The age distribution was approximately even, 50.5% were male, 77.6% completed at least university education and 65.8% had higher household income than their country/territory-specific medians. 25.5% self-reported that they had liver disease history and 70.0% reported that their last health screening was within 2 years (Table 1).

3.2 | Liver index

Cronbach's alpha for section 1 and section 2 were 0.80 and 0.70. The overall liver index mean was 62.4, the section 2 mean was slightly higher

TABLE 1 Demographic characteristics of the respondents participating in the survey

		N	%
Age	*Less than 25 years old*	1522	20.3
	25 – 34 years old	1685	22.5
	35 – 44 years old	1622	21.6
	45 – 54 years old	1440	19.2
	55 years old and above	1231	16.4
Gender	*Male*	3790	50.5
	Female	3710	49.5
Education	*Secondary school & below*	1683	22.4
	University	4594	61.3
	Postgraduate	1223	16.3
Household income[†]	*Low*	2567	34.2
	High	4933	65.8
Self-reported ever diagnosed liver disease	*No*	5588	74.5
	Yes	1912	25.5
Self-reported last health screening within 2 years	*No*	2252	30.0
	Yes	5248	70.0

[†]*Household income was dichotomized as high or low using the median household income in each country/territory.*

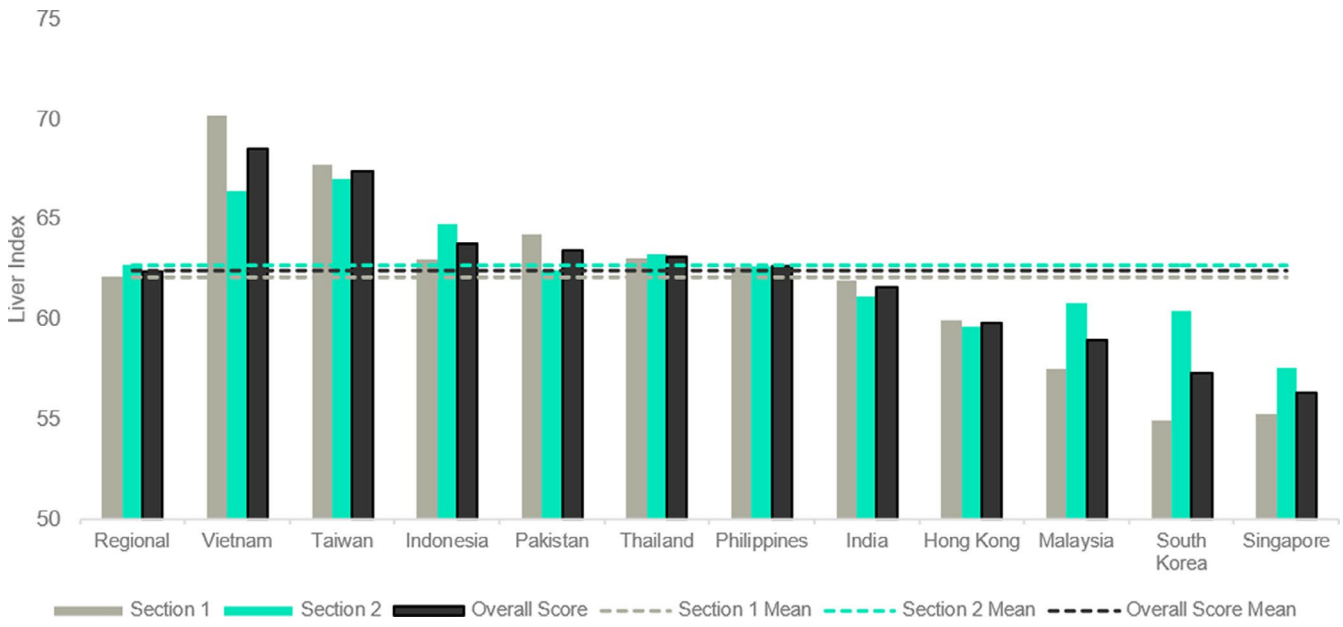

FIGURE 1 Liver index across the 11 countries/territories

than the section 1 mean (62.7 vs. 62.1) (Figure 1). The liver indices for the 11 countries/territories ranged from 56.3 to 68.5 with a standard deviation of 3.8. Six out of the eleven countries/territories' indices were above the overall mean (Figure S1). Vietnam and Taiwan were well ahead of the other countries/territories, being 9.8% and 8.1% above the overall mean, whereas South Korea and Singapore were in the lower range, being 8.1% and 9.8% below the overall mean, respectively. Notably, comparing the section indices of the 11 countries/territories, section 1 had larger deviations from its mean than that of section 2 (section 1: −11.6% to 13% vs. section 2: −8.2% to 6.9%) (Figures S2 and 3).

3.3 | Liver index of self-reported diagnosed with liver disease vs. undiagnosed individuals

Across 11 countries/territories, the respondents who self-reported of having been diagnosed with any liver disease scored significantly higher in overall (66.2 vs. 61.0, *p*-value: <0.0001) and section 1 index (67.9 vs. 60.1, *p*-value:<0.0001), compared to the undiagnosed. This also held true within each country/territory (Figure 2 & Figure S6A). When comparing section 2 index between the self-reported diagnosed and the undiagnosed, the self-reported diagnosed scored

significantly higher in overall index across 11 country/territory (64.1 vs 62.2, *p*-value:<0.0001) but not in each country/territory (Figure S6B).

3.4 | Factors associated with overall liver index

Table 2 shows the results of the three-step analysis. In model 1, all individual-level factors were found to be associated with the overall liver index. Respondents aged 55 years and older (OR:1.99, CI:1.68–2.34) were the most associated with a high overall liver index, compared to other age groups. In model 2, ICC/VPC was 9.1% and MOR (1.73) was considerable. Both ICC/VPC and MOR showed that adding general contextual effect was of importance in explaining the variation in overall liver index. However, the added value of general contextual effect may be limited, as when assessing AUC, it only increased 0.06 unit from 0.70 to 0.76. In model 3, only two macro-level variables (HBV prevalence and HCV death rate) were selected among 12 variables. These two variables' narrow 80% IORs and small POORs suggested that they were of relevance. Being in a country/territory with higher HBV prevalence (80% IOR: 1.20–2.79) or higher HCV death rate (80% IOR: 1.35–3.13) increased the individual probability of obtaining a high overall liver index. Also, the total variance declined from 0.33 to 0.05 and PCV was large as 84.8%, which meant that the inclusion of the macro-level variables explained for 84.8% of the total variance in model 2, further justifying the importance of specific contextual effect for understanding the overall liver index.

In addition, 129 provinces/districts were used as the random effect instead of 11 countries/territories. ICC/VPC increased from 9.1% to 12.6% and MOR increased from 1.73 to 1.93, suggesting that including more detailed geographic location that respondents are residing in each country/territory explained more variation in the overall liver index.

4 | DISCUSSION

This is the first cross-sectional survey conducted across 11 countries/territories in Asia, wherein an overall liver index was developed as a tool to monitor the gaps in knowledge and awareness of liver diseases such as viral hepatitis, including the attitude towards prevention, screening, diagnosis and treatment. To our knowledge, this composite liver index quantifying the public's knowledge, awareness of, and attitudes towards liver diseases is a novel scoring system; which would be valuable in the re-examination of health policies within each country/territory by identifying areas of deficiency with regard to the health education, prevention and treatment of liver diseases in Asia where chronic liver diseases are prevalent.[4]

The regional average of the overall liver index was 62.4 on a 0–100-point scale. Vietnam and Taiwan scored better than the rest of the countries/territories, whereas South Korea and Singapore had the lowest scores. The higher overall liver index could be indicative of local efforts to improve general public's awareness and knowledge about liver diseases. However, as this is a first-ever liver health study conducted across Asia using this system, the test-retest reliability of this liver index construct would warrant further validation in wider populations.

Beyond that, this work is a web-based survey wherein the respondents might be well educated and with relatively high socioeconomical status compared to individuals without accessibility for the survey. Therefore, the generalizability might be considered. The liver index score could be even lower if it was applied in the general population.

Consistent with previously published studies, individual-level risk factors (eg older age, higher education qualification and socioeconomic status) were observed to be associated with knowledge, awareness of, and attitudes towards liver diseases.[31,32] In view of public health, it is also important to understand the association of macro-level factors. The three-step multilevel analysis approach used in this study identified factors influencing the liver index as well as the contextual effect. The overall liver index was positively associated with the two macro-level factors such as HBV prevalence and HCV death (Table 2). In this study, the median of the 11 countries/territories was used to dichotomize high or low prevalence and death rate. Country/territory with its HBV prevalence and HCV death rate above the median was classified as high (Tables S1 and 2). Respondents residing in a country/territory with higher HBV prevalence or HCV death rate, such as Vietnam, Taiwan and Indonesia, were found to have scored higher on the liver index than countries/territories of lower HBV prevalence or HCV death rate. This could be attributed to the increased national efforts in advocating for liver health. For instance, in Vietnam, liver health awareness campaigns conducted by the Vietnam Viral Hepatitis Alliance, included awareness messages on hepatitis B/C,[33] while another campaign 'Healthy Liver, Happy Life' conducted by PATH (Program for Appropriate Technology in Health) further raised the awareness of HCV and motivate people to engage in HCV testing.[34] In Taiwan, there have been public education campaigns on the prevention and treatment of liver diseases as well as health education seminars on the basic understanding of liver disease.[35]

On the other hand, countries/territories with lower HBV prevalence and HCV death rate, such as Hong Kong, Malaysia, South Korea and Singapore, were observed to have lower awareness and knowledge level about liver diseases according to their liver index. This is concerning since viral hepatitis still imposes a substantial burden in these countries/territories despite the lower prevalence and mortality rates. Notably, these countries/territories are considered to have better access to more advanced healthcare systems in the region. This could be attributed to the limited or recently established national campaigns to cohesively promote the awareness of viral hepatitis in the population in some of these countries/territories.[36–40] Thus, there is a need to actively promote policies and efforts in countries/territories of lower HBV prevalence and HCV

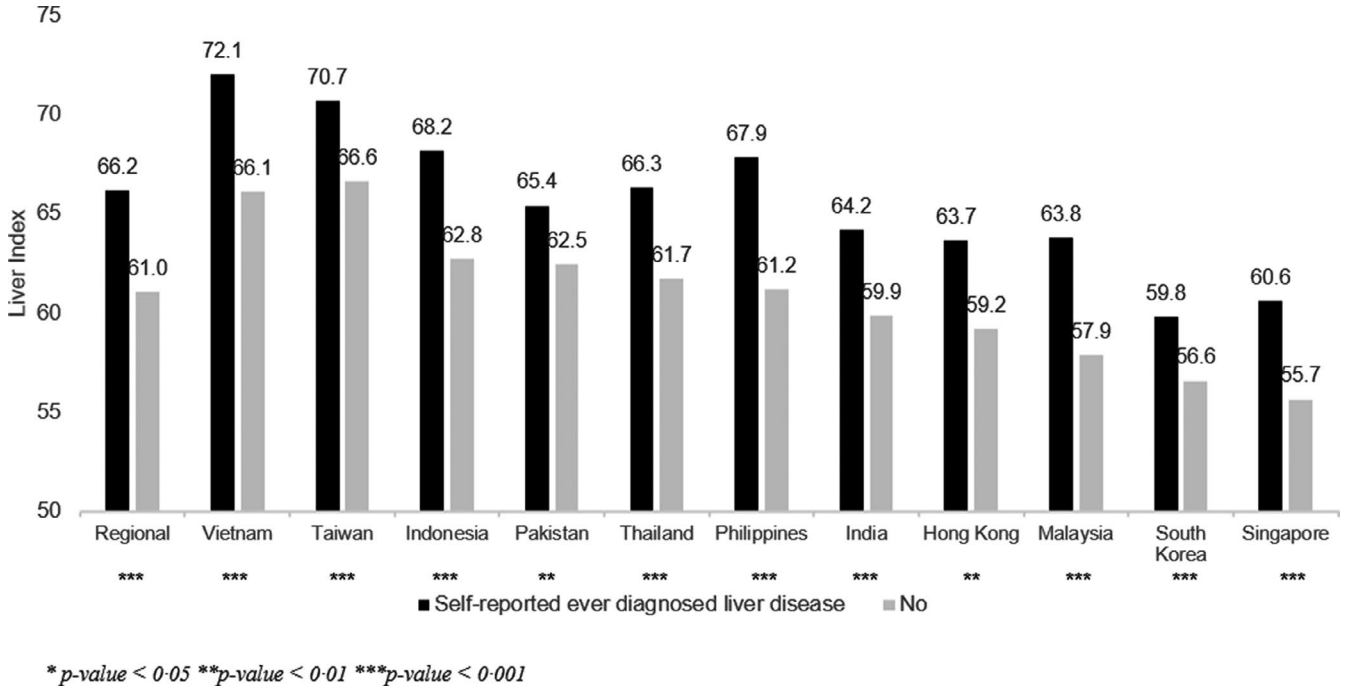

FIGURE 2 Overall liver index for self-reported diagnosed with liver diseases versus undiagnosed individuals

mortality rates to further increase the public's knowledge, awareness and attitude towards liver diseases.

This study also highlighted areas where respondents had scored higher or lower in the liver index. The respondents generally had higher knowledge and awareness regarding liver protection, basic liver functions, knowledge on liver diseases as well as the association of viral hepatitis with liver cancer/failure. Areas of knowledge and awareness gaps included awareness of different types of hepatitis, knowledge on infectious hepatitis and its mode of transmission and awareness of various staging of liver scarring/fibrosis. About 1 in 2 had misunderstood that HBV and HCV are transmitted by eating contaminated or raw seafood or by dining together with an infected person. Approximately one-quarter had misunderstood that hepatitis is transmissible by mosquito bites. These misconceptions of the transmission modes of viral hepatitis may be irrespective of a country/territory's liver index, wherein, similar findings were also observed in some community-based surveys across Asia.[31,32,41] A survey in India showed that only 3 in 10 people were knowledgeable about the different modes of transmission of HBV.[32,41] In Pakistan, a study also reported that majority of the study population had expressed confusions regarding the transmission mode and vaccination protocols of HBV and HCV, which were corrected during an awareness campaign.[32] This further highlights an unmet to educate and dispel these misconceptions to increase the public's knowledge and reduce the burden of liver diseases.

With regard to the attitudes towards screening, diagnosis or treatment, the respondents had scored higher in areas pertaining to the greater sense of urgency to treat liver disease, attending general health screening and had low stigma attached with being diagnosed with hepatitis. Despite this, the findings revealed that a proportion of respondents had expressed a lower sense of urgency to undergo screening if they were exposed to risk factors associated with HBV and HCV. The findings also showed while two-thirds were aware of the complications associated with viral hepatitis, there was poor awareness on the various stages of liver scarring or fibrosis. Taken altogether, this lower sense of urgency could be reflective of the limited knowledge of the people on different modes of transmission and the associated complications of viral hepatitis.

Besides the knowledge and awareness gaps towards liver diseases, the findings also highlighted additional potential barriers for not seeking timely treatment from hospitals or clinics. These barriers include financial burden (price or lack of insurance or being underinsured), absence of or limited patient-physician communication pertaining to post-diagnosis treatment and follow-ups, hesitancy to take prescription treatment due to the drugs' side effects, the belief that taking prescription medication would disrupt their normal life and the belief that hepatitis is not a life-threatening condition. While these barriers are common among many countries/territories, the various policies implemented differ in their approaches and initiatives towards elimination viral hepatitis.[7,36,42] For example, the quantum of reimbursement varies across countries/territories, such as 50% in Singapore versus 70% in South Korea for prescription medicines for hepatitis B.[43] In Vietnam, where the liver index score was the highest, studies have shown that the financial burden of treating HCV as well as HBV infection is very high and this could be a factor leading an average patient to lack treatment for hepatitis.[44,45] In Taiwan, comprehensive strategies were implemented as early as 2003 towards overcoming the barriers to facilitate prevention, screening, care and treatment against viral hepatitis.[42] Collectively, these suggest that

TABLE 2 Results of the three-step regression analysis

		Single-level logistic regression			Multilevel logistic regression					
		Model 1			Model 2			Model 3[†]		
		OR	95% CI	*p*-value	OR	95% CI	*p*-value	OR	95% CI	*p*-value
Individual-level variable										
Age (ref: less than 25 years old)	*25 – 34 years old*	1.82	(1.56, 2.12)	<.0001	1.83	(1.55, 2.15)	<.0001	1.83	(1.56, 2.15)	<.0001
	35 – 44 years old	1.90	(1.63, 2.23)	<.0001	1.90	(1.61, 2.24)	<.0001	1.90	(1.62, 2.24)	<.0001
	45 – 54 years old	1.57	(1.34, 1.84)	<.0001	1.59	(1.35, 1.89)	<.0001	1.60	(1.35, 1.89)	<.0001
	55 years old and above	1.99	(1.68, 2.34)	<.0001	2.05	(1.72, 2.45)	<.0001	2.06	(1.73, 2.45)	<.0001
Gender	*Female vs. male*	1.23	(1.11, 1.35)	<.0001	1.23	(1.11, 1.36)	0.0001	1.23	(1.11, 1.36)	0.0001
Education (ref: secondary school & below)	*University*	1.60	(1.41, 1.82)	<.0001	1.55	(1.35, 1.77)	<.0001	1.55	(1.36, 1.77)	<.0001
	Postgraduate	1.76	(1.49, 2.08)	<.0001	1.85	(1.55, 2.22)	<.0001	1.88	(1.57, 2.25)	<.0001
Household Income	*High vs. low*	1.34	(1.20, 1.49)	<.0001	1.54	(1.36, 1.75)	<.0001	1.52	(1.34, 1.72)	<.0001
Self-reported ever diagnosed liver disease	*Yes vs. no*	1.87	(1.67, 2.10)	<.0001	1.94	(1.71, 2.18)	<.0001	1.93	(1.71, 2.18)	<.0001
Self-reported last health screening within 2 years	*Yes vs. no*	3.14	(2.81, 3.50)	<.0001	3.98	(3.52, 4.49)	<.0001	3.97	(3.52, 4.49)	<.0001
Specific contextual effect										
HBV prevalence (High vs. Low)								1.83	(1.35, 2.5)	0.0001
80% IOR								(1.20, 2.79)		
POOR								3.2%		
HCV death rate (High vs. Low)								2.05	(1.51, 2.79)	<.0001
80% IOR								(1.35, 3.13)		
POOR								1.4%		
General contextual effect										
Total variance					0.33			0.05		
PCV					Reference			84.8%		
ICC / VPC					9.1%			1.6%		
MOR					1.73			1.25		
AUC			0.70		0.76			0.76		

[†]*There were 12 macro-level variables included in model 3: HBV/HCV prevalence, diagnosed HBV/HCV percentage, HBV/HCV death rate, HBV/HCV infection treated percentage, human development index (HDI), gross domestic product (GDP) and if meet HBV/HCV elimination target in each region. After model selection, only HBV prevalence and HCV death rate were selected in model.*

Abbrivations: AUC, area under the receiver operating characteristic curve; CI, confidence interval; HBV, hepatitis B virus; HCV, hepatitis C virus, ICC, intra-class correlation coefficient; IOR, interval odds ratio; MOR, mean-odd ratio; OR, odds ratio; PCV, proportional change in variance; POOR, proportion of opposed odds ratio; VPC, variance partition coefficient

while it is crucial to raise the knowledge, awareness and attitudes towards liver diseases among the general population, it is also important to improve the availability and affordability of treatment to effectively manage chronic hepatitis infections. Thus, these barriers need to be addressed to ensure easy access to treatment for hepatitis.

However, we would need to consider the limitations of the study. Although translations of the questionnaire were validated by linguists, cognitive testing was not conducted before administering the questionnaire to all respondents. As the findings were derived from the respondents' self-reported data, verification could not be performed, and recall bias could not be excluded. Additionally, other hierarchical structure and macro-level information such as neighbourhoods, socio-economic disparities, for example in Pakistan[46] and India,[47] public healthcare infrastructure, media consumption and information channels were not considered. These factors could be explored in the future to better understand the impact of these factors on the variations in the liver index. Furthermore, individual-level characteristics, such as profession, education, health consciousness and family history, could also account for variations in the liver index.[16,17,48–50]

Our findings quantified the relevance of residing location within Asia to evaluate the general population's knowledge and attitudes towards liver diseases. As the provinces/districts' macro-data were unavailable, the associated specific contextual effects were not investigated. The inclusion of more detailed residing location data could potentially explain for more variations in the overall liver index.

4.1 | Statement of significance

The findings from the liver index survey highlight the need to improve public's knowledge and awareness on hepatitis and mode of transmission of viral hepatitis across the 11 countries/territories through well-designed public awareness programs or social media campaigns; particularly in countries/territories with lower HBV prevalence and HCV death rate where there may have been limited national campaigns advocating the importance of liver-related health and diseases.

Notably, while increasing liver disease awareness, knowledge and attitudes towards screening and treatment uptakes are essential, it is also important for policies to address the barriers of care cascade to improve the ease of accessibility to screening, treatment and care to effectively manage and eradicate viral hepatitis.

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CONFLICT OF INTEREST

BLN, VT and JY are employees of Gilead Sciences. SS is an employee of Kantar Health. All other authors declare no competing interests.

AUTHORS CONTRIBUTION

MHL led and all authors contributed to the design of the study and the analysis. SS contributed to the execution, analysis and led manuscript writing. All authors involved in interpreting the data, contributed to the writing of manuscript, provided input at the writing stage and the final draft, and read and approved the final version of the manuscript.

ETHICAL APPROVAL

The protocol and questionnaire for the survey were reviewed for exemption by the Pearl Institutional Review Board (IRB) and determined to be exempt from IRB review for the periods the data used in the current study. All the respondents who participated in the study provided their consent.

DATA AVAILABILITY STATEMENT

The data sets generated and/or analysed during the current study are available from the corresponding author on reasonable request.

ORCID

Mei Hsuan Lee https://orcid.org/0000-0002-0222-2251
Henry L. Y. Chan https://orcid.org/0000-0002-7790-1611
Tawesak Tanwandee https://orcid.org/0000-0001-7634-0843

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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APPENDIX 1

Descriptive question score

In section 1, the areas that the respondents scored higher were as follows: i) knowledge on how to keep liver healthy (Q2), ii) knowledge of liver health and liver diseases (Q1) and iii) awareness of association of viral hepatitis with liver cancer/failure (Q10, Q11) and WHO statement that viral hepatitis if left untreated could lead to complications such as liver cancer or failure (Q12). More than half knew of healthy liver practices such as by eating balanced diet or going for regular health, including liver function screens (Q2). Over 40% people were knowledgeable about the different functions of liver (Q1). More than half were aware that viral hepatitis is one of the key causes of liver failure (Q10). On the other hand, there were areas that the respondents scored lower in section 1: i) awareness of different types of hepatitis (Q6), ii) knowledge on infectious hepatitis and its mode of transmission (Q8 and Q9) and iii) awareness of various staging of liver scarring/fibrosis (Q13). 49% of the respondents had not heard of hepatitis C and 5% had not heard of any type of hepatitis (Q6). Additionally, only 1 in 10 knew that hepatitis C could not be prevented by vaccination (Q8). Half of the respondents misunderstood that hepatitis B/C is transmitted by eating contaminated or raw seafood, and 60% were not knowledgeable that hepatitis B/C is not transmitted by mosquito bites (Q9). 70% were not aware of various staging of liver scarring/fibrosis (Q13).

The areas that respondents scored higher in section 2 were as follows: i) higher sense of urgency to treat liver disease (Q23, Q24), ii) undergoing health screening tests (Q16 and Q18) and iii) low stigma attached with being diagnosed with hepatitis (Q21). 83% stated that they would be likely undergo treatment upon diagnosis of viral hepatitis (Q23) and 48% of those recently being diagnosed with a liver condition would start treatment right after the diagnosis (Q24). 70% of respondents had health screening within 2 years (Q16) and half of them mentioned their health screening tests included screening for liver diseases (Q18). Among those who were diagnosed with liver conditions, only 31% people felt guilty after being diagnosed, 29% blamed themselves and 26% felt hopeless (Q21). The areas that respondents scored lower in section 2 were as follows: i) low sense of urgency to get tested for hepatitis if exposed to risky conditions (Q15) and ii) many barriers for not accessing treatment (Q22). The full descriptive data are provided in the appendix, and question scores are shown in Figures S4, 5.

APPENDIX 2

Detailed Responses to Questionnaire

Q1 (*N* = 7500) based on your understanding of the function of your liver, please indicate whether you agree or disagree with the following statements	% of agree	% of disagree	% of not sure
Liver helps to clean blood by taking harmful substances out of the blood	86	6	8
Liver stores vitamins and minerals	61	15	24
Liver stores nutrition/energy we take in from food	64	16	19
Liver makes bile that helps digest food	76	12	12
Liver helps with blood clotting, which helps in stopping the bleeding when there is a cut/wound	49	24	27
Liver produces cholesterol which our body needs for normal growth and health	63	14	23
Q2 (*N* = 7500) how can you protect your liver and keep it healthy? Please indicate if you agree or disagree with the following statements	**% of agree**	**% of disagree**	**% of not sure**
By exercising regularly	89	6	5
By eating a balanced diet	94	3	3
By drinking alcohol modestly	62	29	9
By practicing safe sex	77	12	11
Follow directions on all medications	91	4	5
By getting vaccinated	88	5	7
Go for regular screening to keep a check the liver	92	4	5
By taking liver supplements on my own	57	27	16
By sleeping well with good quality of sleep	90	5	5
Q3 (*N* = 7500) what are the conditions you associate with liver disease	**%**		
Hepatitis	71		
Cirrhosis	57		
Fibrosis	32		
Scarring	10		
Hypertension	12		
Fatty liver disease	66		
Dementia	3		
Liver cancer	77		
Non-Alcoholic SteatoHepatitis (NASH)	37		
Diabetes	13		
Q4 (*N* = 7500) based on what you understand about liver diseases, please indicate if you agree or disagree with the following statements	**% of agree**	**% of disagree**	**% of not sure**
Liver diseases are only caused by alcohol consumption	31	61	8
Hepatitis is an inflammation of the liver	73	10	17
Cirrhosis can lead to number of complications including organ failure, liver cancer or death	82	4	14
Long-term injury/inflammation to the liver leads to excessive scar tissue formation called fibrosis	72	5	23
Cirrhosis is the final stage of scarring and it can have a serious effect on the health	69	6	25
Q5 (*N* = 7500) others have told us what do elevated liver enzymes such as AST/ALT levels mean to them. Which of the following applies to you? Please indicate if you agree or disagree with the following statements	**% of agree**	**% of disagree**	**% of not sure**
Elevated AST/ALT levels are main indicators of the damage to the lungs	50	10	40
Elevated AST/ALT levels could indicate infection with viral hepatitis	55	7	37
Elevated AST/ALT levels could indicate risk of liver cancer	59	6	35
Elevated AST/ALT levels are indicators of damage to the liver	62	4	33

(Continues)

APPENDIX 2 (Continued)

Elevated AST/ALT levels could indicate bacterial infection	53	8	39
Elevated AST/ALT levels could indicate risk of having Nonalcoholic steatohepatitis (NASH) or Nonalcoholic fatty liver disease (NAFLD)	57	5	38
Q6 (*N* = 7500) have you heard of the following types of hepatitis	**%**		
Hepatitis B	86		
Hepatitis A	75		
Hepatitis C	51		
Hepatitis D	13		
Hepatitis E	11		
None of the above	5		
Q7 (*N* = 7500) on a scale of 1 to 5 how would you rate your knowledge of Hepatitis	**%**		
Very Poor	11		
Poor	24		
Average	39		
Good	20		
Excellent	7		
Q8.i (*N* = 6482) please indicate if you agree or disagree with the following statements for hepatitis B	**% of agree**	**% of disagree**	**% of not sure**
Hepatitis B is a bacterial infection	52	26	22
Hepatitis B is a viral infection	61	19	21
Hepatitis B can cause chronic inflammation of the liver	85	4	12
Hepatitis B can cause liver failure	83	5	13
Hepatitis B can be prevented by vaccination	75	9	16
Hepatitis B is airborne	25	51	24
Hepatitis B is hereditary	36	40	25
Hepatitis B increases the risk of the development of liver cirrhosis and cancer	82	4	13
Q8.ii (*N* = 3797) please indicate if you agree or disagree with the following statements for hepatitis C	**% of agree**	**% of disagree**	**% of not sure**
Hepatitis C is a bacterial infection	49	29	22
Hepatitis C is a viral infection	61	17	21
Hepatitis C can cause chronic inflammation of the liver	84	6	10
Hepatitis C can cause liver failure	85	5	11
Hepatitis C can be prevented by vaccination	70	13	16
Hepatitis C is airborne	27	50	23
Hepatitis C is hereditary	34	43	23
Hepatitis C increases the risk of the development of liver cirrhosis and cancer	84	5	11
Q9.i (*N* = 6482) please indicate if you agree or disagree with the following statements for transmission of Hepatitis B from one person to another. hepatitis infection can be transmitted by the following means	**% of agree**	**% of disagree**	**% of not sure**
a. By touching an infected person	36	50	14
b. Through sexual intercourse	48	35	17
c. Through blood, for example contact with an open wound	71	17	12
d. By sharing non-sterile needles or through needlestick injuries	77	12	11
e. Faecal oral route usually through contaminated food	61	20	19
f. From pregnant mother to her baby at birth	69	12	18
g. By sharing of razors, toothbrushes	60	21	19
h. By receiving tattoos, body piercing from settings with poor infection control standards	68	15	17
i. By eating contaminated or raw seafood, for example shellfish	54	24	22

APPENDIX 2 (Continued)

j. Having received blood (products) before around 1990s	54	15	31
k. Having received long-term kidney dialysis	46	21	34
l. By mosquito bites	24	50	26
m. By dining together (eg sharing food) with an infected person	47	35	18
Q9. ii (*N* = 3797) please indicate if you agree or disagree with the following statements for transmission of Hepatitis C from one person to another. hepatitis infection can be transmitted by the following means	**% of agree**	**% of disagree**	**% of not sure**
a. By touching an infected person	37	48	15
b. Through sexual intercourse	55	28	17
c. Through blood, for example contact with an open wound	73	14	12
d. By sharing non-sterile needles or through needlestick injuries	78	12	10
e. Faecal oral route usually through contaminated food	61	22	17
f. From pregnant mother to her baby at birth	67	16	17
g. By sharing of razors, toothbrushes	63	20	17
h. By receiving tattoos, body piercing from settings with poor infection control standards	69	16	15
i. By eating contaminated or raw seafood, for example shellfish	50	27	23
j. Having received blood (products) before around 1990s	53	17	30
k. Having received long-term kidney dialysis	47	22	31
l. By mosquito bites	27	49	24
m. By dining together (eg sharing food) with an infected person	47	35	18
Q10 (*N* = 7500) do you know that viral hepatitis is one of the key causes of liver failure in the world	**%**		
Yes	56		
No	24		
Not sure	21		
Q11 (*N* = 7500) do you know that chronic viral hepatitis can cause liver cancer	**%**		
Yes	66		
No	17		
Not sure	16		
Q12 (*N* = 7500) are you aware that World Health Organization (WHO) has stated that viral hepatitis if left untreated could lead to complications such as liver failure or liver cancer	**%**		
Yes	64		
No	21		
Not sure	16		
Q13 (*N* = 7500) are you aware of the various staging of liver scarring/fibrosis	**%**		
Yes	33		
No	67		
Q14 (*N* = 7500) do you know liver fibrosis and cirrhosis is a key determinant of progression for liver disease-related death or ill-health	**%**		
Yes	63		
No	37		
Q15 others have told us what they would do, if the following happens to them	**Extremely unlikely**	**Unlikely**	**Neutral**
i. If I got pricked accidentally by a used needle, then I would go to a doctor and get checked for hepatitis (*N* = 5385)	5	15	20
ii. If I get tattooed or body piercing from a place with low infection control standards, I would test myself for hepatitis. (*N* = 4796)	4	11	18
iii. If I want to be pregnant or if I am pregnant, I would talk to the doctor about being tested for hepatitis (*N* = 2480)	3	4	13

(Continues)

APPENDIX 2 (Continued)

iv. If I have unprotected sex with multiple partners, then I would get screened for hepatitis (*N* = 3578)	4	7	14
v. If I am on long-term kidney dialysis, then I would screen for hepatitis (*N* = 3400)	3	5	15
Q16 (*N* = 7500) when was the last time you did a health screening test	**%**		
Less than a year ago	39		
1–2 years ago	31		
3–5 years ago	12		
5–10 years ago	4		
More than 10 years ago	3		
Never	11		
Q17 (*N* = 799) here are several reasons people have given for not attending health screening tests. Which of the following applies to you	**%**		
Do not see a reason for going for health screenings tests since they feel they are healthy	55		
The doctor did not recommend health screening tests	27		
Health screenings tests are expensive	37		
Health screening tests are not routine	19		
Going for health screening tests is a hassle due to busy schedule	26		
Health insurance does not cover screening	21		
Fear of discrimination at workplace or socially if diagnosed with a disease, for example HIV, cancer, mental illness and hepatitis during health screening	10		
None	1		
Q18 (*N* = 6701) you mentioned you did health screening tests; did it include screening for any liver diseases	**%**		
Yes	55		
No	28		
Do not know/do not remember	17		
Q19 (N = 3713) what kind of liver screening tests did it include	**%**		
Hepatitis A	68		
Hepatitis B	46		
Hepatitis C	31		
Hepatitis D	29		
Autoimmune hepatitis	16		
Alcohol-related liver disease	14		
Fatty liver disease (eg NASH)	9		
Liver cancer	7		
Others	1		
Don't remember	8		
Q20 (*N* = 1871) thinking of the most recent liver condition you have been diagnosed with, when did you start treating your condition after diagnosis	**%**		
Right after diagnosis	48		
1–2 months	18		
3–6 months	11		
More than 6 months	10		
Never had a treatment	14		
Q21 (*N* = 1344) others have mentioned what they felt, when they were diagnosed with Hepatitis. Which of the following applies to you	**%**		
Felt guilty	31		
Blamed others	29		
Blamed themselves	26		

APPENDIX 2 (Continued)

Felt hopeless	24
Felt ashamed	18
Felt helpless	15
Had a fear of discrimination by family or friends or workplace etc.	15
Find a cure	0
Ordinary	0
Optimistic	0
None of the above	17
Q22 (*N* = 706) others also mentioned that these are the reasons for not receiving treatment from a hospital/clinic. Which of the following statements applies to you	**%**
Prescription treatment was too expensive	73
Did not believe in Western medicine	45
Did not believe that the condition was life-threatening	56
Was hesitant because of the side effects	62
Was hesitant because it would disrupt normal life	62
Doctor did not prescribe any treatment	54
Doctor was not able to explain the treatment plan clearly	54
Prescription medicine was not available in our area	53
Was unable to receive treatment because of lack of insurance or being underinsured	56
Doctor recommends observation and follow-up without initiating treatment	63
Q23 (*N* = 7500) if you were diagnosed with viral hepatitis how likely are you to undergo treatment	**%**
Extremely unlikely	4
Unlikely	3
Neutral	10
Likely	27
Extremely likely	56
Q24 (*N* = 4777) now, knowing that viral hepatitis if left untreated could lead to complications such as liver failure or liver cancer, if you were diagnosed with viral hepatitis, how likely are you to undergo treatment	**%**
Extremely unlikely	4
Unlikely	2
Neutral	7
Likely	22
Extremely likely	65
Q25 (*N* = 7500) which of the following tests are you aware of for diagnosis of Hepatitis B and C	**%**
Anti-HCV antibody test	46
Liver function tests such as liver enzyme levels [AST/ALT levels]	33
HBsAg test	24
Not sure	1
None of the above	28