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Knowledge, attitudes, practices and prevalence of hepatitis B and C and hepatitis B vaccination coverage among public sector healthcare workers in Cambodia

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Abstract: Healthcare workers (HCWs) are a key population at high risk for hepatitis B (HBV) and hepatitis C (HCV) infections. We aim to study HBV vaccination coverage, seroprevalence, knowledge, attitudes, and practices towards HBV and HCV infections among HCWs in public sector in Cambodia. A nationally representative cross-sectional study was implemented in 2019, among Cambodian HCWs. A standardized questionnaire was administered to randomly selected HCWs whose blood was then sampled. We used univariate and multivariate regression to determine predictors of outcomes. Among 755 participants, we found 4.9% positive HBsAg and 2.3% positive anti-HCV Ab. HBV vaccination coverage was 59.3%. Lack of knowledge was found on the route of transmission, HBV vaccination, diagnosis and treatment of HBV and HCV. 67% of HCWs thought that all patients should be screened for HBV and HCV and about 30% of them would refuse to take care of infected patients. 58% of HCWs always recapped the needle after use. In univariate analysis, older age-group (> 50 years) is more likely to have positive anti-HCV (OR: 9.48; 95% CI: 2.36–38.18). HCWs who were younger, female or having higher education or having ever been tested, were more likely to have gotten HBV vaccinated. Multivariate analysis reconfirmed these predictors of getting vaccinated. Study findings indicated an urgent need of a national policy for Cambodian HCWs given the high prevalence of hepatitis among this group. Policy should include an effective in-service training program to improve knowledge and practices, a testing and vaccination program for HCWs and it should emphasize stigma intervention towards people living with HBV/HCV.

***Keywords*:** HBV, HCV, healthcare workers, vaccination, Cambodia

Introduction

Hepatitis B virus (HBV) and hepatitis C virus (HCV) infection is a major global public health problem responsible for liver damage including cirrhosis and hepatocellular carcinoma. World Health Organization estimated that 257 million people were living with chronic HBV infection and 75 million were living with chronic HCV infection, and 1.34 million died from HBV and HCV related complications, such as liver cirrhosis and hepatocellular carcinoma (HCC) (*1*). In Cambodia, viral hepatitis is responsible for 44.3% of HBV-associated primary liver cancer, and 43% of HCV-associated primary liver cancer among HCC patients (*2*). Epidemic modelling in 2017 estimated 3% prevalence of chronic HBV infection and 1.6% prevalence of chronic HCV infection in general Cambodians (*3*). HBV vaccination coverage among children is high in Cambodia with 81.5% of newborns having received birth dose administration during the first 24h and 98.3% got 3rd dose vaccination in 2021 (*4*). A Cambodia nationwide HBV serosurvey conducted in 2017 revealed 0.56% HBsAg positivity among children aged 5–7 years (*5*), emphasizing the success of the HBV immunization program held by the National Immunization Program (NIP).

Although Cambodia has made significant progress with hepatitis B immunization for infants, no national policy for vaccinating healthcare workers (HCWs) has been developed to date. HCWs are at higher risk for HBV or HCV infection because of exposure to blood and body fluids, usually through needle-stick

injuries, with an estimated range of 5% to 36% of HBV infections and 27% to 41% of HCV infections attributed to contaminated sharp injuries among HCW in the Western Pacific Region (*6*). The Regional Action Plan for Viral Hepatitis in the Western Pacific 2016–2020 calls for establishment of national policies for vaccinating HCWs against HBV in over 80% of countries by 2017 and of HCWs, medical students in all countries and areas by 2020 (*7*). Furthermore, direct-acting antivirals (DAAs), which effectively cure HCV infection provide a great opportunity to control and eventually eliminate HCV as a public health threat. However, the rate of HBV vaccination for Cambodian HCWs and their HBV and HCV prevalence remains unknown. To inform the national responses to properly address viral hepatitis prevention in health facilities in Cambodia, we undertook a study to assess data and policy gaps in HBV vaccination for Cambodian HCWs and determine knowledge, attitude and practice (KAP), and seroprevalence of HBV and HCV among HCWs.

Materials and Methods

Study setting and population

A nationally representative cross-sectional survey was conducted from July to September 2019 among HCWs in public healthcare services of Cambodia. A two-stage cluster sample was designed to first randomly select public healthcare institutions including Operational District and National hospital (OD/NH) geographical clusters, and then select participants among HCWs from those healthcare facilities within each selected OD/NH clusters. Among 100 Operational Districts and 8 National Hospitals across Cambodia, 26 clusters were selected to enroll in the study. HCWs were randomly selected from the most up to date staff lists of each selected cluster. HCWs in the study included medical doctors, nurses, midwifes, pharmacists, dentists, laboratory technicians, radiology technicians, physiotherapists, administration staffs, janitorial, security and all other staffs registered in staff lists.

Sample size

Sample size calculations assumed 5% prevalence of HBV and 50% HBV vaccination coverage among HCWs at a 95% level of significance, a design effect of 1.5 and 10% nonresponse rate. The target sample size was 761. Thirty HCWs were recruited from each of the 26 selected clusters.

Data collection

After obtaining informed consent, data on KAP towards HBV vaccination, HBV and HCV infection, prevention and treatment were obtained through face-to-face interviews using structured questionnaires by twenty teams (1 team supervisor, 2 interviewers and 1 phlebotomist).

Laboratory testing and interpretation

Blood samples were collected from each participant and tested on site for the presence of HBV surface antigen (HBsAg), HBV surface antibody (anti-HBs), and HCV antibody (anti-HCV) using SD Bioline rapid tests (Ref. 01FK10, 01F20 and 02FK0, respectively). Remaining sera were sent to Rodolphe Mérieux laboratory of the University of Health Sciences in Phnom Penh capital for further laboratory analyses to detect the presence of IgM antibody to HBV core antigen (IgM anti-HBc) and total HBV core antibody (total anti-HBc) by ELISA Biocentic Kits (Ref. 4CME3 and 4CBE3, respectively) and for HCV RNA viral load by Real-time PCR using HCV PUMA PCR Kit (Omunis, ref. OPK2-100).

HBV and HCV infection status was interpreted as follows: susceptible to HBV infection (negative for HBsAg, total anti-HBc and anti-HBs); immune due to natural infection (HBsAg negative, total anti-HBc positive, and anti-HBs positive); immune due to vaccination (HBsAg negative, total anti-HBc negative, and anti-HBs positive); acute HBV infection (positive for HBsAg, total anti-HBc and IgM anti-HBc and negative for anti-HBs); chronic HBV infection (positive for HBsAg and total anti-HBc and negative for anti-HBs and IgM anti-HBc); past HCV infection (anti-HCV positive and HCV RNA negative) and chronic HCV infection (positive for anti-HCV and HCV RNA). Overall HBV vaccination coverage was defined as self-reported to having completed three doses of hepatitis B vaccination or having obtained immunity from natural infection or vaccination.

Statistical analysis

Data were analyzed by weighing statistics using STATA v.15 and presented as percentage or odd ratio (OR) with 95% confidence intervals (CI). We conducted a univariate analysis to measure the association of the outcomes with socio-demographic and KAP factors. Only risk factors with significant association (p-value < 0.05) were further analyzed using a Binary logistic regression model to check the association between HBV/HCV prevalence or HBV vaccination coverage with other important predictors including age, sex, education level, current profession and working exposure.

Ethical considerations

Ethical clearance was obtained from the National Ethic Committee for Health Research (NECHR, N°. 320) of the Cambodia Ministry of Health and the Ethical

Review Panel of the World Health Organization Regional Office for the Western Pacific (WPRO-ERC, N°.19.7.Cam.1.HIS). This study was conducted in accordance with the Declaration of Helsinki. Informed consent was obtained from each participant regarding the blood sample and the use of his or her data for research purposes.

Results

Sociodemographic characteristics of study participants

A total of 755 HCWs consented to participate in the study while 745 HWCs accepted providing blood samples. Twenty-five HCWs refused to participate in the study. Table 1 describes study participant characteristics. The gender proportion is very similar to the whole HCWs population in Cambodia. The majority of participants were nurses (42.7%), followed by midwives (30.2%) and medical doctors (10.0%). With respect to the highest education attained, 44.4% of participants hold an associate degree and 12.6% a bachelor's degree. Most participants (60.9%) reported a monthly income between 250–500 USD. With respect to years spent in the current job position, 23.1% reported 2–5 years, 25.6% reported 5-10 years and 27.8% reported over 20 years.

Knowledge of HBV and HCV

HCWs have ever heard of HBV for 97.2% (95% CI: 95.9–98.1) and of HCV for 95.7% (95% CI: 94.1–96.9). Participants answered correctly for up to more than 90% on transmission not through mosquito or insect bites, on transmission route through syringe or needle sharing, or blood transfusion (Table 2). Only 36.3% and 42.6% of participants knew that HBV and HCV respectively could not be transmitted by just eating with

Table 1. Sociodemographic and occupational characteristics of HCWs participants

Participant characteristics	*n* = 755	%	(95% CI)
Gender			
Male	340	45.0	(40.1–50.0)
Female	415	55.0	(50.0–59.9)
Age (Years)			
20–34 Year	380	50.4	(43.6–57.2)
35–49 Year	215	28.2	(24.4–32.4)
50–64 Year	154	20.7	(16.6–25.5)
≥ 65 Year	6	0.7	(0.3–1.9)
Marital Status			
Single	127	16.7	(13.2–20.9)
Currently married	589	78.0	(73.5–81.9)
Living together, not married	4	0.5	(0.2–1.8)
Separated/Divorced	5	0.7	(0.2–1.9)
Widowed	28	3.8	(2.3–6.2)
No response	2	0.3	(0.1–1.3)
Profession			
Medical Doctor	77	10.0	(6.8–14.5)
Nurse	320	42.7	(42.7–48.0)
Midwife	224	30.2	(24.3–36.9)
Dentist	5	0.7	(0.3–1.7)
Pharmacist	8	1.0	(0.5–2.2)
Laboratory technician	17	2.3	(1.5–3.4)
Radio technician	4	0.6	(0.2–1.5)
Physiotherapist	2	0.3	(0.1–1.2)
Administrator	16	2.1	(1.1–3.9)
Janitorial	22	2.9	(1.3–6.6)
Security and Labor Unit	16	2.0	(1.1–3.5)
Unknown (other)	44	5.4	(3.5–8.4)
Highest education attained			
Doctoral degree	14	1.9	(1.1–3.3)
Master's degree	10	1.3	(0.7–2.6)
Specialized doctoral degree	25	2.8	(1.2–6.5)
General Practitioner/General Dentist	44	6.0	(3.9–9.1)
Bachelor's degree	98	12.6	(9.8–16.1)
Associate degree	332	44.4	(37.2–51.9)
Primary level Professional degree	97	13.2	(9.1–18.8)
High school	39	5.1	(2.6–9.7)
Secondary school	32	4.2	(2.8–6.3)
Primary school	25	3.3	(1.8–5.9)
No education	22	2.9	(1.0–8.4)
Don't know	5	0.7	(0.2–1.9)
No response	12	1.5	(0.7–3.1)

Table 2. Proportion of HCWs correctly answering questions on transmission of HBV and HCV, HBV vaccination, diagnosis and treatment and guideline

Correctly answered	HBV		HCV	
	%	(95% CI)	%	(95% CI)
Knowledge on transmission and prevention of HBV/HCV				
1. HBV/HCV is a viral infection.	77.9	(73.3–81.8)	74.1	(67.9–79.4)
2. Someone infected with HBV/HCV can look healthy.	70.7	(64.5–76.3)	66.7	(60.4–72.5)
3. Eating with HBV/HCV infected people, will not get him/her also infected.	36.3	(31.9–40.9)	42.6	(38.2–47.2)
4. HBV/HCV can be transmitted through unprotected sex.	80.1	(75.7–83.9)	77.8	(72.8–82.1)
5. HBV/HCV cannot be transmitted through sneezing, coughing & spitting.	57.1	(52.4–61.7)	58.8	(53.6–63.9)
6. HBV/HCV cannot be transmitted through Mosquito / insect bite.	91.2	(88.0–93.5)	89.4	(85.7–92.3)
7. HBV/HCV can be transmitted through sharing needles and syringes.	95.7	(93.8–97.1)	95.0	(92.9–96.5)
8. HBV/HCV can be transmitted through blood transfusion.	96.6	(95.0–97.8)	96.4	(94.3–97.7)
9. HBV/HCV can be transmitted from mother to child through breastfeeding, during birth process and in utero.	17.4	(11.7–25.1)	16.0	(10.9–22.7)
10. HBV/HCV infection is preventable.	96.7	(94.5–98.0)	75.0	(68.7–80.4)
11. HBV/HCV infection could be prevented by using condom when having sexual intercourse.	77.5	(73.7–80.9)	79.1	(75.4–82.4)
12. We cannot prevent HBV/HCV by just avoiding touching HBV/HCV infected person.	73.9	(67.0–79.8)	73.7	(66.7–79.6)
13. HBV/HCV infection can be prevented by not sharing needle & syringe.	91.4	(87.4–94.3)	91.1	(86.7–94.2)
Knowledge on HBV vaccination				
14. Ever heard about HBV vaccination.	98.1	(96.9–98.8)		
15. Vaccination can protect a person from HBV infection.	92.2	(88.7–94.7)		
16. HBV vaccine cannot protect all types of liver diseases.	86.5	(83.0–89.4)		
17. An adult should receive 3 doses of HBV vaccination to be effective.	56.6	(50.2–62.8)		
18. A child should receive 3 doses of HBV vaccination to be effective.	40.2	(33.8–47.1)		
19. An infant should receive their first dose of hepatitis B vaccine within 24 hours after birth.	91.5	(85.7–95.1)		
20. A full dose of hepatitis B vaccine can protect someone for ≥ 20 years.	37.1	(30.2–44.6)		
Knowledge on HBV/HCV diagnosis and treatment				
21. Symptoms of HBV infection are jaundice, nausea, vomiting, loss of appetite, no symptom.	7.3	(4.2–12.3)	7.1	(4.1–12.1)
22. We can tell that someone is infected by HBV/HCV by testing blood.	98.4	(95.8–99.4)	97.8	(95.8–98.9)
23. There is a treatment available for HBV/HCV infection.	72.7	(64.8–79.4)	81.2	(74.7–86.4)
24. HBV is not curable / HCV is curable.	36.9	(32.2–41.8)	71.4	(65.5–76.7)
25. A treatment for chronic HBV infection is a long-life treatment.	72.9	(68.8–76.5)		
Knowledge on HBV/HCV guideline				
26. There is a national guideline for treatment of HBV/HCV infection in Cambodia.	41.5	(33.7–49.7)	44.7	(36.8–52.8)
27. Has Cambodia got a national immunization program that includes vaccination for HBV? vaccination for HCV?	93.6	(88.0–96.7)	71.6	(65.2–77.2)

HBV/HCV infected people. Only 57.1% and 58.8% knew that HBV and HCV respectively could not be transmitted through sneezing, coughing and spitting. Less than 20% answered correctly for the possible transmission route from mother to child by breast feeding, during birth process and in utero, with 66.3% (95% CI: 58.2–73.5) of respondents not knowing that HBV can be transmitted in utero (data not shown) and being mostly medical staffs (69% of medical doctors, 69% of nurses and 65% of midwifes). Around 78% answered correctly that using a condom during sexual intercourse is an infection protection. More than 90% knew that the vaccination could protect someone from HBV infection. But only 56.6% and 40.2% answered correctly that 3 doses of HBV vaccine were effective to protect an adult and a child respectively. Only 37.1% knew that a full dose of HBV vaccine could protect someone for > 20 years. For the diagnosis and treatment theme, more than 97% knew that blood testing is a mean to detect an infected patient. Less than 10% knew all correct clinical symptoms of HBV/HCV infection with 67.2% and 69.4% of respondents not knowing that HBV and HCV respectively would have no symptoms. 36.9% knew that HBV was not curable while 71.4% knew that HCV was curable. Less than 50% of participants knew there was a national treatment guideline for HBV and HCV infection.

Among the 755 respondents, up to 87% thought that their current workers were at risk of being infected with HBV/HCV and more than 95% answered that they

would join the profession even though knowing the risk. Almost all participants thought that HCWs should be tested for HBV/HCV and they were also willing to test for it. Around 67% thought that all patients should have been screened for HBV/HCV and 51% thought that infected patients should have been separated from others. Around 67% answered that they would accept taking care of infected patients. Around 88% thought that HCWs infected with HBV/HCV should be allowed to work. For vaccination, 16% of participants still thought that HBV vaccine was slightly effective but 99% were willing to get the vaccination. There was a very high demand (> 99%) for getting treatment and up to 85% answered they would go to a public hospital (Table 3).

Around 57.7% responded that they always recapped needles after uses, putting them at a higher risk of needle stick injury. About half (46.7%) reported ever been vaccinated for HBV and 80% got a vaccination at private facilities (Table 4).

Prevalence of HBV and HCV infection

Among 745 participants who accepted providing blood samples, 4.9% (95% CI: 3.6–6.6) and 2.3% (95% CI: 1.6–3.2) were positive for HBsAg and for anti-HCV respectively but there was no coinfection. We found 3.8% (95% CI: 2.7–5.2) chronic HBV infection, 1.1%

Table 3. Attitude answers on HBV and HCV

Questions on attitude	"yes" for HBV		"yes" for HCV	
	%	(95% CI)	%	(95% CI)
Attitude towards HBV/HCV risk exposures / susceptibility				
1. Think that his/her current work is at risk of being infected with HBV/HCV.	88.0	(84.5–90.8)	87.3	(83.4–90.4)
2. He/she would join this profession though knowing the potential risks of exposure to HBV/HCV.	95.8	(93.2–97.5)	95.7	(93.2–97.3)
Attitude towards HBV/HCV Testing and infected patients				
3. He/she think that all healthcare workers (HCWs) should be tested for HBV/HCV infection.	96.8	(95.2–97.9)	96.3	(94.7–97.4)
4. He/she is willing to be tested for HBV/HCV infection.	98.8	(97.0–99.6)	98.8	(97.0–99.5)
5. To avoid contamination to/from patients, it is important to screen HBV/HCV on all patients.	67.0	(60.1–73.2)	67.1	(60.3–73.3)
6. He/she would accept if being asked to take care of HBV/HCV infected patients.	67.6	(61.6–73.1)	66.8	(60.9–72.2)
7. He/she think that an HBV/HCV infected patient should be taken care separately from other patients.	51.9	(45.5–58.2)	51.7	(45.3–58.0)
8. Think that if a HCW was infected with HBV/HCV, he/she would be at risk of transmitting HBV/HCV to patients.	56.8	(50.5–62.8)	55.4	(49.3–61.3)
9. Think that HCWs infected with HBV/HCV should be allowed to work.	88.4	(84.5–91.3)	88.3	(84.8–91.2)
Attitude towards HBV vaccination				
10. Think that all HCWs who are working directly with patients should be vaccinated for HBV.	98.0	(95.9–99.0)		
11. He/she is willing to get vaccination, if not yet infected.	99.0	(97.8–99.6)		
12. He/she think that, in protecting someone against HBV infection, HBV vaccination is:				
Very effective	78.3	(74.1–81.9)		
Slightly effective	16.0	(12.9–19.6)		
Not effective	0.6	(0.6–1.8)		
13. He/she think that all infants shall get HBV vaccine.	99.6	(98.6– 99.9)		
Attitude towards HBV treatment/ seriousness				
14. If found infected with HBV/HCV, he/she is willing to go for further investigation and treatment.	99.6	(98.6–99.9)	99.7	(98.7–99.9)
15. For HBV/HCV treatment, he/she would go to:				
Public hospital	84.8	(78.4–89.5)	85.1	(79.3–89.5)
NGO clinics	7.5	(4.6–12.0)	7.8	(5.1–11.6)
Private hospital/clinic	4.3	(2.9–6.4)	3.8	(2.4–6.0)
In another country	2.7	(1.5–4.8)	2.5	(1.4–4.2)
16. If found chronically infected with HBV/HCV, he/she would be worried the most about:				
Developing liver cancer	46.5	(40.1–53.1)	47.4	(41.1–53.8)
Transmission to family	27.2	(21.8–33.4)	26.5	(20.9–32.9)
Death	12.3	(8.3–17.7)	12.2	(8.4–17.6)
No effective treatment	6.3	(4.4–9.1)	5.8	(3.9–8.6)
High cost of treatment	5.8	(4.0–8.2)	5.2	(3.5–7.6)

Table 4. Practice answers on HBV and HCV

Questions for Practice	Response "yes"	
	%	(95% CI)
Practice on prevention and vaccination		
1. He/she has ever tested for HBV infection.	72.0	(66.1–77.2)
2. He/she has ever tested for HCV infection.	55.8	(48.3–63.1)
3. Ask his/her barber to change to new blade, every time he/she has haircut:		
Always	77.1	(70.4–82.6)
Never	13.1	(9.2–18.3)
Sometimes	6.2	(3.8–9.9)
4. Ask beauty salon staff to use clean nail cutter, every time she has her nail cut:		
Always	66.7	(57.1–75.1)
Never	7.3	(4.7–11.2)
Sometimes	4.6	(2.9–7.3)
5. He/she recap needle after usage in everyday practice:		
Always	57.6	(49.4–65.4)
Never	29.9	(23.3–37.4)
Sometimes	9.3	(6.5–13.2)
6. He/she has ever been vaccinated against HBV.	46.7	(40.5–53.1)
7. If vaccinated, he/she got injection of:		
≥ Three doses	81.6	(77.1–85.5)
Two doses	11.0	(8.0–14.9)
One doses	5.9	(4.0–8.6)
8. After receiving the last dose of HBV vaccine, he/she has checked anti-HBs Ab.	73.5	(68.2–78.2)
9. He/she received the last HBV vaccine at:		
Private hospital/clinic	79.7	(71.2–86.2)
Public facility	18.6	(12.1–27.5)

(95% CI: 0.6–2.0) acute HBV infection and 0.9% (95% CI: 0.4–2.1) active HCV infection among all HCWs. Among positive HBsAg HCWs, HBV acute infection was 22.2%.

HBV vaccination coverage

Serological markers showed 21.6% (95% CI: 18.3–25.4) immunity due to natural infection, 24.9% (95% CI: 20.7–29.7) immunity due to vaccination and 38.8% (95% CI: 33.0–45.0) immunity on 3 doses reported. The overall HBV vaccination coverage was 59.3% (95% CI: 53.1–65.2).

Factors associated with HBV and HCV infection and HBV vaccination coverage

Univariate analysis found no significant association between HBsAg positive with socio-demographic variables, nor with work exposure, nor with KAP outcomes in the study. However, the prevalence of anti-HCV positive was seven times higher in the old age group (≥ 50 years old) compared to other age groups (OR = 9.5, 95% CI: 2.4–38.2, p = 0.003). For HBV vaccination coverage, the study showed that the young age group (20–34 years old) was more likely to have gotten vaccinated compared to old age groups (35–49 and ≥ 50 years old) (Table 5). Females are also more likely to have gotten vaccinated compared to males (OR = 1.7; 95% CI: 1.2–2.5, p = 0.008). Participants with education above high school were more likely to have gotten vaccinated compared to those with high school level and below. For professions, nurses, janitorial and security were less likely to have gotten vaccinated if compared to medical doctors (Table 5). No statistically significant association was found between HBV vaccination coverage and work exposure to blood and other body fluids. When analyzing with KAP variables, participants who answered being ever tested for HBV infection were seven times more likely to have gotten vaccinated when compared to other participants (OR = 7.2, 95% CI: 4.9–10.7, p = 0.0001). Multivariate analysis reconfirmed that younger age group, females, and higher professional categories are predictors of getting vaccinated (Table 5).

Discussion

Study results reveal low knowledge on HBV/HCV route of transmission. A quarter of HCWs wrongly knew that eating and touching were routes of transmission, similar to a recent finding among HCWs in Vietnam regarding HBV transmission (*8*). This might potentially lead to discrimination of HCWs from providing care to HBV/HCV infected patients as previously seen in HIV infected patients (*9*). Route of transmission from mother to child in utero was also not well known by HCWs, in particular medical doctors, nurses and midwifes who should have been well trained about this transmission route, so that they would take preventive measures of testing, and treatment prior to antennal care (*10*). However, they are HCWs at the front line

Table 5. Univariate and multivariate analysis with significant associated outcomes

Variables	*n*	%	Crude association		Adjusted association	
			OR	(95% CI)	AOR	(95% CI)
Outcome: Vaccination coverage						
Association with socio-demographic variables						
Age	754					
20-34		66.9	1.0	-	1.0	-
35-49		54.6	**0.6**	(0.4–0.9)	**0.7**	(0.5–1.0)
≥ 50		47.4	**0.5**	(0.3–0.7)	**0.5**	(0.3–0.7)
Sex	754					
Male		52.2	1.0	-	1.0	-
Female		65.0	**1.7**	(1.2–2.5)	**2.1**	(1.4–3.2)
Education level	737					
High School and Below		41.9	1.0	-		
Above High School		62.8	**2.3**	(1.4–3.9)		
Current profession	754					
Medical Doctor		68.6	1.0	-	1.0	-
Nurse		57.7	**0.6**	(0.4–0.9)	**0.6**	(0.3–1.0)
Midwife		64.1	0.8	(0.4–1.6)	**0.4**	(0.2–0.7)
Dentist		81.2	1.9	(0.2–21.6)	1.4	(0.1–13.3)
Pharmacist, RadioTech, Physio		84.6	2.5	(0.6–11.3)	2.1	(0.4–10.4)
Laboratory technician		66.2	0.9	(0.3–2.6)	0.8	(0.2–2.4)
Administrator		51.2	0.5	(0.2–1.2)	0.5	(0.2–1.5)
Janitorial		27.8	**0.2**	(0.1–0.5)	**0.1**	(0.0–0.4)
Security & Labor		22.3	**0.1**	(0.0–0.5)	**0.2**	(0.0–0.5)
Other (unknown)		46.5	**0.4**	(0.2–0.7)	**0.3**	(0.2–0.7)
Work exposure	747					
Minimum Exposure = 1		57.3	1.0	-		
Medium blood exposure = 2		57.8	1.0	(0.7–1.5)		
High blood exposure = 3		65.3	1.4	(0.8–2.4)		
Association with KAP variables						
Have you ever tested for HBV infection?	754	72.3	**7.2**	(4.9–10.7)		

Note: OR and AOR numbers in bold indicate significant association between outcomes and predictors.

with low knowledge of this transmission route and would put infants at high risk of becoming HBV infected ranging from 70% to 90%, especially when mothers have high HBV load or are HBeAg positive (*11*). While almost all HCWs knew that HBV was preventable, only a quarter responded that HCV could be prevented. This is possibly because respondents were attributing prevention of transmission only to the existence of vaccines, rather than considering all potential preventative measures of blood-borne diseases. The results surprisingly showed that only around 80% of HCWs knew that unprotected sex was a route of transmission while 20% did not know, and those included 6% of medical doctors, 22% of nurses and 15% of midwifes (data not shown). There were still up to 30% of HCWs who did not know that HCV is treatable but fortunately, 90% of medical doctors got the correct answer (data not shown). To improve the knowledge of HCWs, the 1st national strategic plan (2020–2024) for viral hepatitis B and C has set specific action plans, which include increasing awareness of hepatitis infection to HCWs by integrating the prevention and treatment of viral hepatitis into the existing training curriculum for all healthcare providers, providing in-service training and integrating content on prevention and treatment of viral hepatitis into the National Infection Prevention Control (IPC) program (*12*).

Regarding HCW's attitude, positive responses to their wanting for HCWs to be tested for HBV/HCV and willingness to be tested and vaccinated, indicate that a national policy would be welcomed by Cambodian HCWs. However, we are concerned that a smaller number of HCWs want all patients to be tested that may indicate some stigma (*13*) to be addressed in the national policy. So awareness needs to be raised that HCWs can be protected without compromising equal treatment of patients, to prevent potential stigma and discrimination of patients in the health care setting.

The national immunization program (NIP) provides free HBV vaccine to newborns in public healthcare facilities up to the 3rd dose. The NIP began in 2001 and became universal in the country in 2005 (*14*). This indicates that all HCWs participants in this study were not covered by this Universal coverage immunization program, because they were older than 20 years old at the study time, 2019. Today HBV vaccination for 3 doses could cost around 30$, so it appears expensive if compared to their monthly incomes between $250–500 for 61% (95% CI: 52.5–68.8), so there would be a need for free vaccination or at least an affordable price in the national policy. This vaccination policy would apply

across the public and private health workforce, given that 25% of HCWs work also in the private sector (data not shown). The HBV vaccination coverage found is similar to some recent studies among HCWs in Asian countries (*15,16*).

High acute HBV prevalence indicates IPC problems. As expected, the HBV prevalence among HCWs is higher than among the general population (4.9% *vs.* 3.0%, respectively). However, this prevalence was slightly lower compared to studies among HCWs in neighboring countries (*17-19*). Risk factors associated with HBV/HCV prevalence was not found. The lack of significance associated with a positive HBsAg was not surprising, because the infection may occur during childhood (*20*). The seroprevalence of HCV among HCWs and among the Cambodian general population was similar (2.3 *vs.* 2.6%, respectively) (*21*). Surprisingly, the HCV viremic prevalence was even lower among HCWs than among Cambodian general population (0.9 *vs.* 1.9%, respectively) (*21*). The older ages (≥ 50 years) seemed to be the main risk factor associated with the HCV seroprevalence in HCWs addressing that DAA medicines shall be included in the national policy for HCWs and make the medicine available to protect and cure HCWs.

As another IPC concern, the study still found risks of infection due to HCWs practicing recapping needles after use. This inappropriate behavior might be a result of the lack of sharp boxes available in the setting in remote areas as noticed on site by the study teams. These IPC issues might be supported by high acute HBV infection (22%) among positive HBsAg HCWs, addressing IPC is still very critical for the health care setting given the high proportion of those who are recently infected.

The study provides first-time data of HBV and HCV well representative for general HCWs based on HCWs' data of the Ministry of Health in 2019. However, it has several limitations. Some parts of IPC questionnaires were missing, so we could not conclude the actual link between HBV high prevalence and practical issues of HCWs. Finally, overall HBV vaccination coverage included self-reported data of having completed three doses of HBV vaccine without proof of vaccination card, which might be subject to recall bias.

Conclusion

Findings from the study indicated an urgent need of a national policy for Cambodian HCWs given the high prevalence of hepatitis among this group and an annual action plan to implement that policy in order to strengthen the capacity of HCWs through in-service training programs for health professionals. The policy should also include a testing strategy and vaccination program for HCWs. There is need to ensure a strong policy on stigma and discrimination towards people living with HBV/HCV, including in healthcare settings.

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