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RESEARCH PAPER

Prevalence and factors associated with hepatitis B virus infection among household members: a cross-sectional study in Beijing

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ABSTRACT

HBV prevention and control presents a global public health priority because of the tremendous economic and healthcare burdens involved. This study was designed to investigate the status of HBV epidemics among household members, and to analyze the risk factors of HBV infection in couples and their offspring. A total of 1,035 couples and 541 offspring were included. We sourced the data from a population-based serological survey conducted by the Beijing Center for Disease Prevention and Control in 2014. Chi-square test and multiple logistic were used to assess differences in the prevalence of categorical variables, and identify risk factors for HBV infection and exposure in couples and offspring after controlling for confounding factors. In couples, the prevalence of chronic HBV infection was 4.3% and the prevalence of exposure 32.7%. The prevalence of chronic HBV infection in offspring was 0.9%, and the prevalence of exposure 8.7%. Sharing syringes with others and living with a spouse who was infected or exposed to HBV were associated with a significantly higher risk for transmission of HBV for couples. In offspring, maternal HBV infection was a significant risk factor for HBV exposure. This study provides evidence that having household members infected or exposed to HBV increases the risk of HBV transmission, and in order to achieve better control of HBV infection effective strategies must be established to prevent intra-familial transmission.

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Introduction

Hepatitis B virus (HBV) is a major public health issue worldwide. An estimated 250 million people are living with chronic HBV infection globally, despite the availability of vaccines and antiviral treatment.[1,2] Moreover, a substantial number of chronic HBV carriers will progress to develop a broad spectrum of disease outcomes including liver cirrhosis and hepatocellular carcinoma, and an estimated 0.5 to 1.2 million people die from HBV-related liver disease annually.[3–6] Therefore, in 2015, combating viral hepatitis by 2030 was included in the Sustainable Development Goals (3.3).[7] The Global Health Sector Strategy for Viral Hepatitis was also adopted by the World Health Assembly in 2016, one of the goals of which was to eliminate HBV and hepatitis C virus by 2030.[8]

China has the world's largest HBV infection burden, with an estimated 75 million people chronically infected,[2,9] accounting for almost a third of the global total HBV infections.[10] As a result, HBV has long been a public health threat and has induced substantial social panic in China.[11,12] The Chinese National Hepatitis Seroepidemiological Survey[13] found that hepatitis B endemicity in China shifted from high to intermediate after the implementation of effective nationwide vaccination programs, but it also suggested no obvious change in prevalence in adults aged 20–59 years. Beijing, as the capital of China, enjoys abundant high-quality medical resources. But it provides medical services to a large migrating population at the same time, which complicates the status of hepatitis B infection and transmission and aggravates the difficulty of prevention and control.

Previous research have shown that a family history of chronic hepatitis B is evidently a risk factor for HBV infection in developing countries such as China,[14–16] and the prevalence of familial HBV transmission may vary depending on geographical location, history, family religious beliefs, and social customs.[17–19] This study based on a large-scale cross-sectional household survey in Beijing was designed to analyze the current status of the hepatitis B epidemic and the risk factors associated with HBV infection and exposure among household members.

Materials and methods

Study design and study participants

We performed the current cross-sectional study to investigate rates of HBV infection and HBV exposure, and risk factors associated with HBV infection and exposure, with a particular focus on intra-familial contact. The data were from a serological survey conducted by the Beijing Center for Disease Prevention and Control in 2014. The survey included structured questionnaire and blood specimens test. All participants or their guardians completed questions about their socio-demographic characteristics, risk behaviors and self-reported HBV immunization histories. Blood

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specimens were collected to screen for the presence of HBsAg, anti-HBs, HBeAg, anti-HBe and anti-HBc by microparticle enzyme immunoassay (AXSYM Plus; Abbott America). We obtained written inform consent from each adult or parent/guardian of each child, and the participants' identifications were removed before the analysis. That survey included 6,705 individuals aged > 1 year, and the respondents were randomly selected from 20 communities in 10 districts in Beijing. Of the 1,050 couples initially screened for inclusion in this study, 15 were subsequently excluded due to a lack of data pertaining to socio-demographic characteristics or HBV seromarkers. Thus, a total of 1,035 couples were ultimately enrolled in the study. Of those, 463 couples had a total of 541 offspring, 7 of whom were excluded due to a lack of data on socio-demographic characteristics or seromarkers.

Definition of HBV infection and exposure

In accordance with previous studies,[20,21] chronic HBV infection was defined as HBsAg seropositivity. Exposure to HBV was defined as anti-HBc seropositivity, which is a universal indicator of either past or present HBV infection.[22–25]

Data analysis

Baseline data were summarized descriptively. Chi-square analysis was used to assess differences between the distributions of categorical variables. Multiple logistic regression analysis was adopted to identify risk factors associated with HBV infection and exposure in both couples and offspring after adjusting for potential confounding factors including gender, age, education, ethnicity, place of residence, and self-reported immunization. In the logistic model, infection or exposure to HBV was the outcome variable, while HBV infection status of household members and known risk factors such as blood transfusion, surgical intervention and sharing syringes were independent variables. Crude OR with 95% confidence intervals (CIs) and adjusted OR with 95% CIs of each risk factor were calculated, and $p < .05$ was deemed to indicate statistical significance. All statistical analyses were two-sided and performed using Stata14.0.

Results

Socio-demographic characteristics

The socio-demographic characteristics of the 1,035 couples enrolled in the study are shown in Table 1. Their overall

Table 1. Prevalence of hepatitis B virus infection and exposure in couples.

		Chronic HBV infection						Exposure to HBV					
		total		wives		husbands		total		wives		husbands	
	sample size	Positive (%)	*p*	Positive (%)	*p*	Positive (%)	*p*	Positive (%)	*p*	Positive (%)	*p*	Positive (%)	*p*
Age groups													
18–24	73	6.8		3.9		13.6		27.4		25.5		31.8	
25–34	557	4.7		3.8		5.6		24.1		23.0		25.2	
35–44	565	4.2		2.2		6.1		34.2		31.3		36.9	
45–54	596	4.2		5.5		3.0		37.1		35.1		39.0	
≥55	279	3.2	.71	3.8	.39	2.7	.06	38.7	.00	33.1	.02	43.6	.00
Education													
Primary school and below	152	5.9		7.0		4.5		46.1		44.2		48.5	
Junior middle school	829	4.5		4.7		4.3		36.4		33.7		39.0	
High school	537	4.7		4.8		4.5		29.2		25.8		32.7	
Junior college	285	3.5		1.3		5.9		26.7		26.7		26.7	
Bachelor or above	267	3.0	.60	.0	.03	5.5	.93	26.6	.00	20.5	.00	31.7	.01
Ethnicity													
Han	1998	4.2		3.7		4.7		33.0		30.2		35.8	
Other	72	6.9	.26	6.5	.34	7.7	.47	22.2	.05	23.9	.36	19.2	.08
Residence													
Urban	808	3.0		1.8		4.0		28.5		26.6		30.2	
Rural	1262	5.2	.02	5.1	.01	5.2	.38	35.3	.00	31.9	.07	38.9	.00
Local													
Yes	1691	3.8		3.5		4.0		32.3		29.4		35.2	
No	379	6.6	.01	5.1	.28	8.5	.01	34.0	.53	32.2	.41	36.4	.77
Immune													
Yes	163	4.9		5.1		4.8		22.1		19.0		25.0	
No	1907	4.2	.69	3.8	.57	4.7	.99	33.6	.00	30.9	.03	36.3	.04
NO of Immune													
None	1907	4.2		3.8		4.7		33.6		30.9		36.3	
<3 doses	54	7.4		9.5		6.1		27.8		19.0		33.3	
≥3 doses	109	3.7	.50	3.4	.39	3.9	.90	19.3	.01	19.0	.09	19.6	0.05
Infected spouse													
Yes	89	2.2		2.0		2.5		46.1		40.8		52.5	
No	1981	4.4	.33	4.0	.50	4.8	.50	32.1	.01	29.4	.09	34.7	0.02
Exposed spouse													
Yes	676	6.1		5.7		6.5		36.7		33.9		40.0	
No	1394	3.4	.01	2.8	.02	4.0	.09	30.7	.01	27.8	.04	33.4	0.04
Immunized spouse													
Yes	163	7.4		4.8		10.1		29.4		21.4		38.0	
No	1907	4.0	.04	3.8	.66	4.3	.02	32.9	.36	30.7	.08	35.1	0.61

mean age was 41.60 years (standard deviation [SD] ±10.33 years). Among them, wives have a mean age of 40.85 (SD ±10.53 years) and husbands 42.36 (SD ±10.07). Participants whose highest levels of education were completing junior high school (40.05%) or senior high school (25.9%) represented the two largest groups. Most were Han, and minority nationalities only accounted for 3.5% of the participants. Approximately 39.0% of participants lived in urban areas, and 81.7% were Beijing locals. Of the 541 offspring of 463 couples, 54.9% were male; 4.5% were minority nationalities; 43.8% lived in urban areas; and 89.1% were Beijing locals (Table 2). The mean age of the offspring was 15.09 years (SD ±9.87 years).

Prevalence of HBV infection and exposure in couples

The overall prevalence of chronic HBV infection in the 1,035 couples was 4.3%, in wives 3.9%, and in husbands 4.7% (p = .33). The overall prevalence of exposure to HBV in the 1,035 study couples was 32.7%, in wives 30.0%, and in husbands 35.4% (p = .01). The individual rates of chronic HBV infection and HBV exposure associated with different study characteristics are provided in Table 1.

Table 2. Prevalence of hepatitis B virus infection and exposure in offspring.

		Chronic HBV infection		Exposure to HBV	
	sample size	positive(%)	p	positive(%)	p
Age groups					
<5	80	0.0		7.5	
5–14	192	0.5		6.3	
15–24	158	0.0		8.2	
≥25	104	3.8	.01	15.4	.06
Gender					
Male	293	1.0		10.6	
Female	241	0.8	.82	6.6	.11
Ethnicity					
Han	510	0.8		8.4	
Other	24	4.2	.09	16.7	.16
Residence					
Urban	234	0.9		17.1	
Rural	300	1.0	.86	2.3	.00
Local					
Yes	476	1.1		9.9	
No	58	0.0	.43	0.0	.01
Immune					
Yes	389	0.8		7.2	
No	145	1.4	.52	13.1	.03
NO of Immune					
None	145	1.4		13.1	
<3 doses	344	0.9		6.4	
≥3 doses	45	0.0	.69	13.3	.03
Infected parents					
None	481	0.6		8.9	
Infected mother	24	8.3		12.5	
Infected father	28	0.0		3.6	
Infected parents	1	0.0	.27	0.0	.69
Exposed parents					
None	231	0.0		6.9	
Exposed mother	111	0.9		9.9	
Exposed father	127	0.8		10.2	
Expose parents	65	4.6	0.01	10.8	0.61
Immunized parents					
None	478	0.8		9.2	
Immunized mother	21	0.0		9.5	
Immunized father	19	5.3		5.3	
Immunized parents	16	0.0	.24	0.0	.58

Chronic HBV infection was more common in participants who lived in rural areas than in those in urban areas (p = .02), and more common in non-locals than in local residents (p = .01). Rates of chronic HBV infection were significantly higher in individuals whose spouses were exposed to HBV (p = .01) and those whose spouses were vaccinated against HBV (p = .04). Wives who lived in rural areas (p = .01) and whose spouses were exposed to HBV(p = .02) had a significantly higher rate of chronic HBV infection, and HBV infection was significantly correlated with level of education (p = .03). There was also a higher prevalence in husbands who were non-locals (p = .01) and whose spouses were vaccinated against HBV (p = .02).

The prevalence of HBV exposure was significantly associated with age (p < .01), level of education (p < .01), place of residence (p < .01), hepatitis B vaccination (p < .01), dose of HBV vaccine (p = .01), having a spouse infected with HBV (p = .01), and having a spouse exposed to HBV (p = .01). Husbands living in rural areas (p < .01) and husbands with an infected wife (p = .02) were more likely to test positive for HBV exposure.

Prevalence of chronic HBV infection and exposure in offspring

In offspring the prevalence of chronic HBV infection was 0.9%, and the prevalence of HBV exposure was 8.7%. The individual rates of chronic HBV infection and HBV exposure associated with different study characteristics in offspring are presented in Table 2. Exposure was significantly associated with age (p = .01) and having an exposed parent (p = .01). Among study offspring, chronic HBV infection was highest in individuals aged above 25 years (3.8%) among the other defined age groups. Offspring whose parents both exhibited HBV exposure had an HBV infection rate at 4.6%, higher than that of offspring with two parents who exhibited no HBV exposure (0.0%), only a mother who exhibited exposure (0.9%), and only a father who exhibited exposure (0.8%). Offspring who lived in urban areas and were locals had a significantly higher prevalence of HBV exposure. Children who had never been vaccinated against HBV were more likely to exhibit HBV exposure (p = .03), and those who had received within 3 doses of HBV vaccinations exhibited a significantly lower rate of exposure than those who reported receiving ≥ 3 doses of vaccinations (p = .03).

Factors associated with HBV infection and exposure in couples

Factors associated with chronic HBV infection and HBV exposure in couples identified via multiple logistic regression analysis after controlling for other confounding factors are shown in Table 3. Having a spouse who was positive for HBV exposure was associated with a significantly higher risk of HBV infection (aOR 1.91, p = .01), as was sharing syringes with others (aOR 2.65, p < .01). HBV infection in a spouse (aOR 1.66, p = .03) and sharing syringes with others (aOR 2.09, p < .01) were associated with a higher prevalence of HBV exposure.

Table 3. Factors associated with hepatitis B virus infection and exposure in couples.

	Chronic HBV infection						Exposure to HBV					
	cOR	95%CI	*p*	aOR	95%CI	*p*	cOR	95%CI	*p*	aOR	95%CI	*p*
Infected spouse												
No	1.00	(reference)		1.00	(reference)		1	(reference)		1	(reference)	
Yes	0.28	[0.07,1.21]	.09	0.26	[0.06,1.10]	.07	1.57	[0.99,2.48]	.06	1.66	[1.04,2.65]	.03
Exposed spouse												
No	1.00	(reference)		1.00	(reference)		1	(reference)		1	(reference)	
Yes	1.93	[1.23,3.04]	.01	1.91	[1.20,3.04]	.01	1.15	[0.94,1.42]	.18	1.09	[0.88,1.35]	.42
Immunized spouse												
No	1.00	(reference)		1.00	(reference)		1	(reference)		1	(reference)	
Yes	2.33	[1.21,4.49]	.01	2.05	[0.96,4.37]	.06	0.95	[0.67,1.37]	.79	1.24	[0.83,1.85]	.29
Contacting with HBV carriers always												
No	1.00	(reference)		1.00	(reference)		1.00	(reference)		1.00	(reference)	
Yes	1.35	[0.40,4.6]	.63	1.34	[0.38,4.75]	.65	1.00	[0.54,1.86]	1.00	1.22	[0.64,2.32]	.55
Sharing shaver												
No	1.00	(reference)		1.00	(reference)		1.00	(reference)		1.00	(reference)	
Yes	1.05	[0.41,2.7]	.92	1.04	[0.4,2.68]	.94	1.24	[0.85,1.81]	.27	1.19	[0.81,1.75]	.37
Surgery												
No	1.00	(reference)		1.00	(reference)		1.00	(reference)		1.00	(reference)	
Yes	0.66	[0.40,1.12]	.12	0.68	[0.40,1.15]	.15	0.82	[0.66,1.02]	.07	0.84	[0.68,1.04]	.12
Dental treatment												
No	1.00	(reference)		1.00	(reference)		1.00	(reference)		1.00	(reference)	
Yes	1.04	[0.67,1.63]	.85	1.15	[0.72,1.82]	.55	1.05	[0.87,1.28]	.59	1.03	[0.84,1.26]	.78
Endoscopic medicine												
No	1.00	(reference)		1.00	(reference)		1.00	(reference)		1.00	(reference)	
Yes	0.60	[0.24,1.52]	.28	0.60	[0.23,1.53]	.28	1.13	[0.82,1.55]	.44	1.05	[0.77,1.45]	.75
Blood transfusion												
No	1.00	(reference)		1.00	(reference)		1.00	(reference)		1.00	(reference)	
Yes	1.82	[0.68,4.87]	.23	1.91	[0.71,5.17]	.20	0.93	[0.57,1.53]	.78	0.84	[0.51,1.38]	.49
Acupuncture												
No	1.00	(reference)		1.00	(reference)		1.00	(reference)		1.00	(reference)	
Yes	0.55	[0.26,1.17]	.12	0.59	[0.27,1.27]	.18	0.98	[0.75,1.27]	.86	0.93	[0.71,1.22]	.60
Sharing syringes												
No	1.00	(reference)		1.00	(reference)		1.00	(reference)		1.00	(reference)	
Yes	2.66	[1.61,4.40]	.00	2.65	[1.52,4.62]	.00	2.22	[1.71,2.89]	.00	2.09	[1.58,2.77]	.00
Tattooing												
No	1.00	(reference)		1.00	(reference)		1.00	(reference)		1.00	(reference)	
Yes	1.35	[0.59,3.08]	.48	1.33	[0.57,3.09]	.51	1.18	[0.80,1.74]	.40	1.15	[0.78,1.70]	.49
Body piercing												
No	1.00	(reference)		1.00	(reference)		1.00	(reference)		1.00	(reference)	
Yes	1.13	[0.67,1.91]	.64	0.97	[0.57,1.66]	.91	0.83	[0.66,1.04]	.11	0.89	[0.70,1.13]	.34

Factors associated with HBV exposure in offspring

Multiple logistic regression analysis was conducted to investigate factors potentially associated with HBV exposure in offspring after controlling potential confounding factors. Logistic regression analysis of HBV infection in offspring was not performed, due to the small number of chronically infected offspring in the study sample. Maternal HBV infection was significantly associated with a higher risk of HBV exposure (aOR 6,77, $p < .01$) (Table 4).

Discussion

The prevalence of chronic HBV infection among couples in this study was 4.3%, lower than the estimated prevalence of HBV positivity in China in previous research, which ranged from 5.5% to 6.9% .[26] One likely explanation relates to differences between the study populations. Previous studies have been based on the general population, whereas the current study focused on couples living in Beijing. It is also potentially relevant that as the capital of China, Beijing has abundant high-quality medical resources and better social and economic conditions than other regions, which are more conducive to prevention and treatment of infectious diseases including hepatitis B.[18,27] For example, the National Immunization Coverage Survey indicated that the coverage rate of timely first dose for HBV vaccination nationwide was 91.5% in 2011,[28] and in Beijing it was 97.3%.[29]

In this study increased age was associated with an increased prevalence of HBV exposure in couples, with a rate of 27.4% in those aged < 24 years and a rate of 38.7% in those aged > 55 years. Age was also significantly associated with the prevalence of chronic HBV infection in offspring, the anti-HBV positivity of those aged > 25 years was much higher than others. These results are consistent with previous reports in which age was significantly associated with anti-HBc positivity.[30,31]

In this study, participants with a lower education level had a significantly higher prevalence of HBV exposure, and the highest rate of HBV exposure was evident in individuals with an education level of primary school completion or below (46.1%). This association was significant in both wives and husbands. In addition, higher rates of HBV exposure and HBV infection were more common in individuals living in rural areas, where health systems are poorly equipped and medical resources are scarce. Other studies have similarly detected higher rates of HBV exposure in people with lower levels of education and in those living in rural areas.[32–34]

Furthermore, non-local residency was one of the risk factors for both HBV infection in couples and HBV exposure in their

Table 4. Factors associated with hepatitis B virus exposure in offspring.

	cOR	95%CI	*p*	aOR	95%CI	*p*
Infected parents						
None	1.00	(reference)		1.00	(reference)	
Infected mother	1.42	[0.37,5.50]	.61	6.77	[1.30,35.26]	.02
Infected father	0.31	[0.04,2.45]	.27	0.32	[0.03,2.99]	.32
Infected parents	omitted			omitted		
Exposed parents						
None	1.00	(reference)		1.00	(reference)	
Exposed mother	1.30	[0.55,3.08]	.54	1.12	[0.42,2.98]	.83
Exposed father	1.54	[0.70,3.42]	.29	1.29	[0.54,3.09]	.57
Expose parents	1.75	[0.65,4.75]	.27	1.91	[0.61,6.01]	.27
Immunized parents						
None	1.00	(reference)		1.00	(reference)	
Immunized mother	0.93	[0.19,4.49]	.93	0.58	[0.09,3.59]	.56
Immunized father	0.56	[0.07,4.39]	.58	1.33	[0.14,13.06]	.81
Immunized parents	omitted			omitted		
Contacting with HBV carriers always						
No	1.00	(reference)		1.00	(reference)	
Yes	3.68	[0.31,43.92]	.30	1.16	[0.06,21.21]	.92
Sharing shaver						
No	1.00	(reference)		1.00	(reference)	
Yes	1.99	[0.69,5.75]	.21	2.03	[0.55,7.49]	.29
Surgery						
No	1.00	(reference)		1.00	(reference)	
Yes	0.79	[0.26,2.39]	.68	1.03	[0.29,3.67]	.97
Dental treatment						
No	1.00	(reference)		1.00	(reference)	
Yes	0.73	[0.34,1.53]	.40	0.47	[0.20,1.12]	.09
Sharing syringes						
No	1.00	(reference)		1.00	(reference)	
Yes	0.85	[0.15,4.69]	.85	0.69	[0.11,4.34]	.69
Tattooing						
No	1.00	(reference)		1.00	(reference)	
Yes	2.34	[0.23,24.11]	.48	2.23	[0.18,27.49]	.53
Body piercing						
No	1.00	(reference)		1.00	(reference)	
Yes	0.38	[0.09,1.71]	.21	0.12	[0.02,0.69]	.02

offspring in the present study. It has been reported that HBsAg prevalence was much higher in floating populations than in local residents.[35–38] A large floating population in urban areas can affect the original HBV infection patterns, and this may be attributable to poor understanding of HBV vaccination, scant awareness of HBV infection control and prevention measures, and low levels of education.[40]

In our findings, there were significant associations between HBV vaccination and the prevalence of HBV exposure in both couples and offspring, and receiving ≥3 doses of HBV vaccinations was protective against exposure to HBV. Notably some of the participants in the sample received < 3 doses of vaccinations, and a Chinese survey revealed that 35%–45% of subjects failed to complete the prescribed HBV vaccination series.[39] Improving vaccination compliance would be an effective way to achieve better control of HBV infection and transmission, as in a previous study, approximately 90%–95% of healthy individuals exhibited protective levels of anti-HBsAg antibody after completing a 3-vaccination HBV immunization regimen.[40]

In multiple logistic regression analysis sharing syringes was a risk factor for both HBV infection and HBV exposure after controlling for other confounding factors in the couples. Among the numerous risk behaviors pertaining to HBV, only sharing syringes was significantly associated with increased HBV infection and exposure, which may be related to unsafe vaccine injections and drug injection.[12,41,42] Consistent with previous studies, other potential risk factors such as blood transfusion and surgery were not significantly associated with HBV infection or exposure in the present study, which can be attributed to safe medical practices including blood donor screening, blood product testing, and strict infection control measures in operating theaters.[43–45]

Data from couples indicated a higher prevalence of HBV exposure among individuals whose spouses were infected with or exposed to the virus. Having a spouse infected with HBV was a significant risk factor for exposure in multiple logistic regression analysis, and having a spouse exposed to HBV was a risk factor for HBV infection. These findings were in accordance with previous research,[46–49] and both sexual intercourse and parenteral routes such as kissing and sharing personal belongings were the predominant modes of HBV transmission between spouses.[39] In this study the prevalence of HBV infection was higher in those whose spouses were self-reported HBV immunized, probably because partners were more likely to get vaccinated if they knew their spouse had been infected.

In multiple logistic regression analysis maternal HBV infection was a significant risk factor for HBV exposure in offspring after controlling for other confounding factors including gender, age, ethnicity, and self-reported immunization, but the corresponding association with paternal HBV infection was not significant. As well as horizontal transmission, intimate contact between mother and child during perinatal or early childhood period can result in an HBV-infected mother becoming a main source of intra-familial transmission.[50–53]

In general, intra-familial clustering was a common mode of HBV transmission,[54] and close contact with household members exposed to HBV increased the risk of infection.[51,52,55–57] Thus, effective measures such as HBV vaccination are urgently needed to prevent transmission.[58,59]

Our study had several limitations. First, there was potential for recall bias concerning risk behaviors and immunization history. Second, the premarital HBV status of individuals was uninvestigated, which may have led to an overestimated risk of intra-familial transmission. Lastly, the study was cross-sectional so interpretations of causality are limited.

Conclusion

The rates of HBV infection and exposure identified in this study were lower than the national averages. Our findings reveal the prevalence of HBV infection and exposure among household members, and constitute evidence that household members infected with or exposed to HBV increase the risk of HBV transmission, and thus controlling intra-familial transmission may contribute to hepatitis B prevention. The study suggests that to achieve better control of HBV transmission, as well as ensuring HBV immunization of newborns, booster vaccinations must be prioritized among high risk populations such as those living with HBV-infected individuals.

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