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Risk factors of hepatitis B virus infection between vaccinated and unvaccinated groups among spouses in 2006 and 2014: a cross-sectional study in Beijing

Yiwei Guo [a], Pei Gao [b], Huai Wang [b], Jiang Wu [b], Qian Bai [a], Lieyu Huang [a], Shuo Li [a], Min Lv [b], and Xuefeng Shi [a]

[a]School of Management, Beijing University of Chinese Medicine, Beijing, China; [b]Beijing Center for Disease Control and Prevention, Beijing Research Center for Preventive Medicine, Beijing, China

ABSTRACT

Objectives: To assess the prevalence of hepatitis B virus (HBV) infection among married individuals and to analyze the associated risk factors of HBV infection in vaccinated and unvaccinated groups in 2006 and 2014.

Methods: Information of married individuals aged over 16 y with a clear HBV vaccination status was extracted from the database constructed by the Beijing Center for Disease Prevention and Control from population-based investigation.

A structured questionnaire was employed to collect demographic information, vaccinated history, and other related influence information of HBV of participants. Pearson chi-square test, Fisher's test, and logistic regression were used to explore the risk factors of HBV infection.

Results: A total of 2874 individuals in 2006 and 1622 individuals in 2014 were enrolled in our study. The mean age of individuals was 49.30 and 46.68 y in 2006 and 2014, respectively. The overall positive rates of HBsAg, anti-HBc, and single anti-HBs were 4.80%, 43.01%, and 5.78% in 2006, which were 4.69%, 38.22%, and 14.18% in 2014, respectively. For vaccinated individuals, age was significantly correlated with anti-HBc in 2014 (40 < age ≤50 versus age ≤30, relative risk (RR) = 3.03, 95% confidence interval (95%CI) = 1.04–8.84). Gender [male versus female, RR = 0.60, 95%CI = 0.36–1.00 (2006); RR = 0.71, 95%CI = 0.52–0.97 (2014)] and age (in 2006) were found to be significantly associated with single anti-HBs.

For unvaccinated individuals, HBsAg positivity was statistically significant correlated with gender [RR = 1.47, 95%CI = 1.04–2.06, in 2006], residence (urban versus rural, RR = 0.40, 95%CI = 0.24–0.67, in 2006; RR = 0.58, 95%CI = 0.34–0.99, in 2014), sharing syringes [RR = 3.75, 95%CI = 1.33–10.63 (in 2006); RR = 2.07, 95%CI = 1.26–3.41 (in 2014)], infected wives (RR = 1.97, 95%CI = 1.28–3.05, in 2006), and infected husbands (RR = 2.19, 95%CI = 1.25–3.82, in 2006). Anti-HBc positivity was significantly associated with gender [RR = 1.19, 95%CI = 1.10–1.30 (in 2006); RR = 1.24, 95%CI = 1.09–1.40 (in 2014)], age (in 2006 and 2014), endoscopic medicine treatment [RR = 1.16, 95%CI = 1.03–1.32 (in 2006), RR = 1.21, 95%CI = 1.01–1.45 (in 2014)], sharing syringes (RR = 1.43, 95%CI = 1.25–1.64, in 2014), body piercing (RR = 0.84, 95%CI = 0.75–0.93, in 2006), infected wives (RR = 1.32, 95%CI = 1.18–1.47, in 2006), and infected husbands (RR = 1.39, 95%CI = 1.22–1.59, in 2006). Anti-HBs positivity was associated with age (in 2006 and 2014).

Conclusions: Prevalence of HBV infection was lower in 2014 than in 2006 according to HBsAg and anti-HBc positivity. Unvaccinated individuals faced much more risk of HBV infection than those of vaccinated.

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Introduction

As one of the most serious public health issues worldwide, hepatitis B virus (HBV) infection could cause lifelong chronic HBV carrier or lead to cirrhosis or hepatocellular carcinoma (HCC).[1,2] It was estimated that HBV had affected at least 257 million people worldwide,[3] and about 90 million people suffered from HBV-related diseases in China.[4]

Liver cancer and other chronic diseases caused by HBV could be effectively prevented by HBV vaccine. In order to control the ascending tendency of HBV infection, the World Health Organization (WHO) encouraged all member countries to popularize HBV vaccine immunization.[3] As one of the member countries with high HBV prevalence, China responded to WHO strategy actively by recommending HBV vaccine immunization for newborns in 1992 and took HBV vaccination into Expanded Program on Immunization (EPI) in 2002. HBV vaccination for newborns was free of charge after 2005.[5] China also launched a HBV vaccination project for adolescents and adults since 2006.[6] To realize the goal of better controlling hepatitis B transmission, China government even encouraged some conditional districts to take effective measures promoting adult hepatitis B vaccine. For example, free vaccination of adult hepatitis B vaccine was executed in the Chaoyang District of Beijing since 2017.[7]

Nevertheless, the number of HBV-infected people was growing year by year.[8] HBV had threatened public health and induced serious social panic in China.[9,10] It is well known that risk behaviors such as dialysis, blood transfusion, or tattooing

CONTACT Xuefeng Shi shixuefeng981206@163.com School of Management, Beijing University of Chinese Medicine, No. 11, Bei San Huan Dong Lu, Chaoyang District, Beijing 100029, China; Min Lv lm@bjcdc.org.cn Beijing Center for Disease Control and Prevention, Beijing Research Center for Preventive Medicine, 16 Heping Li Middle Street, Dongcheng District, Beijing 100013, China

were shown to be related to HBV infection in earlier studies.[11–13] In addition, HBV was vertically transmitted from mother to child or horizontally transmitted by transfusion of HBV-infected blood or body fluid.[14] Sexual contact is one of the most common routes of horizontal HBV transmission.[15] Similarly, intimate behaviors of spouses such as kissing and sharing things with each other may also lead to HBV infection.[16] It still remains unclear that whether marriage is a risk factor of HBV infection or not for those who have been vaccinated. Although a study in Gambia reported that marriage was not a risk factor of HBV infection for vaccinated females;[17] there were contradictory evidence that people who had a HBV-infected spouse were at high risk for acquiring HBV.[18,19]

Majority studies on risk factors of HBV infection among married people were cross-sectional studies with small sampling, and subjects in some studies were unvaccinated population.[13,20] In China, there were some studies reporting the prevalence and risk factors of HBV infection among couples in rural area.[21,22] However, study on risk factors of HBV focusing on the vaccinated individuals who were married is rare. Our study explores the risk factors of HBV infection for vaccinated and unvaccinated married people aiming to examine (1) the prevalence of HBV among married individuals in 2006 and 2014; (2) the risk factors of HBV infection, especially infected spouses, in vaccinated and unvaccinated groups; and (3) changes in prevalence rate, risk factors, and relative risk (RR) value of HBV infection among vaccinated and unvaccinated individuals between 2006 and 2014.

Materials and methods

Study design

A cross-sectional study was designed to examine the risk factors of HBV in married individuals. All of these individuals were divided into vaccinated or unvaccinated groups according to "whether vaccinated or not."

Data collection

We employed data drawn from the serological surveys conducted by the Beijing Center for Disease Prevention and Controlin 2006 and 2014.[23] The surveys mentioned above covered 5078 (in 2006) and 6705 individuals (in 2014), and participants over 1 y old were randomly selected from 20 communities in 10 districts (10/18). A total of 1523 (in 2006) and 1047 couples (in 2014) were included in our study for the purpose of analyzing the effect of HBV vaccine immunization in spouses (Figure 1).

All of the vaccinated individuals were screened for HBsAg, anti-HBs, and anti-HBc before HBV vaccine immunization until 2012. After 2012, the technical guide for adult hepatitis B immunization in China recommended that screening before vaccination was unnecessary.[24,25]

The status of HBV infection of spouses was diagnosed with a serological test. Furthermore, 172 individuals in 2006 and 472 individuals in 2014 whose "vaccination history" were

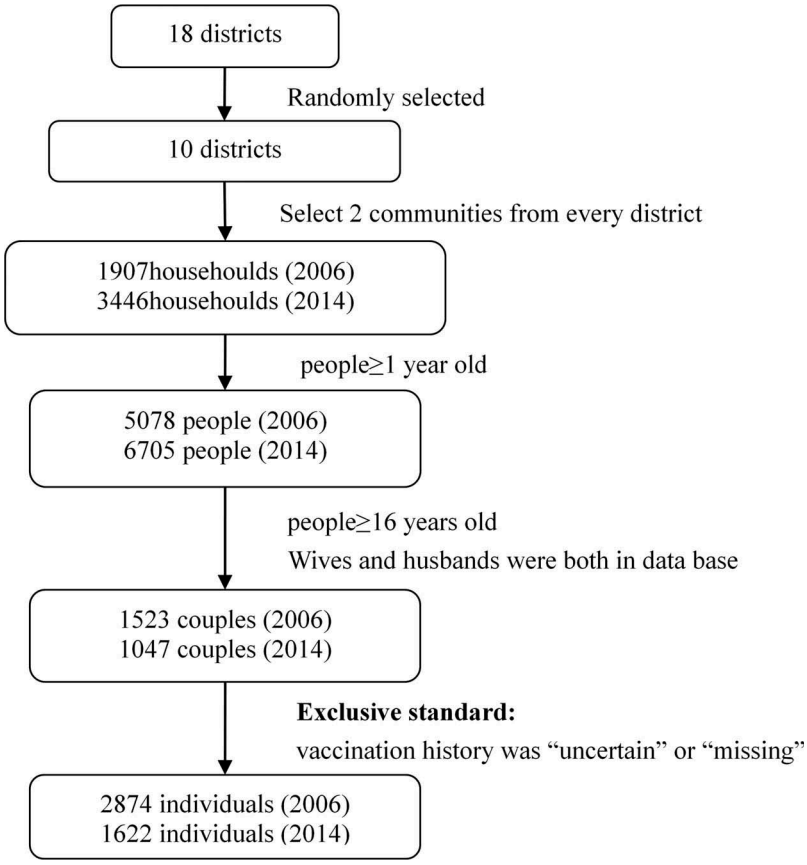

Figure 1. Data source and selective standard. Description of the data filtering process.

"uncertain" or "missing" in the questionnaire were excluded from the study. Finally, a total of 2874 and 1622 participants were enrolled in our study in 2006 and 2014, respectively. Information on demographic features and risk factors were collected by questionnaires.

Laboratory tests

HBsAg, anti-HBs, HBeAg, anti-HBe, and anti-HBc were tested by microparticle enzyme immunoassay (AXSYM Plus; Abbott America).

Measures

Definition of HBV-infected individuals

Based on the prognosis of HBV infection of HBV infection, we defined people as HBV-infected individuals when one or more of their HBsAg, HBeAg, anti-HBe, and anti-HBc was positive.[5,26] Meanwhile, we considered HBsAg, anti-HBc,[27] and anti-HBs as outcome indicators to examine the risk factors of HBV infection.

It is a common sense that anti-HBs positivity might be induced by vaccinated immunity,[28] and so we did not consider it as an indicator when defining whether individuals were infected or not. However, it was also known that single anti-HBs positivity was a symbol of recovery from previous HBV infection without HBV vaccination, and so we regarded it as an outcome indicator of HBV infection in the unvaccinated group.

Definition of risk behaviors of HBV infection

Risk behaviors including history of endoscopic treatment, sharing syringes, ear or body piercing, dialysis, surgery, dental treatment, blood transfusion, and tattooing were derived from the results of the questionnaire.

Statistical analysis

Pearson chi-square test and Fisher's test were used to identify the association between serological markers of HBV and independent variables. Logistic regression analysis was employed to identify the association between age and serological markers of HBV. RR value along with 95% confidence intervals (CIs) of each risk factor was reported. *P*-value (two-tailed) less than 0.05 was considered as statistically significant. All the analyses were performed by SPSS22.0.

Results

Characteristics of socio-demographic variables

A total of 2874 and 1622 participants were investigated in 2006 and 2014, respectively. There were three subjects who had experienced dialysis, lack of the adequate amount of analysis. There were 54 males and 78 females in the vaccinated group, 1374 males and 1368 females in the unvaccinated group in 2006, 86 males and 95 females in the vaccinated group, and 724 males and 717 females in the unvaccinated group in 2014. The mean age of individuals was 49.30 and 46.68 y in 2006 and 2014. A total of 138 (4.80%) and 294 (18.13%) individuals were living in rural area in 2006 and 2014, respectively (Tables 1 and 2).

Seroprevalence of HBV markers

In 2006, the overall number of HBsAg, anti-HBc, and single anti-HBs positive subjects was 138 (4.80%), 1236 (43.01%), and 166 (5.78%) respectively, which was 76 (4.69%), 620 (38.22%), and 230 (14.18%) in 2014, and the positive rates of these three serological markers in vaccinated and unvaccinated group are presented in Figure 2. The number of individuals who had HBV vaccine immunization history was 132 (4.59%) and 181 (11.16%) in 2006 and 2014, respectively.

Risk behaviors of HBV infection

In 2006 and 2014, 311 (10.84%) and 174 (10.76%) individuals had experienced endoscopic medicine treatment, 19 (0.66%) and 269 (16.62%) individuals had shared syringes with others, 730 (25.42%) and 420 (25.91%) individuals had body piercing experience, 999 (34.78%) and 510 (31.54%) individuals had undergone surgeries, 1646 (57.29%) and 825 (50.96%) individuals had received dentist treatment, 214 (7.45%) and 110 (6.79%) individuals had a history of tattooing, and 196 (6.82%) and 68 (4.20%) individuals had a history of blood transfusion, respectively (Tables 1 and 2).

Information on spouses' infected status

In 2006, there were 15 (27.78%) infected wives and 40 (51.28%) infected husbands in the vaccinated group and 544 (39.59%) and 644 (47.08%) in the unvaccinated group. The number of infected wives and husbands were 30 (34.88%) and 37 (38.95%) in the vaccinated group, which were 241 (33.29%) and 244 (34.03%) in the unvaccinated group in 2014 (Tables 3 and 4).

Risk factors associated with HBV infection among the vaccinated group

The results of chi-square test and logistic regression are presented in Table 1 and Table 3. For the vaccinated group, no risk factor was found to be significantly correlated with HBsAg. But we observed a significant correlation between age and anti-HBc in 2014 (40< age ≤50 versus age ≤30, RR = 3.03, 95%CI = 1.04–8.84). Gender [male versus female, RR = 0.60, 95%CI = 0.36–1.00 (2006); RR = 0.71, 95%CI = 0.52–0.97 (2014)] and age (in 2006) were significantly correlated with single anti-HBs.

Risk factors associated with HBV infection among the unvaccinated group

For unvaccinated individuals, HBsAg positivity was correlated with gender (male versus female, RR = 1.47, 95% CI = 1.04–2.06, in 2006), residence (urban versus rural, RR = 0.40, 95%CI = 0.24–0.67, in 2006; RR = 0.58, 95%CI = 0.34–0.99, in 2014), sharing syringes [RR = 3.75, 95% CI = 1.33–10.63 (in 2006); RR = 2.07, 95%CI = 1.26–3.41 (in 2014)], infected wives

Table 1. Correlation between independent variables and viral serological markers in the vaccinated group.

	2006							2014						
	Sample size (%)	HBsAg positive (%)	RR (95%CI)	Anti-HBc positive (%)	RR (95%CI)	Single Anti_HBs Positive(%)	RR(95%CI)	Sample size (%)	HBsAg Positive(%)	RR(95%CI)	Anti-HBc positive(%)	RR(95%CI)	Single anti-HBs positive(%)	RR(95%CI)
Age group[a]														
x ≤ 30	35 (26.52)	1 (2.86)	ref	9 (25.71)	ref	19(54.29)	ref	54(29.83)	3(5.56)	ref	8(14.81)	ref	29(53.70)	ref
30 < X ≤ 40	36 (27.27)	4 (11.11)	4.25 (0.45–40.08)	8 (22.22)	0.83 (0.28–2.46)	16(44.44)	0.67 (0.26–1.72)	78(43.09)	3(3.85)	0.68 (0.13–3.50)	15(19.23)	1.37(0.54–3.5)	38(48.72)	0.82 (0.41–1.64)
40 < X ≤ 50	24 (18.18)	1 (4.17)	1.48 (0.09–24.85)	12 (50.00)	2.89 (0.96–8.7)	6(25.00)	0.28 (0.09–0.88) *	29(16.02)	2(6.90)	1.26 (0.20–8.00)	10(34.48)	3.03 (1.04–8.84) *	12(41.38)	0.61 (0.24–1.52)
50 < X ≤ 60	31 (23.48)	1 (3.23)	1.13 (0.07–18.92)	15 (48.39)	2.71 (0.96–7.62)	7(22.58)	0.25 (0.08–0.72) *	6(3.31)	0(0)	0	1(16.67)	1.15 (0.12–11.18)	2(33.33)	0.43 (0.07–2.56)
60 < X	6 (4.55)	0 (0)	0	2 (33.33)	1.44 (0.23–9.27)	0(0)	0	14(7.73)	0(0)	0	4(28.57)	2.30 (0.58–9.16)	6(42.86)	0.65 (0.20–2.12)
Gender														
Male	54 (40.91)	4 (7.41)	1.93 (0.45–8.26)	23 (42.59)	1.44 (0.91–2.29)	14(25.93)	0.60 (0.36–1.00) *	86(47.51)	4(4.65)	1.11 (0.29–4.28)	21(24.42)	1.37 (0.77–2.41)	34(39.53)	0.71 (0.52–0.97) *
Female	78 (59.09)	3 (3.85)	ref	23 (29.49)	ref	34(43.59)	ref	95(52.49)	4(4.21)	ref	17(17.89)	ref	53(55.79)	ref
Residence														
Urban	117 (89.31)	6 (5.13)	0.72 (0.09–5.54)	39 (33.33)	0.78 (0.4–1.50)	43(36.75)	1.03 (0.49–2.16)	121(66.85)	7(5.79)	3.47 (0.44–27.57)	27(22.31)	1.22 (0.65–2.28)	58(47.93)	0.99 (0.72–1.37)
Rural	14 (10.69)	1 (7.14)	ref	6 (42.86)	ref	5(35.71)	ref	60(33.15)	1(1.67)	ref	11(18.33)	ref	29(48.33)	ref
Endoscopic medicine														
Yes	13 (9.92)	1 (7.69)	1.51 (0.20–11.61)	7 (53.85)	1.63 (0.93–2.87)	3(23.08)	0.62 (0.22–1.72)	24(13.26)	2(8.33)	2.18 (0.47–10.19)	6(25.00)	1.23 (0.57–2.62)	12(50.00)	1.05 (0.68–1.61)
No	118 (90.08)	6 (5.08)	ref	39 (33.05)	ref	44(37.29)	ref	157(86.74)	6(3.82)	ref	32(20.38)	ref	75(47.77)	ref
Sharing syringes														
Yes	2 (1.52)	0 (0)	-	2 (100.00)	-	0(0)	-	14(7.73)	2(14.29)	3.98 (0.88–17.9)	4(28.57)	1.40 (0.58–3.39)	7(50.00)	1.04 (0.60–1.80)
No	130 (98.48)	7 (5.38)	-	44 (33.85)	-	48(36.92)	-	167(92.27)	6(3.59)	ref	34(20.36)	ref	80(47.9)	ref
Body piercing														
Yes	38 (28.79)	2 (5.26)	0.99 (0.20–4.88)	14 (36.84)	1.08 (0.66–1.79)	18(47.37)	1.48 (0.95–2.32)	61(33.70)	1(1.64)	0.28 (0.04–2.23)	11(18.03)	0.80 (0.43–1.50)	33(54.1)	1.20 (0.89–1.63)
No	94 (71.21)	5 (5.32)	ref	32 (34.04)	ref	30(31.91)	ref	120(66.30)	7(5.83)	ref	27(22.5)	ref	54(45.00)	ref
Surgery														
Yes	63 (47.73)	4 (6.35)	1.46 (0.34–6.27)	17 (26.98)	0.64 (0.39–1.05)	23(36.51)	1.01 (0.64–1.58)	66(36.46)	6(9.09)	5.23 (1.09–25.16)	19(28.79)	1.74 (1.00–3.05)	34(51.52)	1.12 (0.82–1.52)
No	69 (52.27)	3 (4.35)	ref	29 (42.03)	ref	25(36.23)	ref	115(63.54)	2(1.74)	ref	19(16.52)	ref	53(46.09)	ref
Dental treatment														
Yes	83 (62.88)	4 (4.82)	0.79 (0.18–3.37)	27 (32.53)	0.84 (0.53–1.34)	32(38.55)	1.18 (0.73–1.92)	105(58.01)	7(6.67)	5.07 (0.64–40.33)	19(18.1)	0.72 (0.41–1.27)	53(50.48)	1.13 (0.83–1.54)
No	49 (37.12)	3 (6.12)	ref	19 (38.78)	ref	16(32.65)	ref	76(41.99)	1(1.32)	ref	19(25.00)	ref	34(44.74)	ref
Tattooing														
Yes	16 (12.12)	1 (6.25)	1.21 (0.16–9.40)	5 (31.25)	0.88 (0.41–1.90)	7(43.75)	1.24 (0.67–2.27)	20(11.05)	1(5.00)	1.15 (0.15–8.87)	3(15.00)	0.69 (0.23–2.04)	8(40.00)	0.82 (0.47–1.43)
No	116 (87.88)	6 (5.17)	ref	41 (35.34)	ref	41(35.34)	ref	161(88.95)	7(4.35)	ref	35(21.74)	ref	79(49.07)	ref
Blood transfusion														
Yes	4 (3.03)	0 (0)	-	2 (50.00)	1.46 (0.53–3.99)	1(25.00)	0.68 (0.12–3.77)	2(1.10)	0(0)	-	1(50.00)	2.42 (0.59–9.96)	1(50.00)	1.04 (0.26–4.20)
No	128 (96.97)	7 (5.47)	-	44 (34.38)	ref	47(36.72)	ref	179(98.90)	8(4.47)	-	37(20.67)	ref	86(48.04)	ref

Notes : [a]Age group were tested by logistic regression.
*Two-sided *p*-value <0.05; **two-sided *p*-value <0.01; ***two-sided *p*-value <0.001; ref = references which were used to compared with another group when calculated the RR value.

Table 2. Correlation between independent variables and viral serological markers in the unvaccinated group.

	2006							2014						
	Sample size (%)	HBsAg positive (%)	RR (95%CI)	Anti-HBc positive(%)	RR (95%CI)	Single anti-HBs positive (%)	RR (95%CI)	Sample size (%)	HBsAg positive (%)	RR (95%CI)	Anti-HBc positive (%)	RR (95%CI)	Single anti_HBs positive (%)	RR (95%CI)
Age group [a]														
x ≤ 30	153 (5.58)	7 (4.58)	ref	42 (27.45)	ref	27 (17.65)	ref	155 (10.76)	8 (5.16)	ref	48 (30.97)	ref	30 (19.35)	ref
30 < X ≤ 40	495 (18.05)	31 (6.26)	1.39 (0.60–3.23)	192 (38.79)	1.68 (1.12–2.49) *	16 (3.23)	0.16 (0.08–0.30) ***	268 (18.60)	15 (5.60)	1.09 (0.45–2.63)	87 (32.46)	1.07 (0.70–1.64)	45 (16.79)	0.84 (0.50–1.40)
40 < X ≤ 50	769 (28.05)	40 (5.20)	1.14 (0.50–2.61)	303 (39.40)	1.72 (1.17–2.52) **	27 (3.51)	0.17 (0.10–0.30) ***	365 (25.33)	22 (6.03)	1.18 (0.51–2.71)	149 (40.82)	1.54 (1.03–2.29) *	31 (8.49)	0.39 (0.23–0.67) **
50 < X ≤ 60	740 (26.99)	28 (3.78)	0.82 (0.35–1.91)	315 (42.57)	1.96 (1.33–2.88) **	21 (2.84)	0.14 (0.08–0.25) ***	431 (29.91)	14 (3.25)	0.62 □0.25–1.50□	187 (43.39)	1.71 (1.16–2.52) **	20 (4.64)	0.20 (0.11–0.37) ***
60 < X	585 (21.33)	25 (4.27)	0.93 □0.40–2.20□	338 (57.78)	3.62 (2.45–5.35) ***	27 (4.62)	0.23 □0.13–0.40) ***	222 (15.41)	9 (4.05)	0.78 □0.29–2.06□	111 (50.00)	2.23 (1.45–3.43) ***	17 (7.66)	0.35 (0.18–0.65) **
Gender														
Male	1374 (50.11)	78 (5.68)	1.47 (1.04–2.06) *	649 (47.23)	1.19 (1.10–1.30) ***	57 (4.15)	0.93 (0.65–1.32)	724 (50.24)	38 (5.25)	1.25 (0.79–2.00)	323 (44.61)	1.24 (1.09–1.40) **	75 (10.36)	1.09 (0.80–1.49)
Female	1368 (49.89)	53 (3.87)	ref	541 (39.55)	ref	61 (4.46)	ref	717 (49.76)	30 (4.18)	ref	259 (36.12)	ref	68 (9.48)	ref
Residence														
Urban	2612 (95.47)	117 (4.48)	0.40 (0.24–0.67) **	1126 (43.11)	0.88 (0.73–1.05)	114 (4.36)	1.35 (0.51–3.61)	1207 (83.76)	51 (4.23)	0.58 (0.34–0.99) *	490 (40.60)	1.03 (0.87–1.23)	118 (9.78)	0.92 (0.61–1.38)
Rural	124 (4.53)	14 (11.29)	ref	61 (49.19)	ref	4 (3.23)	ref	234 (16.24)	17 (7.26)	ref	92 (39.32)	ref	25 (10.68)	ref
Endoscopic medicine														
Yes	298 (10.88)	9 (3.02)	0.60 (0.31–1.18)	148 (49.66)	1.16 (1.03–1.32) *	9 (3.02)	0.68 (0.35–1.32)	150 (10.45)	4 (2.67)	0.54 (0.20–1.45)	72 (48.00)	1.21 (1.01–1.45) *	14 (9.33)	0.94 (0.56–1.59)
No	2440 (89.12)	122 (5.00)	ref	1041 (42.66)	ref	109 (4.47)	ref	1286 (89.55)	64 (4.98)	ref	509 (39.58)	ref	128 (9.95)	ref
Sharing syringes														
Yes	17 (0.62)	3 (17.65)	3.75 (1.33–10.63) *	9 (52.94)	1.22 (0.78–1.92)	0 (0)	-	255 (17.73)	21 (8.24)	2.07 (1.26–3.41) **	137 (53.73)	1.43 (1.25–1.64) ***	18 (7.06)	0.67 (0.42–1.08)
No	2723 (99.38)	128 (4.70)	ref	1180 (43.33)	ref	118 (4.33)	-	1183 (82.27)	47 (3.97)	ref	445 (37.62)	ref	124 (10.48)	ref
Body piercing														
Yes	692 (25.26)	32 (4.62)	0.96 (0.65–1.41)	262 (37.86)	0.84 (0.75–0.93) **	35 (5.06)	1.25 (0.85–1.84)	359 (24.93)	20 (5.57)	1.26 (0.76–2.09)	130 (36.21)	0.87 (0.74–1.01)	31 (8.64)	0.83 (0.57–1.22)
No	2048 (74.74)	99 (4.83)	ref	927 (45.26)	ref	83 (4.05)	ref	1081 (75.07)	48 (4.44)	ref	452 (41.81)	ref	112 (10.36)	ref
Surgery														
Yes	936 (34.16)	46 (4.91)	1.04 (0.74–1.48)	409 (43.70)	1.01 (0.92–1.11)	36 (3.85)	0.85 (0.58–1.24)	444 (30.92)	18 (4.05)	0.80 (0.48–1.36)	170 (38.29)	0.93 (0.81–1.07)	41 (9.23)	0.91 (0.64–1.28)
No	1804 (65.84)	85 (4.71)	ref	780 (43.24)	ref	82 (4.55)	ref	992 (69.08)	50 (5.04)	ref	410 (41.33)	ref	101 (10.18)	ref
Dental treatment														
Yes	1563 (57.02)	70 (4.48)	0.87 (0.62–1.21)	689 (44.08)	1.04 (0.95–1.13)	68 (4.35)	1.03 (0.72–1.47)	720 (50.07)	33 (4.58)	0.94 (0.59–1.50)	304 (42.22)	1.09 (0.97–1.24)	67 (9.31)	0.89 (0.65–1.22)
No	1178 (42.98)	61 (5.18)	ref	501 (42.53)	ref	50 (4.24)	ref	718 (49.93)	35 (4.87)	ref	277 (38.58)	ref	75 (10.45)	ref
Tattooing														
Yes	198 (7.23)	7 (3.54)	0.73 (0.34–1.53)	76 (38.38)	0.88 (0.73–1.05)	12 (6.06)	1.45 (0.81–2.59)	90 (6.25)	6 (6.67)	1.45 (0.65–3.26)	40 (44.44)	1.11 (0.87–1.41)	9 (10.00)	1.01 (0.54–1.92)
No	2542 (92.77)	124 (4.88)	ref	1113 (43.78)	ref	106 (4.17)	ref	1349 (93.75)	62 (4.60)	ref	542 (40.18)	ref	133 (9.86)	ref
Blood transfusion														
Yes	192 (7.01)	11 (5.73)	1.22 (0.67–2.22)	87 (45.31)	1.05 (0.89–1.23)	9 (4.69)	1.10 (0.56–2.13)	66 (4.59)	4 (6.06)	1.30 (0.49–3.46)	21 (31.82)	0.78 (0.54–1.12)	3 (4.55)	0.45 (0.15–1.37)
No	2548 (92.99)	120 (4.71)	ref	1102 (43.25)	ref	109 (4.28)	ref	1373 (95.41)	64 (4.66)	ref	561 (40.86)	ref	139 (10.12)	ref

Note : [a] Age group was tested by logistic regression.
*Two-sided *p*-value <0.05; **two-sided *p*-value <0.01; ***two-sided *p*-value <0.001; ref = references which were used to compared with another group when calculated the RR value.

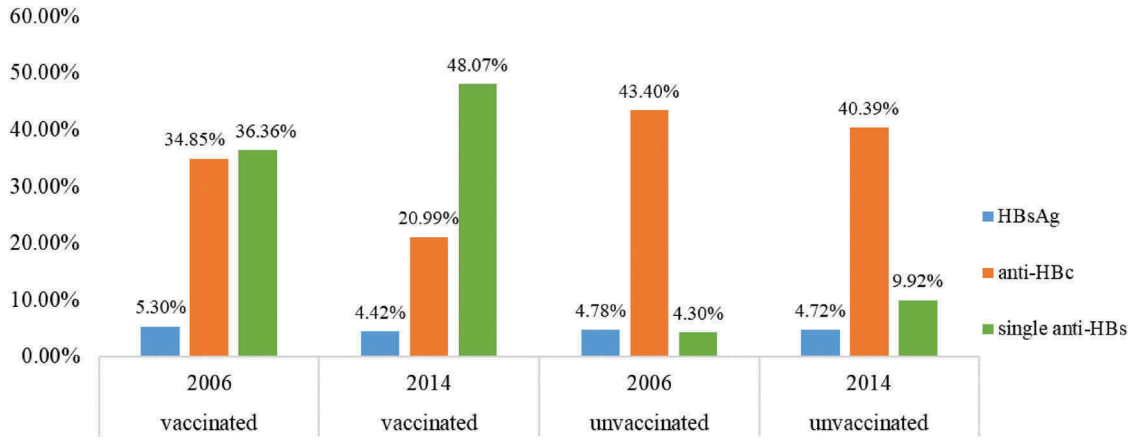

Figure 2. Positive rate of serological markers of HBV infection in 2006 and 2014. The prevalence rates of serological positive indicators in 2006 and 2014 among the vaccinated and unvaccinated groups are presented in the figure.

(RR = 1.97, 95%CI = 1.28–3.05, in 2006), and infected husbands (RR = 2.19, 95%CI = 1.25–3.82,in 2006).

Anti-HBc positivity was associated with gender [male versus female, RR = 1.19, 95%CI = 1.10–1.30 (in 2006); RR = 1.24, 95% CI = 1.09–1.40 (in 2014)], age (in 2006 and 2014), endoscopic medicine treatment [RR = 1.16, 95%CI = 1.03–1.32 (in 2006); RR = 1.21, 95%CI = 1.01–1.45 (in 2014)], sharing syringes (RR = 1.43, 95%CI = 1.25–1.64, in 2014), body piercing (RR = 0.84, 95%CI = 0.75–0.93, in 2006), infected wives (RR = 1.32, 95%CI = 1.18–1.47, in 2006), and infected husbands (RR = 1.39, 95%CI = 1.22–1.59, in 2006). Anti-HBs positivity was associated with age (in 2006 and 2014) (Tables 2 and 4).

Discussion

In our study, the proportion of individuals who had accepted HBV vaccine immunization increased from 4.59% to 11.16% from 2006 to 2014. In 2006, the overall positive rates of HBsAg, anti-HBc, and single anti-HBs were 4.80%, 43.01%, and 5.78%, respectively, which were 4.69%, 38.22%, and 14.18% in 2014. The positive rate of HBsAg decreased in the vaccinated and unvaccinated groups as well as anti-HBc, which was attributed to newborn immunization policy launched in Beijing since the year 1992[29–31] and immunization policy for adolescents and adults since 2006.[6]

The prevalence of single anti-HBs positivity increased in the vaccinated group from 2006 to 2014, which might be caused by the lower cost of HBV vaccine, improvement of income, and promotion of complete vaccination rate during that period.[32,33]

However, we found that the positive rate of anti-HBs, in the unvaccinated group, was higher in 2014 than that in 2006, which was contradictory to the change of anti-HBc. In addition to the impact of sampling error, the possible explanation was that the number of individuals who were undergone naturally immunized after HBV infection was higher in 2014. A study reported that the naturally immunization of HBV infection might last for many years .[34] The reason should be figured by further study. Meanwhile, we found that there was little difference in the HBsAg-positive rate between the vaccinated and unvaccinated groups in our study. This result was contradictory to the fact that HBsAg-positive rate declined after vaccination. This might be due to different age structure and low response rate of HBV vaccine. In this study, the low response rate could be further explained by family history, drinking history, and the validity period of vaccine protection.[35,36] For vaccinated individuals, there was no risk factor significantly correlating with HBsAg positivity. Anti-HBc positivity was found to be correlated with age by a study in 2014 (40< age ≤50), and it was possible that anti-HBc positivity could occur with the decline of anti-HBs.[28,34] But this result did not occur in other older age groups, which could not be explained by our existing data, and needed to be further studied.

Both in 2006 and in 2014, we observed that gender and age were significantly correlated with single anti-HBs positivity. Single anti-HBs positive rate was higher in females than in males, which was possible that females were more likely to develop anti-HBs than males after HBV vaccine immunization.-[37] Positive rate of single anti-HBs decreased with age, which was consistent with the previous study.[34]

Vaccinated individuals faced with nearly zero-level common risk factors of HBV infection than those unvaccinated, which might indirectly prove the conclusion that vaccination might effectively protect people from HBV infection.

For unvaccinated subjects, males were at high risk of HBsAg positivity,[38,39] which might link to complicated lifestyle and increased risk of chronic HBV infection in males.[40,41] Anti-HBc-positive rate was higher in older individuals owing to the decline of anti-HBs level with time or exposure to more risk factors with long duration of marriage.[34,42] Single anti-HBs decreased with age, which was similar to the result in the vaccinated group.

Individuals living in the rural area accounted for a high proportion of HBsAg positivity, which could always be caused by imbalanced income, non-hospital delivery, less health awareness of HBV knowledge, lack of health service resource, and lower education levels of caregivers.[43,44]

Using unsafe medical devices might lead to HBV infection. Endoscopic medicine treatment was a risk behavior of HBV infection both in 2006 and in 2014, demonstrating that medical infection from endoscopy device should not be neglected.[45]

Table 3. Correlation between infected spouses and viral serological markers in the vaccinated group.

		2006						2014						
	Sample size(%)	HBsAg positive (%)	RR (95%CI)	Anti-HBc positive (%)	RR (95%CI)	Single anti-HBs positive (%)	RR (95%CI)	Sample size□%)	HBsAg positive (%)	RR (95%CI)	Anti-HBc positive (%)	RR (95%CI)	Single anti-HBs positive (%)	RR (95%CI)
Infected wives														
Yes	15 (27.78)	2 (13.33)	2.60 (0.40–16.82)	9 (60.00)	1.67 (0.93–3.01)	2 (13.33)	0.43 (0.11–1.71)	30 (34.88)	1 (3.33)	0.62 (0.07–5.73)	8 (26.67)	1.15 (0.54–2.46)	10 (33.33)	0.78 (0.43–1.40)
No	39 (72.22)	2 (5.13)	ref	14 (35.9)	ref	12 (30.77)	ref	56 (65.12)	3 (5.36)	ref	13 (23.21)	ref	24 (42.86)	ref
Infected husbands														
Yes	40 (51.28)	3 (7.50)	-	13 (32.50)	1.24 (0.62–2.47)	17 (42.50)	0.95 (0.57–1.57)	37 (38.95)	1 (2.70)	0.52 (0.06–4.84)	6 (16.22)	0.86 (0.35–2.11)	20 (54.05)	0.95 (0.66–1.38)
No	38 (48.72)	0 (0)	-	10 (26.32)	ref	17 (44.74)	ref	58 (61.05)	3 (5.17)	ref	11 (18.97)	ref	33 (56.90)	ref

Note: *Two-sided *p*-value <0.05; **two-sided *p*-value <0.01; ***two-sided *p*-value <0.001; ref = references which were used to compared with another group when calculated the RR value.

Table 4. Correlation between infected spouses and viral serological markers in the unvaccinated group.

		2006						2014						
	Sample size(%)	HBsAg positive (%)	RR (95%CI)	Anti-HBc positive (%)	RR (95%CI)	Single anti-HBs positive (%)	RR (95%CI)	Sample size□%)	HBsAg positive (%)	RR (95%CI)	Anti-HBc positive (%)	RR (95%CI)	Single anti_HBs positive(%)	RR (95%CI)
Infected wives														
Yes	544 (39.59)	44 (8.09)	1.97 (1.28–3.05) **	301 (55.33)	1.32 (1.18–1.47) ***	18 (3.31)	0.70 (0.41–1.22)	241 (33.29)	15 (6.22)	1.31 (0.70–2.46)	106 (43.98)	0.98 (0.82–1.16)	27 (11.20)	1.13 (0.72–1.76)
No	830 (60.41)	34 (4.10)	ref	348 (41.93)	ref	39 (4.70)	ref	483 (66.71)	23 (4.76)	ref	217 (44.93)	ref	48 (9.94)	ref
Infected husbands														
Yes	644 (47.08)	35 (5.43)	2.19 (1.25–3.82) **	299 (46.43)	1.39 (1.22–1.59) ***	22 (3.42)	0.63 (0.38–1.06)	244 (34.03)	6 (2.46)	0.49 (0.20–1.17)	86 (35.25)	0.96 (0.78–1.19)	23 (9.43)	0.99 (0.61–1.60)
No	724 (52.92)	35 (4.83)	ref	242 (33.43)	ref	39 (5.39)	ref	473 (65.97)	24 (5.07)	ref	173 (36.58)	ref	45 (9.51)	ref

Note: *Two-sided *p*-value <0.05; **two-sided *p*-value <0.01; ***two-sided *p*-value <0.001; ref = references which were used to compared with another group when calculated the RR value.

Sharing syringes could also lead to HBV infection, which might link to unsafe vaccine injections, blood donation, and drug injection.[10,46,47]

Body piercing was statistically significantly associated with anti-HBc in 2006, supporting the earlier finding that body piercing was a risk factor of HBV infection, but it could be avoided by safe piercing practice.[48]

Sexual intercourse, kissing, and other close contacts such as sharing toothbrush were main routes of HBV transmission among spouses. Numerous previous studies had found that infected spouse was one of the causes of HBV infection.[13,19,22,42] HBV vaccine immunization was an effective approach to prevent HBV transmission among infected spouses in some studies.[17,49] In our study, infected spouse was significantly associated with HBsAg and anti-HBc only in the unvaccinated group in 2006, which meant that individuals who were hepatitis B patients or carriers would be a threat to their unvaccinated spouses. Additionally, infected spouse was not significantly correlated with HBV infection in 2014. The reason for this difference might be due to the promotion of national health literacy.

In this study, we found that there was no statistically significant correlation between positive HBV serological markers and risk factors such as history of surgery, dental treatment, blood transfusion, and tattooing. Our result was partly inconsistent with existing research.[47,50,51]

In conclusion, this study illustrates the risk factors of HBV infection among married individuals in the vaccinated and unvaccinated groups. The transmission of HBV has been well controlled by the HBV vaccine immunity policy implemented in Beijing. Unvaccinated individuals face much more HBV infection risk than those vaccinated, and we tentatively conclude that HBV vaccine could effectively protect people from the risk of HBV infection among married people.

Limitation

To our best knowledge, our study is the largest population-based investigation in Beijing, the data was collected by investigation, and there may be recall bias in this study. Information about screening before vaccination was not investigated. Additionally, HBV-infected status of individuals before marriage was not investigated, which would lead to overestimation of the RRof infected spouses.

Disclosure of potential conflicts of interest

No potential conflicts of interest were disclosed.

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Dawei Zhu[1] Chuanxi Fu[2]

1 Center for Health Policy and Management, Institute of Medical Information & Library, Chinese

Academy of Medical Sciences & Peking Union Medical College, No. 3 Yabao Road, Chaoyang

District, 100020, Beijing, China;zhu_dawei@163.com

2 Guangzhou Center for Disease Control and Prevention, Guangzhou,China, fuchuanxi@zcmu.edu.cn

ORCID

Yiwei Guo http://orcid.org/0000-0003-3496-1662
Pei Gao http://orcid.org/0000-0003-2061-0861
Huai Wang http://orcid.org/0000-0002-2807-7929
Jiang Wu http://orcid.org/0000-0002-8505-4723
Qian Bai http://orcid.org/0000-0002-8642-4730
Lieyu Huang http://orcid.org/0000-0002-4846-5726
Shuo Li http://orcid.org/0000-0003-0300-1298
Min Lv http://orcid.org/0000-0003-2962-2658
Xuefeng Shi http://orcid.org/0000-0001-7056-2912

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