

## Research

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# Herd Immunity Conferred By Hepatitis B Vaccination Increases the Protection Efficacy against Hepatitis B Virus Infection

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## ABSTRACT

Most of the chronic infections with Hepatitis B Virus (HBV) are acquired in perinatal period or in early life in China. We conducted HBV serosurveys in the same community among the age 5-6 year old children who were born in 1979-1980, in 1985-1986, and in 2002-2003, respectively. The seropositive rate of HBV surface antigen (HBsAg) was 11.43% in the unvaccinated population. It decreased to 2.08% among the vaccinated children born in the same year. With increased vaccination coverage the HBsAg seropositive rate decreased to 0.24% among the age 6-7 year old children born in 2002-2003, with 98.21% protection efficacy. Herd immunity conferred by HBV vaccination increases the protection efficacy against HBV infection.

**KEYWORDS:** Hepatitis B virus; Hepatitis B virus infection; Primary liver cancer; Vaccine protection.

## INTRODUCTION

Hepatitis B Virus (HBV) infection is one of the leading cause of illness and death in China.<sup>1</sup> Primary Liver Cancer (PLC) and liver cirrhosis are the long-term major adverse outcomes of chronic HBV infection.<sup>2</sup> In the Chinese population, most of the chronic infections are acquired in perinatal period or in early life. In 1992 before the national HBV vaccination program, seropositive rate of HBV surface antigen (HBsAg), that reflect the status of chronic HBV infection, in the 1-4 age group was 9.67%, as high as in the general population (9.75%).<sup>3</sup> In response to the recommendation from a WHO scientific group about the prevention of chronic HBV infection and PLC,<sup>4</sup> China implemented the universal immunization to newborns by integrating the HBV vaccination into the Expanded Program of Immunization (EPI), beginning in January, 1992 with 3 doses of vaccines paid by the family.<sup>5</sup> From January 1, 2002 the HBV vaccination was integrated into the national EPI program with the vaccine provided entirely by the government. Here we reported the effect of herd immunity after HBV vaccination on HBV infection among children.

## METHODS

### Study Population

The children aged 5-6 years who were born in different years and resided in Qidong county, Jiangsu Province of China were recruited for the study. Serum samples were collected in the following years, respectively. In 1985 just before the Hepatitis B vaccine was introduced into China, a total of 433 blood samples from the children born in 1979-1980 were collected.

In 1991 before the Expanded Program of Immunization (EPI), a total of 3002 children, who were born in 1985-1986 and had the record of not receiving the vaccine, donated the blood samples. In addition, 674 children, who were born in 1985-1986 and had the record of receiving 3 dose of the plasma-derived hepatitis B vaccination after birth, donated the blood samples. In 2008 a total of 823 children born in 2002-2003 when all the neonates received obligatory hepatitis B vaccination after birth donated blood samples.

**Serological analysis for HBV infection**

Upon receiving a written consent from the children’s parents, 2 ml peripheral blood was collected from each of children. All HBV serological markers were determined within 12 hours after blood sampling. Individuals with serum HBsAg-positivity were retested in six months. All the serum HBsAg was detected using the reagents from Abbott Laboratories, North Chicago, IL, USA.

**Statistical analysis**

Chi-square test and Fisher’s exact test were conducted to compare HBsAg seropositive rates. Vaccine protection efficacy is calculated based on the HBsAg seropositivity determined among the children born in 1979-80 (as the reference group) by the form:  $\frac{\text{HBsAg}(+) \text{ rate in reference group} - \text{HBsAg}(+) \text{ rate in intervention group}}{\text{HBsAg}(+) \text{ rate in reference group}}$ .

**RESULTS**

**HBsAg Seroprevalence among the Children in Different Period**

We conducted HBV serosurveys among the children aged 5-6 years in different period. The using of disposable medical materials and having the baby delivered in hospital began from 1980s in Qidong, one of the rural areas with HBV high prevalence. The seropositive rate of HBsAg was 13.39% among the children born in 1979-1980 and was 11.86% among those born in 1985-1986 when no vaccination was given after birth (Table 1). Chi-square test showed no difference among the chil-

dren born in these two different years ( $p=0.3587$ ).

**Protection Efficacy of HBV Vaccination on the Children in Different Period**

The Expanded Program of Immunization (EPI) began in January, 1992. Some of the children born in 1985-1986 received the hepatitis B vaccination after birth. It was found that the HBsAg sero-positive rate (2.08%) decreased dramatically in the vaccinated children compared to those children without vaccination (11.86%) who were born in the same year. The protection efficacy of HBV vaccination was 84.47%. With increased vaccination coverage among the population the HBsAg seropositive rate (0.24%) further decreased, with 98.21% protection efficacy.

**DISCUSSION**

With the using of disposable medical materials and having the baby delivered in hospital the HBsAg-seroprevalence decreased in the HBV highly prevalence area. However, the most important strategy to protect the children from HBV infection was proven to be the neonatal HBV vaccination. Vertical transmission is a major route for HBV infection in Asian countries and endemic areas, which accounts for about 40-50% of HBsAg carriers in Taiwan and in mainland China.<sup>3,6</sup> However, horizontal transmission through close contact among children and family members is also a critical route for HBV infection.<sup>6</sup> Our results showed that HBsAg-seropositive rate was further reduced among the population when all the neonates received obligatory hepatitis B vaccination after birth. Thus herd immunity by vaccination is critical to protect population from HBV infection.

The nationwide HBV sero-survey among the mainland of China conducted in 2006 showed that the HBsAg-seroprevalence was 0.96% in the population aged 1-4 years, 2.32% aged 5-14 years, 5.4% aged 15-19 years, and more than 8.0% aged 20-59 years.<sup>7</sup> In 2014, the HBsAg-seroprevalence decreased to 0.32% in the 1~4 age group, to 0.94% in the 5~14 age group and 4.38% in those aged 15~29 years.<sup>8</sup> These data highlighted the importance of national wide neonatal HBV vaccination in reducing the HBV infection in child and adults.

Group	Year Born	Year Sampled	Age Determined	Total Num	HBsAg(+) Number Rate (%)		P value	Protection Efficacy
No vaccination	1979-80	1985	5-6 years	433	58	13.39	0.3587 <sup>a</sup>	Reference
No vaccination	1985-86	1991	5-6 years	3002	356	11.86		11.43%
vaccination	1985-86	1991	5-6 years	674	14	2.08	0.0006 <sup>b</sup>	84.47%
vaccination	2002-03	2008	6-7 years	823	2	0.24		98.21%

<sup>a</sup>Chi-square test  
<sup>b</sup>Fisher’s exact test

**Table 1:** HBsAg seroprevalence in the children aged 5-7 years living in Qidong in different years.

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**CONFLICTS OF INTEREST:** None.

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