Hepatitis B vaccination coverage among Iranian children aged 15–26 months in 2006

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التغطية بلقاح الالتهاب الكبدي «بي» بين الأطفال الإيرانيين الذين تتـراوح أعمارهم ما بين 15 و 26 شهراً في عام 2006

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الخلاصة: قام الباحثون في عام 2006 بتقدير التغطية بلقاح الالتهاب الكبدي «بي» في جمهورية إيران الإسلامية على المستوى الوطني ومستوى المناطق بين السكان القاطنين في المناطق الحضرية والريفية والمناطق النائية، وذلك في مواقع تقديم الخدمات الصحية التابعة لإحدى وأربعين جامعة. ومن إجمالي 21.905 طفلاً شملتهم الدراسة، بلغت نسبة التغطية باللقاح وفقا لبطاقة تسجيل التطعيم 100٪ في 14، و15، و10 من إجمالي 41 منطقة تابعة للجامعات، وذلك بالجرعة الأولى والثانية والثالثة من لقاح الالتهاب الكبدي «بي» على التوالي. وكانت المعدلات الوطنية للتغطية بالجرعات الأولى والثانية والثالثة من اللقاح 98.9٪، و 98.8٪، و 98.4٪ على التوالي. أما أكثر المعدلات انخفاضا في التغطية باللقاح فكانت 90.7٪ (في إحدى المناطق النائية). ومن ثمَّ تُعْتَبَر التغطية بلقاح الالتهاب الكبدي «بي» بين الأطفال الإيرانيين تغطية مقبولة.

ABSTRACT This study in 2006 estimated the hepatitis B virus (HBV) vaccination coverage in the Islamic Republic of Iran at the national and district levels in urban, rural and remote populations of 41 university health service areas. Of 21 905 children recruited to the study, vaccination coverage based on vaccination card records was 100% in 14, 15 and 10 of the 41 university areas for the 1st, 2nd and 3rd doses of HBV respectively. National levels of HBV1, HBV2 and HBV3 coverage were 98.9%, 98.8% and 98.4% respectively. The lowest HBV vaccination coverage rate was 90.7% (in a remote district). HBV vaccination coverage was at an acceptable level in Iranian children.

Couverture vaccinale contre l'hépatite B des enfants iraniens âgés de 15 à 26 mois en 2006

RÉSUMÉ La présente étude, réalisée en 2006 en République islamique d'Iran, a estimé la couverture vaccinale contre le virus de l'hépatite B, à l'échelle du pays et des districts, des populations urbaines, rurales et isolées de 41 zones de services de santé universitaires. Sur 21 905 enfants recrutés pour l'étude, la couverture vaccinale était de 100 % dans 14, 15 et 10 des 41 zones universitaires pour les première, deuxième et troisième doses du vaccin contre le virus de l'hépatite B, respectivement, selon les informations portées sur les cartes de vaccination. À l'échelle nationale, la couverture vaccinale était de 98,9 % pour la première dose, de 98,8 % pour la deuxième dose et de 98,4 % pour la troisième dose. Le taux de couverture vaccinale contre le virus de l'hépatite B le plus faible était de 90,7 % (dans un district éloigné). La couverture vaccinale contre le virus de l'hépatite B avait donc atteint un niveau acceptable chez les enfants iraniens.

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Introduction

Hepatitis B virus (HBV) infection is a global health problem. There are approximately 350 million chronic hepatitis B surface antigen (HBsAg) carriers in the world [1], an estimated 75% of whom live in developing countries [2]. Asia and Africa have previously been classified as areas of high endemicity for HBV. In the Eastern Mediterranean region and surrounding countries, Bahrain, Islamic Republic of Iran, Israel and Kuwait are areas of low endemicity, Cyprus, Iraq and the United Arab Emirates have intermediate endemicity, while Egypt, Jordan, Oman, Palestine, Yemen and Saudi Arabia have high endemicity. All of these countries reach a large proportion of their population with HBV vaccination, which is reducing the infection rate, particularly in Saudi Arabia [3].

The prevalence of HBsAg among Iranian voluntary blood donors has decreased from 1.8% in 1998 to 0.4% in 2007 [4]. These carriers constitute a major health problem in the Islamic Republic of Iran. In the absence of an effective therapy, universal immunization of infants is the only strategy that will lead to the control and eradication of HBV infection [1]. HBV vaccination was added to the Iranian Expanded Programme on Immunization (EPI) in 1993 [5]. In practice, however, the EPI may be affected by factors such as changes in government and public health priorities. Regular monitoring and periodical evaluation is the best way to assess the completeness and effectiveness of HBV vaccination. For this reason, vaccination coverage surveys have been recommended by the World Health Organization (WHO) [6]. During the 1980s and 1990s many countries were interested in estimating their level of immunization coverage, either nationally or subnationally [7].

There are few data about HBV vaccination coverage in the Islamic Republic of Iran, especially at national level and the last reported study was in 1997 [8]. We conducted this study to evaluate the coverage of HBV vaccination at the national and district levels in urban, rural and remote populations of university health service areas.

Methods

Subjects

All Iranian children aged 15–26 months living in the Islamic Republic of Iran during the study year (2006) were included in the survey. Children not receiving vaccine due to contraindications were excluded.

Sampling method

According to WHO methods for sample size calculation for vaccine coverage surveys [6], we needed 210 children aged 15–26 months. Each Iranian child lives in a health service area belonging to one of the 41 medical universities in the country. In each university area, 3 sub-districts were defined according to access to primary care services; urban, rural and remote. Therefore, 630 children were required in the area covered by each university. The population of remote districts was very small in some university areas and there were no remote populations in other districts; therefore, we used finite population correction to calculate the corrected sample size in these populations.

Using cluster sampling [6], we defined 30 clusters of 7 participants in each in the 3 sub-districts of the university health service areas. To identify clusters, we obtained the list of all households in each population (urban, rural and remote) from the deputy of health in all 41 university areas based on the last health census [Deputy of Health, Ministry of Health and Medical Education, unpublished report, Health Census Report, 2005]. To find the first household of each cluster we used systematic random sampling from a cumulative list of households in each district. The sampling interval was calculated from the number of clusters in each area divided by the total number of households in the district. The first household of the first cluster was identified by randomly selecting a number between 1 and ≤ sampling interval. The first household of the second cluster was located by adding the sampling interval to the random number. For subsequent clusters, we identified the first household by adding the sampling interval to the running total. The right side neighbour (clockwise direction) of the first household in each cluster was selected as the second household of that cluster. We continued this process until we had identified 7 subjects in each cluster. In the case of households with more than 1 child aged 15–26 months we selected only the youngest one. In households with twin eligible children, 1 of them was selected randomly.

Data collection

A structured questionnaire to collect sociodemographic and vaccination status data was completed for each of the selected children. The questionnaire was designed by immunization experts at the national level and 2 epidemiologists. Interviews with households were carried out by immunization or communicable diseases experts from the local university. The experts were trained by epidemiologists at the national level. The data quality was assured by developing a documented study protocol and manual of operation. National supervisors monitored the data gathering phase using documented checklists.

EPI services are only carried out by the public sector in the Islamic Republic of Iran. At the first visit to a health centre or health house, a new immunization card is completed for each child and all EPI vaccines (types and dates) are documented on the card. The card is kept by the child's mother. Retention rates of the immunization card were noted as the percentage of individuals with a card at the time of the survey.

The coverage levels were recorded for the 1st, 2nd and 3rd doses of HBV (HBV1, HBV2 and HBV3 respectively). Two measures of HBV vaccination coverage were used. Record-based coverage was based only on the vaccination card records. Record- and recall-based coverage was based on the records plus mothers' recall in interviews in cases where the vaccination record card had been lost.

In the pilot phase, agreement between the record dates (record-based immunization date) and mother's recall (recall-based immunization date) was assessed. The kappa statistics for all vaccines ranged from 0.76 to 0.89 and was 0.86 for HBV vaccine.

Data analysis

Proportions and 95% confidence intervals (CI) were calculated using *SPSS*, version 13 and *STATA*, version 8/SE software. Primary sampling units was used to consider the design effect in interval estimation of immunization coverage. Because the population distribution in the urban, rural and remote districts was not the same in each university area, and because the proportion of the national population varied between university areas, we used weightings in the estimation of immunization coverage in each university area and at the national level.

Results

We recruited 21 905 children to the study. The mean age was 20.6 [standard deviation (SD) 3.5] months and the male to female ratio was 1:1.09. The proportions of urban, rural and remote sample sizes were 41.5%, 39.5% and 19.0% respectively. Retention of the immunization card was 97.8% at the national level. This varied from 80.5% (Zabol) to 100% (Eastern Azerbaijan and Jahrom). The proportion of children who did not receive any EPI vaccines was very low, 0.02% nationally.

Table 1 shows the number of vaccinated children and the weighted percentage coverage in the 3 sub-districts in each university health service area and the total (national) level of vaccine coverage, based only on vaccination records,. The national vaccination coverage levels of HBV1, HBV2 and HBV3 were 98.9%, 98.8% and 98.4% respectively.

Record-based vaccination coverage of HBV1 in 14 of 41 university health service areas was 100%. Fars and Sabzevar had the lowest coverage (around 96%). Remote districts of Ilam and Kerman had the lowest HBV1 coverage in all areas (Table 1). Based on records and mother's recall, HBV1 vaccination coverage in most university areas was 100% and the HBV1 vaccination coverage at national level was 99.0%.

Record-based HBV2 vaccination coverage in 15 of 41 university health service areas was 100%. Fars and Sabzevar had the lowest coverage, around 96% (Table 2). Among the sub-districts, the vaccination coverage in remote districts of Ilam and Kerman was the lowest. Based on records or recall the HBV2 vaccination coverage in national level as well as in most university areas was about 100%.

Our results showed that record-based HBV3 vaccination coverage in 10 of 41 university health service areas was 100% (Table 3). Fars, Sabzevar and Qom had the lowest coverage (around 96%). Remote populations of Ilam, Kerman and Hormozgan had the lowest coverage among the sub-districts. Based on records or recall HBV3 vaccination coverage in 16 university areas was 100% and the national level was 99.6%.

Discussion

This survey assessed coverage of vaccination against HBV in Iranian children from routine immunization data in the government health system. The results showed that the national levels of HBV1, HBV2 and HBV3 coverage in the Islamic Republic of Iran were 98.9%, 98.8% and 98.4% respectively. The drop-out rates for the 2nd and 3rd dose of HBV were 0.1% and 0.4% respectively. The lowest HBV immunization coverage rate of Iranian infants was 90.7% (in a remote area).

Until now, no national immunization survey has been carried out in the Islamic Republic of Iran. Some local surveys in different provinces of the country have been carried out with different methodologies and samples. In Kerman province (south-east of the country), among tribal children aged 12 months, complete HBV coverage (card-based records only) was 46.5% at 2001 [9]. The HBV coverage rates in Kohgelooye province (south-east of the country) of children aged 0–12 months were 99.8%, 99.0% and 92.7% for 1st, 2nd and 3rd doses of HBV respectively in 2000–01 [10]. In western urban areas of Tehran, HBV1, HBV2 and HBV3 coverage rates were 99.1%, 97.0% and 92.0% respectively in 1998 [8]. In 1999, the national infant HBV coverage rate was estimated as 93% for the whole Islamic Republic of Iran [11]. The national vaccination coverage for HBV1, HBV2 and HBV3 was 99%, 100% and 98.4% respectively [12]. The results of the current study show that latest HBV vaccination coverage rates were 98.9%, 98.8% and 98.4% and that coverage has improved in most provinces compared with previous surveys. The coverage rate in remote areas has greatly improved, leading to declining disparities in vaccination coverage.

The coverage rate of the 3 recommended doses (HBV1, HBV2, HBV3) is high in the Islamic Republic of Iran compared with other Asian countries. The vaccination coverage in the south-east Anatolia region of Turkey was 44% for the 3rd dose of HBV vaccine in children aged 12–23 months [13]. According to data from the United Nations Children's Fund (UNICEF), the rate of

Table 1 Record-based coverage of 1st dose of hepatitis B virus vaccine (HBV1) in Iranian children by university health service areas and sub-districts

University area	Urban		Rural		Remote		All districts[b]	
	No.	%	No.	%	No.	%	No.	%
Eastern Azerbaijan	209	100.0	207	100.0	213	100.0	629	100.0
Western Azerbaijan	210	98.1	211	100.0	208	99.5	629	99.0
Ardabil	214	97.2	207	100.0	209	100.0	630	98.4
Isfahan	210	100.0	210	99.5	57	100.0	477	99.9
Ilam	205	100.0	212	100.0	102	93.1	519	99.8
Babol	213	100.0	204	99.5	113	100.0	530	99.8
Booshehr	206	100.0	217	100.0	68	100.0	491	100.0
Tehran (TUMS)[a]	210	96.7	205	99.5	64	100.0	479	97.0
Tehran (IUMS)[a]	623	97.0	378	99.7	41	100.0	1042	97.1
Tehran (SBUMS)[a]	217	96.8	201	99.0	64	100.0	482	96.9
Jahrom	210	100.0	210	100.0	35	100.0	455	100.0
Chahar Mahal Bakhtyaree	210	100.0	210	100.0	·	·	420	100.0
Southern Khorasan	210	96.7	210	99.5	209	96.7	629	98.0
Khorasan Razavi	212	99.5	211	100.0	207	99.5	630	99.7
Northern Khorasan	231	97.0	182	100.0	217	99.5	630	98.5
Khoozestan	210	99.5	211	100.0	210	99.5	631	99.7
Rafsanjan	210	100.0	211	100.0	·	·	421	100.0
Zabol	217	93.1	203	100.0	21	100.0	441	97.5
Zanjan	210	100.0	200	98.5	133	100.0	543	99.3
Sabzevar	210	92.9	210	100.0	105	99.1	525	96.1
Semnan	210	99.5	210	100.0	33	100.0	453	99.6
Sistan–Baluchestan	203	97.0	200	99.5	227	99.1	630	98.3
Shahrood	217	100.0	210	100.0	16	100.0	443	100.0
Fars	210	95.7	209	97.6	212	99.5	631	96.3
Fasa	209	100.0	194	100.0	16	100.0	419	100.0
Qazvin	210	99.5	210	100.0	210	100.0	630	99.7
Qom	210	97.1	207	100.0	–	–	417	97.2
Kashan	231	99.1	126	100.0	–	–	357	99.2
Kordestan	210	100.0	209	100.0	57	100.0	476	100.0
Kerman	210	99.1	223	100.0	195	95.9	628	99.0
Kermanshah	210	100.0	210	99.1	112	99.1	532	99.7
Kohgelooye	209	100.0	210	100.0	20	100.0	439	100.0
Golestan	210	96.7	210	99.5	117	100.0	537	98.3
Gonabad	203	100.0	218	100.0	31	100.0	452	100.0
Gilan	209	100.0	210	99.5	125	99.2	544	99.8
Lorestan	217	100.0	209	100.0	202	100.0	628	100.0
Mazandaran	210	99.5	224	100.0	91	100.0	525	99.7
Markazi	209	100.0	210	100.0	–	–	419	100.0
Hormozgan	210	100.0	232	100.0	188	100.0	630	100.0
Hamedan	210	100.0	210	100.0	42	100.0	462	100.0
Yazd	210	98.6	210	100.0	–	–	420	98.8
Total[b]	–	–	–	–	–	–	–	98.9

[a]Tehran province population was divided by 3 areas covered by Tehran University of Medical Sciences (TUMS), Iran University of Medical Sciences (IUMS) and Shahid Beheshti University of Medical Sciences (SBUMS).
[b]Weighted proportions.

Table 2 Record-based coverage of 2nd dose of hepatitis B virus vaccine (HBV2) in Iranian children by university health service areas and sub-districts

University area	Urban		Rural		Remote		All districts[b]	
	No.	%	No.	%	No.	%	No.	%
Azerbaijan Eastern	210	100.0	207	100.0	213	100.0	630	100.0
Azerbaijan Western	210	98.1	211	100.0	209	99.5	630	99.0
Ardabil	214	97.2	207	100.0	209	100.0	630	98.4
Isfahan	210	100.0	210	99.5	57	100.0	477	99.9
Ilam	205	100.0	212	100.0	102	93.1	519	99.8
Babol	213	100.0	205	100.0	113	100.0	531	100.0
Booshehr	206	100.0	217	100.0	68	100.0	491	100.0
Tehran (TUMS)[a]	210	96.7	205	99.5	64	100.0	479	97.0
Tehran (IUMS)[a]	626	96.7	379	99.7	42	100.0	1047	96.9
Tehran (SBUMS)[a]	217	97.2	201	99.0	64	100.0	482	97.3
Jahrom	210	100.0	210	100.0	35	100.0	455	100.0
Chahar Mahal Bakhtyaree	210	100.0	210	100.0	.	.	420	100.0
Khorasan Southern	210	97.1	210	99.5	209	96.7	629	98.2
Khorasan Razavi	212	99.1	211	100.0	207	99.5	630	99.3
Khorasan Northern	231	97.4	182	100.0	217	99.5	630	98.7
Khoozestan	210	99.5	211	100.0	210	99.5	631	99.7
Rafsanjan	210	99.5	211	100.0	–	–	421	99.7
Zabol	217	93.1	203	100.0	21	100.0	441	97.5
Zanjan	210	100.0	200	100.0	133	100.0	543	100.0
Sabzevar	210	92.4	210	100.0	105	97.1	525	95.8
Semnan	210	99.5	210	100.0	33	100.0	453	99.6
Sistan-Baluchestan	203	96.6	200	99.0	227	99.6	630	98.0
Shahrood	217	100.0	210	100.0	16	100.0	443	100.0
Fars	210	95.7	209	97.6	212	99.5	631	96.3
Fasa	209	100.0	194	100.0	16	100.0	419	100.0
Qazvin	210	100.0	210	100.0	210	100.0	630	100.0
Qom	210	97.1	210	100.0	–	–	420	97.2
Kashan	231	99.1	126	100.0	–	–	357	99.2
Kordestan	210	100.0	209	100.0	57	100.0	476	100.0
Kerman	210	99.1	223	100.0	195	94.9	628	98.9
Kermanshah	210	100.0	208	99.0	112	96.4	530	99.7
Kohgelooye	209	100.0	210	100.0	20	100.0	439	100.0
Golestan	209	96.7	210	99.5	117	100.0	536	98.3
Gonabad	203	99.5	218	100.0	31	100.0	452	99.7
Gilan	209	98.6	210	99.5	125	99.2	544	99.0
Lorestan	217	100.0	210	100.0	202	100.0	629	100.0
Mazandaran	210	100.0	224	100.0	91	100.0	525	100.0
Markazi	209	100.0	210	100.0	–	–	419	100.0
Hormozgan	210	100.0	232	100.0	188	99.5	630	99.9
Hamedan	210	100.0	210	100.0	42	100.0	462	100.0
Yazd	210	98.6	210	100.0	–	–	420	98.8
Total[b]	–	–	–	–	–	–	–	98.8

[a]Tehran province population was divided by 3 areas covered by Tehran University of Medical Sciences (TUMS), Iran University of Medical Sciences (IUMS) and Shahid Beheshti University of Medical Sciences (SBUMS).
[b]Weighted proportions.

Table 3 Record-based coverage of 3rd dose of hepatitis B virus vaccine (HBV3) in Iranian children by university health service areas and sub-districts

University area	Urban		Rural		Remote		All districts[b]	
	No.	%	No.	%	No.	%	No.	%
Eastern Azerbaijan	210	99.5	207	100.0	213	99.5	630	99.7
Western Azerbaijan	210	96.7	211	100.0	208	99.5	629	98.2
Ardabil	214	96.7	207	99.5	209	99.0	630	97.9
Isfahan	210	100.0	210	99.5	57	100.0	477	99.9
Ilam	205	100.0	212	99.1	102	91.2	519	99.3
Babol	213	100.0	205	100.0	113	100.0	531	100.0
Booshehr	206	100.0	217	100.0	68	100.0	491	100.0
Tehran (TUMS)[a]	210	96.7	205	99.0	64	100.0	479	97.0
Tehran (IUMS)[a]	625	96.3	379	99.5	42	100.0	1046	96.5
Tehran (SBUMS)[a]	217	96.8	201	98.5	64	100.0	482	96.8
Jahrom	210	99.5	210	100.0	35	97.1	455	99.7
Chahar Mahal Bakhtyaree	210	100.0	210	100.0	–	–	420	100.0
Southern Khorasan	210	95.2	210	97.6	209	94.3	629	96.2
Khorasan Razavi	211	99.1	211	98.6	207	99.0	629	98.9
Northern Khorasan	231	96.1	182	100.0	216	99.5	629	98.1
Khoozestan	210	98.1	211	99.5	210	99.1	631	98.6
Rafsanjan	210	100.0	211	100.0	–	–	421	100.0
Zabol	217	92.6	203	99.0	21	100.0	441	96.7
Zanjan	210	99.5	199	100.0	133	100.0	542	99.8
Sabzevar	210	91.4	210	100.0	105	98.1	525	95.3
Semnan	210	99.5	210	100.0	33	97.0	453	99.6
Sistan–Baluchestan	203	95.1	200	99.5	227	100.0	630	97.5
Shahrood	217	100.0	210	100.0	16	100.0	443	100.0
Fars	210	95.2	209	96.7	212	97.2	631	95.6
Fasa	209	100.0	194	100.0	16	100.0	419	100.0
Qazvin	210	100.0	210	100.0	210	100.0	630	100.0
Qom	210	96.7	210	100.0	–	–	420	96.8
Kashan	231	99.1	126	100.0	–	–	357	99.2
Kordestan	210	99.5	209	99.0	57	100.0	476	99.3
Kerman	210	98.6	223	97.3	194	90.7	627	97.3
Kermanshah	209	99.5	210	99.1	112	92.9	531	99.3
Kohgelooye	209	99.5	210	100.0	20	100.0	439	99.8
Golestan	210	96.7	210	99.5	117	99.1	537	98.3
Gonabad	203	99.5	218	100.0	31	100.0	452	99.7
Gilan	209	98.6	210	99.5	125	98.4	544	99.0
Lorestan	217	100.0	210	100.0	202	100.0	629	100.0
Mazandaran	210	100.0	224	99.6	91	100.0	525	99.8
Markazi	209	100.0	210	100.0	·	·	419	100.0
Hormozgan	210	96.7	232	97.8	188	92.0	630	96.7
Hamedan	210	100.0	210	100.0	42	100.0	462	100.0
Yazd	210	98.6	210	100.0	·	·	420	98.8
Total[b]	–	–	–	–	–	–	–	98.4

[a]Tehran province population was divided by 3 areas covered by Tehran University of Medical Sciences (TUMS), Iran University of Medical Sciences (IUMS) and Shahid Beheshti University of Medical Sciences (SBUMS).
[b]Weighted proportions.

HBV vaccine was 77% for Turkey [14]. Assuming that 77% is correct for the whole country, 44% is very low for this region because the percentage of HBV carriers is higher in south-east Anatolia than in Turkey as a whole [15]. The authors concluded that efforts must focus on family planning services, education of women, follow-up visits and strengthening health facilities, especially in rural regions, to improve vaccination coverage. It is possible that slight differences occur in official rates and research data in developed countries, so greater differences in developing countries are not surprising. The coverage of birth doses and complete HBV vaccination in Mongolia was very low in provincial centres and rural areas [16].

In developed countries the rates are sometimes even lower [17–19]. In France, for example, HBV vaccine was administered to only 40.1% of children aged 0–2 years [20]. In Germany, vaccination is not mandatory [21]. UNICEF data for Italy showed that the rate of HBV vaccination was 95% [14] and in another study in Italy, coverage was 90% on average [22]. In the United States of America (USA) safe and effective vaccines have been available for HBV since 1981 [23]. Since their addition to the recommended childhood vaccination schedule, large increases in national coverage were observed for the 3 doses of HBV and varicella vaccine; coverage with 3 doses of HBV increased by 19% during 1995–98 (from 68.0% in 1995 to 87.0% in 1998) [24,25]. Estimated coverage levels in 2006 for HBV in the USA were above 90% for all racial/ethnic groups except for American Indian/Alaskan native children aged 19–35 months [26].

There is some evidence that premarriage prevention of HBV transmission in Islamic Republic of Iran is a cost-effective strategy [27,28]. Administration of HBV vaccine at the time of marriage prevents the transmission of HBV in susceptible spouses [29]. This could be applied in other the countries with cultural backgrounds similar to ours.

Mothers' recall may be not a valid and reliable source for assessing vaccine coverage. Fortunately, more than 95% Iranian children had an immunization card at the time of our survey. Nevertheless, a pilot study showed that agreement between mothers' recall and the immunization card was acceptable. Unavailability of mothers may be a source of selection bias. Interviewing in mother's home and performing 3 visits helped to minimize this area of bias.

In summary, the study showed the HBV vaccination coverage was at an acceptable level in Iranian children. Disparity of the vaccine coverage was very low across university health service areas and urban, rural or remote district. The authors suggest monitoring HbsAg seropositivity prevalence to assess the vaccine immunogenicity especially in high-risk areas.

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