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Vaccination Coverage of Foreign-Born Children 19 to 35 Months of Age: Findings From the National Immunization Survey, 1999–2000

Tara W. Strine, MPH; Lawrence E. Barker, PhD; Ali H. Mokdad, PhD; Elizabeth T. Luman, MS; Roland W. Sutter, MD; and Susan Y. Chu, PhD

ABSTRACT. *Objective.* To compare coverage estimates of foreign-born children 19 to 35 months old with those of US-born children of the same age group.

Methods. The National Immunization Survey is a multistage, random-digit dialing survey designed to measure vaccination coverage estimates of US children 19 to 35 months old. Data from 1999–2000 were combined to permit comparison of vaccination coverage among foreign- and US-born children.

Results. Foreign-born and US-born children 19 to 35 months of age had comparable 3:3:1 series coverage (3 or more doses of diphtheria and tetanus toxoids and pertussis vaccine [DTP/DTaP/DT], 3 or more doses of poliovirus vaccine, and 1 or more doses of measles-containing vaccine), the standard in most countries. However, coverage for a US standard, 4:3:1:3 series (4 or more doses of DTP/DTaP/DT, 3 or more doses of poliovirus vaccine, 1 or more doses of measles-containing vaccine, and an adequate number of *Haemophilus influenzae* type b [Hib] doses based on age at first dose) was lower among foreign-born children because of markedly lower Hib cover and marginally lower DTP/DTaP/DT coverage. In addition, hepatitis B coverage was markedly lower in foreign-born children.

Conclusion. Lower vaccination coverage among foreign-born children, especially against Hib and hepatitis B, is of concern because foreign-born children often live in households and communities characterized by more intense exposure to these diseases, and many originate from countries with much higher prevalence rates of these diseases than the United States. The differences in Hib and hepatitis B coverage suggest a need for increased culturally competent public health immunization interventions to increase coverage among foreign-born children. *Pediatrics* 2002;110(2). URL: <http://www.pediatrics.org/cgi/content/full/110/2/e15>; *immigrants, child, immunization programs, vaccines, vaccinations, health surveys.*

ABBREVIATIONS. INA, Immigration and Nationality Act; NIS, National Immunization Survey; Hib, *Haemophilus influenzae* type b, DTP/DTaP/DT, diphtheria and tetanus toxoids and pertussis vaccine; MCV, measles-containing vaccine; CI, confidence interval.

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In 1996, the US Immigration and Nationality Act (INA) mandated that immigrant children (excluding adoptees)¹ applying for permanent US residency show documentation of recommended immunizations or undergo vaccination with at least the first vaccine of each required vaccine series before admission to the United States.² A literature search found no studies that compared vaccination coverage in US- and foreign-born children. To examine the national vaccine coverage rates for foreign-born children aged 19 to 35 months and compare these rates with those of children born in the United States, we examined data from the National Immunization Survey (NIS).

METHODS

To obtain sufficient numbers of foreign-born children to ensure stable vaccination coverage estimates, we combined data for 1999 and 2000 from the NIS. The NIS is an annual multistage, random-digit dialing survey designed to measure vaccination coverage estimates for children in the United States. NIS uses a complex weighting scheme to compensate for homes without phones, response propensity, and other characteristics of the respondents to produce national level estimates.³ A screening questionnaire is administered to adult respondents to identify households with 19- to 35-month-old children. In eligible households, a parent or guardian is interviewed to collect demographic information, the child's immunization history, and consent to contact the child's immunization provider. A survey is mailed to immunization providers to validate immunization information. Only provider verified vaccinations are included in this analysis (65.4% provider response rate in 1999, 67.4% provider response rate in 2000). During the interview, respondents were asked the child's birthplace (city, county, state, country). We used this question to categorize children as foreign- or US-born. NIS methods, including the NIS weighting procedure, are described elsewhere.^{3–4}

The number of recommended doses of *Haemophilus influenzae* type b (Hib) depends on the age at which the child received the first dose.⁵ If the series was started by 11 months old, we considered the child up-to-date if he/she received 3 doses. If the series was started between 12 and 14 months old, we considered the child up-to-date if he/she received 2 doses. If the series was started at 15 months old, we considered the child up-to-date if he/she received 1 dose. The child was considered up-to-date for the 4:3:1:3 series if he/she received 4 or more doses of diphtheria and tetanus toxoids and pertussis vaccine (DTP/DTaP/DT), 3 or more doses of poliovirus vaccine, 1 or more doses of measles-containing vaccine (MCV), and 3 or more doses of Hib or an adequate number of Hib doses based on age at first dose.

National foreign- and US-born demographic estimates, coverage estimates, and confidence intervals (CIs) were calculated using SUDAAN version 7.5.3 (Research Triangle Park, NC).⁶ Multivariate logistic regression analysis was used to determine significant differences in coverage levels while controlling for differences in population characteristics between foreign- and US-born children.

TABLE 1. Characteristics of Foreign- and US-Born Children Aged 19 to 35 Months†—NIS, 1999–2000

Characteristic		Foreign-Born Children % (95% CI)	US-Born Children % (95% CI)	Difference in Foreign- and US-Born Demographics P Value
Birthplace				
Latin America		48.7 (41.0–56.4)	NA	NA
Asia		21.0 (14.8–27.2)	NA	NA
Europe		16.8 (10.9–22.7)	NA	NA
Africa		3.7 (0.5–6.9)	NA	NA
Other		5.2 (1.8–8.7)	NA	NA
Unknown		4.6 (1.7–7.5)	NA	NA
Race/ethnicity				
White	*	28.0 (21.1–34.9)	57.8 (57.1–58.5)	<.01
Black	*	6.2 (2.9–9.5)	15.5 (14.9–16.0)	<.01
Hispanic	*	47.6 (39.9–55.3)	21.6 (21.0–22.2)	<.01
American Indian		0.5 (0.0–1.1)	1.0 (0.8–1.1)	.16
Asian	*	17.2 (11.2–23.2)	3.9 (3.6–4.2)	<.01
Other		0.6 (0.0–1.5)	0.3 (0.2–0.3)	.51
Gender				
Male		47.3 (39.6–54.9)	50.9 (50.2–51.6)	.36
Female		52.8 (45.1–60.4)	49.1 (48.4–49.8)	.36
Age of child (mo)				
19–24		29.3 (22.3–36.2)	35.8 (35.1–36.4)	.07
25–29		31.4 (24.2–38.5)	29.5 (28.8–30.1)	.61
30–35		39.4 (31.9–46.9)	34.8 (34.1–35.5)	.23
First-born				
Yes		43.8 (36.2–51.3)	40.3 (39.6–41.0)	.37
No		56.2 (48.7–63.8)	59.7 (59.0–60.4)	.37
Mother's age (y)				
≤19		2.8 (0.03–5.6)	3.4 (3.1–3.7)	.68
20–29		53.9 (46.2–61.5)	46.6 (45.8–47.3)	.06
30+		43.3 (35.8–50.8)	50.0 (49.3–50.8)	.08
Phone interrupted in past year				
Yes		10.3 (5.8–14.9)	7.6 (7.2–8.0)	.24
No		89.7 (85.1–94.2)	92.4 (92.0–92.8)	.24
Income				
0–\$30 000	*	73.4 (66.0–80.7)	46.8 (46.0–47.6)	<.01
\$30 001–\$50 000	*	8.1 (3.4–12.8)	21.8 (21.2–22.4)	<.01
\$50 001–\$75 000	*	7.5 (3.4–11.5)	16.5 (15.9–17.0)	<.01
\$75 001+		11.0 (5.9–16.1)	15.0 (14.5–15.5)	.13
Education of mother				
<12 y	*	39.3 (31.5–47.0)	16.7 (16.1–17.3)	<.01
12 y	*	25.5 (19.0–32.0)	36.9 (36.2–37.7)	<.01
Some college	*	8.5 (5.1–11.9)	17.7 (17.2–18.2)	<.01
College graduate		26.8 (20.2–33.3)	28.6 (28.0–29.2)	.59
Number of people in the household				
2	*	1.2 (0.2–2.2)	3.2 (2.9–3.4)	<.01
3		26.5 (20.2–32.8)	23.6 (23.0–24.2)	.37
4		33.0 (25.7–40.3)	36.6 (35.9–37.3)	.34
5		19.0 (12.6–25.3)	20.6 (20.0–21.2)	.62
6+		20.4 (13.9–26.8)	16.0 (15.5–16.6)	.18
Mother's marital status				
Widowed/separated/divorced		5.8 (2.6–9.0)	8.8 (8.3–9.2)	.07
Never married	*	10.7 (5.6–15.9)	20.1 (19.5–20.7)	<.01
Married	*	83.5 (77.6–89.3)	71.1 (70.4–71.8)	<.01
Child ever received Women, Infant and Child services				
Yes		60.1 (52.5–67.7)	54.1 (53.3–54.8)	.12
No		39.9 (32.3–47.5)	46.0 (45.2–46.7)	.12
Shot card availability				
Yes	*	69.6 (62.3–76.9)	50.0 (49.3–50.7)	<.01
No	*	30.4 (23.1–37.7)	50.0 (49.3–50.7)	<.01
Number of providers				
1	*	55.7 (48.0–63.4)	68.2 (67.6–68.9)	<.01
2+	*	44.3 (36.6–52.1)	31.8 (31.1–32.4)	<.01
Type of provider				
All public	*	35.8 (28.5–43.1)	15.5 (15.0–16.0)	<.01
All private	*	40.3 (32.6–47.9)	54.6 (53.9–55.3)	<.01
Other/mixed/unknown		24.0 (17.6–30.3)	29.9 (29.2–30.6)	.07
Interview conducted in what language				
English	*	31.2 (24.6–37.9)	87.9 (87.4–88.4)	<.01
Spanish	*	46.0 (38.3–53.7)	10.0 (9.5–10.5)	<.01
Other	*	22.8 (16.0–29.6)	2.1 (1.9–2.3)	<.01

NA indicates not applicable.

* Significant difference between foreign-born and US-born demographics

† Children in survey period born between February 1996 and May 1999.

RESULTS

Characteristics of Foreign-Born Children Aged 19 to 35 Months

Approximately 49% of foreign-born children were born in Latin America, 21% in Asia, 17% in Europe, 9% in other regions of the world, and 5% were of unknown origin. Compared with children born in the United States, a lower percentage of foreign-born children were white non-Hispanic (28.0% vs 57.8%) and black non-Hispanic (6.2% vs 15.5%), and a higher percentage were Hispanic (47.6% vs 21.6%) and Asian (17.2% vs 3.9%; Table 1). Approximately 31% of all interviews of caregivers of foreign-born children were conducted in English, compared with 88% for US-born children. Compared with US-born children, foreign-born children were more likely to come from a household with an income of \$30 000 or less (73.4% vs 46.8%), have mothers with less than a high school education (39.3% vs 16.7%), and have >1 provider (44.3% vs 31.8%). Foreign-born children were also more likely to receive immunizations in public facilities (35.8% vs 15.5%).

Vaccination Coverage of Foreign-Born Children Aged 19 to 35 Months

Foreign-born and US-born children 19 to 35 months old had comparable 3:3:1 series coverage (3 or more doses of DTP/DTaP/DT, 3 or more doses of poliovirus vaccine, and 1 or more doses of MCV), the standard in most countries (Table 2). However, 4:3:1:3 series coverage, a US standard, was statistically significantly lower for foreign-born children (67.2%, 95% CI: 59.8–74.6) than for US-born children (78.0%, 95% CI: 77.4–78.6). Coverage with the fourth dose of DTP/DTaP/DT was significantly higher for US-born children, but only marginally so (*P* value = .04). Hib

and hepatitis B coverage, on the other hand, was markedly lower for foreign-born children than for US-born children. Coverage with 3 doses of poliovirus vaccine, 3 doses of DTP/DTaP/DT, and 1 dose of varicella were comparable between the 2 groups, and MCV coverage was significantly higher for foreign-born children than children born in the United States.

A logistic regression model was built using the variables in Table 1 except for language of interview, which was excluded because of its high correlation with birthplace. The child's gender; family income; whether the child received assistance from the Special Supplemental Nutrition Program for Women, Infants and Children; and type of provider were removed from the model because they were not significant (Wald *F*). The final model appears in Table 3. After controlling for other factors in the model, foreign-born children were ~45% less likely to be up-to-date for 4:3:1:3 coverage than US-born children (odds ratio: 0.55, 95% CI: 0.39–0.78).

DISCUSSION

Our study demonstrates that foreign-born children have equivalent 3:3:1 series coverage, the standard in most countries. This comparability is attributable, in part, to the worldwide availability of the 3:3:1 series vaccines (DTP/DTaP/DT, poliovirus, and MCV), which have been promoted globally by the World Health Organization since 1974, when the Expanded Program of Immunizations was created.⁷ In addition, polio coverage may also be boosted in foreign-born children because of the ongoing effort to eradicate this disease globally, which provides supplemental doses in many countries where these children were born.

TABLE 2. Vaccine Coverage Levels Among Foreign- and US-Born Children Aged 19–35 Monthst, by Selected Vaccines—NIS, 1999–2000

Vaccination	Foreign-born % 95% CI	US-Born % 95% CI	Difference in Foreign- and US-Born Coverage <i>P</i> Value
DTP/DT/DTaP‡			
≥3 doses	90.6 (86.2–95.1)	95.1 (94.7–95.4)	.05
≥4 doses *	75.6 (68.8–82.5)	82.6 (82.0–83.2)	.04
Poliovirus			
≥3 doses	88.4 (83.8–92.9)	89.6 (89.1–90.0)	.62
Hib§ *	87.2 (82.2–92.2)	95.0 (94.7–95.3)	<.01
MCV			
≥1 dose *	94.9 (91.9–97.9)	91.1 (90.6–91.4)	.01
Hepatitis B			
≥3 doses *	73.6 (66.7–80.6)	89.4 (89.0–89.9)	<.01
Varicella			
≥1 dose	68.1 (61.2–75.1)	64.6 (64.0–65.3)	.33
Combined series			
3:3:1	84.9 (79.6–90.2)	84.8 (84.3–85.4)	.98
4:3:1:3¶ *	67.2 (59.8–74.6)	78.0 (77.4–78.6)	<.01

* Significant difference between foreign-born and US-born coverage

† Children in survey period born between February 1996 and May 1999.

‡ Diphtheria and tetanus toxoids and pertussis vaccine (DTP), diphtheria and tetanus toxoids (DT), and diphtheria and tetanus toxoids and acellular pertussis vaccine (DTaP).

§ Three or more doses of Hib or adequate number of Hib doses given age at start of series.

|| Three or more doses of DTP/DT/DTaP, 3 or more doses of poliovirus vaccine, and 1 or more dose of MCV.

¶ Four or more doses of DTP/DT/DTaP, 3 or more doses of poliovirus vaccine, 1 or more doses of MCV, and 3 or more doses of Hib or adequate number of Hib doses given age at start of series.

TABLE 3. Final Logistic Regression Model for 4:3:1:3 * Vaccination Coverage of Foreign-Born Children Aged 19 to 35 Months†—NIS, 1999–2000

Characteristic	Odds Ratio (95% CI)
Birthplace	
United States	Referent
Foreign	0.55 (0.39–0.78)
Race/ethnicity	
White	Referent
Black	0.77 (0.69–0.86)
Hispanic	0.87 (0.79–0.97)
Asian	0.83 (0.68–1.02)
Other	0.85 (0.64–1.14)
Age of child (mo)	
19–24	Referent
25–29	1.57 (1.44–1.71)
30–35	1.71 (1.57–1.87)
First-born	
No	Referent
Yes	1.30 (1.18–1.44)
Mother's age (y)	
≤19	Referent
20–29	0.93 (0.76–1.14)
30+	1.16 (0.94–1.44)
Phone interrupted in past year	
Yes	Referent
No	1.21 (1.06–1.38)
Education of mother	
<12 y	Referent
12 y	1.09 (0.97–1.23)
Some college	1.32 (1.16–1.51)
College graduate	1.52 (1.33–1.74)
Number of people in the household	
2	Referent
3	0.90 (0.72–1.12)
4	0.89 (0.70–1.12)
5	0.79 (0.62–1.00)
6+	0.70 (0.55–0.90)
Mother's marital status	
Widowed/separated/divorced	Referent
Never married	1.31 (1.13–1.51)
Married	1.43 (1.26–1.63)
Shot card availability	
Yes	Referent
No	0.66 (0.62–0.72)
Number of providers	
1	Referent
2+	0.77 (0.71–0.83)

* Four or more doses of DTP/DT/DaP, 3 or more doses of poliovirus vaccine, 1 or more doses of MCV, and 3 or more doses of Hib or adequate number of Hib doses given age at start of series.

† Children in survey period born between February 1996 and May 1999.

Since 1996, the INA has mandated that immigrant children (excluding adoptees)¹ applying for permanent US residency show documentation of recommended immunizations or undergo vaccination with at least the first vaccine of each required vaccine series before admission to the United States.² This requirement would increase varicella and MCV coverage rates in foreign-born children because 1 dose of each of these vaccines would render a child 19 to 35 months old fully vaccinated.

Although vaccination coverage against epidemic-prone diseases such as measles and polio is comparable between foreign- and US-born children, additional progress is needed to increase foreign-born

Hib and hepatitis B coverage. Increased coverage is important because, as our analysis shows, foreign-born children are often living in low socioeconomic households. Low socioeconomic status (especially crowding) is a known risk factor for both Hib and hepatitis B disease.^{8–9} Foreign-born children are also at greater risk for hepatitis B disease because a high proportion of these children originate from areas where the disease is more prevalent than in the United States.⁸

Our study has several limitations. First, immunization coverage may have been underreported for some foreign-born children as documentation may be inaccurately transferred or missing for vaccinations obtained in their country of birth. However, the extent of underreporting is likely to be minimal because foreign-born children had available shot cards more often than US-born children (69.6% and 50.0% in foreign- and US-born children, respectively) and the 3:3:1 coverage was the same for both groups. Second, international adoptees 10 years of age or younger are currently exempt from the INA requirement; however, adoptive parents are required to sign a waiver ensuring compliance with those requirements within 30 days after the child arrives in the United States.²

Despite these limitations, our findings indicate that foreign-born children have markedly lower coverage for hepatitis B and Hib. Although it is unlikely that these differences would give rise to epidemics, the lower vaccination coverage, combined with a greater exposure potential in many immigrant families and communities, may put these children at greater risk for these diseases. The difference in vaccination coverage between foreign- and US-born children, specifically Hib and hepatitis B coverage, suggest a need for increased culturally competent public health immunization interventions. This may have particular impact in large metropolitan areas with high percentages of foreign-born populations such as New York-Northern New Jersey-Long Island (22.8%), Los Angeles-Riverside-Orange County (29.6%), San Francisco-Oakland-San Jose (28.3%), and Miami (42.7%).¹⁰

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