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Vaccination Coverage Among American Indian and Alaska Native Children, 2006–2010

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WHAT'S KNOWN ON THIS SUBJECT: Disparities in vaccination coverage between American Indian/Alaska Native and white children previously existed between 2001 and 2004 but were not present in 2005.

WHAT THIS STUDY ADDS: This study updates a previous study by analyzing data through 2010 and found that these gains have been maintained.

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KEY WORDS
American Indian, Alaska Native, immunization assessment, health disparities

ABBREVIATIONS
AI/AN—American Indian/Alaska Native
CHSDA—contract health services delivery areas
CI—confidence interval
DTaP—≥Diphtheria and tetanus toxoids and pertussis vaccine, or diphtheria and tetanus toxoids, or diphtheria and tetanus toxoids and any acellular pertussis vaccine
Hib—*Haemophilus influenzae* type b
HepB—hepatitis B
IHS—Indian Health Service
I/T/U—Indian Health Service, Tribal, Urban Indian health facility
MMR—measles, mumps, rubella
MSA—Metropolitan Statistical Area
NIS—National Immunization Survey
PCV—pneumococcal conjugate vaccine
Var—varicella
VPD—vaccine-preventable diseases
4:3:1:3:3:1—≥4 doses, diphtheria and tetanus toxoids and pertussis vaccine, diphtheria and tetanus toxoids, or diphtheria and tetanus toxoids and any pertussis vaccine, ≥3 doses of oral or inactivated polio vaccine, ≥1 dose of measles, mumps, and rubella vaccine, ≥3 doses of *Haemophilus influenzae* type b vaccine, ≥3 doses of hepatitis B vaccine, and ≥1 dose of varicella vaccine
4:3:1:x:3:1—the 4:3:1:3:3:1 series excluding the Hib vaccine
4:3:1:3:3:1:4—≥4 doses diphtheria and tetanus toxoids and pertussis vaccine, diphtheria and tetanus toxoids, or diphtheria and tetanus toxoids and any pertussis vaccine, ≥3 doses of oral or inactivated polio vaccine, ≥1 dose of measles, mumps, and rubella vaccine, ≥3 doses of *Haemophilus influenzae* type b vaccine, ≥3 doses of hepatitis B vaccine, ≥1 dose of varicella vaccine, and ≥4 doses of pneumococcal conjugate vaccine
4:3:1:x:3:1:4—the 4:3:1:3:3:1:4 series excluding the Hib vaccine

(Continued on last page)

abstract

BACKGROUND AND OBJECTIVES: A previous study on vaccination coverage in the American Indian/Alaska Native (AI/AN) population found that disparities in coverage between AI/AN and white children existed from 2001 to 2004 but were absent in 2005. The objective of this study was to describe vaccination coverage levels for AI/AN children aged 19-35 months in the United States between 2006 and 2010, examining whether gains found for AI/AN children in 2005 have been sustained.

METHODS: Data from the 2006 through 2010 National Immunization Surveys were analyzed. Groups were defined as AI/AN (alone or in combination with any other race and excluding Hispanics) and white-only non-Hispanic children. Comparisons in demographics and vaccination coverage were made.

RESULTS: Demographic risk factors often associated with underimmunization were significantly higher for AI/AN respondents compared with white respondents in most years studied. Overall, vaccination coverage was similar between the 2 groups in most years, although coverage with 4 or more doses of pneumococcal conjugate vaccine was lower for AI/AN children in 2008 and 2009, as was coverage with vaccine series measures the series in 2006 and 2009. When stratified by geographic regions, AI/AN children had coverage that was similar to or higher than that of white children for most vaccines in most years studied.

CONCLUSIONS: The gains in vaccination coverage found in 2005 have been maintained. The absence of disparities in coverage with most vaccines between AI/AN children and white children from 2006 through 2010 is a clear success. These types of periodic reviews are important to ensure we remain vigilant. *Pediatrics* 2012;130: e1592–e1599

During the prevaccine era in the United States, the American Indian and Alaska Native (AI/AN) population suffered disproportionately from vaccine-preventable diseases (VPDs) such as *Haemophilus influenzae* type b (Hib), invasive pneumococcal disease, hepatitis A, and hepatitis B.[1] While routine childhood vaccination resulted in large declines in VPDs, maintaining high vaccination coverage is important, especially for populations at increased risk of disease. The AI/AN population remains vulnerable to VPDs due to risk factors such as higher background rates of disease, household crowding, and lack of running water in some AI/AN communities.[1–3] Studies have also shown that many of the risk factors associated with underimmunization are more prevalent among AI/AN children compared with white children.[4,5] A previous study on vaccination coverage in this population found that nationally, disparities in vaccine coverage between AI/AN and white children existed from 2001 through 2004 but were absent in 2005[4]; a 2010 study in North Dakota, however, found that AI children were significantly less likely to be up to date with their vaccinations compared with white children.[6]

According to the 2010 census, the AI/AN population represents ~1.7% of the US population[7]. AI/AN people receive health care from a variety of sources including the Indian Health Service (IHS) and private and/or public health insurance programs.[8,9] The IHS is a federal health program for AI/AN people that provides care through a network of IHS, tribal, and urban Indian health facilities (I/T/U) to eligible AI/AN people. Approximately 2 million AI/AN people, 38% of the total US AI/AN population, are eligible to receive care at these predominantly rural I/T/U health facilities.[10] However, some AI/AN people who are eligible for care may not reside near an I/T/U facility, as the majority of AI/AN people reside in urban areas.[11,12] In addition, some AI/AN people are not eligible to receive care from the I/T/U system because they are not enrolled members of a federally recognized tribe. While IHS monitors vaccination coverage among AI/AN children served by an I/T/U facility,[13] it cannot produce national estimates of vaccination coverage for the AI/AN population.

The overall objective of this study was to describe vaccination coverage levels for AI/AN children in the United States between 2006 and 2010, examining whether the gains found for AI/AN children in 2005[4] have been sustained.

METHODS

Data from the 2006 through the 2010 National Immunization Surveys (NIS) were analyzed. The NIS is an ongoing, national, random-digit-dial telephone survey of households with children 19 to 35 months old at the time of interview. The household telephone survey is followed by a survey mailed to the immunization providers identified during the telephone survey and for which permission was granted. All vaccination coverage estimates are based on provider-reported vaccinations. The household response rates for each year of the NIS studied (2006–2010) as defined by the Council of American Survey Research Organizations (CASRO)[14] were 64.5%, 64.9%, 63.2%, 63.9%, and 63.8%, respectively. Adequate provider vaccination records were obtained for 70.4% of children with completed household interviews in 2006 (n = 21 044), 68.6% in 2007 (n = 17 017), 71.0% in 2008 (n = 18 430), 70.7% in 2009 (n = 17 313), and 71.2% in 2010 (n = 17 004).[15–19] Methodological details of the NIS have been previously published.[20]

Vaccination Coverage Definitions

Vaccination coverage assessed in this study included ≥4 doses of diphtheria and tetanus toxoids and pertussis vaccine, or diphtheria and tetanus toxoids, or diphtheria and tetanus toxoids and any acellular pertussis vaccine (4+DTaP), ≥3 doses of poliovirus vaccine (3+polio), ≥1 dose of measles, mumps, and rubella (1+MMR) vaccine, ≥3 doses of *Haemophilus influenza* type b (3+Hib) vaccine, ≥3 doses of hepatitis B (3+HepB) vaccine, ≥1 dose of varicella (1+Var) vaccine, and ≥4 doses of pneumococcal conjugate (4+PCV) vaccine. In addition, we examined coverage with the combined 4+DTaP, 3+polio, 1+MMR, 3+Hib, 3+HepB, and 1+Var vaccine series, referred to as the 4:3:1:3:3:1 series, and coverage with this series plus 4+PCV, referred to as the 4:3:1:3:3:1:4 series. Finally, because of the Hib vaccine shortage from 2007 to 2009,[21] we analyzed coverage for these 2 series without Hib vaccine (4:3:1:x:3:1, 4:3:1:x:3:1:4).

Race Variable Definition

During the telephone portion of the NIS, the parent/guardian of the child was asked a series of questions about the race/ethnicity of the child. These included: "Is [child] of Hispanic or Latino origin?" and "Now, I am going to read a list of categories. Please choose one or more of the following categories to describe [child's] race. Is [child] white, black or African American, American Indian, Alaska native, Asian, native Hawaiian or other Pacific Islander?" By using responses to these questions, we defined white as all non-Hispanic children who were identified by their parents as white alone, and AI/AN as all non-Hispanic children who were identified by their parents as either AI/AN alone or AI/AN in combination with any other race. Hispanic children were excluded from the AI/AN definition as this designation may include American Indians from Central or South America. To determine if there were differences in coverage estimates depending on

the population definition used for AI/AN, we compared vaccination coverage estimates for AI/AN alone to AI/AN in combination with another race. All results refer to the combined group of AI/AN alone or in combination with another race.

Demographic Variable Definitions

Demographic characteristics of the children in the sample were obtained during the telephone interview of the parent/guardian, as part of routine NIS data collection. Poverty level was determined by using household reported income level, number of people reported living in the household and US poverty thresholds. Characteristics of providers are provider-reported (ie, provider type). Three additional geographic variables were included: IHS Contract Health Service Delivery Areas, or CHSDAs, are defined by IHS and represent the catchment area for IHS-funded facilities. For regional comparisons, the IHS administrative areas were combined into 6 larger regions as has been done in previous studies.[22] Lastly, Metropolitan Statistical Area (MSA) was used for urban versus rural comparisons.

Statistical Methods

The percentage of AI/AN children who were vaccinated was compared with the percentage of white children vaccinated by using Wald χ^2 tests. Proportions are reported along with 95% confidence intervals (CIs). Data were weighted to adjust for households having multiple telephone lines, nonassessment of households without telephones, household unit nonresponse, provider nonresponse, and to reflect population demographic totals. A 2-sided significance level of .05 was adopted for all statistical tests. Analysis were conducted by using SAS, release 9.2 (SAS, Cary, NC) and SUDAAN, release 10.0 (Research Triangle Institute, Research Triangle Park, NC) to take into account the complex nature of the survey.

RESULTS

There were no differences in vaccination coverage estimates between children who were AI/AN-only compared with AI/AN in combination with another race with the one exception of 3+HepB in 2008 (91.5% vs 98.6%, $P = .01$). All subsequent AI/AN results refer to the combined group of AI/AN alone or in combination with another race. AI/AN sample sizes are included in Table 1, and ranged from 421 to 519 in any given year.

For all 5 years examined, AI/AN children were more likely than white children to live below the poverty level, have younger mothers, and have mothers with less education (Table 1). Mothers of AI/AN children were also less likely than mothers of white children to have ever been married. In 2006–2008, AI/AN children were significantly more likely to live in a household with more children; additional results are presented in Table 1.

Overall there were no significant differences in vaccination coverage between AI/AN and white children with the following vaccines in any of the 5 survey years: 4+DTaP, 3+polio, 3+Hib, or 3+HepB (Table 2 and Fig 1). In 2007, AI/AN children had higher 1+Var vaccine coverage than white children (92.8% vs 89.2%, $P < .05$), and in 2008, AI/AN children had higher 1+MMR coverage than white children (95.3% vs 91.3%, $P < .01$). AI/AN children had significantly lower 4+PCV coverage than white children in both 2008 (74.9% vs 81.4%) and 2009 (71.4% vs 83.4%; both $P < .05$); however, coverage did not differ in 2010. There were no significant differences between AI/AN and white children in the 4:3:1:3:3:1 vaccination series in any of the years studied. In 2006 and 2009, coverage with the 4:3:1:3:3:1:4 series was lower for AI/AN children (51.2% vs 62.7% in 2006; 52.3% vs 64.1% in 2009, both $P < .05$) and in 2009 coverage with the 4:3:1:x:3:1:4 series was lower for AI/AN children (58.1% vs 72.4%, $P < .01$).

There were some differences in vaccination coverage levels between AI/AN children and white children in all 6 regions (Table 3). For the Northern Plains region in 2006, AI/AN children had lower coverage with 4+DTaP, 3+polio, and 3+Hib vaccines compared with white children and lower 4:3:1:x:3:1:4 coverage in 2009, although coverage in other years was not significantly different. Vaccination coverage levels for all other regions for all other years revealed that AI/AN children had either the same or higher coverage compared with white children (Table 3). For all years studied, between 63% and 69% of AI/AN children resided in a CHSDA county. There were no significant differences in vaccine coverage among AI/AN children residing in a CHSDA county compared with AI/AN children not residing in a CHSDA county. There were few differences in coverage between AI/AN children residing in an MSA versus non-MSA; coverage with 4:3:1:3:3 (2006), 3+polio (2007), and 1+MMR and 1+Var vaccines (2008) were higher among AI/AN children residing in a non-MSA compared with those residing in an MSA. There were no differences in coverage for 2009 or 2010.

DISCUSSION

From 2006 through 2010, few differences in vaccination coverage between AI/AN and white children were found. Indeed, in some regions (Southwest and Alaska), coverage for AI/AN children was frequently higher than that for white children. Instances of significantly lower coverage for AI/AN children were relatively rare, and by 2010 there was no evidence of vaccination coverage disparities between AI/AN children and white children. These

TABLE 1 Sociodemographic Characteristics of the Sample of AI/AN[a] and White-Only Children, NIS, 2006–2010, United States

	2006					2007					2008					2009					2010				
	AI/AN		White			AI/AN		White			AI/AN		White			AI/AN		White			AI/AN		White		
	% ± 95% CI	*n*	% ± 95% CI	*n*	*P*	% ± 95% CI	*n*	% ± 95% CI	*n*	*P*	% ± 95% CI	*n*	% ± 95% CI	*n*	*P*	% ± 95% CI	*n*	% ± 95% CI	*n*	*P*	% ± 95% CI	*n*	% ± 95% CI	*n*	*P*
Gender																									
Male	48.2 ± 10.0	251	51.6 ± 1.4	6146	.50	45.5 ± 7.9	220	53.3 ± 1.6	5395	.08	55.2 ± 7.4	253	51.3 ± 1.5	5761	.32	48.7 ± 9.7	212	51.4 ± 1.6	5584	.59	48.4 ± 8.3	251	51.4 ± 1.6	5338	.49
Female	51.8 ± 10.0	268	48.4 ± 1.4	5815		54.5 ± 7.9	211	46.7 ± 1.6	5010		44.8 ± 7.4	226	48.7 ± 1.5	5522		51.3 ± 9.7	209	48.6 ± 1.6	5187		51.6 ± 8.3	234	48.6 ± 1.6	5158	
First born																									
Yes	58.9 ± 9.2	293	53.0 ± 1.4	6499	.23	42.6 ± 7.9	219	51.1 ± 1.6	5521	.05	47.7 ± 7.5	256	52.6 ± 1.5	6065	.22	55.1 ± 9.8	227	52.2 ± 1.6	5825	.58	47.8 ± 8.2	259	54.3 ± 1.6	5871	.15
No	41.1 ± 9.2	226	47.0 ± 1.4	5462		57.4 ± 7.9	212	48.9 ± 1.6	4884		52.3 ± 7.5	223	47.4 ± 1.5	5218		44.9 ± 9.8	194	47.8 ± 1.6	4946		52.2 ± 8.2	226	45.7 ± 1.6	4625	
Mother's age, y																									
≤19	4.5 ± 3.8	19	1.3 ± 0.4	100	.03	2.0 ± 1.8	10	1.7 ± 0.6	91	<.01	4.0 ± 2.9	18	1.4 ± 0.4	94	<.01	5.0 ± 4.5	16	1.5 ± 0.4	92	<.01	2.9 ± 2.6	17	1.4 ± 0.4	74	<.01
20–29	44.6 ± 9.3	254	36.2 ± 1.5	3691		61.9 ± 7.4	220	35.5 ± 1.6	3245		51.6 ± 7.5	219	33.0 ± 1.5	3200		50.7 ± 10.1	229	33.9 ± 1.6	2967		55.1 ± 8.0	232	34.6 ± 1.7	2913	
≥30	50.9 ± 9.8	246	62.5 ± 1.5	8170		36.0 ± 7.2	201	62.8 ± 1.6	7069		44.4 ± 7.4	242	65.6 ± 1.5	7989		44.4 ± 10.0	176	64.5 ± 1.6	7712		41.9 ± 7.8	236	64.0 ± 1.7	7509	
Poverty level[b]																									
Above	62.0 ± 8.7	314	84.6 ± 1.1	10625	<.01	52.9 ± 8.6	254	82.5 ± 1.4	9128	<.01	59.2 ± 7.5	283	81.6 ± 1.4	9878	<.01	61.3 ± 9.6	256	80.9 ± 1.5	9421	<.01	56.4 ± 8.2	280	78.3 ± 1.4	8986	<.01
At or below	30.8 ± 7.7	175	11.8 ± 1.0	1023		43.5 ± 8.8	167	13.6 ± 1.3	984		38.2 ± 7.4	183	13.4 ± 1.2	1055		36.7 ± 9.6	152	15.0 ± 1.3	1083		38.2 ± 7.9	182	17.0 ± 1.3	1190	
Unknown	7.2 ± 4.4	30	3.6 ± 0.6	313		3.7 ± 3.2	10	3.9 ± 0.7	293		2.6 ± 2.0	13	5.0 ± 0.9	350		2.0 ± 1.5	13	4.0 ± 0.7	267		5.4 ± 3.6	23	4.7 ± 0.7	320	
Mother's education																									
<12 y	19.2 ± 6.4	84	8.7 ± 1.0	598	<.01	27.5 ± 9.6	74	9.4 ± 1.2	518	<.01	25.9 ± 7.3	91	9.4 ± 1.1	542	<.01	23.2 ± 9.5	73	9.1 ± 1.2	486	<.01	25.5 ± 7.9	79	9.8 ± 1.2	501	<.01
12 y	42.3 ± 10.5	152	30.9 ± 1.5	2082		33.1 ± 7.4	119	29.2 ± 1.7	1571		39.7 ± 7.5	141	28.3 ± 1.7	1611		42.0 ± 10.1	130	29.3 ± 1.7	1540		37.7 ± 8.6	151	28.7 ± 1.7	1495	
>12 y, not grad	19.7 ± 6.3	156	19.0 ± 1.0	2841		24.0 ± 5.9	155	22.3 ± 1.3	3024		22.4 ± 5.6	159	21.3 ± 1.1	3094		21.1 ± 6.8	145	19.8 ± 1.1	2785		18.5 ± 4.6	146	19.5 ± 1.1	2651	
College graduate	18.8 ± 6.8	127	41.4 ± 1.4	6440		15.4 ± 4.8	83	39.1 ± 1.5	5292		12.0 ± 3.7	88	41.0 ± 1.5	6036		13.7 ± 6.0	73	41.8 ± 1.5	5960		18.3 ± 5.5	109	42.0 ± 1.6	5849	
Mother's marital status																									
Ever married	69.6 ± 8.0	347	89.7 ± 1.0	11114	<.01	68.3 ± 7.3	293	87.9 ± 1.2	9569	<.01	63.4 ± 7.4	317	88.8 ± 1.1	10383	<.01	65.7 ± 9.8	266	87.9 ± 1.1	9859	<.01	62.5 ± 8.7	311	86.8 ± 1.2	9579	<.01
Never married	30.4 ± 8.0	172	10.3 ± 1.0	847		31.7 ± 7.3	138	12.1 ± 1.2	836		36.6 ± 7.4	162	11.2 ± 1.1	900		34.3 ± 9.8	155	12.1 ± 1.1	912		37.5 ± 8.7	174	13.2 ± 1.2	917	
No. of children in household																									
1	24.5 ± 8.0	113	25.8 ± 1.3	2928	.01	34.2 ± 9.0	109	25.7 ± 1.5	2505	<.01	25.7 ± 7.0	112	24.1 ± 1.4	2646	.02	18.6 ± 7.8	89	24.8 ± 1.4	2570	.32	27.1 ± 8.5	107	23.4 ± 1.5	2398	.24
2-3	52.2 ± 9.8	287	62.0 ± 1.5	7709		48.4 ± 8.3	232	62.7 ± 1.6	6717		53.3 ± 7.6	262	63.1 ± 1.5	7261		68.0 ± 8.7	246	62.3 ± 1.6	6924		56.5 ± 8.5	275	63.3 ± 1.6	6738	
≥4	23.2 ± 7.5	119	12.2 ± 1.0	1324		17.4 ± 5.3	90	11.6 ± 1.0	1183		21.0 ± 6.4	105	12.8 ± 1.1	1376		13.4 ± 4.9	86	12.9 ± 1.2	1277		16.3 ± 5.2	103	13.2 ± 1.0	1360	
No. of providers																									
1	65.6 ± 8.3	318	71.4 ± 1.3	8460	.16	62.3 ± 8.0	263	69.7 ± 1.5	7278	.07	56.7 ± 7.6	288	70.6 ± 1.5	7994	<.01	52.8 ± 10.2	234	63.4 ± 1.6	7107	.06	58.0 ± 8.8	284	62.6 ± 1.6	6653	.33
≥2	34.4 ± 8.3	200	28.6 ± 1.3	3475		37.7 ± 8.0	165	30.3 ± 1.5	3105		43.3 ± 7.6	190	29.4 ± 1.5	3264		47.2 ± 10.2	185	36.6 ± 1.6	3627		42.0 ± 8.8	198	37.4 ± 1.6	3802	
Provider type																									
All public	23.4 ± 11.3	140	7.2 ± 0.7	824	<.01	25.2 ± 8.7	114	7.4 ± 0.9	767	<.01	27.3 ± 6.5	164	8.3 ± 0.9	887	<.01	21.2 ± 6.0	130	8.9 ± 1.0	854	<.01	27.3 ± 8.6	136	8.1 ± 0.9	774	<.01
All hospitals	6.0 ± 3.1	38	5.2 ± 0.6	797		6.7 ± 3.1	35	6.1 ± 0.7	768		12.3 ± 4.2	75	9.1 ± 0.9	1113		9.9 ± 5.7	44	8.4 ± 0.9	1087		7.1 ± 3.3	48	8.5 ± 0.8	1042	
All private	35.1 ± 9.2	151	56.9 ± 1.4	6828		38.3 ± 8.0	147	60.7 ± 1.6	6325		37.2 ± 7.5	154	69.8 ± 1.4	7625		46.4 ± 10.2	149	66.2 ± 1.6	6952		37.4 ± 7.7	154	59.8 ± 1.6	6199	
Other/mixed	35.5 ± 8.4	187	30.7 ± 1.4	3426		29.8 ± 6.9	127	25.7 ± 1.4	2455		23.1 ± 6.6	85	12.7 ± 1.0	1533		22.6 ± 9.3	94	16.5 ± 1.2	1749		28.1 ± 7.4	142	23.6 ± 1.5	2350	
Interruption in telephone service[c]																									
Yes	19.6 ± 7.5	61	9.6 ± 1.1	553	.01	21.8 ± 9.8	44	9.9 ± 1.2	500	.03	15.9 ± 6.3	50	9.3 ± 1.2	520	.05	23.5 ± 9.9	52	9.2 ± 1.1	549	.01	16.5 ± 6.7	60	10.3 ± 1.2	595	.08
No	80.4 ± 7.5	458	90.4 ± 1.1	11408		78.2 ± 9.8	387	90.1 ± 1.2	9905		84.1 ± 6.3	429	90.7 ± 1.2	10763		76.5 ± 9.9	369	90.8 ± 1.1	10222		83.5 ± 6.7	425	89.7 ± 1.2	9901	

[a] AI/AN defined as non-Hispanic American Indian/Alaska Native alone or in combination with any other race. White defined as non-Hispanic white only.

[b] Poverty level is based on reported income and number of persons in the household and using US poverty thresholds.

[c] Interruption in telephone service based on the survey question: "During the past 12 months, has your household been without telephone service for 1 week or more? Please do not include cellular phones in your answer. Do not include interruptions of phone service due to weather or natural disasters."

TABLE 2 Vaccination Coverage of AI/AN[a] and White-Only Children, NIS, 2006–2010, United States

	2006					2007					2008					2009					2010				
	AI/AN		White			AI/AN		White			AI/AN		White			AI/AN		White			AI/AN		White		
	% ± 95% CI	n	% ± 95% CI	n	P	% ± 95% CI	n	% ± 95% CI	n	P	% ± 95% CI	n	% ± 95% CI	n	P	% ± 95% CI	n	% ± 95% CI	n	P	% ± 95% CI	n	% ± 95% CI	n	P
4+DTaP	77.5 ± 11.4	416	86.6 ± 1.1	10 498	.15	85.4 ± 4.7	354	85.3 ± 1.2	8979	.96	84.3 ± 5.2	400	85.0 ± 1.2	9689	.79	83.8 ± 5.6	349	85.8 ± 1.1	9246	.48	77.0 ± 7.4	386	84.5 ± 1.3	9065	.06
3+Polio	89.9 ± 5.3	465	93.3 ± 0.7	11 192	.21	92.5 ± 3.8	399	92.6 ± 0.9	9723	.97	93.3 ± 3.6	448	93.6 ± 0.8	10 568	.90	92.6 ± 5.1	396	93.3 ± 0.8	10 076	.79	91.9 ± 4.3	453	93.2 ± 0.8	9827	.56
1+MMR	89.1 ± 4.2	460	92.8 ± 0.7	11 118	.07	94.0 ± 2.9	396	92.1 ± 0.8	9591	.22	95.3 ± 2.9	450	91.3 ± 1.0	10 310	.01	89.4 ± 6.1	387	90.8 ± 0.9	9754	.65	90.2 ± 5.0	444	90.6 ± 0.9	9561	.88
3+Hib	91.3 ± 3.6	463	94.1 ± 0.8	11 312	.12	92.2 ± 3.7	395	92.9 ± 0.9	9760	.70	90.2 ± 4.0	426	90.8 ± 0.9	10 194	.75	87.5 ± 5.4	364	82.9 ± 1.2	8818	.12	88.7 ± 4.7	432	90.3 ± 1.2	9553	.51
3+HepB	94.2 ± 2.6	478	93.8 ± 0.7	11 185	.80	93.4 ± 3.2	396	92.5 ± 0.9	9709	.60	94.6 ± 3.1	449	93.4 ± 0.8	10 533	.48	93.9 ± 3.2	391	92.3 ± 0.9	9967	.35	93.5 ± 4.0	455	91.4 ± 0.9	9606	.34
1+Var	86.5 ± 4.4	428	88.7 ± 0.9	10 578	.33	92.8 ± 3.1	388	89.2 ± 1.0	9213	.04	91.4 ± 4.0	431	89.8 ± 1.0	10 048	.46	89.0 ± 4.9	369	89.2 ± 1.0	9554	.93	89.4 ± 4.7	435	88.9 ± 1.1	9389	.87
4+PCV	65.8 ± 8.4	326	70.9 ± 1.3	8676	.23	75.9 ± 6.2	316	76.6 ± 1.4	8222	.83	74.9 ± 6.3	362	81.4 ± 1.2	9294	.05*	71.4 ± 10.1	322	83.4 ± 1.2	9074	.03	81.4 ± 5.9	381	84.2 ± 1.2	8997	.35
4:3:1:3:3:1	67.9 ± 11.1	363	77.8 ± 1.2	9376	.11	80.0 ± 5.5	329	77.5 ± 1.3	8097	.39	77.9 ± 5.9	364	75.3 ± 1.4	8537	.41	69.4 ± 8.2	301	69.2 ± 1.5	7279	.97	69.3 ± 7.7	342	73.6 ± 1.5	7898	.28
4:3:1:x:3:1	69.0 ± 11.2	367	78.4 ± 1.2	9439	.13	80.9 ± 5.4	332	78.1 ± 1.3	8154	.33	79.2 ± 5.8	373	78.2 ± 1.3	8882	.76	75.3 ± 7.4	321	78.1 ± 1.3	8384	.46	72.5 ± 7.5	358	76.7 ± 1.4	8219	.28
4:3:1:3:3:1:4	51.2 ± 10.0	512	62.7 ± 1.4	11 961	.05	70.7 ± 6.7	285	67.0 ± 1.6	7126	.30	66.6 ± 6.9	317	68.2 ± 1.5	7804	.66	52.3 ± 9.8	264	64.1 ± 1.5	6795	.03	66.7 ± 7.7	320	69.9 ± 1.6	7520	.43
4:3:1:x:3:1:4	52.1 ± 10.1	288	63.0 ± 1.4	7647	.06	70.7 ± 6.7	285	67.4 ± 1.5	7162	.35	67.8 ± 6.8	325	70.7 ± 1.4	8105	.41	58.1 ± 10.0	282	72.4 ± 1.4	7816	.01	69.8 ± 7.6	335	72.7 ± 1.5	7809	.47

* $P = .047$.

[a] AI/AN defined as non-Hispanic American Indian/Alaska Native alone or in combination with any other race. White defined as non-Hispanic white only.

findings suggest that programs like the Vaccines for Children program that began in 1994, and provides free vaccine for AI/AN children younger than 19 years of age,[23] as well as health care infrastructure improvements and vaccine delivery strategies used by I/T/U facilities,[1,4,5] have been successful in improving immunization coverage for AI/AN children across the country.

Due to the 2008 and 2009 Hib vaccine shortage, the overall decrease in coverage with the Hib vaccine and the series containing Hib vaccine in those years is not unexpected.[24] To ensure vaccine was provided to those at higher risk, the Advisory Committee on Immunization Practices (ACIP) recommended that AI/AN children continue to receive the full Hib series, and PedvaxHib vaccine from the CDC stockpile was made available for use in this population.[25] In 2009, coverage with the 4:3:1:3:3:1 series nationally was higher for AI/AN children compared with white children. There was no difference in Hib vaccine coverage among AI/AN children compared with white children nationally, although 2 IHS regions (Alaska, Southwest) did achieve higher Hib coverage among AI/AN children in 2008 and 2009. Both Alaska and the Southwest used PedvaxHib vaccine almost exclusively even before the shortage, whereas other regions used a mix of Hib products, which may explain why the higher Hib vaccine coverage was limited to these regions. Higher coverage with other vaccines in both these regions in 2008 and in Alaska in 2009, however, suggest that the AI/AN Hib recommendation was not the only contributing factor to the increased coverage reported among AI/AN children in these regions. Reasons for increased coverage in these 2 regions may be related to population characteristics such as geographical concentration (eg reservations/villages) with an I/T/U facility in close proximity

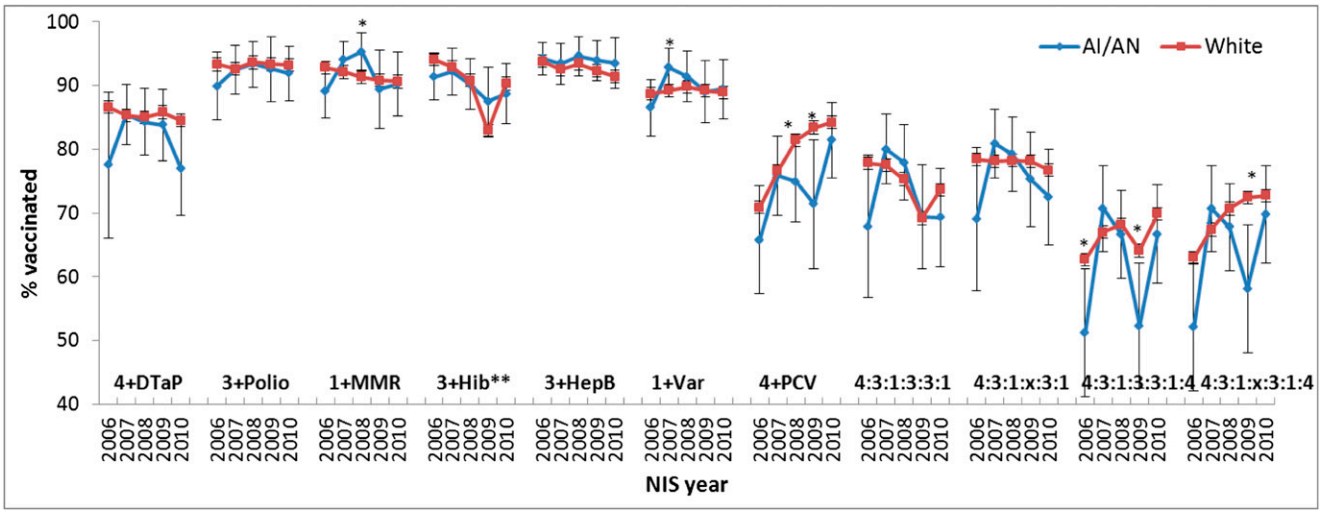

FIGURE 1

Vaccination coverage of AI/AN and white-only children, NIS, 2006–2010, United States. AI/AN defined as non-Hispanic American Indian/Alaska Native alone or in combination with any other race. White defined as non-Hispanic white only. *$P < .05$ for comparison of AI/AN versus white children. **3+Hib measure that does not take brand into account.

and the use of public health nurses to support immunization activities.[1,4,5] In addition, higher immunization coverage among Alaska Natives compared with whites in Alaska has been noted in previous years[5,26] and is likely a result of the collaborative efforts between state and tribal entities to deliver immunizations in remote Alaska Native villages.

Disparities present nationally in 2006 for the 4:3:1:3:3:1:4 series and in 2008 and 2009 for 4+ doses of PCV (which also contributed to lower coverage with the 4:3:1:3:3:1:4 and 4:3:1:x:3:1:4 series in 2009) were not present in 2010. We could not determine if these differences were true differences or were due to random fluctuations in estimates from year to year. The sample size of AI/AN children is relatively small in the NIS in any one year, leading to large CIs around the estimates. Additionally, numerous statistical comparisons were made in this study with no correction made for multiple comparisons; therefore, some comparisons are likely to be statistically significant by chance alone. However, because the 4+PCV differences were found for 2 consecutive years, they may be more likely to have been true differences. It is unclear why coverage would have been lower for AI/AN children than for white children in 2008 and 2009, but it may be that coverage among AI/AN children was not increasing at the same rate as coverage among white children (Fig 1). Because certain AI/AN populations have an elevated rate of invasive pneumococcal disease compared with other populations,[1] maintaining high PCV coverage for AI/AN children is important. In addition, while coverage at 2 years of age is helpful for monitoring disparities, looking at timeliness of vaccination before 2 years of age may provide additional insight. Future studies to examine the timeliness of vaccination in this population are needed.

Because the NIS is a random-digit-dial survey that samples at the proportion present in the population, the sample size of AI/AN children is relatively small each year. Other mechanisms for measuring vaccination coverage among the AI/AN population include the IHS data and state immunization registries. Vaccination coverage among AI/AN children tracked by IHS is limited to those receiving care through I/T/U facilities. Immunization registries have the potential to provide more complete data on AI/AN children regardless of where they receive care and, as was done in North Dakota,[6] can help to identify disparities at the local level that may not be present in national level estimates. Identifying local pockets of underimmunized children is important as regional differences exist and strategies to improve vaccination coverage for the AI/AN population may differ depending on where children are receiving care. Improving exchange of data between state immunization registries and I/T/U facilities could help ensure more complete data on the AI/AN population to allow for these types of assessments.

This report's findings are subject to at least 5 limitations. First, before 2011, NIS was a landline telephone survey; although statistical weights adjust for nonresponse and nonlandline telephone households, as well as interruption in telephone service, some bias might remain. Second, although NIS relies on provider-verified vaccination histories, incomplete records and reporting could result in underestimates of coverage. Third, the exclusion of Hispanic AI/AN children may

TABLE 3 Differences in AI/AN Versus White Non-Hispanic Vaccination Coverage by Region[a] and by Year, NIS, 2006–2010, United States

Region	Year	4+DTaP	3+Polio	1+MMR	3+Hib	3+HepB	1+Var	4+PCV	4:3:1:3:3:1	4:3:1:x:3:1	4:3:1:3:3:1:4	4:3:1:x:3:1:4
East	2006	—	—	—	—	—	—	—	—	—	—	—
	2007	—	—	—	—	—	—	—	—	—	—	—
	2008	—	—	—	—	—	—	—	—	—	—	—
	2009	—	—	—	—	—	—	—	—	—	—	—
	2010	—	↑H	—	—	—	—	—	—	—	—	—
Southern Plains	2006	—	↑H	—	—	↑H	—	—	↑H	↑H	—	—
	2007	—	—	—	—	—	—	—	—	—	—	—
	2008	—	—	↑H	—	—	—	—	—	—	—	—
	2009	—	—	—	—	—	—	—	—	—	—	—
	2010	—	—	—	—	—	—	—	—	—	—	—
Northern Plains	2006	↓L	↓L	—	↓L	—	—	—	↓L	↓L	—	—
	2007	—	—	—	—	—	↑H	—	—	—	—	—
	2008	—	—	↑H	—	—	—	—	—	—	—	—
	2009	—	—	—	—	—	—	—	—	—	—	↓L
	2010	—	—	—	—	↑H	—	—	—	—	—	—
Southwest	2006	—	—	—	—	—	—	—	—	—	—	—
	2007	—	—	—	—	↑H	—	↑H	—	—	—	—
	2008	↑H	↑H	↑H	↑H	↑H	—	—	↑H	↑H	—	—
	2009	—	—	—	↑H	—	—	—	—	—	—	—
	2010	—	—	—	—	—	—	—	—	—	—	—
Pacific Coast	2006	—	—	—	—	—	—	—	—	—	—	—
	2007	—	↑H	↑H	↑H	—	↑H	—	—	—	—	—
	2008	—	↑H	—	—	—	—	—	—	—	—	—
	2009	—	—	—	—	—	—	—	—	—	—	—
	2010	—	—	—	—	—	—	—	—	—	—	—
Alaska	2006	↑H	—	—	—	—	—	↑H	↑H	↑H	↑H	↑H
	2007	↑H	—	—	—	—	—	—	↑H	↑H	↑H	↑H
	2008	↑H	↑H	↑H	↑H	↑H	↑H	—	↑H	↑H	—	—
	2009	—	—	↑H	↑H	—	↑H	—	↑H	↑H	—	—
	2010	—	↑H	↑H	—	↑H	—	—	—	—	—	—

—, No statistically significant difference between AI/AN and white non-Hispanic; ↑H, AI/AN vaccination coverage statistically significantly ($P < .05$) HIGHER than white non-Hispanic vaccination coverage; ↓L, AI/AN vaccination coverage statistically significantly ($P < .05$) LOWER than white non-Hispanic vaccination coverage.

[a] The regions were defined by collapsing the IHS administrative regions into 6 regions. The definitions were as follows: East: ME, NH, VT, MA, RI, CT, NY, NJ, PA, MD, DE, OH, WV, VA, KY, NC, SC, TN MO, AR, LA, MS, AL, GA, FL; Southern Plains: KS, OK, TX; Northern Plains: MT, WY, ND, SD, NE, MN, IA, WI, IL, IN, MI; Southwest: NV, UT, AZ, NM, CO; Pacific Coast: WA, OR, ID, CA; Alaska; AK.

have produced some bias by excluding children of mixed Hispanic-AI/AN parents. Fourth, the sample size of AI/AN children in any one year of the NIS is small, resulting in large CIs for the estimates. Because of the small sample size, there is much lower statistical power to detect small differences in vaccination coverage between AI/AN and other children, especially at subnational levels. Last, a large number of statistical comparisons were made in this study and thus some were likely to be statistically significant by chance alone.

CONCLUSIONS

The gains in vaccination coverage found in 2005 by a previous study have been maintained.[4] The absence of disparities in coverage with most vaccines between AI/AN children and white children from 2006 through 2010 is a clear success, although the ongoing presence of risk factors related to underimmunization and disparities in PCV coverage for 2 years highlights the need to continue these types of periodic reviews.

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