



Recent Developments with the National Immunization Survey-Child (NIS-Child)

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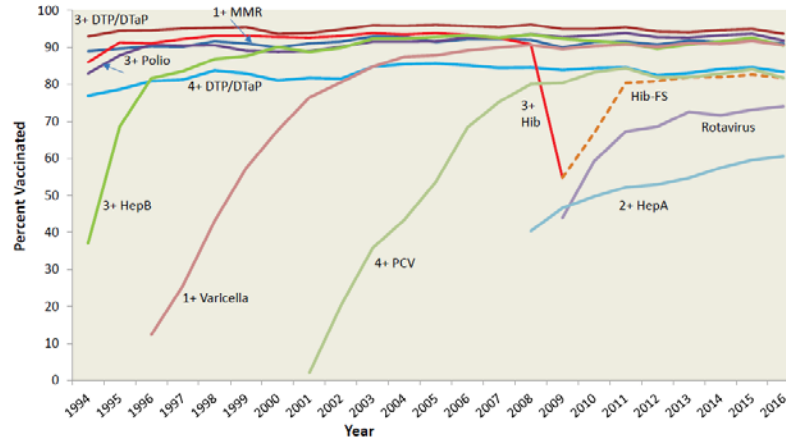
Topics covered

- Measuring vaccination coverage from NIS-Child by birth cohort
- Update on IIS-NIS integration

State and National Vaccination Coverage Levels Among Children Aged 19-35 Months -- United States, April-December 1994

The National Immunization Survey (NIS) is a single survey providing state and national estimates of vaccination coverage levels among children aged 19-35 months. CDC implemented the NIS in April 1994 as one element of the five-part Childhood Immunization Initiative (CII) (1), a national strategy to achieve and maintain high vaccination levels among children during the first 2 years of life. NIS collects quarterly data from the 50 states, the District of Columbia, and 27 urban areas considered to have populations at high risk for undervaccination. This report of initial NIS findings provides the results of both national and state vaccination coverage levels for April-December 1994.

Vaccine-specific coverage among children 19-35 months, National Immunization Survey-Child, 1994-2016



Current Paradigm

Morbidity and Mortality Weekly Report

Vaccination Coverage Among Children Aged 19–35 Months — United States, 2016

Holly A. Hill, MD, PhD¹; Laurie D. Elam-Evans, PhD¹; David Yankey, MS, MPH¹; James A. Singleton, PhD¹; Yoonjae Kang, MPH¹

Vaccination is the most effective intervention to reduce morbidity and mortality from vaccine-preventable dis-

inability to pay. Greater awareness and facilitating use of VFC might be helpful in reducing these disparities. Efforts should

Key Features of the NIS-Child

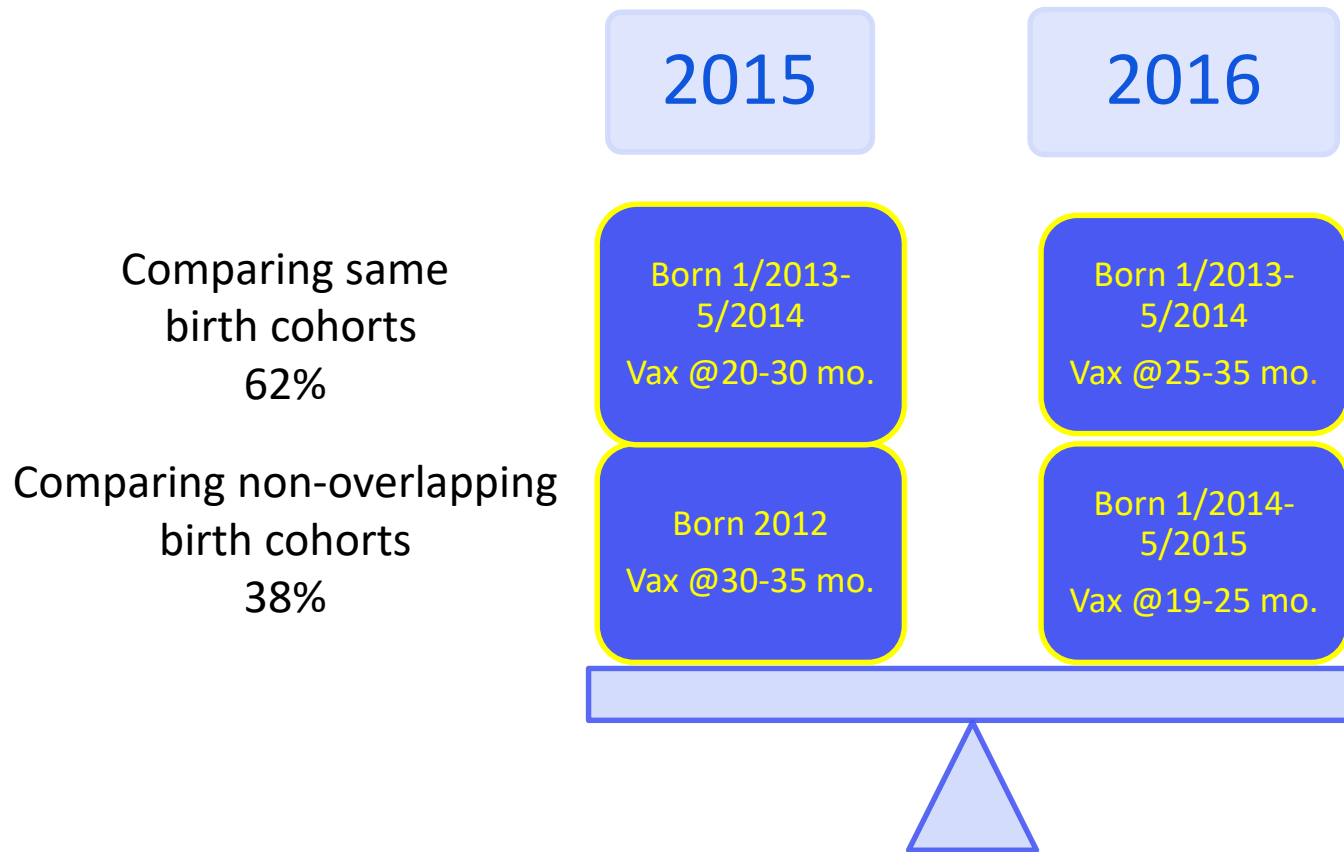
- Target population
 - Children ages 19-35 months anytime during each quarter of data collection
- Design
 - Random sample of cell telephone numbers
 - Stratified by 56 state/local awardee areas, selected local areas and territories
- Data Collection in two phases
 - Telephone interview of parent/guardian
 - Mail survey of child's vaccination providers
- Estimates produced annually ***by survey year***
 - Weighted to account for sampling design and minimize bias

Why Consider Switching to Birth Cohort Analysis?

Summary of Report on the 2016 NIS-Child Data

- Annual NIS estimates by survey year are difficult to interpret
 - Includes wide birth range (January 2013 – May 2015 for 2016 data)
 - Children are assessed for vaccination at differing ages (19-35 months)
- Interpreting a change in vaccination coverage from one survey year to the next is even more difficult
- Possible change in accuracy of estimates from 2015 to 2016 was identified using “bridging cohort” analysis
 - Created an appearance of decreased vaccination coverage
- Measuring year-to-year trends in vaccination coverage by birth cohort may be more informative for the NIS-Child community of users than the traditional measure by survey year

Comparing NIS-Child Vaccination Coverage Estimates – a Difference in Complex Moving Averages



- 1) Comparing NIS-Child estimates from one year to the next is complicated because it is a difference in complex moving averages
- 2) The difference in 2015 and 2016 survey year estimates can be split into two parts
 - 1) The first part compares the same birth cohorts
 - 1) This measures catch-up vaccination from age 20-30 months to 25-35 months
 - 2) This represents about 62% of the overall difference
 - 2) The second part compares older children born in 2012 to younger children born 2014-May 2015
 - 1) There is no overlap in birth range of children being compared
 - 2) But the younger children are assessed for vaccinations at earlier ages
 - 3) This represents about 38% of the overall difference

New Paradigm

Typical Sample Size per State by Survey Year and Annual Birth Cohort, NIS-Child 2013-2017

		Annual Birth Cohort							
		2010	2011	2012	2013	2014	2015	2016	Total
Survey Year	2013	94	134	22	0	0	0	0	250
	2014	0	94	134	22	0	0	0	250
	2015	0	0	94	134	22	0	0	250
	2016	0	0	0	94	134	22	0	250
	2017	0	0	0	0	94	134	22	250
Total		94	228	250	250	250	156	22	

- 1) This figure illustrates the relationship between survey year and annual birth cohort, for a typical state with a final sample of 250 per year.
- 2) For each survey year (the rows in the table), the expected distribution of the 250 children by birth year is the same, with about 94 born three years before the survey year, 134 born two years before, and 22 born the year before.

Typical Sample Size per State by Survey Year and Annual Birth Cohort, NIS-Child 2013-2017

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Survey Year	2013	94	134	22	0	0	0	0	250
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	2015	0	0	94	134	22	0	0	250
	2016	0	0	0	94	134	22	0	250
	2017	0	0	0	0	94	134	22	250
Total		94	228	250	250	250	156	22	

- 1) Now if we look at sample size by annual birth cohort, we see we have only 22 for the most recent 2016 birth cohort, 156 for the 2015 birth cohort, and back to 250 for the 2014 birth cohort
- 2) So we could report estimates each year by the most recent complete annual birth cohort.
- 3) Using data through 2017, that would be children born in 2014.
- 4) However, this would not use the majority of data collected during 2017, and would increase the lag from time of vaccinations to time estimates are reported.

Typical Sample Size per State by Survey Year and Annual Birth Cohort, NIS-Child 2013-2017

		Annual Birth Cohort							
		2010	2011	2012	2013	2014	2015	2016	Total
Survey Year	2013	94	134	22	0	0	0	0	250
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	2015	0	0	94	134	22	0	0	250
	2016	0	0	0	94	134	22	0	250
	2017	0	0	0	0	94	134	22	250
Total		94	228	250	250	250	156	22	

406

- 1) If we combine the 2014 and 2015 birth cohorts, we get 406 children.
- 2) Also note that most of the 2016 sample was born in 2014 and 2015.
- 3) Thus, by combining children born during 2014 and 2015, we are including the main birth cohorts in the 2017 survey year, adding children for these birth cohorts from previous years, and thus getting larger sample size.
- 4) A main limitation of the NIS for state-level estimates has been relatively wide confidence intervals and difficulty detecting differences from one year to the next.
- 5) So if we base the 2017 NIS-Child estimates on children born during 2014-2015, what do we compare this estimate to see if coverage has increased, decreased, or stayed the same?

Typical Sample Size per State by Survey Year and Annual Birth Cohort, NIS-Child 2013-2017

		Annual Birth Cohort							
		2010	2011	2012	2013	2014	2015	2016	Total
Survey Year	2013	94	134	22	0	0	0	0	250
	2014	0	94	134	22	0	0	0	250
	2015	0	0	94	134	22	0	0	250
	2016	0	0	0	94	134	22	0	250
	2017	0	0	0	0	94	134	22	250
Total		94	228	250	250	250	156	22	

500
406

- 1) As a measure of recent change in vaccination coverage, we propose comparing the 2014-2015 birth cohorts to the 2012-2013 birth cohorts (shaded in blue).
- 2) This provides more precise assessment of change in recent coverage because the comparison is based on estimates with 406 and 500 children, instead of 250 children each using estimates by survey year.

Proposed Annual NIS-Child Estimation by Birth Cohort

Defining the Denominator

Example Using Data Through 2017

	Estimate by Survey Year	Estimate by Birth Cohort
Birth Cohorts Included	2014 2015 2016 (Jan.-May)	2014 2015
Data Years Included	2017	2017 2016 2015

- 1) The proposed approach would provide estimates for children born during 2014-2015, using the most recent three years of NIS-Child data that collect information for children born in these years.
- 2) It would exclude children born January-May 2016, but those make up only 9% of the weighted 2017 NIS-Child sample.

Proposed Annual NIS-Child Estimation by Birth Cohort Defining the Denominator

	Main Estimate		Reference Estimate	
Year Estimates Reported	Birth Cohorts	Data Years	Birth Cohorts	Data Years
2018	2014-2015	2015-2017	2012-2013	2013-2016
2019	2015-2016	2016-2018	2013-2014	2014-2017
2020	2016-2017	2017-2019	2014-2015	2015-2018

- 1) This table shows the main estimates by birth cohort that would be reported in the next three years.
- 2) Each year, recent change in vaccination coverage would be assessed by comparing the main estimate with a reference estimate based on the two previous annual birth cohorts. For example, in 2018, the estimate for children born during 2014-2015 would be compared to children born 2012-2013.
- 3) Note there is one annual birth cohort overlap in the main estimates from one reporting year to the next. The overlap in denominator of estimates by survey year is larger, at 17 months.
- 4) To assess longer term trends, we could analyze by annual birth cohort, including at least three data points

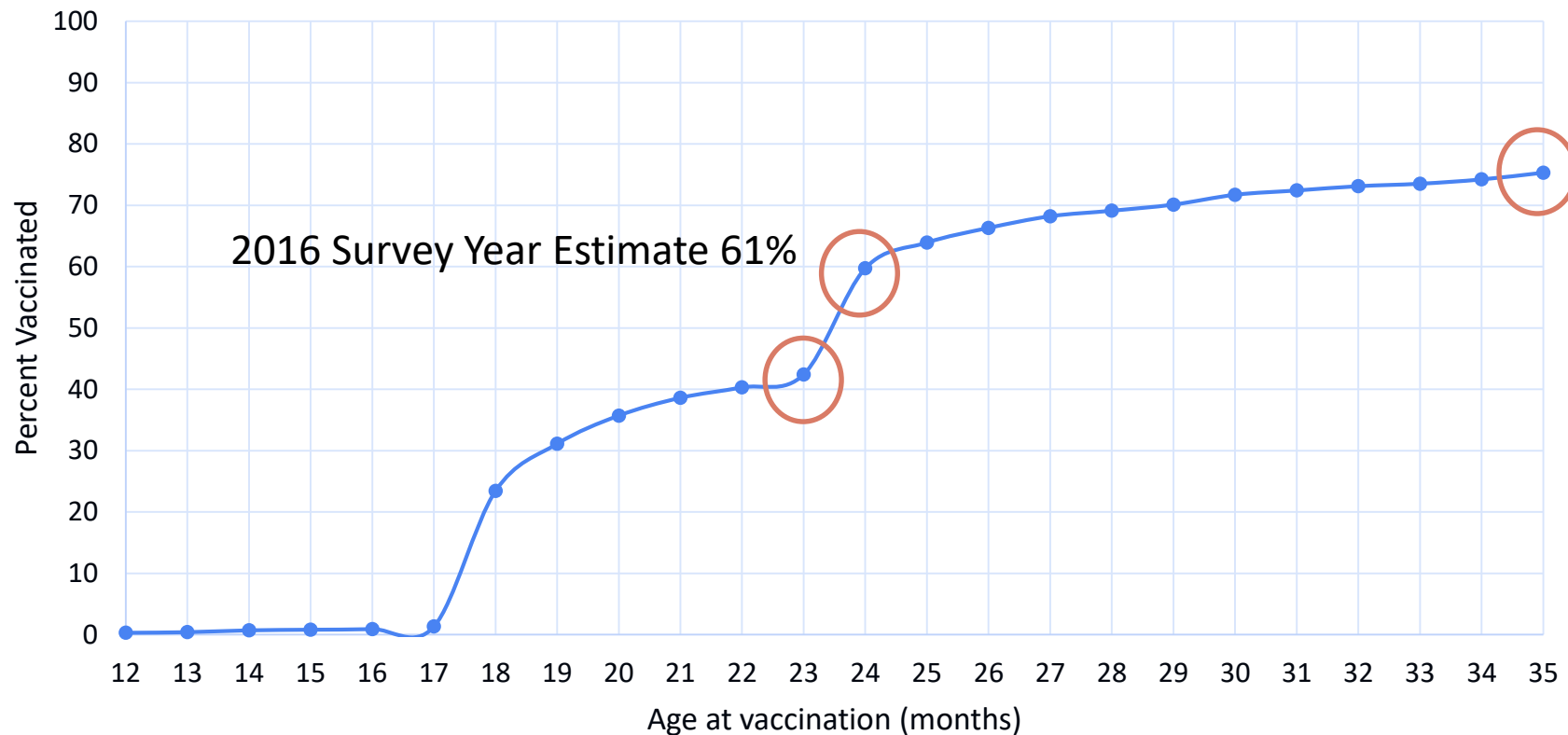
Proposed Annual Estimation by Birth Cohort

Defining the Numerator

- Assess vaccination status by key milestone age to improve interpretation and make fair comparisons
- For main estimates assess vaccination status by age 24 months (before the 2nd birthday), with a few exceptions
 - Hepatitis B birth dose
 - Restrict rotavirus vaccination to doses received by age 8 months, 0 days
 - Expand 2nd dose hepatitis A vaccination coverage to age 35 months
- Use Kaplan-Meier method to account for censoring of vaccination status at ages 19-23 months for some children
 - Also provides vaccination uptake curve by age
 - Same method used for seasonal influenza vaccination coverage

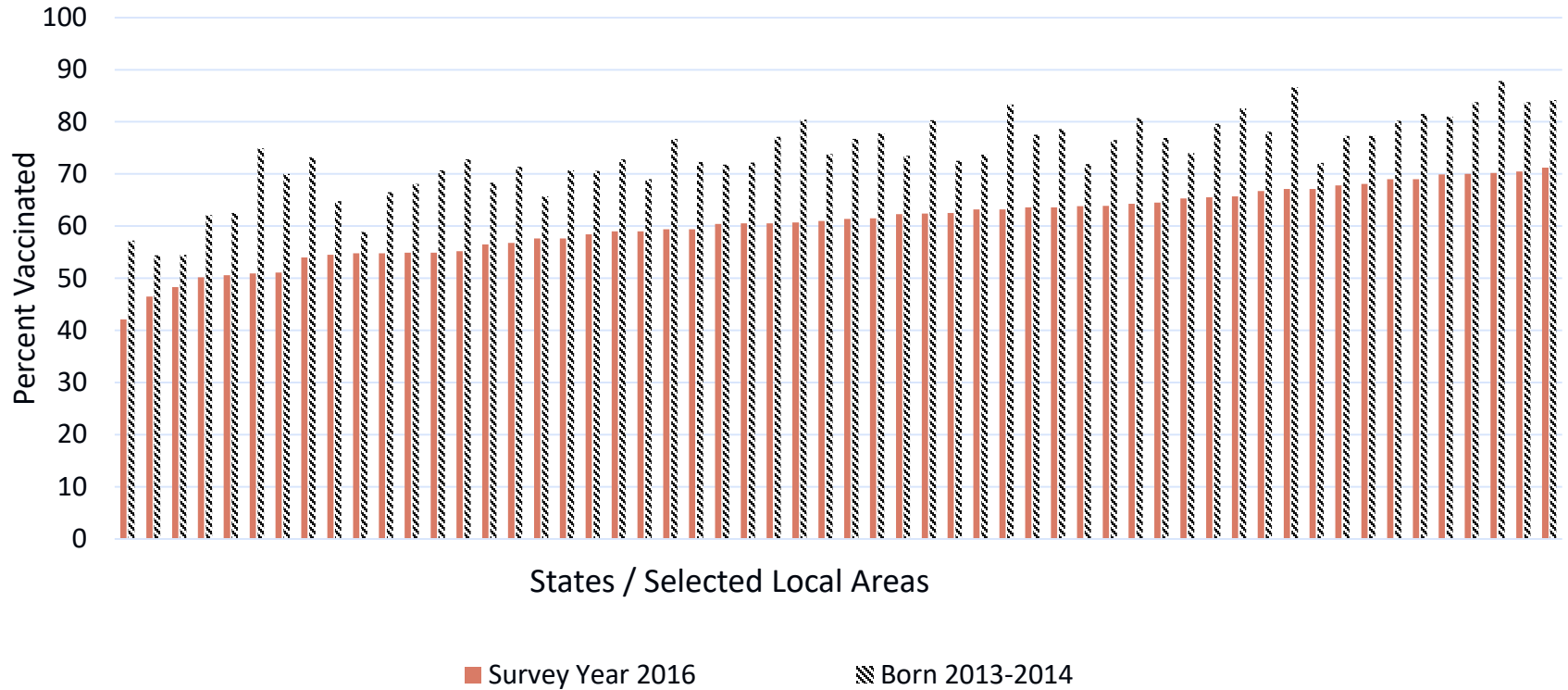
**Applying New Paradigm
Children Born 2010-2014
Using 2011-2016 NIS-Child Data**

Estimated Coverage with ≥ 2 Doses of Hepatitis A Vaccine Among Children Born 2013-2014, NIS-Child 2014-2016, United States



- 1) This chart shows the cumulative percent of children with two doses of hepatitis A vaccine by age, estimated for children born during 2013-2014 using NIS-Child data from 2014-2016.
- 2) 2-dose coverage reaches 42% by 24 months (shown as the point at 23 months on the graph).
- 3) Coverage jumps up to 60% by 25 months, which may reflect vaccinations given at the recommended 2 year well child visit.
- 4) Then coverage gradually increases to 74% by 35 months.
- 5) The 2016 survey year estimate was 61%. The estimate by 35 months is a better reflection of the ACIP recommended schedule, which considers a child getting the first dose before 2 years of age (e.g., at 23 months), and the 2nd dose 18 months later at age 41 months, as allowable under the routine schedule.

Estimated Coverage with ≥ 2 Doses of Hepatitis A Vaccine by 35 Months of Age Among Children born 2013-2014, NIS-Child 2014-2016



Estimated coverage with ≥ 1 MMR by 24 Months Among Children Born 2013-2014, NIS-Child 2014– 2016



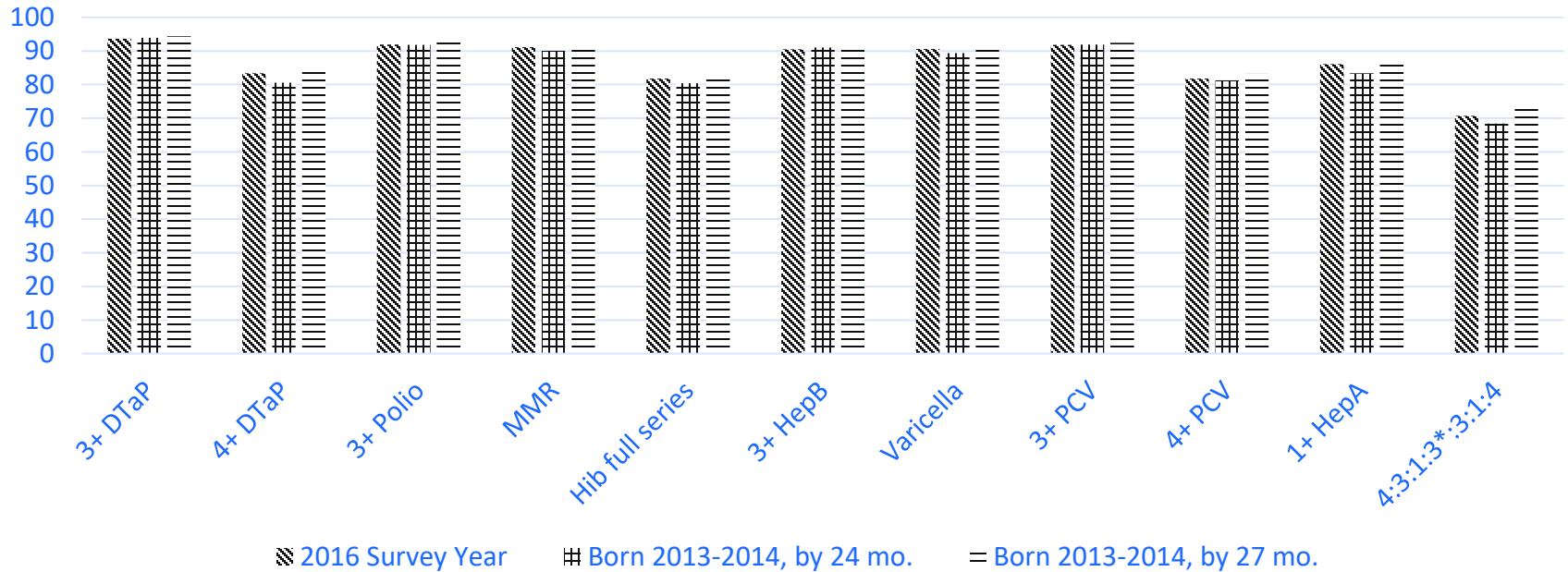
- 1) This chart shows, for states and selected local areas, MMR coverage by 24 months for children born during 2013-2014 (blue bars) compared to the 2016 survey year estimate for children ages 19-35 months at assessment.
- 2) The 2016 estimates are often a percentage point or two higher than the estimates by 24 months.
- 3) Keep in mind that the survey year and birth year COHORT estimates are based on mostly the same birth cohorts, but the birth year COHORT estimates have larger sample size by including earlier survey year data.
- 4) Also, the average age at assessment for 2016 SURVEY estimates was 27 months, so children on average had more time to get vaccinated ~~for~~ TO BE INCLUDED IN the 2016 estimates.
- 5) Based on the 2013-2014 birth cohort estimates, national MMR coverage increased from 90.1% by 24 months to 91.6% by 27 months.

Estimated ≥ 4 DTaP Vaccination Coverage by 24 months Among Children Born 2013-2014, NIS-Child 2014-2016



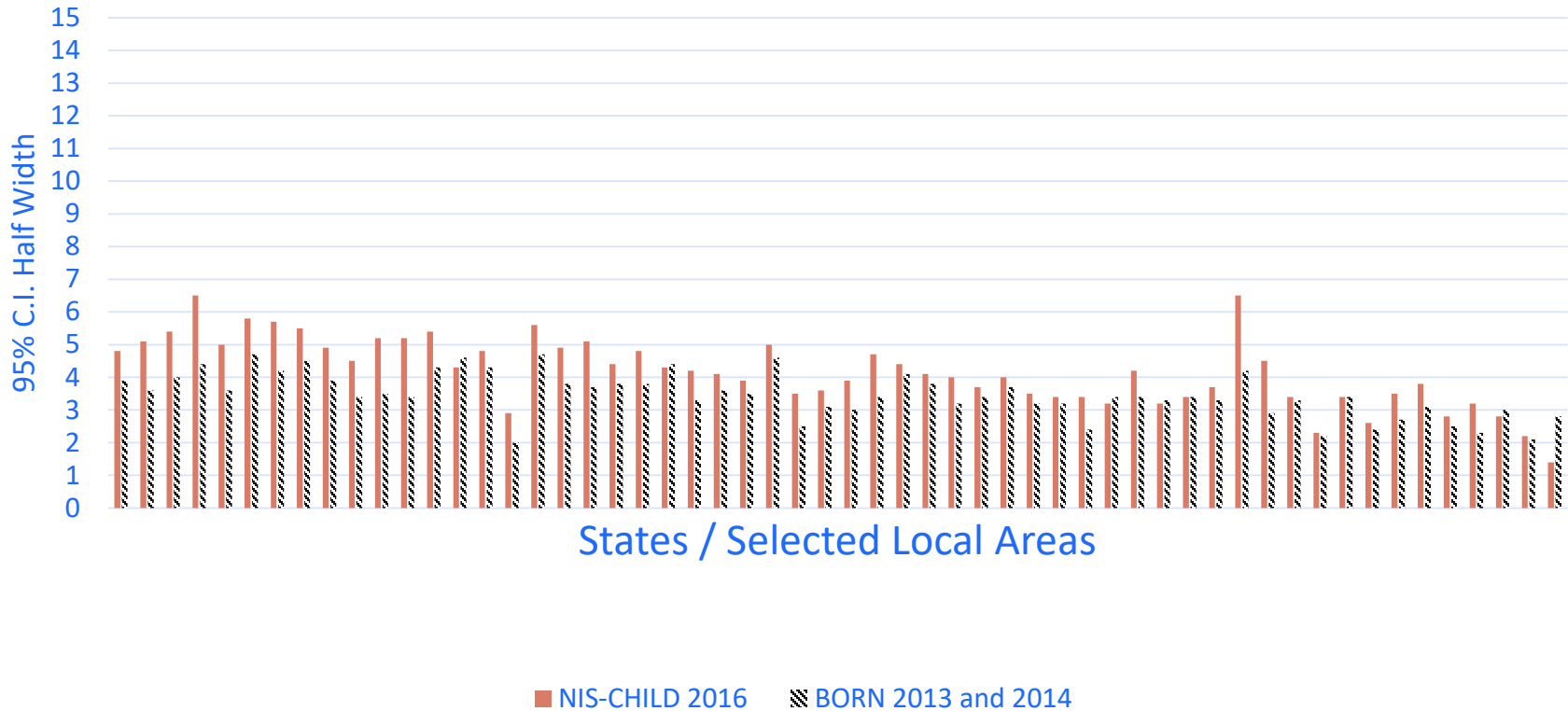
- 1) Similar chart for 4+ DTaP – differences are larger, for U.S. about three percentage points higher for children 19-35 months in 2016 survey estimates compared to coverage by 24 months among children born 2013-2014.

Vaccination Coverage by 2016 Survey Year, and by 24 and 27 Months Among Children Born 2013-2014, NIS-Child 2014-2016

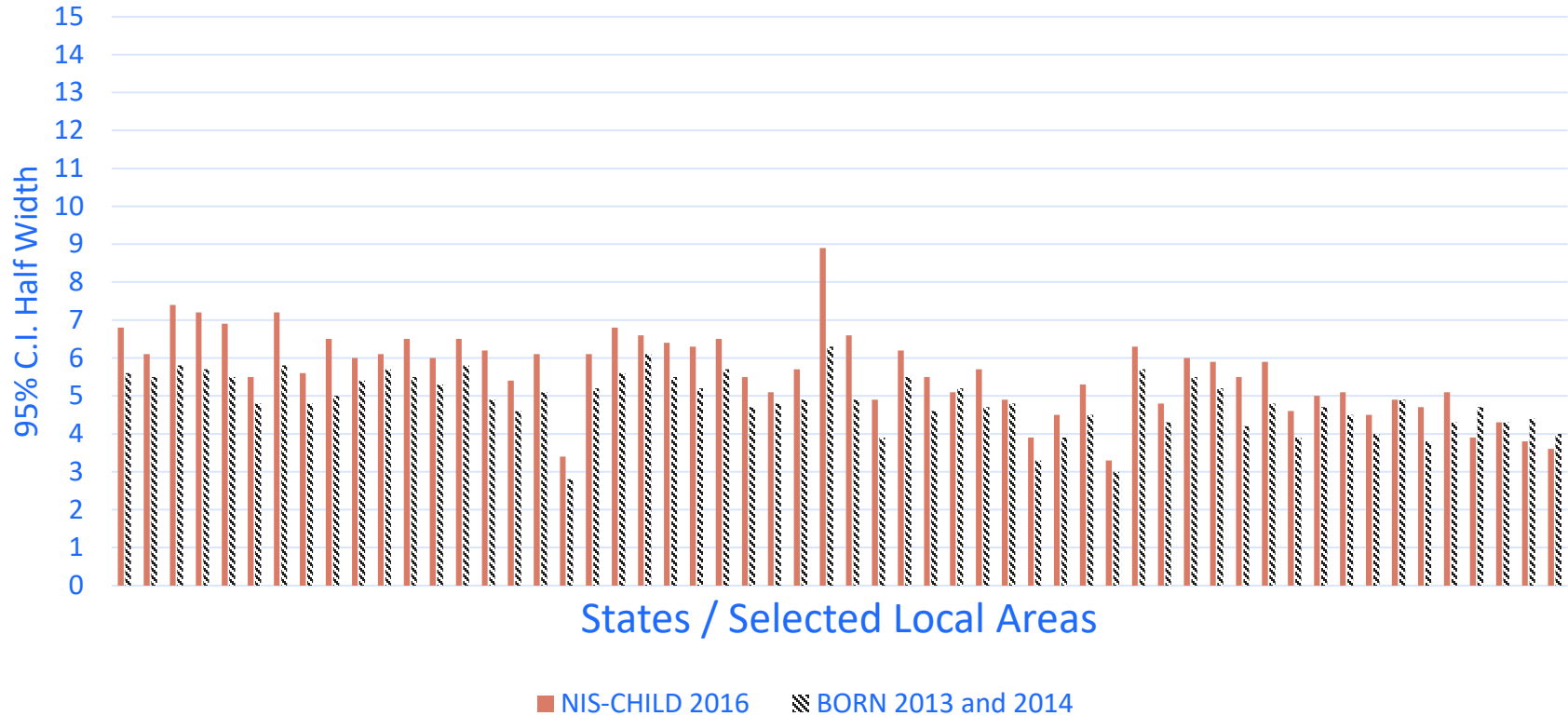


- 1) Nationally, coverage for the 2016 survey year for children assessed at 19-35 months of age tended to fall between estimates for children born 2013-2014 assessed at 24 and 27 months.
- 2) Nationally for the 2013-2014 birth cohort, 4+ DTaP coverage increased from 80.6% by 24 months to 84.9% by 27 months
- 3) For the 2013-2014 birth cohort, coverage for other vaccines increased from by 24 to by 27 months the most for:
 - 1) THE COMBINED SEVEN VACCINE SERIES (4313*314) by 4.2 % pts
 - 2) 1+ HepA by 3 % pts
 - 3) Full series of Hib by 2.5 % pts

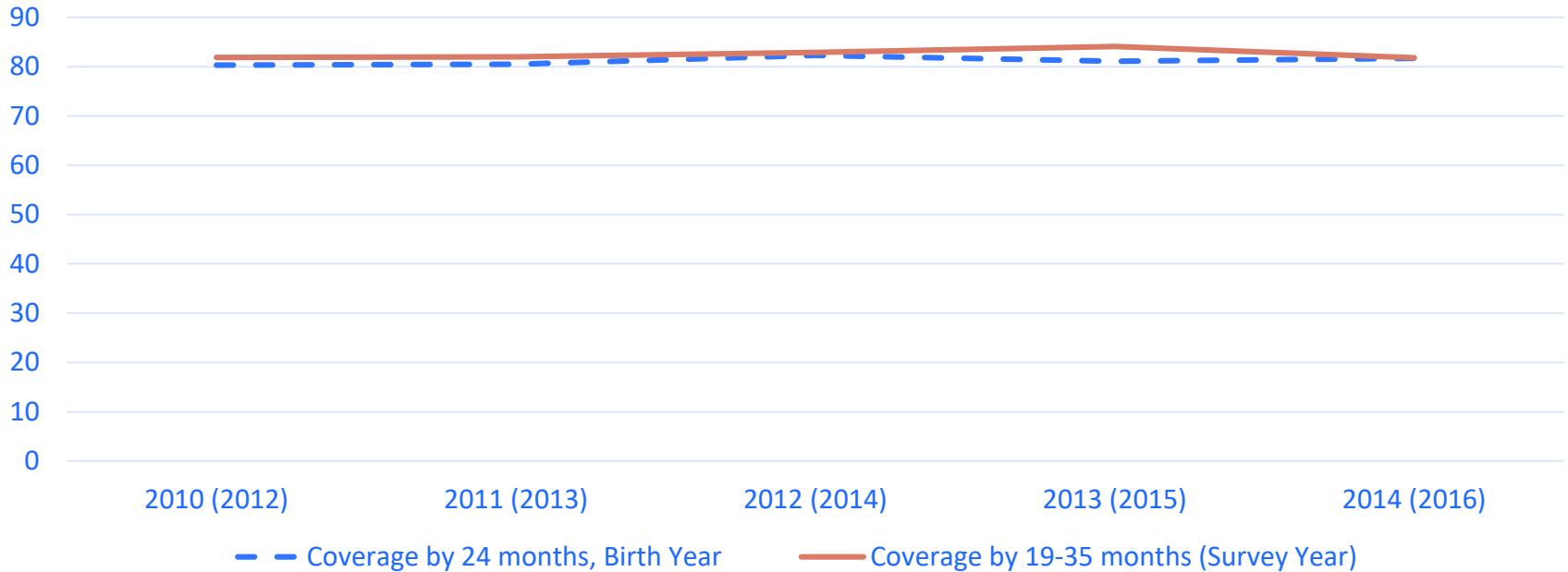
Estimated coverage with ≥ 1 MMR by 24 Months Among Children Born 2013-2014, National Immunization Survey – Child (NIS-Child), 2014– 2016



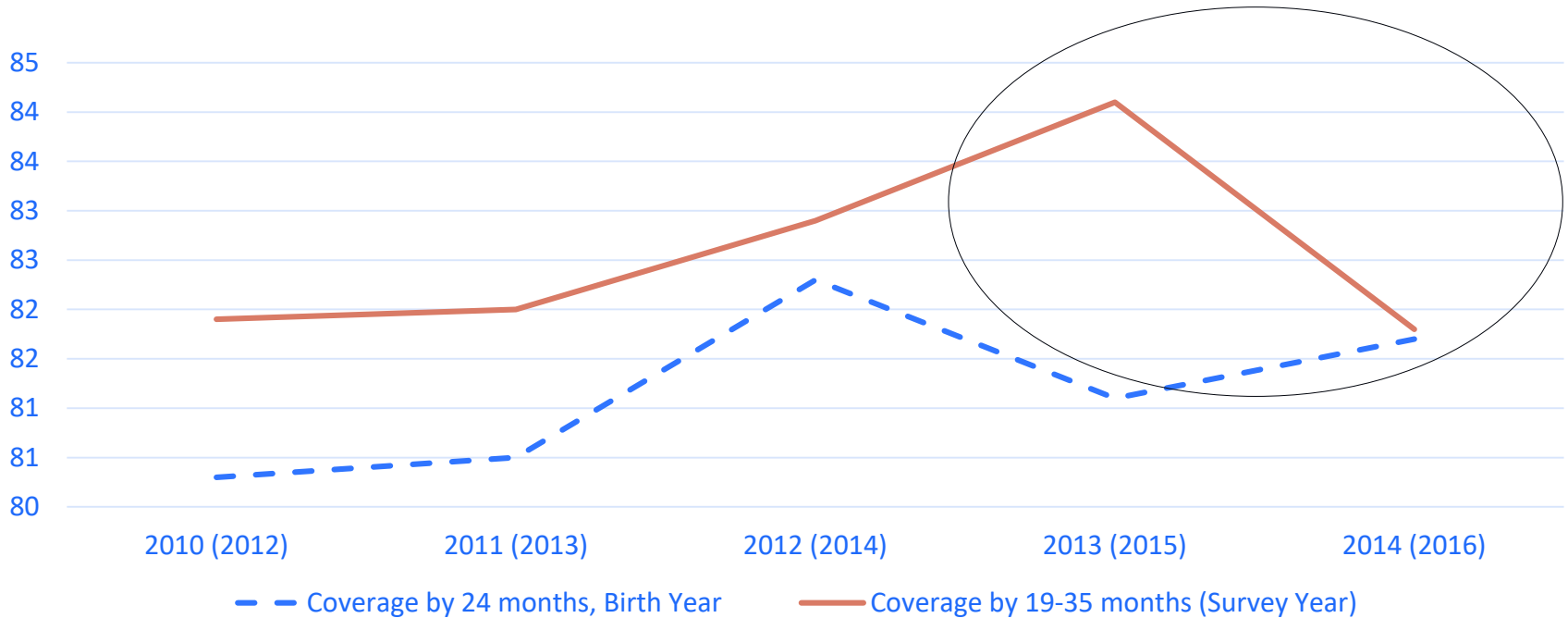
Estimated ≥ 4 DTaP Vaccination Coverage by 24 months Among Children Born 2013-2014, National Immunization Survey – Child (NIS-Child) 2014–2016



Estimated Coverage with 4+ PCV by Annual Birth Cohort and Survey Year, United States, NIS-Child

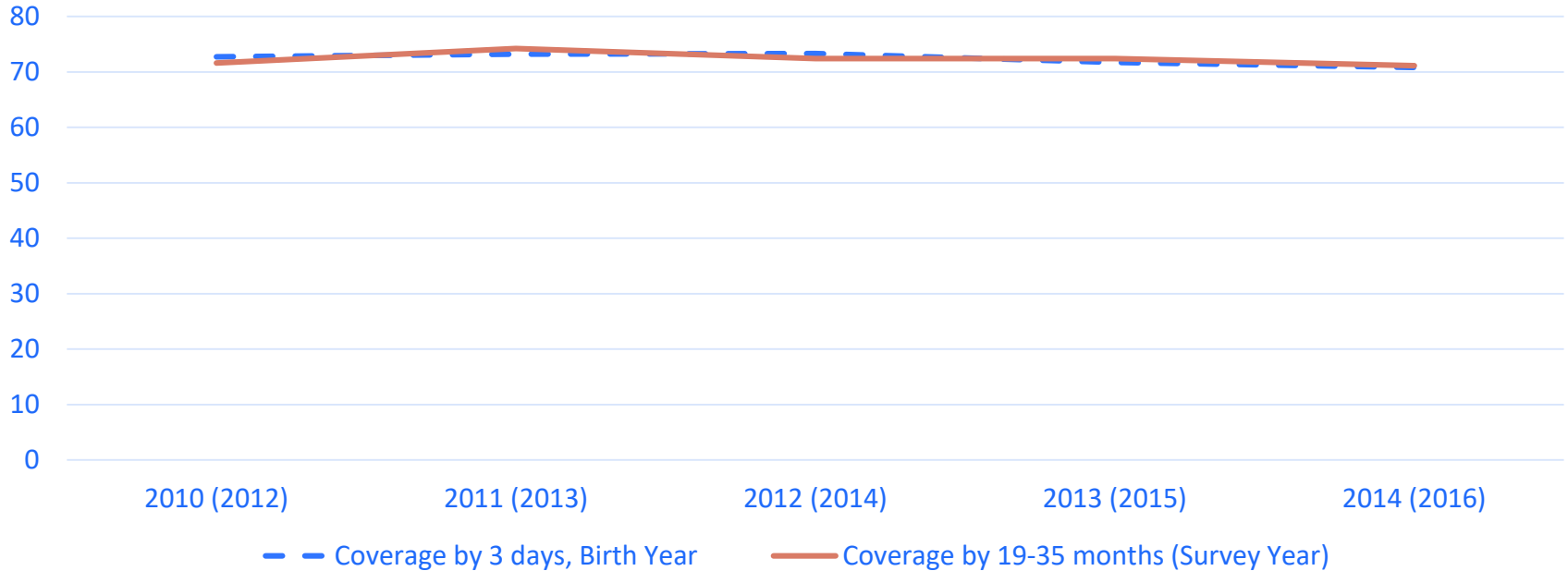


Estimated Coverage with 4+ PCV by Annual Birth Cohort and Survey Year, United States, NIS-Child



Now zoom in on this chart to highlight the statistically significant drop in coverage of 2.3 percentage points from 2015 to 2016, which is not reflected in the estimates by annual birth cohort

Estimated Coverage with Hepatitis B Birth Dose by Annual Birth Cohort and Survey Year, United States, NIS-Child



- 1) Comparing the estimates by 24 months, or earlier for hepatitis B birth dose and rotavirus vaccination, the only statistically significant decrease in coverage for children born 2013-2014 compared to 2011-2012 was for the hepatitis B birth dose; coverage dropped from 73.3% to 71.4%.

Limitations

- Estimates of vaccination coverage using NIS-Child data from 2011-2016 used existing survey weights
 - Weighted distributions of children by month of birth were fairly uniform as expected when based on three years of NIS data
 - For the 2014 birth cohort using the 2015 and 2016 data, the weighted number of children by month of birth decreased from 440k in January to 160k in December
- Estimates of vaccination coverage and confidence intervals may differ if survey weights specifically designed for birth cohort analysis were used

Discussion

Why Change Now

- Improve value of NIS-Child to immunization programs
- NIS-Child estimates by survey year have done their job over the past 23 years, but we are in a new era:
 - Increased use of IIS for vaccination coverage assessment
 - Relatively stable national vaccination coverage rates over time
 - Decreasing response rates and increased susceptibility to artificial changes in estimates by survey year
 - Better understanding of limitations of estimates by survey year
 - Complex rolling average of 2.5 annual birth cohorts with older children assessed at older ages than younger children

Risk of Relying on Estimates by Survey Year

- Difference in vaccination coverage from one survey year to the next is mainly measuring vaccinations received after age 19 months among children born during the same 17 months
- Could lead to false conclusions about trends in immunization program performance
 - Apparent decreases in coverage not supported by more direct assessment by birth cohort (e.g., 2016 NIS-Child)
 - Could also have apparent increases in coverage, or no change in vaccination coverage by survey year, that are not evident by birth cohort analysis

Advantages of Birth Cohort Approach

- More directly assess immunization program performance
- Estimates and trends easier to interpret
- Standard age at assessment (e.g., by 24 months)
 - Flexibility to look at different milestone ages with maximal use of data
 - e.g., ≥ 2 hepatitis A vaccinations by age 35 months
- Larger sample size and improved precision

Advantages of Birth Cohort Approach

- Coherence with other measures
 - HEDIS, FQHC reporting to HRSA, core CMS Medicaid child set, AFIX/IQIP
- Averages over any possible year-to-year changes in survey accuracy
- Ability to combine increasing number of annual birth cohorts for different purposes*
 - Overall national estimates (1), overall awardee estimates (2), awardee estimates stratified by sociodemographic variables or regions (3-5)

* <https://www.census.gov/programs-surveys/acs/guidance/estimates.html>

Advantages of Birth Cohort Approach

- Easier to replicate with IIS data for “apples to apples” comparisons
- Key features of NIS estimates by survey year can be approximated with IIS data using the average of point-in-time estimates taken each day of the year
 - Coverage among children 19-35 months on day x
- Estimates by birth cohort
 - Denominator = children born in year x
 - Numerator = children vaccinated by age 24 months

Disadvantages of Birth Cohort Approach

- Communicating and adjusting to a paradigm shift
- Transition reporting by survey year to birth cohort
 - MMWR, ChildVaxView, HP2030, federal health reports, PAHO/WHO, ...
- Main estimates from one year overlap by one annual birth cohort with estimates from the next year
 - Additional trend assessment by annual birth cohort (e.g., over past five annual birth cohorts)
- Need new survey weights designed for birth cohort analysis
- Increased analytic complexity (Kaplan-Meier method)

Feedback from Immunization Programs

- Presented proposal at NIC May 2018
- Presented AIM webinar July 13, 2018
- AIM member feedback August 3, 2018
- Most AIM members support:
 - Switch to NIS-Child estimates by birth year
 - <24 months of age milestone for main coverage estimates
 - Report HEDIS influenza vaccination measure
 - 2 doses by 24 months, vaccinations reported by providers
- AIM member suggestions
 - CDC propose additional age milestones for coverage estimates
 - CDC provide further support and information during roll-out

Implementation Plan (1)

- MMWR October 12, 2018 similar to last year
 - Two main tables with estimates by survey year
 - Results section and graph with national trends by monthly birth cohort
 - Supplemental tables for updated bridging cohort analysis and trends
 - Awardee estimates for 2017 posted online in ChildVaxView
 - Foreshadow plans for next year
- Healthy People 2030 objectives report most recent complete annual birth cohort – baseline children born 2014 using 2015-2017 data
- Obtain new survey weights specifically designed for annual birth cohort estimation from NIS contractor (~October 2018)

Implementation Plan (2)

- Estimate vaccination coverage by annual birth cohorts from 1994-2015 nationally and by awardee
- Publish peer-reviewed paper on birth cohort approach before next fall
- Decide what to include in MMWR next year
- Further awardee and partner engagement
 - NVAC presentation September 13, 2018
 - Share birth cohort estimates based on NIS-Child data through 2017 with awardees before June 2019, with draft CDC talking points

Implementation Plan (3)

- Redesign interactive awardee estimates in ChildVaxView
 - Decide on supplemental age milestones by vaccine to report online
- Consider changes to NIS sample design to optimize estimation by annual birth cohort (e.g. for 2019 sample)
 - Include children born in 2016 but age >35 months throughout quarter
 - 22% increase in sample size with little additional cost
- When an IIS can provide the sole sample frame, could sample one annual birth cohort per year
 - e.g., in 2020 sample the 2018 birth cohort (all turn 2 years in 2020)

Acknowledgements

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 - Benjamin Fredua (Leidos)
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 - Ben Skalland
 - Kirk Wolter



Update on IIS-NIS Integration

Overall Goal

- Accelerate existing efforts to integrate IIS and NIS functions to produce accurate and comparable estimates of vaccination coverage at national and awardee levels, and monitor disparities by sociodemographic characteristics at the national level
 - Facilitate awardee use of IIS data for state and local level vaccination coverage assessment

What is the path to full IIS-NIS integration?

Phase 1

- IIS augments the NIS cell phone sampling frame; from augmented sample:
- 1) collect uniform set of sociodemographic information, and 2) identify child's vaccination providers
- NIS vaccination data from the NIS provider record check process (PRC)

Phase 2

- IIS as the only sample frame (drop the random digit dialing cell phone sampling frame):
- 1) collect uniform set of sociodemographic information, and 2) identify child's vaccination providers
- NIS vaccination data from the PRC

Phase 3

- IIS as the only sample frame:
- 1) collect uniform set of sociodemographic information, and 2) identify child's vaccination providers
- NIS vaccination data from the PRC and IIS

Phase 4

- IIS as the only sample frame:
- 1) collect uniform set of sociodemographic information, and 2) drop collection of child's vaccination providers
- NIS vaccination data only from the IIS (drop the PRC)

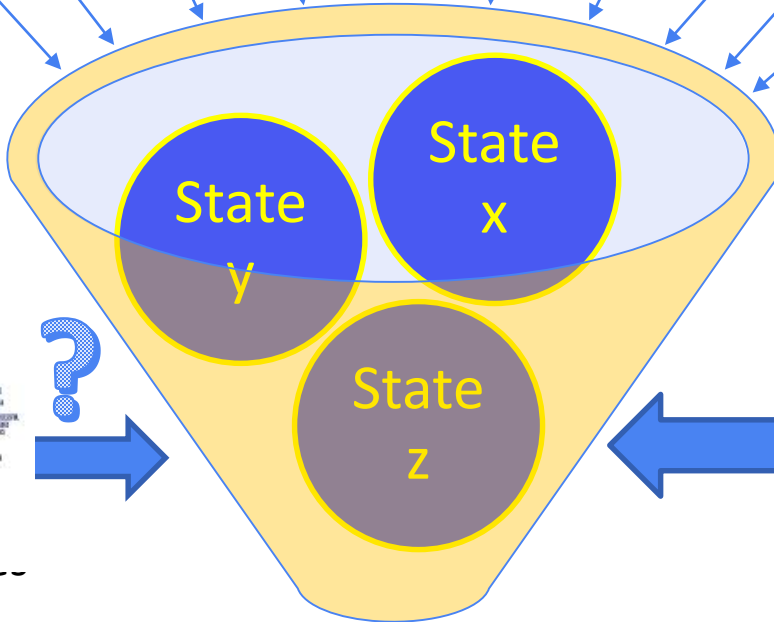
Current Status

- Fourteen state and local immunization programs participating in first wave using phone numbers in IIS to enhance the 2019 NIS random cell phone sample
 - Phone number locating offered
 - Matching of NIS sample to IIS offered
- Participation in IIS-NIS integration a proposed requirement in the fiscal year 2019 VFC/317 cooperative agreement
 - Initial focus on improving prevalence of telephone numbers in IIS and developing data sharing agreements

Planning for Possible Future Without NIS

- Increase the number of IIS that can provide valid vaccination coverage estimates to contribute to national estimates
- How assess validity of IIS data for vaccination coverage assessment?
 - CDC paying for matches of 2017 NIS-Child and NIS-Teen data to IIS, for areas with IIS estimates within 10 percentage points of NIS estimates
 - Best ways to assess IIS data quality for vaccination coverage assessment besides matching to NIS?
 - Retrospective kindergarten or current middle school assessments
 - Chart reviews based on sample from IIS conducted by awardee
 - With or without reach out to parents to identify all providers
- Further develop models for extrapolating IIS estimates from high-quality IIS to national level

State IIS data – aggregated at state or county level



- 1) Adjust for bias for reporting states
- 2) Account for missing data from non-reporting states

National Estimates

Adjusted State Estimates (for reporting states)



...ing, crime, and security

Thank You Questions?

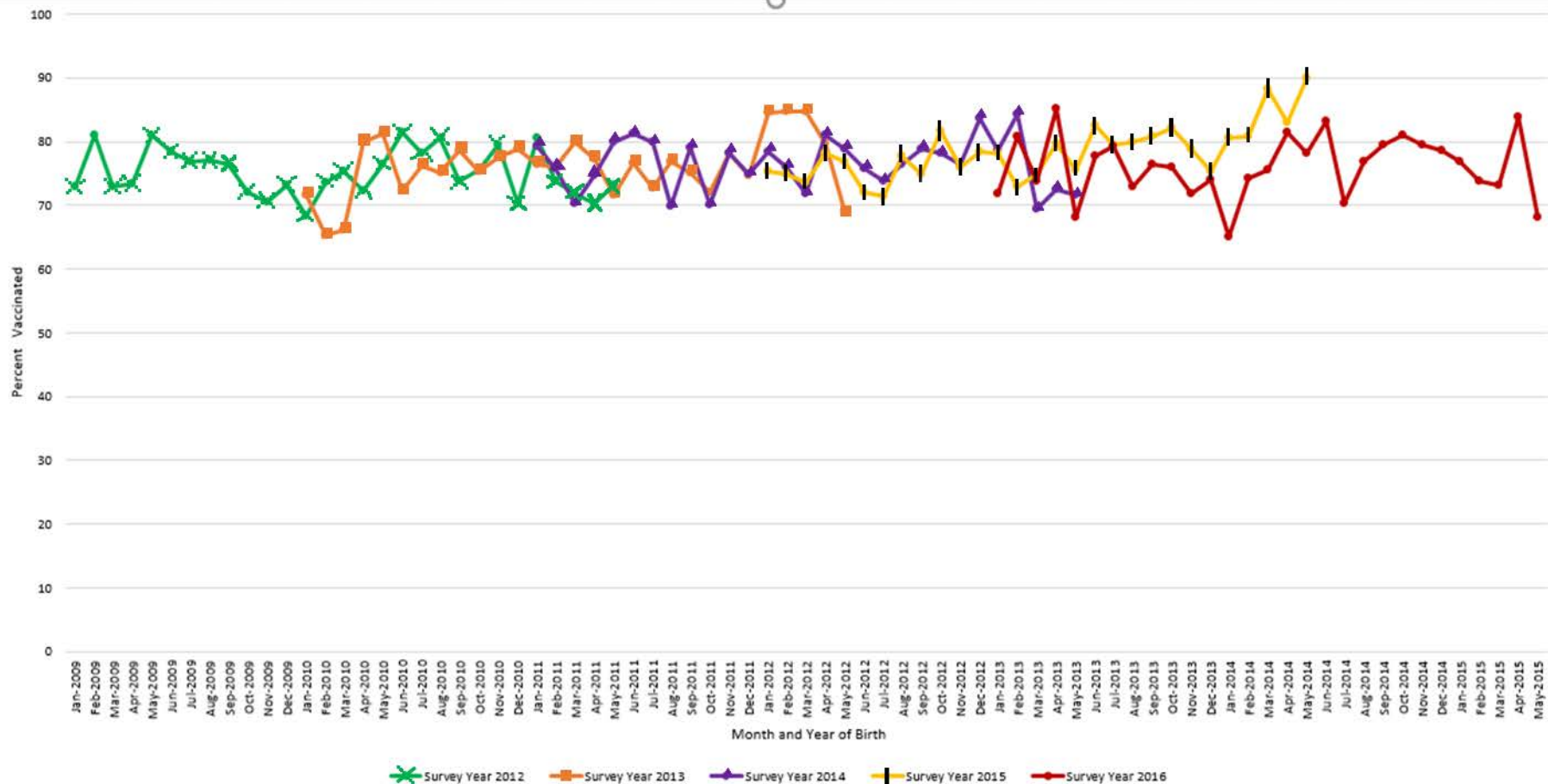
For more information, contact CDC
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TTY: 1-888-232-6348 www.cdc.gov

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.



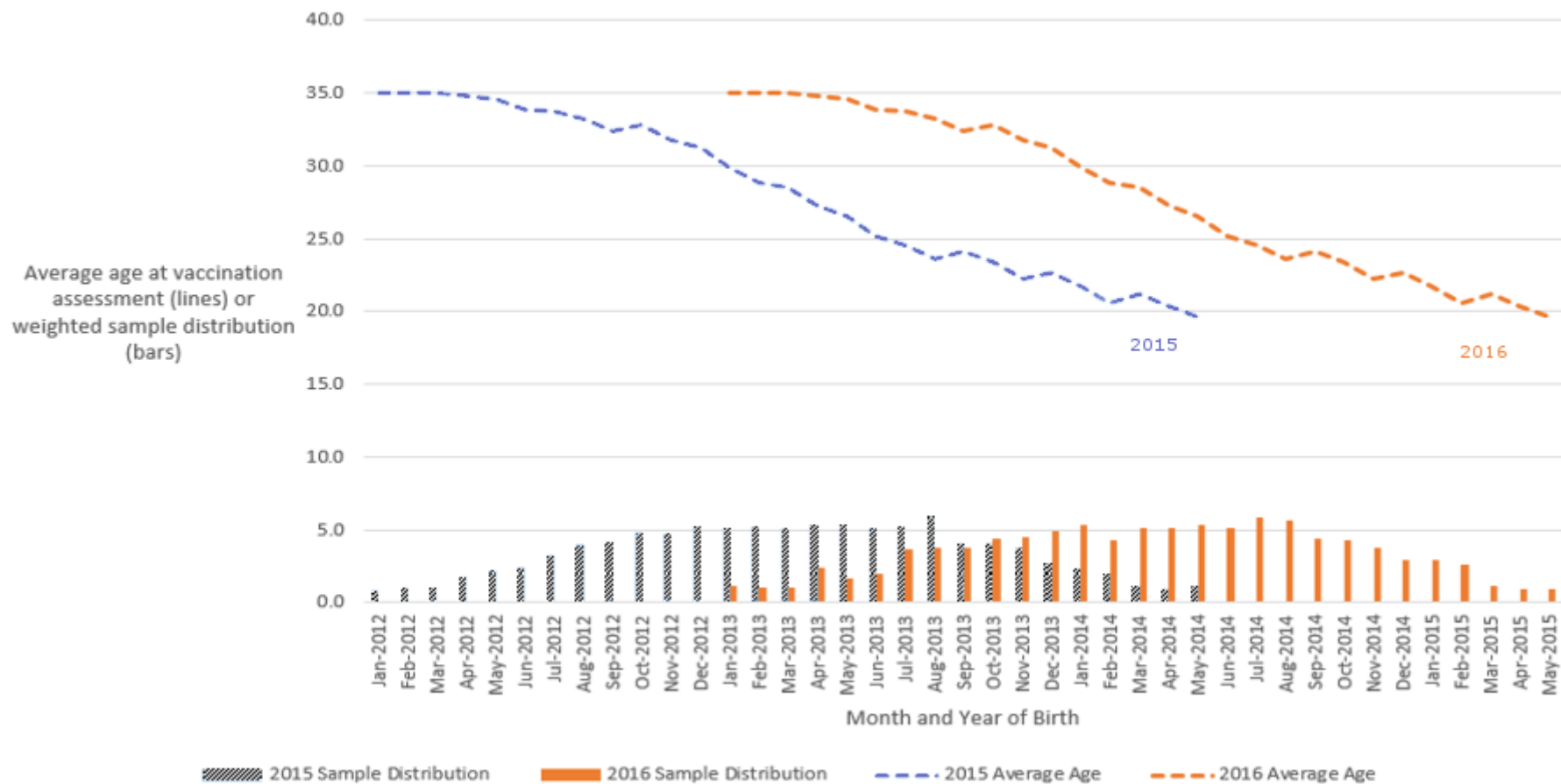
Additional Slides

Figure 13. Estimated vaccination coverage with 24 doses of pneumococcal conjugate vaccine by 19 months of age,* by month and year of birth† -- National Immunization Survey-Child, United States 2012-2016



- 1) Now I'll explain how we assessed possible changes in survey accuracy.
- 2) This graph shows national vaccination coverage for 4+ PCV by month and year of birth, for births included in the 2012 through 2016 NIS-Child.
- 3) Data from each survey year are color coded and connected by lines.
- 4) There is considerable overlap in monthly birth cohorts included in adjacent survey years.
- 5) For example, the overlapping, or bridging cohorts, from 2012 to 2013 are highlighted, with 2012 estimates in green and 2013 estimates in orange; the bridging cohort is children born January 2010 through May 2011.
- 6) Among the 2012 to 2013 bridging cohort, vaccination coverage estimates from 2012 and 2013 data were similar
- 7) Continuing along, estimates among the bridging cohort were similar for 2013 vs. 2014 and 2014 vs. 2015
- 8) But notice for 2015 vs. 2016, the estimates from 2016, in red, are consistently lower than the estimates from 2015, in yellow. On average, the 4+ PCV coverage estimates from 2016 were about five percentage points lower than the 2015 estimates. This average difference was statistically significant.
- 9) Because we are measuring the same birth cohorts by the same age in each of the 2015 and 2016 survey years, we expect the average difference to be zero, unless there is some systematic change in survey respondents or survey methods.
- 10) Thus, this statistically significant average difference among the bridging cohort is a signal of possible change in survey accuracy.
- 11) We found signals for eight of 15 vaccinations examined for the 2015 vs. 2016 comparison; of these eight, six had statistically significant drops in coverage based on the usual annual estimates.
- 12) We also did this bridging cohort analysis for each pair of survey years back to 2011 vs. 2012. There were similar signals for several vaccinations for 2011 vs. 2012, and only one other signal in the other comparisons of 2012 vs. 2013, 2013 vs. 2014, and 2014 vs. 2015.
- 13) Overall, these findings indicate a remarkable stability of NIS-Child estimates across survey years after we implemented cell phones into the sample and greatly increased the share of the sample from cell phones.
- 14) We did not identify any reason for the signals for 2015 vs. 2016, and don't know which estimates, from 2015 or 2016, are closer to the truth.
- 15) We wanted to know what affect these signals had on comparisons of annual estimates of vaccination coverage, so dug deeper into what we are actually measuring with NIS-Child annual estimates.

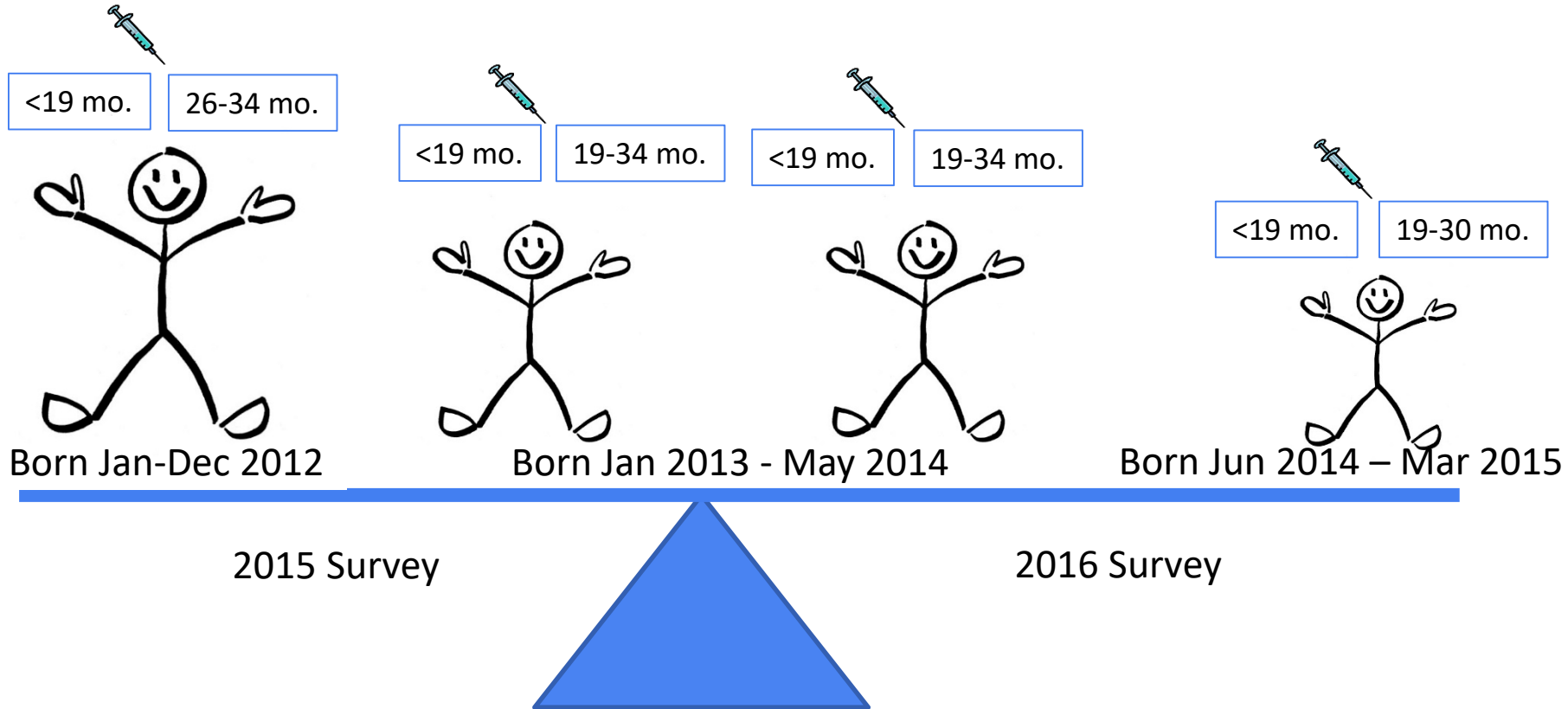
Figure 2. Distribution of weighted sample and average age at vaccination assessment by month and year of birth, National Immunization Survey (NIS)-Child, 2015 and 2016



- 1) This graph shows two key characteristics of annual NIS-Child estimates and how they relate to comparing the 2015 and 2016 estimates
- 2) First, the bars show the distribution of the sample by month and year of birth, with the distribution for 2015 in blue, on the left, and 2016 in orange, on the right.
- 3) Note monthly birth cohorts are not evenly distributed as we would expect in the target population.
- 4) The bridging birth cohort is noted in the middle with the overlapping bars.
- 5) Second, the dotted lines show the average age at assessment of vaccination status. We see that the average age at assessment is 35 months for the oldest children in the 2015 sample, and declines to 19 months for the youngest children. This is consistent from year to year and is the result of the NIS sampling design, with children eligible if aged 19-35 months anytime during each calendar quarter of sampling.
- 6) To better understand what we are measuring when we subtract the 2015 estimate from the 2016 estimate, we split up the overall difference in annual estimates into parts, for comparisons within the bridging cohort, and comparison of the younger children from 2016 with the older children from 2015.
- 7) If there were changes in immunization program performance, we would expect to see that reflected in the comparison of younger children from 2016 with older children from 2015, since these children were born over two years apart on average.
- 8) However, we can see from the graph that except for the hepatitis B birth dose and rotavirus vaccination, this is an unfair comparison, because the younger children from 2016 are assessed for vaccinations at younger ages.

The contribution of the bridging cohort to the difference in annual estimates reflects the extent of late vaccinations at or after age 19 months, and we expect it to be a positive contribution for most vaccinations because the children from 2016 are assessed for vaccinations about 5 to 10 months of age later than their counterparts from the 2015 survey

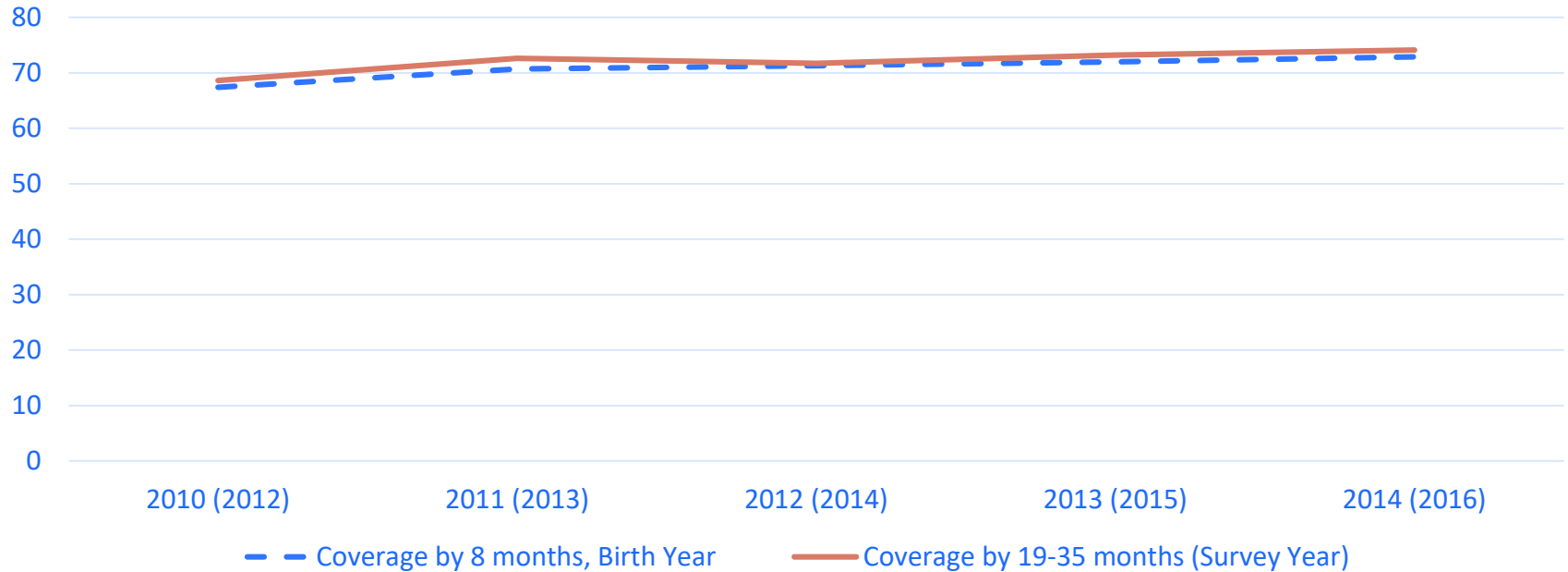
The difference between a NIS-Child 2016 and 2015 vaccination coverage estimate can be split into four parts based on birth dates and age when vaccinated



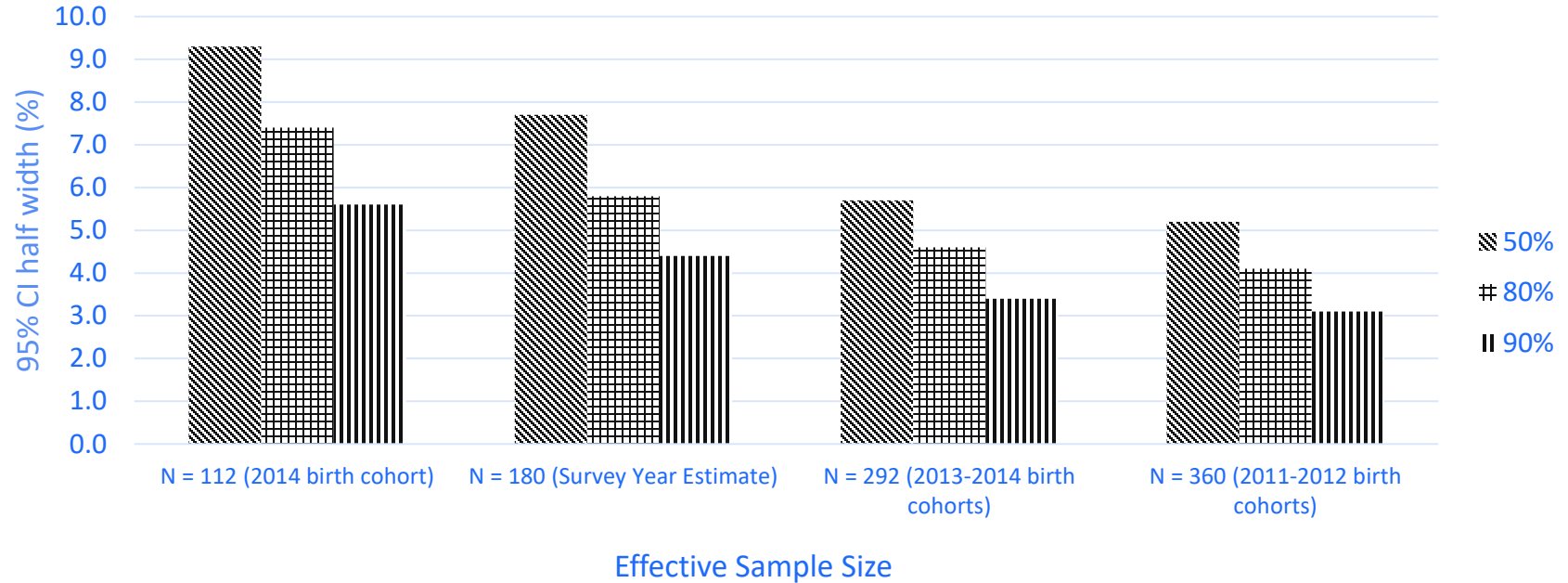
- 1) This is another way to think about it – the overall difference in annual estimates is the result of how estimates differ from 2015 to 2016 within the bridging cohort, and between the younger children from 2016 vs. the older children from 2015.
- 2) We further split the estimates by when vaccinations were received – before turning age 19 months, and from 19 months and later.
- 3) We split out actual differences in vaccination coverage estimates into these component parts, to see what was contributing to the overall difference.
- 4) From this data analysis and conceptual understanding, we identified limitations of the annual NIS-Child estimates for assessing change in immunization program performance. The online report will explain this in more detail.
- 5) It turns out that the signals we identified can magnify the limitations – for example, a difference in coverage by age 19 months among the bridging cohort can result in a statistically significant difference in annual estimates, but does not really provide any evidence for change in coverage over time.
- 6) For this reason, we assessed national trends more directly by month and year of birth, with findings included in the online report.

The MMWR publication will include a figure showing the estimated linear trend by birth cohort, for selected vaccinations

Estimated Coverage with Rotavirus Vaccine by Annual Birth Cohort and Survey Year, United States, NIS-Child



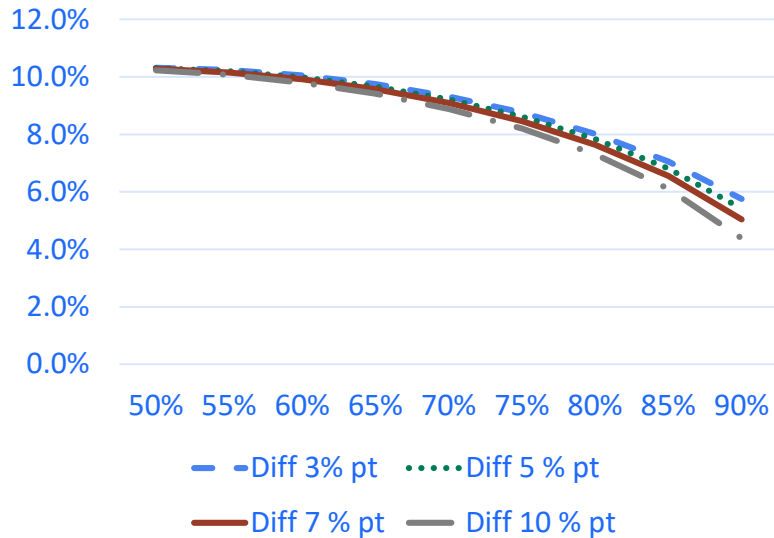
Expected 95% Confidence Interval (CI) Half-Width



- 1) This chart shows how we expect the width of confidence intervals to decrease, meaning improved precision, as we increase the effective sample size of an estimate of vaccination coverage.
- 2) Note also that for each sample size, the confidence interval gets smaller as the estimated coverage goes from 50% to 80% to 90%.
- 3) We see that by switching from estimates by survey year to estimates by two annual birth cohorts, precision of the main estimates improves by about 22%.
- 4) Next I'll show examples of reduction in confidence intervals by state for selected vaccines

Expected 95% Confidence Interval Half-Width for Assessing Recent Change in Vaccination Coverage

Difference by Survey Year



Difference by Birth Cohorts

