RESULTS OF THE 2018 IMMUNIZATION STATUS SURVEY OF 24 MONTH OLD CHILDREN IN TENNESSEE

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Executive Summary

The Tennessee Department of Health (TDH) conducts an annual survey of the on-time immunization status of 24 month old children. The Tennessee Immunization Program (TIP) uses these results to track progress toward achieving the national Healthy People (HP) 2020 objectives for immunization coverage with routinely recommended early childhood vaccines. HP2020 is a national framework established by the Federal Department of Health and Human Services (HHS) for meeting health goals by the year 2020. The 24 month old survey assesses the immunization status of children as of their second birthday. For best results, vaccines should be administered as recommended by the Advisory Committee on Immunization Practices (ACIP) and the Centers for Disease Control and Prevention (CDC).

Value of vaccination:

Timely routine vaccination of children protects health, saves money, and saves lives. The federal Vaccines for Children (VFC) Program, implemented in 1994, assures affordable access to all routine vaccines for children who are without private insurance coverage. The CDC has reported that the routine vaccines already given to U.S. children born between 1994 and 2013 will prevent an average of 4.1 illnesses per child, prevent the hospitalization of one in four and prevent the premature death of nearly one in 100 of these children over their lifetimes.[1] The CDC calculates that vaccination of U.S.-born children each year with the current immunization schedule yields a net savings of nearly $14 billion in direct medical costs and $69 billion in total costs to society.[2] With roughly two percent of the U.S. population living in Tennessee, this suggests Tennessee has benefitted from the prevention of approximately 480,000 cases of disease in the past decade, with ***annual savings*** of $280 million in direct medical costs and $1.38 billion in total costs to society.

Methods:

A random sample of 1,605 children was selected from birth certificates of children born in the first three months of 2016 in Tennessee's six metropolitan counties and seven rural multi-county TDH regions. Local or state public health staff attempted to locate each child and confirm immunization histories with parents or guardians and healthcare providers.

Children were excluded from the survey if:

- the child was determined to have moved out of the state
- the birth record was sealed (e.g. through adoption or placement in foster care)
- the parents or guardians refused to participate in the survey
- the child had died

After exclusion of 97 children for the above reasons, 1,508 children's immunization records were collected. Statewide immunization rates are provided, as well as rates for the six major metropolitan counties and seven rural multi-county regions. County rates within the rural regions are not calculated due to the small number of children sampled in each county.

Complete and on-time immunization in the 2018 survey of Tennessee 24 month olds is defined as follows: having received four doses of DTaP, three doses of IPV, one dose of MMR, three or four doses of HIB (four doses required if any dose is of the 4-dose brand), three doses of HBV, one dose

of VAR and four doses of PCV (abbreviated hereafter as the 4:3:1:FS:3:1:4 series) before turning 25 months old.

Beginning in 2014, a change in methodology was introduced to provide a more accurate assessment of *Haemophilus influenzae* type B (HIB) vaccination and rotavirus vaccination (RTV) rates, as different formulations of vaccines against these diseases require different numbers of doses. This survey now takes into account the vaccine brand, if known, and classifies a child as complete only if the appropriate number of doses has been administered. As a result, point estimates for HIB and RTV coverage rates are lower than previous estimates, but also more accurate and more consistent with methods used by the CDC. Since HIB is part of the core vaccine series, the vaccine series is labeled 4:3:1:FS:3:1:4, with FS indicating a "full series" of HIB.

Summary of Results:

The table below summarizes Tennessee's (TN) 2018 results alongside national Healthy People (HP) 2020 objectives for this age group:

Diseases	Healthy People 2020 Objective (19-35 months)	TN 2018 (24 months)
Diphtheria, Tetanus, Pertussis	90%	82.0%
Poliomyelitis	90%	92.3%
Measles, Mumps, Rubella	90%	90.1%
Hepatitis B	90%	92.7%
Hepatitis B, birth dose	85%	**84.0%
Haemophilus influenzae, type B	90%	78.7%
Varicella (Chickenpox)	90%	90.3%
Pneumococcus	90%	82.4%
All of above	80%	72.0%
Hepatitis A	60% 2-dose	*1 dose: 90.8%
Rotavirus	80%	77.5%
Influenza	70%	2 doses: 49.0% 3 doses: 27.0%

*TN measures 1 dose of hepatitis A because children who receive 1 dose by the 2nd birthday may wait up to 18 months to receive dose 2. ☐ Indicates value is above HP2020 objective.
**TN Hepatitis B, birth dose state estimate confidence interval includes the HP2020 object of 85%

Influenza Vaccination: There has been an increase in the percentage of infants receiving two and three doses of influenza in Tennessee. The two dose coverage increased from 45.9% to 49.0% and three dose coverage increased from 25.6% to 27.0% in 2017 and 2018, respectively. Children six

months through eight years of age require two doses of the influenza vaccine in their first season; thus, they should have received three doses prior to the second birthday.

Racial Disparities:
Influenza vaccination rates continue to be significantly lower among black children compared to white children. In 2018, 34.8% of black children received at least two doses of influenza vaccine compared to 51.1% of white children. While still consistently lower, the full childhood series (4:3:1:FS:3:1:4) completion rate among black children (68.8%) was not significantly lower than that of white children (72.6%) in the 2018 survey population.

Refusals of all vaccines:
Over the past 5 years, the trend in percentage of children included in the survey whose parents refused some or all immunizations has been variable: 1.9% in 2014, 2.3% in 2015, 1.6% in 2016, and 3.5% in 2017. This year's survey marks the second year where vaccine refusals are above 3% with 3.3% (50/1508 including the oversampled Black children) of parents refusing some or all immunizations. Of the analyzed population for this survey, the vaccine refusal rate is 3.2% (47/1481).

Of the 1,508 children surveyed, parents of the 47 children who received no immunizations (3.2%) stated they **did not vaccinate their child for religious (n =21), philosophical (n = 24), or medical (n = 2) reasons**. Parents of three additional children who had received at least one immunization reported refusing additional immunizations for philosophical (n=2) or religious (n=1) reasons. Nashville-Davidson County had the highest regional refusal rate at 16.2% (18/111), an increase from the 2017 rate of 3.5% (4/115). Of the 18 parents who refused to vaccinate their children, ten cited doing so for philosophical reasons, eight cited religious regions, and none cited medical reasons. Regional rates across Tennessee ranged from 0.0% to 16.2% (see Appendix 1 for regional refusal and children not located rates).

TennCare:
In this survey, children covered by TennCare (n=869) had vaccination rates that were not significantly different from that of their non-enrolled peers. Of those enrolled in TennCare, 70.3% (± 3.0) were fully immunized for the 4:3:1:FS:3:1:4 series, compared to 74.5% (± 3.5) of those not enrolled in TennCare. This was the first survey since 2014 to demonstrate no statistically significant difference between the series vaccination rates of children enrolled in TennCare versus those not enrolled in TennCare. Significant disparity does exist with respect to influenza vaccination, with 60.3% of never-enrolled children receiving two doses of vaccine versus 41.0% of those enrolled in TennCare.

WIC:
There is no significant difference in 4:3:1:FS:3:1:4 vaccination series completion rates between children who had ever been enrolled in WIC and children never enrolled in WIC. However, there continues to be significant disparity in influenza vaccination rates, with 58.9% of never-enrolled children receiving two doses of vaccine versus 42.5% of those enrolled in WIC.

Discussion:

While overall vaccination rates among children in Tennessee remain relatively high, the reintroduction of previously eliminated vaccine-preventable diseases across the United States emphasizes the importance of continued vigilance in ensuring that every medically-eligible child is fully vaccinated on-time and according to the Centers for Disease Control and Prevention (CDC) recommended childhood vaccination schedule.

Tennessee currently meets HP2020 targets for only five of 12 vaccination-related measures in 24 month old children.

Unvaccinated and under-vaccinated children have comprised substantial proportions of cases of vaccine-preventable diseases such as measles, mumps, and pertussis (whooping cough), and the majority of children who die each year from seasonal influenza are unvaccinated.[3,4] These diseases not only place Tennesseans at risk for significant morbidity and mortality, but they also create significant fiscal burden upon the State. **A 2016 outbreak of seven cases of measles in west Tennessee, for example, resulted in an estimated cost of more than $4 million**. Even small outbreaks place tremendous strain upon our public health system and its resources and divert attention from other critical public health initiatives.

Three elements are critical to ensuring that every medically-eligible child in Tennessee is fully vaccinated on-time and according to the CDC's recommended childhood vaccination schedule:

- Parental and community education and messaging around the safety, efficacy and critical importance of childhood vaccination
- Ready access to, and provision of, vaccinations at every opportunity
- Reliable and readily accessible vaccination records that ensure vaccinations are provided on-time while avoiding duplication

Key strategies for improving vaccination rates among 24 month old children:

Parental and community education and messaging around the safety, efficacy and critical importance of childhood vaccination:

- The ability of public health to provide a strong and credible message that "vaccines are safe, vaccines are effective, and vaccines save lives" is critical to ensuring the protection of Tennesseans of all ages.
- Philosophical exemptions among parents of children under 24 months of age in Tennessee outnumber religious and medical exemptions, combined. States that have eliminated non-medical exemptions have benefited from higher overall immunization rates than states which allow non-medical exemptions.

Ready access to, and provision of, vaccinations at every opportunity:

- The federally-funded Vaccines for Children Program ensures that children who are covered by TennCare or otherwise lack insurance coverage for vaccines are able to receive them free of charge through a statewide network of healthcare providers and local departments of health.
- Providers should continue to administer vaccinations at every opportunity.

Reliable and readily accessible vaccination records that ensure vaccinations are provided on-time while avoiding duplication:

- The Tennessee Immunization Information System, "TennIIS" (www.TennesseeIIS.gov) is an online immunization registry that is available to all immunization providers, including hospitals, clinics and pharmacies, and includes a suite of tools which may help to improve immunization rates in children and adults.
- Standards implemented in 2017 require clinics participating in the federal Vaccines for Children (VFC) Program to report all immunizations administered to children under 19 years of age to TennIIS. This enables providers to use system features designed to improve patient immunization services, such as vaccine forecasting, practice-based patient reminders and immunization coverage rate reports.
- Reporting all immunizations to an Immunization Information System (IIS) such as TennIIS improves healthcare by establishing a permanent immunization record that is available to all healthcare providers. Any authorized user may access the TennIIS web portal. In addition, TennIIS is linked to the electronic health record (EHR) systems of hundreds of medical facilities and pharmacies statewide, allowing for seamless electronic immunization reporting from those systems.
- The TennIIS immunization certificate feature makes it easy for families to obtain state immunization certificates for daycare, school, college, and employers.

[1] CDC. Benefits from Immunization During the Vaccines for Children Program Era — United States, 1994–2013. Morbidity and Mortality Weekly Report. 63(16);352-355.

[2]CDC. Ten Great Public Health Achievements – United States 2001—2011. Morbidity and Mortality Weekly Report. 60(19);619-623.

[3]Pradke, V., Bednarczyk, R., et al. Association between Vaccine Refusal and Vaccine-Preventable Diseases in the United States: A Review of Measles and Pertussis. JAMA. 2016 Mar 15; 315(11):1149-1158.

[4]Flannery, B., Reynolds, S., et al. Influenza Vaccination Effectiveness against Pediatric Deaths: 2010-2014. Pediatrics. 2017, May; 139(5):e20164244.

Definitions of Abbreviations in Charts

1. **Vaccines**
    a. **DTaP: diphtheria, tetanus, acellular pertussis**
    b. **IPV: inactivated polio vaccine**
    c. **HAV: hepatitis A vaccine**
    d. **HBV: hepatitis B vaccine**
    e. **HIB: *Haemophilus influenzae,* type B vaccine**
    f. **MMR: measles, mumps, rubella**
    g. **VAR: varicella (chickenpox) vaccine**
    h. **PCV: pneumococcal conjugate vaccine**
    i. **FLU: influenza vaccine**
    j. **RTV: rotavirus vaccine**
2. **Public Health Regions**
    a. **Rural, multi-county regions**
        i. **NER: Northeast Region**
        ii. **ETR: East Tennessee Region**
        iii. **SER: Southeast Region**
        iv. **UCR: Upper Cumberland Region**
        v. **SCR: South Central Region**
        vi. **MCR: Mid-Cumberland Region**
        vii. **WTR: West Tennessee Region**
    b. **Metropolitan, single county regions**
        i. **SUL: Sullivan County**
        ii. **KKR: Knoxville-Knox County**
        iii. **HAM: Hamilton County (Chattanooga area)**
        iv. **NDR: Nashville-Davidson County**
        v. **JMR: Jackson-Madison County**
        vi. **SBY: Shelby County (Memphis area)**

Results of the 2018 Immunization Status Survey of 24 Month Old Children in Tennessee

***General**:*
An annual survey of the immunization status of 24 month old children is conducted by the Tennessee Department of Health (TDH) Immunization Program (TIP) to track progress toward achieving at least 90% on-time immunization with each routinely recommended vaccine for that population. The survey is composed of random, statistically-valid samples drawn from birth certificates of infants born during the first quarter of 2016 in each of Tennessee's six metropolitan counties and seven rural multi-county TDH regions. Regional samples are aggregated to give statewide statistics on immunization coverage levels in Tennessee.

Introduction:
This survey assesses the on-time immunization status of young children against the following 14 diseases:

Disease(s)	Possible complications of disease	Vaccination	# of doses*
Diphtheria, tetanus, pertussis	*Diphtheria*: upper airway obstruction, pneumonia, respiratory failure, death *Tetanus*: spasms of respiratory and skeletal muscles, death *Pertussis*: outbreaks; severe, long-term cough, vomiting, breathlessness, death in infants	DTaP	4
Poliomyelitis	Paralysis, death	IPV	3
Measles, mumps, rubella	*Measles:* outbreaks; ear infections, pneumonia, cardiac and neurologic problems, encephalitis, death *Mumps*: outbreaks; sterility, meningitis, arthritis, hearing impairment *Rubella*: arthritis, encephalitis, birth defects	MMR	1
Haemophilus influenzae type B	Pneumonia, meningitis, neurologic problems, death	HIB	3 or 4†
Hepatitis B	Fulminant hepatitis, jaundice, liver cancer, cirrhosis, premature death	HBV	3
Varicella (chickenpox)	Rash illness, severe disease in immunocompromised, birth defects	VAR	1
Pneumococcus (certain strains)	Ear infections, pneumonia, meningitis, blood stream infections, death	PCV	4
Hepatitis A	Outbreaks: fever, nausea, jaundice, rare death	HAV	1
Influenza	Outbreaks: secondary pneumonia, exacerbation of chronic diseases, hospitalizations, deaths	FLU	2
Rotavirus	Outbreaks in daycare settings, dehydration, hospitalization	RTV	2 or 3†

* # of doses for on-time completion at 24 months, according to the published CDC Recommended Childhood Immunization Schedule
† Number of doses in a full series (FS) varies by brand of vaccine

This survey uses the same vaccine series definitions as the Centers for Disease Control and Prevention (CDC) National Immunization Survey (NIS), which assesses 19-35 month old children. Complete on-time immunization in the 2018 survey of Tennessee 24 month olds is defined as having received four doses of DTaP, three doses of IPV, one dose of MMR, three *or* four doses of HIB (four doses required if any dose is the

4-dose brand), three doses of HBV, one dose of VAR and four doses of PCV (abbreviated hereafter as the 4:3:1:FS:3:1:4 series) before the age of 24 months, 30 days.

Before 2014, HIB vaccination was counted as complete with three doses as brand information was unavailable. As of 2014, if any documented HIB dose was given as the 4-dose product, then only receipt of four doses was considered series completion. In the absence of documentation of vaccination with a 4-dose product, three doses of HIB is classified as series completion.

Recommended vaccines not included in the 4:3:1:FS:3:1:4 series are reported individually:

- Influenza vaccine (FLU) is given annually at age six months and older; two doses should be given the first season the vaccine is administered. Because protection is conferred only after two doses, this survey measures the proportion of children with two or more doses by their second birthday.
- Hepatitis A vaccine (HAV) is complete with two doses, starting on or after the first birthday; the recommended dose spacing of 6-18 months means that children who have only one dose by the second birthday are still on schedule. For this reason, this survey reports 24-month-old children as up-to-date with one dose of HAV.
- Rotavirus vaccine (RTV) is complete with two doses of Rotarix©, or with three doses if any dose in the series was known to be Rotateq©. If no brand information was available, two doses of rotavirus vaccine given before 24th months of age is classified as series completion.

Healthy People 2020 objectives:

Healthy People (HP) 2020 objectives are established by the federal Department of Health and Human Services (HHS) to provide national targets for population health. These objectives include vaccine coverage levels among children 19-35 months of age and are tracked nationally through the National Immunization Survey (NIS). TDH aims to reach or exceed each of these targets.

The following objectives for the percentage of children immunized by 19-35 months of age have been established by HP2020 and are relevant comparisons to the results of this survey:

- 80% complete the 4:3:1:FS:3:1:4 series
- 90% complete each individual vaccine included in the 4:3:1:FS:3:1:4 series
- 60% complete hepatitis A vaccination
- 80% complete rotavirus vaccination with two or more doses
- 70% appropriately immunized against influenza
- 85% of all children receive their first dose of hepatitis B vaccine within three days of life

The 2018 sample population:

The 2018 statewide sample consisted of 1,605 children born in the first three months of 2016. Oversampling for black children was done in each region where the random sample contained fewer black children than the actual proportion of black children born in the first quarter of 2016 in that region. Thirty-two (32) additional black children were randomly selected for inclusion in the racial disparity analysis.

Of the 1,605 sampled births, 97 records were excluded from the final analysis: one child had died; parents of 15 refused to participate; 76 had moved out of state; and one had been adopted, put in foster care or was in state's custody. Five of the 32 records of oversampled black children were excluded (four had moved out of state and one refused participation). All of the remaining 27 oversampled children were located and none of their parents claimed an exemption from vaccinating their child.

The point estimates reported in this survey are based off of the 1,481 analyzed sample population; the 1,605 sampled births minus the 97 excluded records. When reporting on racial analysis, the oversampled population is included in the denominator (1,481 + 27 oversampled records = 1,508 total records). Appendix

1 contains a table of the numbers of children who refused vaccines and the number of children who could not be located in each region.

Unable to locate:

Of the 1,508 children included in the survey, 39 had incomplete information in the Tennessee Immunization Information System (TennIIS) but could neither be located nor confirmed as having moved out of state. Twenty-four of the 39 children had at least demographic data in TennIIS, and 10 had at least one vaccination entered into TennIIS. Four of those ten had only a birth dose of Hepatitis B vaccine recorded in TennIIS. By protocol, any available immunization records for these children are included in the analysis.

Of the 39 children, 13 of 247 (5.9%) black children and one of 40 (2.5%) of other races were unable to be located, compared to 25 of 1,221 (2.0%) white children. Eleven (11) of the 39 who were unable to be located were in Shelby County, accounting for 10% of the county's survey sample and 28.0% of all of those unable to be located. (See Appendix 1 for the breakdown of those unable to be located by region.)

TDH uses Accurint, a subscription-based database compiling publicly available address information, to generate contact details for parents of each child. These were provided to local and regional health department staff at the beginning of the survey period.

Vaccine refusal:

The percentage of children included in the survey whose parents refused some or all immunizations remains high. Of the 1,508 children, parents of 47 children who received no immunizations (3.2%) stated that they did not vaccinate their child for religious (n=21), philosophical (n=24), or medical (n=2) reasons. Parents of three additional children who had received at least one immunization reported refusing additional immunizations for philosophical (n=2) or religious (n=1) reasons. These parents represented 3.3% (50/1,508) of those surveyed.

Nashville-Davidson County had the largest number of parents surveyed who refused to vaccinate their children (n=18). Of those 18 parents who refused to vaccinate their children, ten cited doing so for philosophical reasons, eight cited religious regions, and none cited medical reasons. This represented the largest proportion of vaccine refusals (16.2% [18/111]) among regional rates, which ranged from 0.0% to 16.2% (see Appendix 1 for regional refusal and children not located rates).

Statistical notes:

The survey is designed to allow valid statistical comparisons of the populations in each of the 13 health department regions defined in Appendix 6; however, the sample size within multi-county regions is too small for meaningful results at the county level or useful comparisons among subpopulations within a region.

Ninety-five percent confidence intervals (CI) were calculated and are displayed as whisker plots on graphs in this report to permit readers to visualize the statistical significance (or absence of significance) of differences in point estimates. Confidence intervals that do not overlap indicate that the point-estimate differences being compared have at least a 95% chance of representing true differences in the populations being compared. When CIs overlap, differences are not considered to be statistically significant. CIs were not calculated for surveys before 2007.

Sampling comparison limitation:

For the seven multi-county TDH regions (Northeast [NER], East Tennessee [ETR], Southeast [SER], Upper Cumberland [UCR], South Central [SCR], Mid-Cumberland [MCR], West Tennessee [WTR]) in this survey, children were chosen in different proportions from the counties that make up each region. There is no consistent pattern for choosing these participants from year to year. Results are presented as the

summation of all counties in that region; therefore, it is inaccurate to use results of this survey as county-level results for the counties within these regions.

Minimum intervals limitation:

This survey may overestimate appropriate immunization because analysis is based on numbers of doses in a series and not the timing of doses; doses are not excluded if given before minimum intervals as defined by CDC.

Barriers to reporting:

In May 2018, Tennessee became included in a multi-state outbreak of acute hepatitis A infection. Many of the statewide outbreak response efforts have been carried out by local or state public health staff; in many regions, these are the same staff responsible for reporting and verifying the status of 24 month old children's immunization. The burden of this outbreak may have impacted the ability of local staff to find sampled children and update missing vaccination records.

Additional information on specific vaccines:

Hepatitis B vaccine (HBV) birth dose:

In this survey, a birth dose of hepatitis B vaccine is defined as a dose given within the first three days of life. In 2016, the CDC revised its guidance to recommend routine administration of a hepatitis B birth dose to each newborn within 24 hours of life (rather than prior to discharge). Children in this survey population are the first newborns to be vaccinated according to these new CDC-revised recommendations. Birth dose hepatitis B is a key strategy to eliminate transmission of the hepatitis B virus from an infected mother to infant. Survey results are shown in Figures 5a and 5b.

Influenza vaccine (FLU):

Children born in the first quarter of 2016 who received every influenza vaccine on time may have received three doses of seasonal influenza vaccine; however, the number of children who received three doses in this survey is very small. This report reflects the percentage of children who received at least two doses of seasonal influenza vaccine by their second birthday. Influenza-specific charts, including 3-dose coverage, are provided in Appendix 2.

Haemophilus influenzae type B *vaccine (HIB):*

Two HIB schedules exist, depending upon the vaccine used. The full series (FS) of the Merck product requires three doses; the FS of the Sanofi Pasteur product requires four doses. Any mixed-brand schedule requires four doses.

Any child receiving one or more doses of the 4-dose HIB product must have received four doses before the 25th month of life in order to be considered complete and on-time. All others required three doses to classify as complete. Of the 1,426 children who received any HIB doses, 908 required four doses (694 were complete) and 518 received the 3-dose product alone or in combination with unknown doses (471 were complete). This classification by HIB products administered reduces the degree of overestimation of on-time completion demonstrated by past reports. Charts specific to HIB completion are located in Appendix 2.

Rotavirus vaccine (RTV):

Similarly to HIB vaccine, two rotavirus vaccine products are available with different dose schedules. Rotateq© (Merck), requires three doses; Rotarix© (GSK) requires two doses. RTV is unique among vaccines as the series must be initiated no later than 15 weeks of age and no doses should be given after eight months of age.

Of the children surveyed in 2018, 886 received at least one dose of Rotateq©, requiring three doses for a child to be considered completely immunized. Of the 456 children who could have been complete after receiving two doses of RTV, 359 had received two doses of Rotarix©, four had received Rotarix© and a dose of an unknown brand, 63 had received two doses of unknown brand, and eight were incompletely immunized by their second birthday, having received only one dose of Rotarix© or an unknown brand. Charts specific to rotavirus are located in Appendix 2.

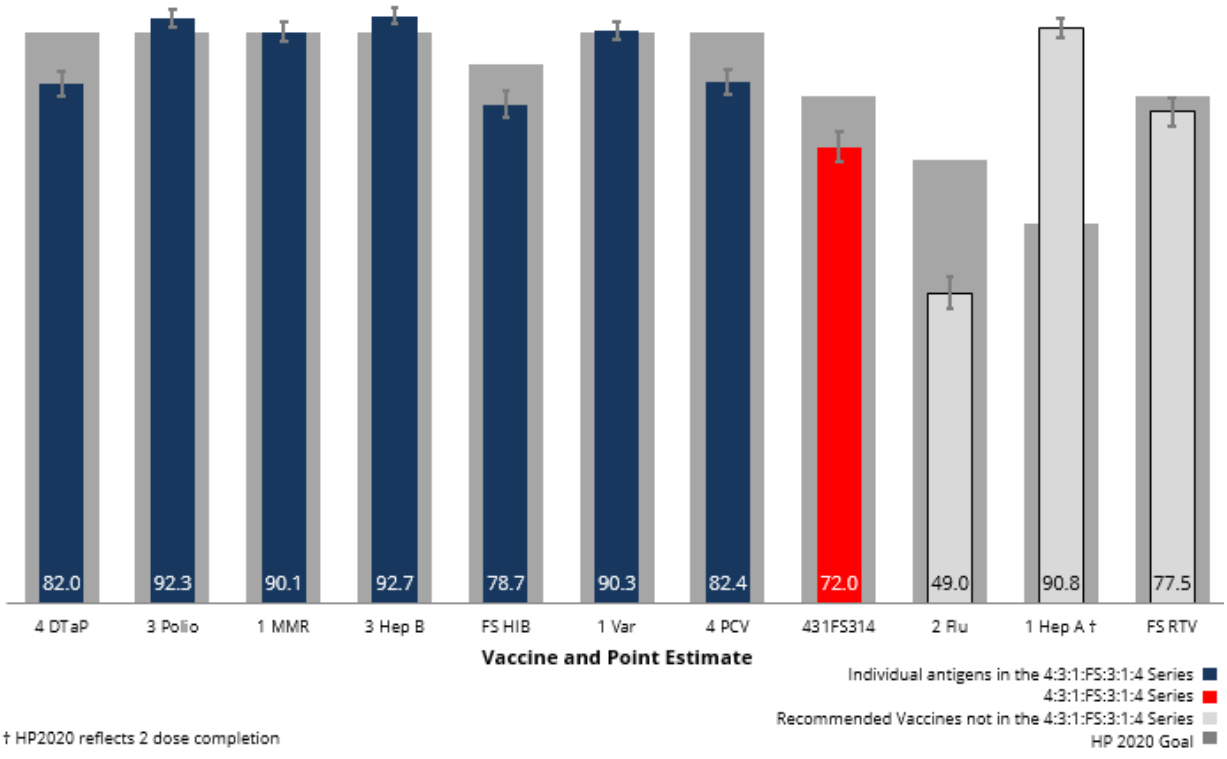
Statewide Results and Trend Analysis:

Vaccine specific on-time immunization coverage:

Figure 1 shows the coverage estimates for each of the recommended vaccines measured by this survey. The HP2020 objective of 90% on-time coverage was met for polio, MMR, hepatitis B and varicella, which are four of the seven vaccines that comprise the 4:3:1:FS:3:1:4 series (navy blue columns). Coverage was lower for all three vaccines in the 4:3:1:FS:3:1:4 series that require a fourth dose or final dose after 12 months of age compared to those that only require three doses, specifically DTaP, PCV and HIB (not statistically significant). The overall statewide coverage estimate for the full, recommended 4:3:1:FS:3:1:4 series was 72.0% (95% CI, 69.8, 74.3).

Figure 1

2018 Immunization Status of 24-Month-Old Children in Tennessee:
Statewide percentage of children with age-appropriate immunization levels by vaccine
(point estimates and 95% confidence intervals, n=1481)



Additional details of DTaP and PCV completion are included in Appendix 2:

- 92.7% of children had received three DTaP doses compared to 82.0% requiring four dose completion.
- 92.0% of children had received three doses of PCV compared to 82.4% requiring four dose completion.

Completion rates are higher for brand options that require fewer doses:

- 61.3% of surveyed children received HIB vaccine requiring four doses for completion. Among children on the 4-dose HIB schedule, 76.4% (694 of 908) were complete on time vs. 90.9% (471/518) that completed a 3-dose schedule.

- RTV vaccines also require either two or three doses, depending upon brand. Among children on a 3-dose schedule, 81.5% (722/886) were complete, vs. 93.4% (426/456) of children who required two doses.

For hepatitis A vaccine, 90.8% had received the first dose of vaccine by 24 months of age. Although not depicted on the graph, 58.9% had completed the 2-dose series (HP2020 objective: 60.0% complete by the *3rd* birthday).

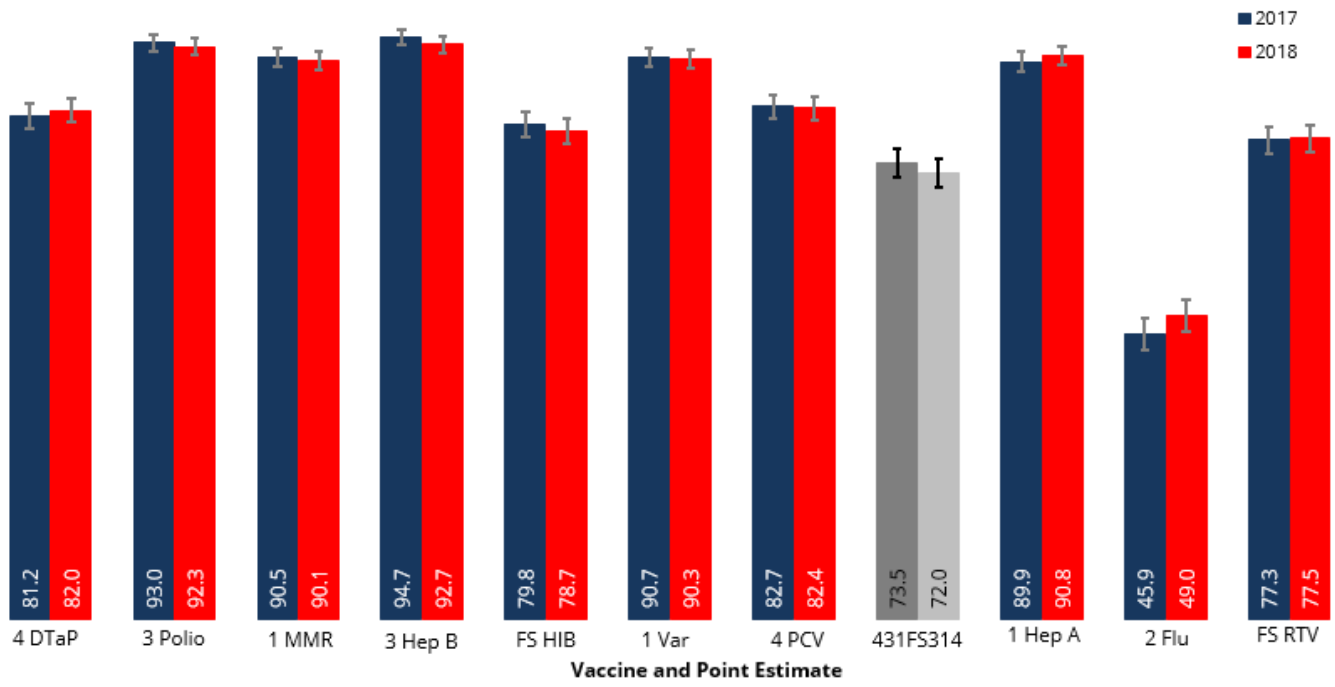
Influenza vaccine remains the least delivered recommended immunization. Just 49.0% of children had received at least two doses of influenza vaccine and, although not displayed, only 27.0% had received three doses. The HP2020 objective is for 70.0% of children to be appropriately immunized against influenza.

Figure 2 compares the 2017 and 2018 statewide coverage rates by individual vaccine. There were small, non-significant differences in vaccination rates in 2018 compared to 2017. There was a 1.5% decrease in 4:3:1:FS:3:1:4 vaccine series completion from 2017 to 2018. This represents no significant change from 2017.

Appendix 2 contains charts of on-time immunization coverage for each vaccine in each public health region.

Figure 2

2018 Immunization Status of 24-Month-Old Children in Tennessee:
Statewide percentage of children with age-appropriate immunization levels by vaccine in 2017 and 2018
(point estimates and 95% confidence intervals, 2017 n=1476, 2018 n=1481)



FS = full series

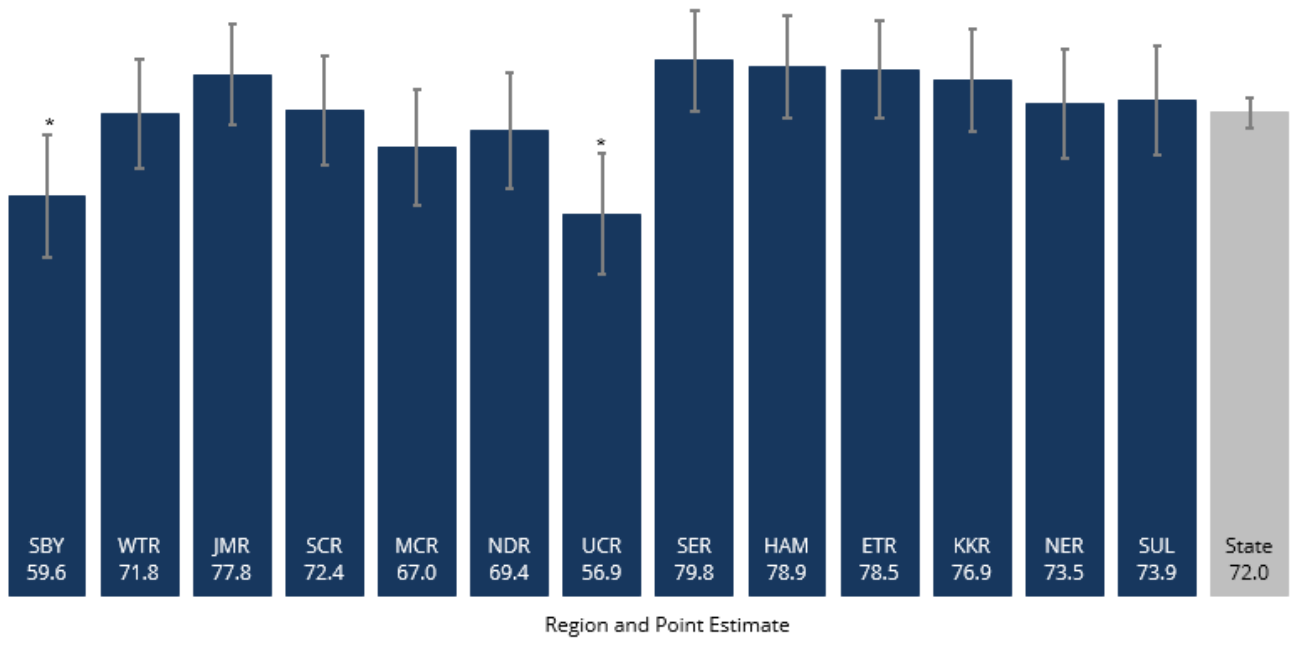
Complete immunization levels statewide and by public health region:

The statewide and regional percentages of children immunized on-time with all vaccines in 4:3:1:FS:3:1:4 series are shown in **Figure 3**. Statewide complete coverage was 72.0% (95% CI, 69.8, 74.3). Memphis-Shelby County (SBY) and Upper-Cumberland Region (UCR) percentages were significantly lower than the state's percentage. **No region reached the HP2020 goal of 80% completion.**

Appendix 3 contains region-specific charts of coverage rates for each vaccine and the 4:3:1:FS:3:1:4 series.

Figure 3

2018 Immunization Status Survey of 24-Month-Old Children in Tennessee:
Percentage of 24-month-old children with on-time immunization (4:3:1:FS:3:1:4)
by health department region
(point estimates and 95% confidence intervals, n=1481)



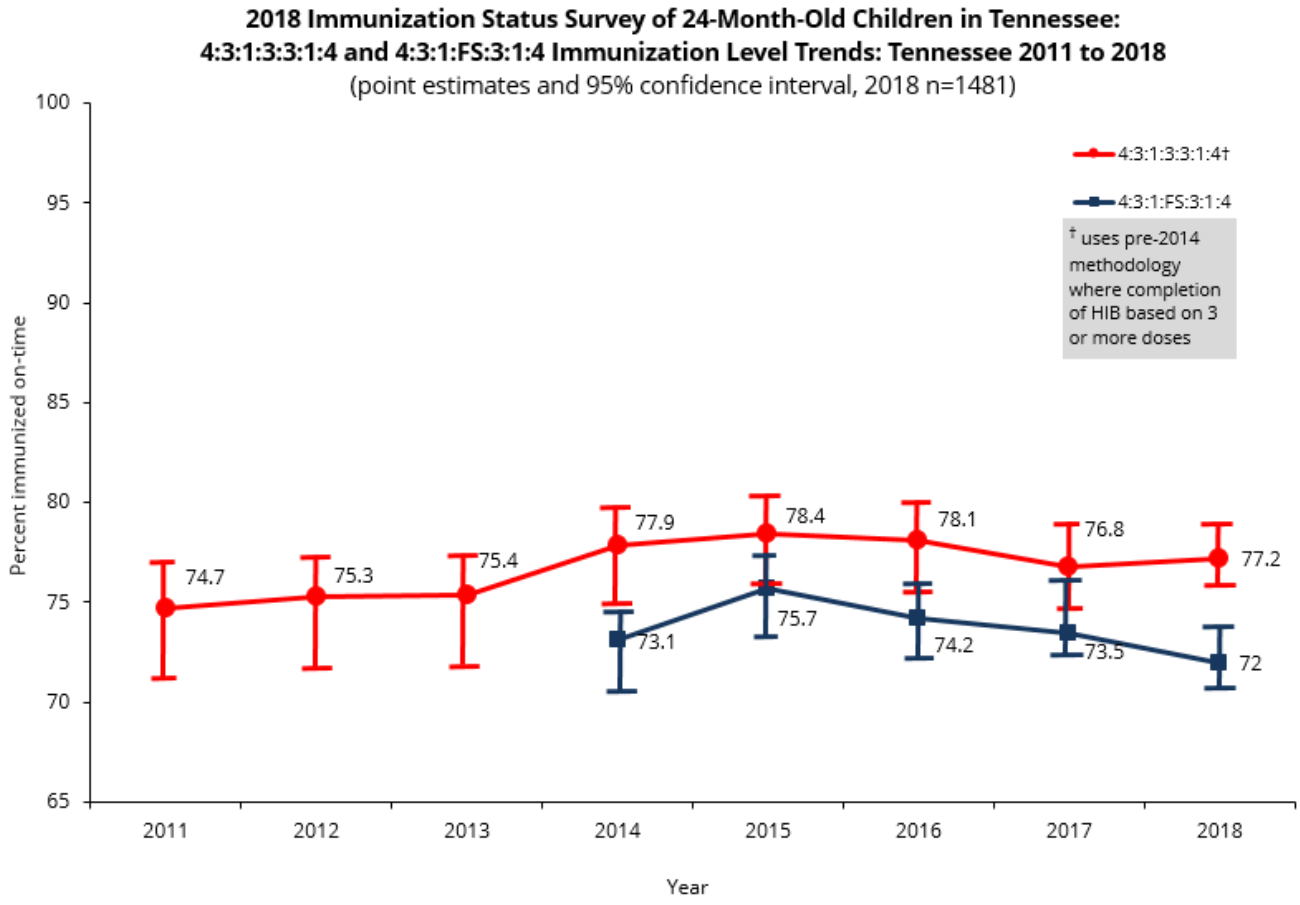
FS = full series

* statistically significant difference from State estimate

Series completion trends over time:

Figure 4 below shows the statewide 4:3:1:3:3:1:4 series completion rate from 2011 to 2018 and the 4:3:1:FS:3:1:4 series completion rate for 2014 to 2018. Both have fluctuated over time, but no significant changes have been observed.

Figure 4



Hepatitis B vaccine birth dose:

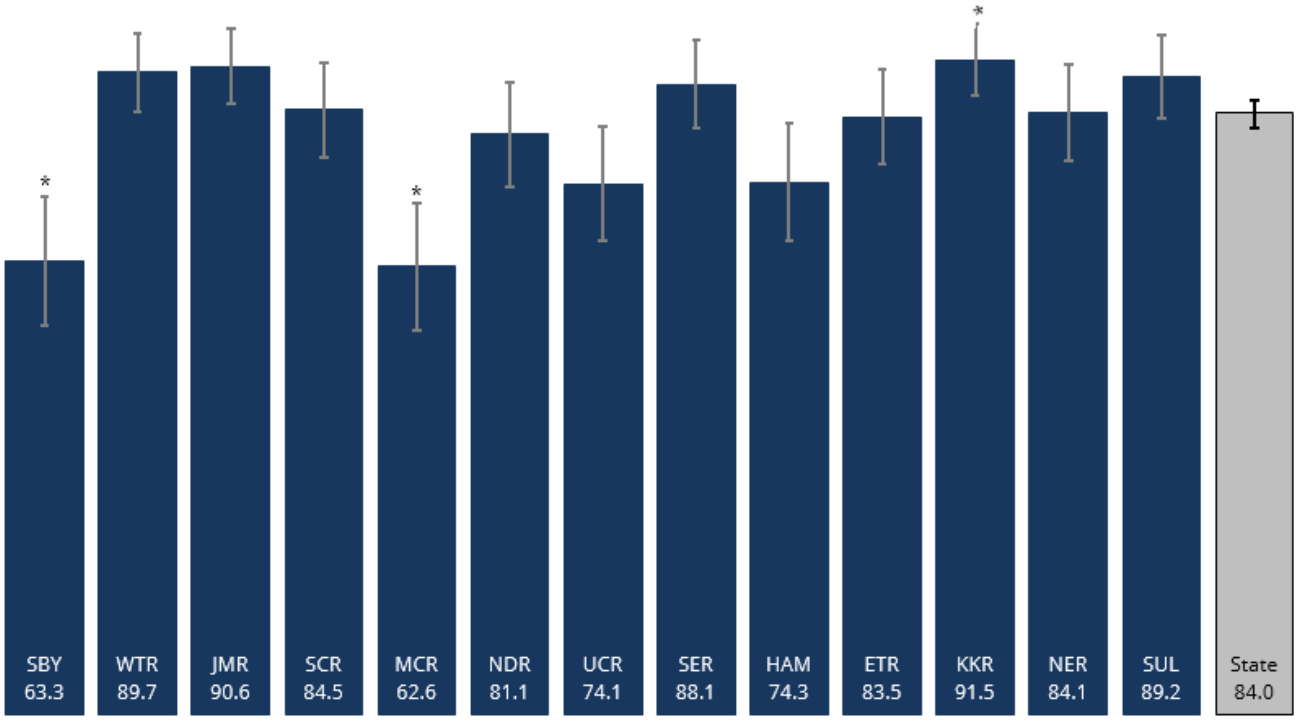
Exposure to hepatitis B virus at the time of birth or in early infancy results in chronic, life-long infection for most infants. Infection with hepatitis B virus is a leading contributor to the development of liver cancer. The HP2020 objective is for 85% of infants to receive a birth dose of HBV, defined as a dose given within the first three days of life.

The percentage of children in each public health region who received a birth dose of HBV is shown in **Figure 5a**. In 2018, 84.0% (95% CI: 82.1, 85.8) of Tennessee infants received a birth dose. This percentage was unchanged from 2017 (84.2%). In 2018, Sullivan County (SUL), Knoxville Knox-County (KKR), West Tennessee Region (WTR), and Jackson-Madison Region (JMR) exceeded the HP2020 objective with percentages higher than the statewide estimate, although only KKR was statistically significantly higher than the statewide estimate. Four other regions: South Central (SCR), Southeast (SER), Nashville-Davidson (NDR), and Northeast (NER) exceeded the HP2020 objective. Memphis-Shelby County (SBY) and Mid-Cumberland Region (MCR) had percentages significantly lower than that of the 2018 statewide percentage. Increases in HBV vaccination

percentage in individual regions could be attributed to the adoption of the CDC recommendation in 2016 to administer a birth dose of HBV within 24 hours of life rather than before hospital discharge (previous recommendation). This survey population is the first cohort to be born since the change in recommendation was made.

Figure 5a

2018 Immunization Status Survey of 24-Month-Old Children in Tennessee:
Percentage of children with birth dose of hepatitis B (HBV) by third day of life
by health department region
(point estimates and 95% confidence intervals, n=1481)

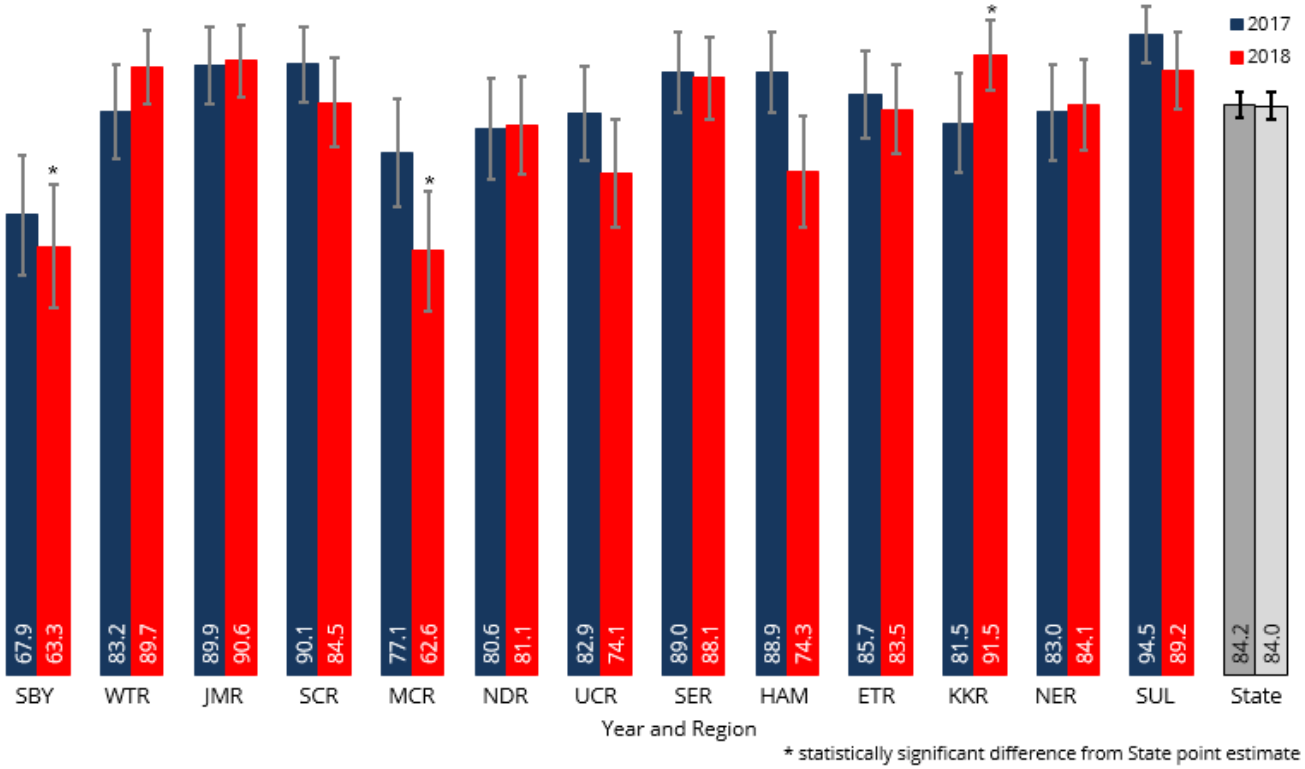


*statistically significant difference from State point estimate

Figure 5b demonstrates variation in percent of children with a birth dose of HBV by the third day of life in most regions from 2017 to 2018. Hamilton (HAM) region was the only region to have statistically significantly lower HBV vaccination rates in 2018 compared to 2017 (74.3% [95%CI= 66.2-82.5], 88.9% [83.0-94.8], respectively). The most effective way to improve birth dose rates is strong enforcement of a written birth dose policy at all delivery hospitals and birthing centers.

Figure 5b

2018 Immunization Status Survey of 24-Month-Old Children in Tennessee:
Percentage of children with birth dose of hepatitis B (HBV) by third day of life
by health department region in 2017 and 2018
(point estimates and 95% confidence intervals n=1481)



* statistically significant difference from State point estimate

Racial disparities:

All racial analyses were calculated with the inclusion of the oversampled population (n=1,508). **Figure 6** shows the rates of on-time immunization of black and white children for each vaccine assessed. The 2018 survey included 247 black and 1,221 white children. Due to small numbers, children of other races (n=40) were excluded from this analysis.

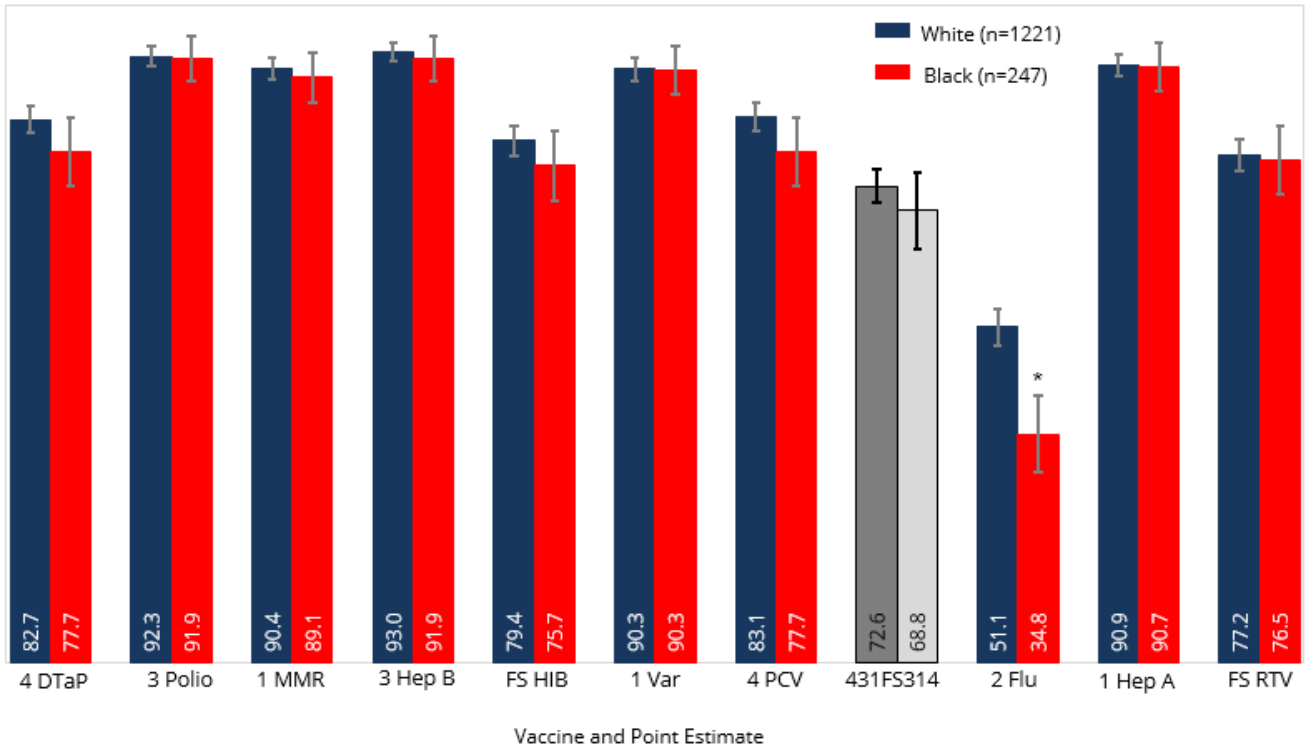
Black children were less likely than white children to be fully immunized with all recommended CDC vaccinations, although this difference was not statistically significant. Among black children, 68.8% (95%CI: 63.0, 74.6) were 4:3:1:FS:3:1:4 complete vs. 72.6% of white children (95% CI: 70.1, 75.1).

Black children were less likely to be fully immunized with every individual vaccine antigen in the 4:3:1:FS:3:1:4 series except for varicella. The racial disparity in the overall 4:3:1:FS:3:1:4 series was most greatly driven by the disparity in the 4-dose vaccine (DTaP and PCV) completion rates. Black children were less likely to be fully immunized on time with DTaP (77.7% black vs. 82.7% white) and PCV (77.7% black vs. 83.1% white), although this difference was not statistically significant. Appendix 4 contains an additional chart showing trends in on-time series completion by race from 2011-2018. From 2014-2017, a gradual, increasing, and statistically-significant racial disparity developed. For the first time since 2014, 2018 demonstrated a decrease in racial disparity of 4:3:1:FS:3:1:4 series completion. See Appendix 4.

Influenza vaccine remains the individual vaccine with the most significant racial disparity. This difference has been documented annually since the first assessment of influenza coverage rates in this survey in 2007. In 2018, 24.8% of black children had received at least two doses of influenza vaccine vs. 51.1% of white children.

Figure 6

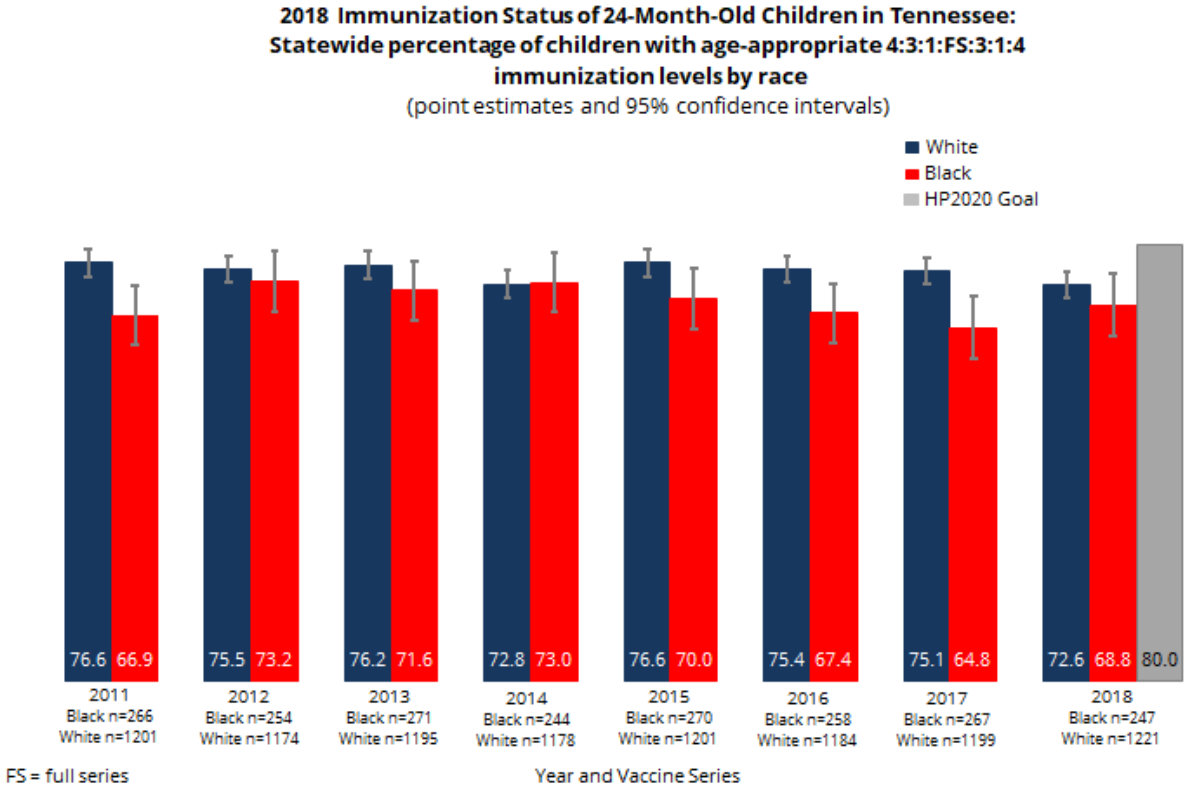
2018 Immunization Status of 24-Month-Old Children in Tennessee: Statewide percentage of children with age-appropriate immunization levels by vaccine and race
(point estimates and 95% confidence intervals)



FS = full series

* statistically significant difference between races

Figure 7



<u>Immunization among selected sub-populations:</u>

Certain risk factors are consistently associated with failure to complete the recommended series of immunizations on time, such as starting routine immunizations late (>120 days of age) or a child having two or more siblings. Race is a less consistent predictor of risk, except in the case of influenza immunization.

Insurance Enrollment:

The survey captures the immunization provider type (public, private or both), TennCare (Medicaid) participation, and enrollment in the Women, Infants and Children (WIC) nutrition program for each child in the survey. Children are counted under TennCare or WIC if they were ever enrolled in these programs. Infants in WIC have immunization records reviewed at WIC visits. Targeted education and telephone follow-up are the primary tools used to encourage catch-up immunization of WIC infants.

In this survey, children covered by TennCare (n=869) and WIC (n=897) had vaccination rates that were not significantly different from that of their non-enrolled peers. Of those enrolled in TennCare, 70.3% (<u>+</u> 3.0) were fully immunized for the 4:3:1:FS:3:1:4 series, compared to 74.5% (<u>+</u> 3.5) of those not enrolled in TennCare. Similarly, 70.6% (<u>+</u> 3.0) of WIC enrollees were complete for the full 4:3:1:FS:3:1:4 series compared to 74.3% (<u>+</u> 3.5) of those not enrolled in WIC. This was the first survey since 2014 to demonstrate no statistically significant difference between the vaccination rates of children enrolled in TennCare versus those not enrolled in TennCare. The difference in vaccination rates between children enrolled in WIC and children who are not enrolled in WIC has remained statistically insignificant since 2014.

Provider Type:

Vaccines administered at local public health department clinics are classified as “public” sources of vaccine in this survey; other vaccinators are considered “private”. Because so few children (n=64) received

immunizations exclusively in a public health department or received their first dose of vaccine beyond 120 days of life (n=47), these coverage rate estimates are imprecise.

Siblings:

Children with two or more siblings were less likely to be fully immunized compared to children with only one sibling or no other siblings. Of children with two or more siblings, 63.1% (± 4.6) were fully immunized while 80.7% of children with no siblings were fully immunized for the 4:3:1:FS:3:1:4 series.

Age at First Immunization:

Children who begin routine immunizations after four months (120 days) of age are at high risk of failing to catch up. In this sample, 47 children received their first routine immunization (other than rotavirus or birth dose HBV) after 120 days of age. Of those, only 11 (23.0%) completed the series on-time. **Table 1** below summarizes the 2018 on-time completion rates in these groups.

Table 1

4:3:1:FS:3:1:4* Completion Levels in the 2018 Survey of 24 Month Old Children: Selected Characteristics (point estimate +/- 95 percent confidence intervals)			
Provider Type	Public Health n=40/64	Private n=852/1113	Both Public Health and Private n=166/241
	62.5% ± 11.9	**76.5% ± 2.5**	**68.9% ± 5.9**
TennCare Enrollment	Enrolled n=611/869	Not Enrolled n=456/612	
	70.3% ± 3.0	**74.5% ± 3.5**	
WIC Enrollment	Enrolled n=633/897	Not Enrolled n=434/584	
	70.6% ± 3.0	**74.3% ± 3.5**	
Other Siblings	None n=444/550	One n=353/501	Two or more n=268/425
	80.7% ± 3.3	**70.5% ± 4.0**	**63.1% ± 4.6**
Age at First Immunization**	≤120 days n=1056/1416	> 120 days n=11/47	
	74.6% ± 2.3	**23.4% ± 12.1**	

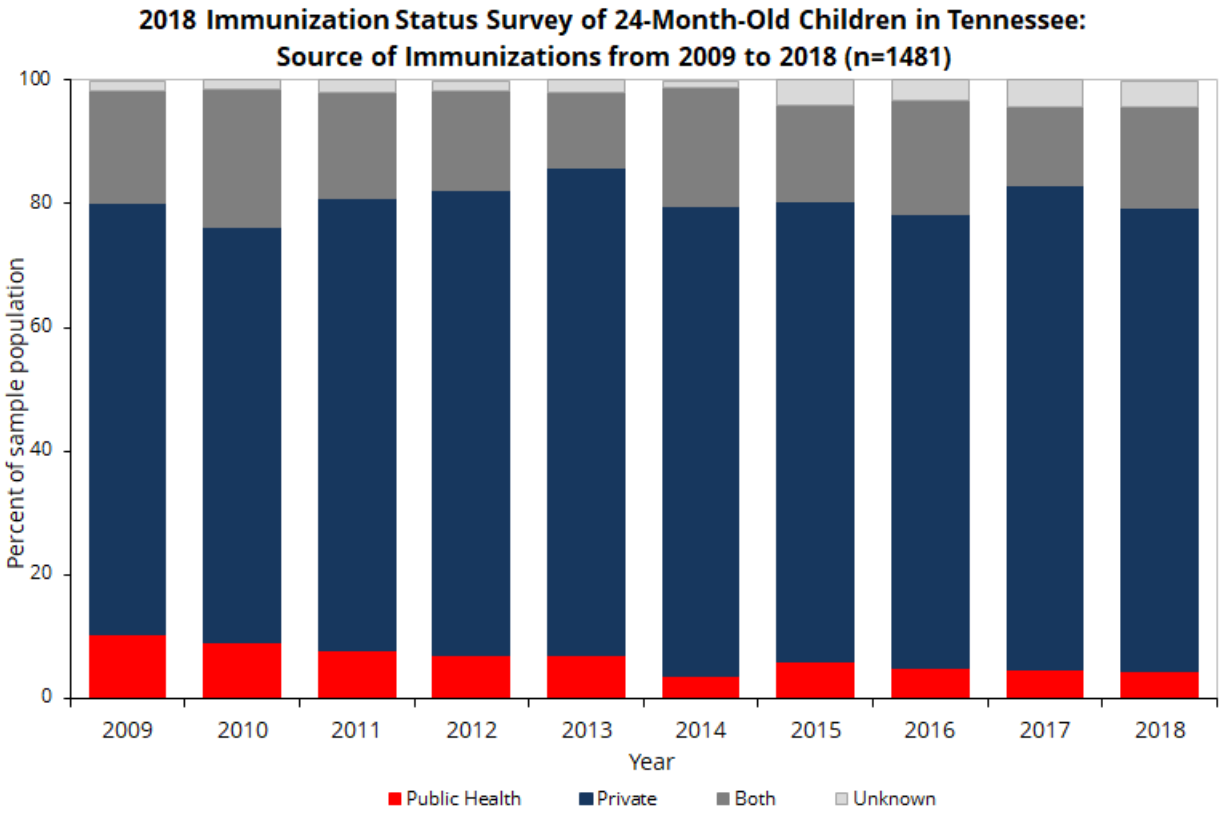
*4:3:1:FS:3:1:4: FS means that a full series (3 or 4 doses) of HIB has been completed.

**Excludes oral rotavirus vaccine or a birth dose of hepatitis B vaccine

Immunization provider types and patient populations:

Of children in the 2018 survey, 79.9% were only immunized by private providers, 15.6% by a combination of private and public health providers, and 3.8% were immunized only at a public health department. Data were unavailable for 1.0% of children. **Figure 7** shows the trends in these proportions over time.

Figure 8



Children immunized in health departments were more likely to have risk factors for failure to complete immunization compared to children who were only immunized by private providers. **Table 2** provides the proportion of children surveyed who have risk factors, by provider type, including black race, having two or more siblings and receipt of a first dose of any vaccine* after the 120th day of life.

Table 2

Prevalence of three risk factors for delayed immunizations in the survey population, by provider type			
Risk Factor	**Public Health Only**	**Private Only**	**Both Public Health and Private**
Black	23.4% (15/64)	13.3% (148/1113)	19.1% (46/241)
2 or more siblings	39.1% (25/64)	24.8% (275/1113)	40.7% (98/241)
Age at first dose >120 days*	20.3% (13/64)	1.8% (20/1113)	5.8% (14/241)
Any of above risk factors	57.8% (37/64)	35.8% (398/1113)	52.3% (126/241)

*excluding oral rotavirus vaccine or birth dose hepatitis B vaccine

Summary of Key Findings:

1. Below is the summary of coverage rates in this report relative to Health People (HP) 2020 objectives:

Measurement	HP2020 Objective (19-35 months)	TN 2018 (24 months)
Complete 4:3:1:FS:3:1:4 series	80%	72.0%
Each vaccine in 4:3:1:FS:3:1:4 (DTaP, IPV, MMR, Hib, HBV, VAR, PCV)	90% rate for each of the 7 vaccines	**Exceeded 90% for 4 of 7** Below 90% for: 4 doses of DTaP (82.0%) Full series of HIB (78.7%) 4 doses of PCV (82.4%)
3 doses DTaP and PCV	*None: this is a process measure*	3 DTaP (92.7%) and 3 PCV (92.0%)
Hepatitis A vaccine	60% 2 doses by 35 months	2 HAV (58.9%); 1 HAV (90.8%): *not comparable to HP2020*
Influenza vaccine	70% appropriately immunized	49.0% with 2 doses 27.0% with 3 doses
Rotavirus vaccine	80% with 2 doses	77.5%
Hepatitis B birth dose	85%	84.0%

2. Tennessee's statewide completion of the 4:3:1:FS:1:3:4 full series would exceed the HP2020 coverage goal of 80% if the children sampled in this survey had received an additional immunization visit in their second year of life to complete their DTaP, PCV, and HIB series.
3. Black children were more likely than white children to be incompletely immunized. This disparity is significant with respect to completion of influenza immunization and has remained a stable finding since 2007.
4. For the first time in four years, children ever enrolled in TennCare were not significantly different in their on-time fully immunized percentage when compared to children never on TennCare. See Appendix 4 for details.
5. Although numbers were small, 3.3% of surveyed parents reported refusing some or all immunizations, compared to 3.5% of parents in 2017. **Approximately half of the parents cited personal, rather than medical or religious, reasons for this decision**. This trend has also been observed in other states and is of concern due to the increased risk of vaccine-preventable disease among groups of unimmunized and under-immunized children.

Next Steps:

The following steps may improve on-time immunization of Tennessee children:

1. Practices should focus patient reminder and recall efforts on young children in the second year of life who are due or overdue for booster doses of DTaP, HIB and PCV. Most children who fell short of complete immunization could have achieved series completion with just one additional immunization visit prior to the second birthday. Minority children are especially vulnerable to missing immunizations.
2. Strict adherence to the early infant schedule of immunizations at 2-, 4-, and 6-months will enable clinicians to administer the 4th DTaP and all other needed immunizations as early as the first birthday, maximizing the number of opportunities to immunize children on time.
3. The Tennessee Immunization Information System (TennIIS) maintains patient immunization records and special tools which may assist providers in improving the quality of their immunization services. Coaching, user guides and other TennIIS resources are available through the training information posted at www.TennesseeIIS.gov.
    a. TennIIS provides individual patient forecasting of immunizations due, based upon the patient's immunization history.
    b. TennIIS is able to generate patient reminders through the use of manual, autodialer, text or other reminder methods. This feature assists providers in reminding patients of immunization appointments and recalling children who are due or overdue for immunizations.
    c. Practices may run their own practice-level immunization coverage reports based on their active patients in TennIIS. Coaching on the use of these reports is available in the training section of TennIIS.
    d. In order to improve the quality of immunization services, more than 630 clinics that participate in the Vaccines for Children Program (VFC) must report all vaccines administered to children younger than 19 years of age, regardless of VFC-eligibility, into TennIIS. Since all TennCare-enrolled children receive VFC vaccines, this requirement supports healthcare providers' efforts to improve TennCare enrollee immunization coverage rates.
4. TIP provides local health departments (LHDs) with lists of children aged 20-24 months who have received immunizations in a LHD and whose records show they are incompletely immunized with DTaP vaccine. These reports facilitate LHD efforts to recall those children who are incompletely immunized.
5. The TIP Medical Director meets quarterly with the leadership of TennCare and the Tennessee Chapter of the American Academy of Pediatrics (TNAAP) to provide updates and discuss areas of potential improvement in immunization services provided to TennCare-eligible children.
6. Patients enrolled in WIC will continue to receive immunization education, immunization record review and follow-up phone calls from WIC staff.
7. TIP will broadly communicate the results of this survey to public health leaders, VFC program participants and professional organizations which include immunization providers. The TIP program will identify opportunities to provide VFC providers with immunization education and strategies to improve immunization coverage across the state.
8. The VFC Quality Assurance team and immunization field staff in each regional and metro public health department will provide practice-level quality assessments and feedback to VFC providers with the lowest rate of 4th DTaP completion. These visits require individualized quality improvement efforts designed to target weaknesses identified by practice staff.
9. TIP staff will continue to monitor kindergarten immunization compliance rates for evidence of trends in vaccine refusal or late immunization within regions.

Appendix 1

2018 Immunization Status Survey of 24 Month Old Children in Tennessee

Details of Regional Samples: Vaccine Refusal and Children not located. Oversampled records not included.

Region	Records analyzed[1]	Total vaccine refusals[2]	Reason given for refusing vaccine[2]			% Refusal	Number not located[3]	% not located
			Religious	Philosophical	Medical			
Northeast TN	113	2	1	1	0	1.8%	0	0.0%
East TN	121	0	0	0	0	0.0%	1	0.8%
Southeast TN	109	3	3	0	0	2.8%	1	0.9%
Upper Cumberland	116	5	3	2	0	4.3%	3	2.6%
Mid-Cumberland	115	1	0	1	0	0.9%	6	5.2%
South Central	116	5	2	2	1	4.3%	6	5.2%
West TN	117	2	1	1	0	1.7%	3	2.6%
Shelby County	109	0	0	0	0	0.0%	11	10.1%
Davidson County	111	18	8	10	0	16.2%	2	1.8%
Knox County	117	4	1	3	0	3.4%	3	2.6%
Hamilton County	109	1	0	1	0	0.9%	0	0.0%
Madison County	117	0	0	0	0	0.0%	0	0.0%
Sullivan County	111	6	2	3	1	5.4%	3	2.7%
TOTAL	1481	47 of 1481	21	24	2	3.2%	39 of 1481	2.6%

[1]Total records included in analysis, excluding children in the original sample who had moved out of state, refused to participate or were adopted, in foster care or in state custody

[2] Sixteen of the 47 children whose parents gave a reason for not vaccinating were partially immunized (range 1-23 total doses). Three had documented exemptions in TennIIS.

[3]Denotes children with incomplete state immunization registry (TennIIS) records who could not be located for further information. These children were included in the analysis of those with any vaccinations recorded in TennIIS. Three of 39 had ≥12 doses documented (range= 1-20 total doses).

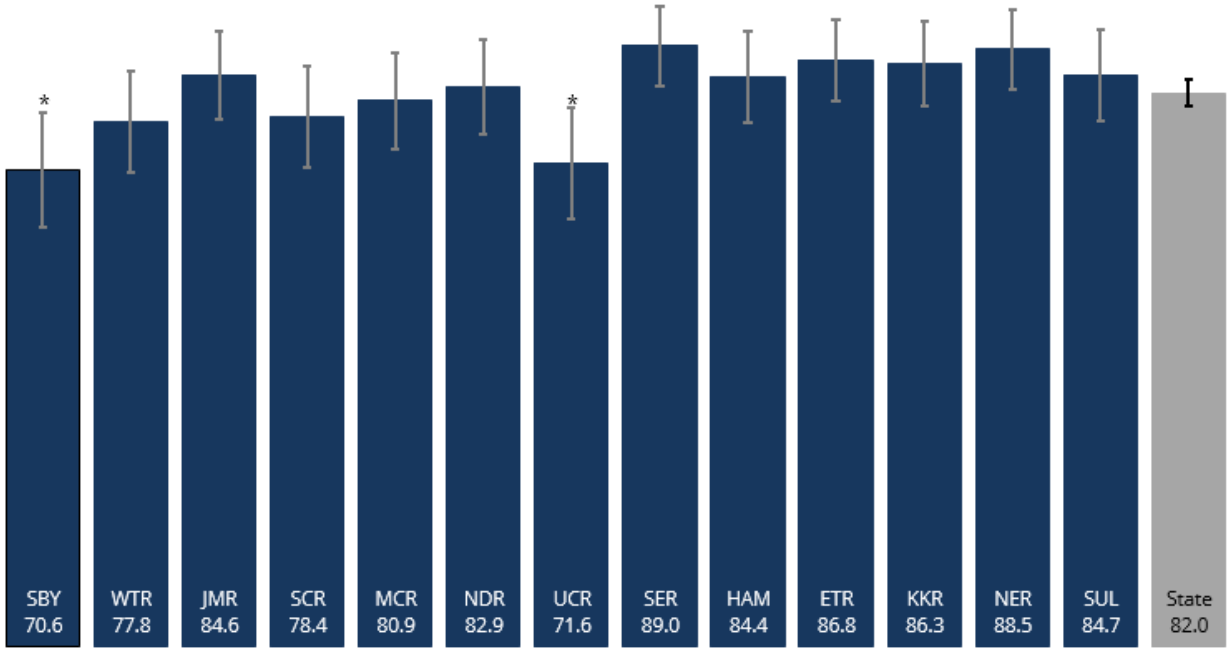
Appendix 2

2018 Immunization Status Survey of 24 Month Old Children in Tennessee

Individual Vaccine Charts, with Coverage Rates Measured in Each Health Department Region and Statewide

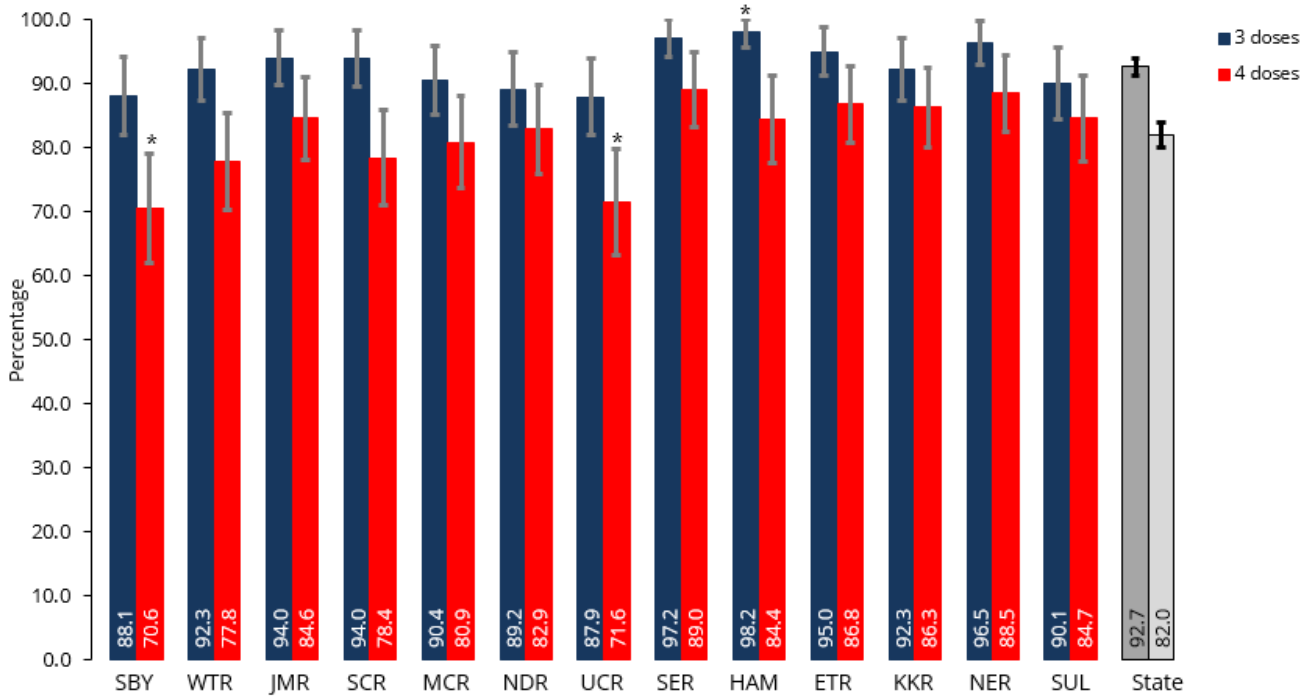
	Page
DTaP (4-dose and 3-dose coverage)	...30
Haemophilus influenzae type b	...31
Hepatitis A (1-dose coverage) & Hepatitis A (2-dose coverage)	...32
Hepatitis B (3-dose coverage) & Hepatitis B (birth dose)	...33
Influenza (2-dose and 3-dose coverage)	...34
MMR & Pneumococcus (4-dose coverage)	...35
Pneumococcus (PCV) (4-dose vs. 3-dose coverage) & Polio	...36
Rotavirus & Varicella	...37

2018 Immunization Status Survey of 24-Month-Old Children in Tennessee: Percentage of children with complete DTaP series (4 doses) by health department region
(point estimates and 95% confidence intervals, n=1481)



* statistically significant difference from State point

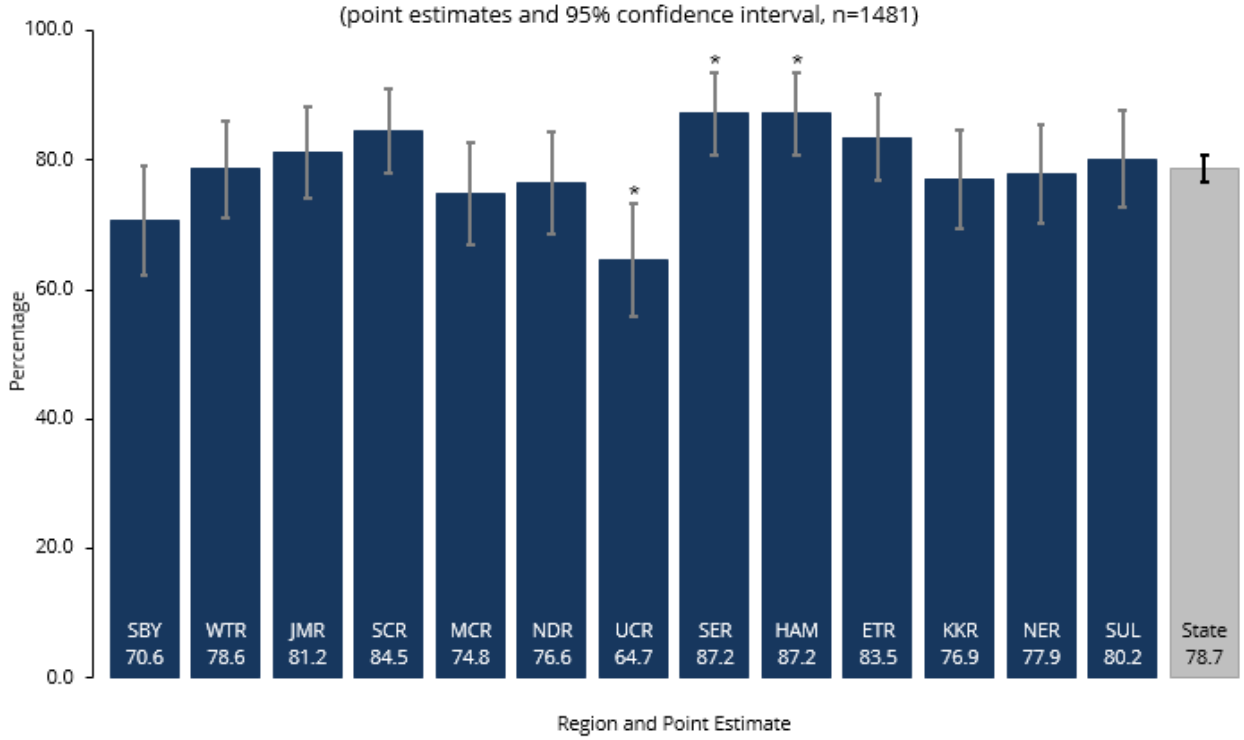
2018 Immunization Status Survey of 24-Month-Old Children in Tennessee: Percentage of children with 3 or 4 doses of diptheria, tetanus and acellular pertussis (DTaP) by health department region
(point estimates and 95% confidence intervals, n=1481)



*statistically significant difference from State point

2018 Immunization Status Survey of 24-Month-Old Children in Tennessee: Percentage of children with complete Haemophilus influenzae type B (Hib) series (either 3 or 4 doses depending on brand) by health department region

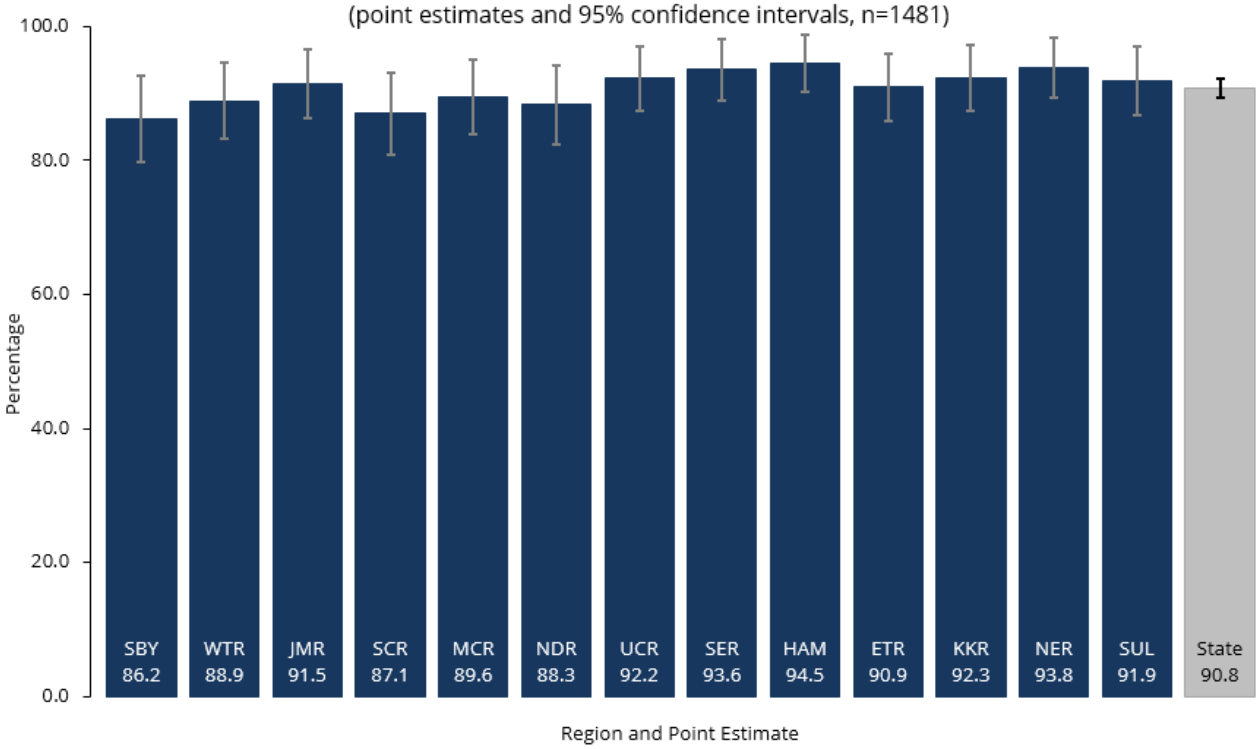
(point estimates and 95% confidence interval, n=1481)



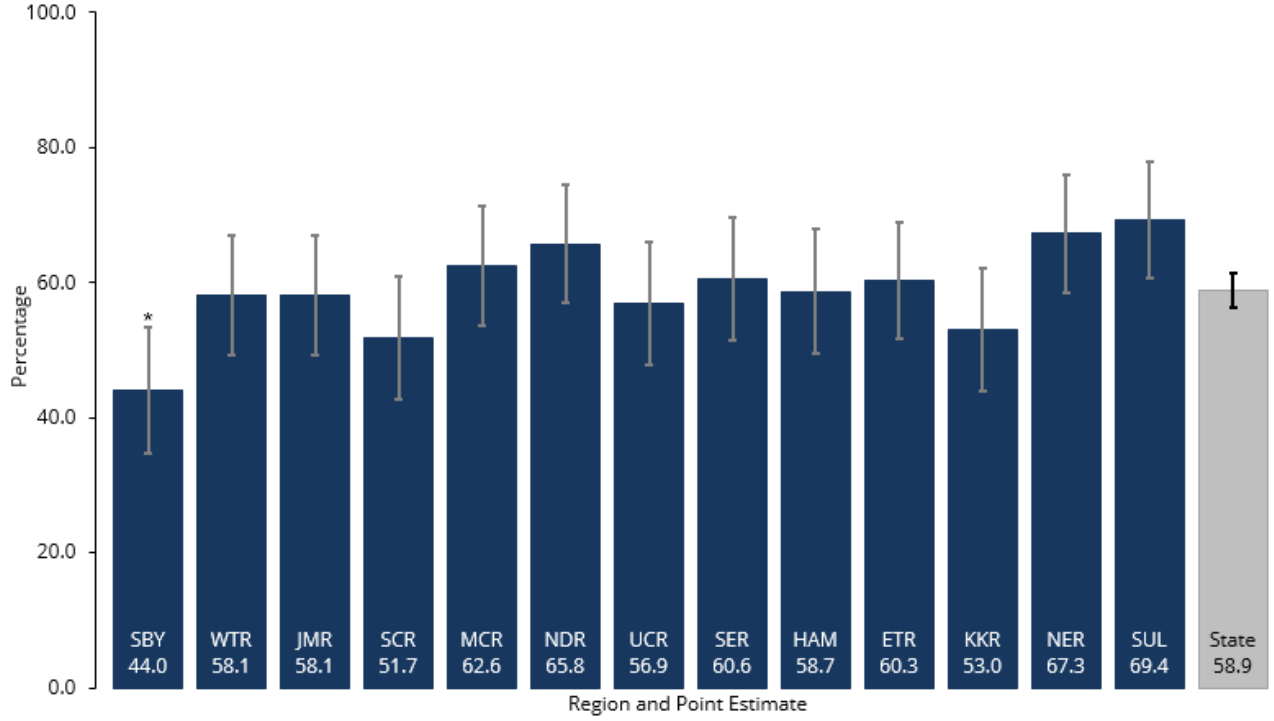
*statistically significant difference from State point estimate

2018 Immunization Status Survey of 24-Month-Old Children in Tennessee: Percentage of children with at least one dose of Hepatitis A (HAV) by health department region

(point estimates and 95% confidence intervals, n=1481)

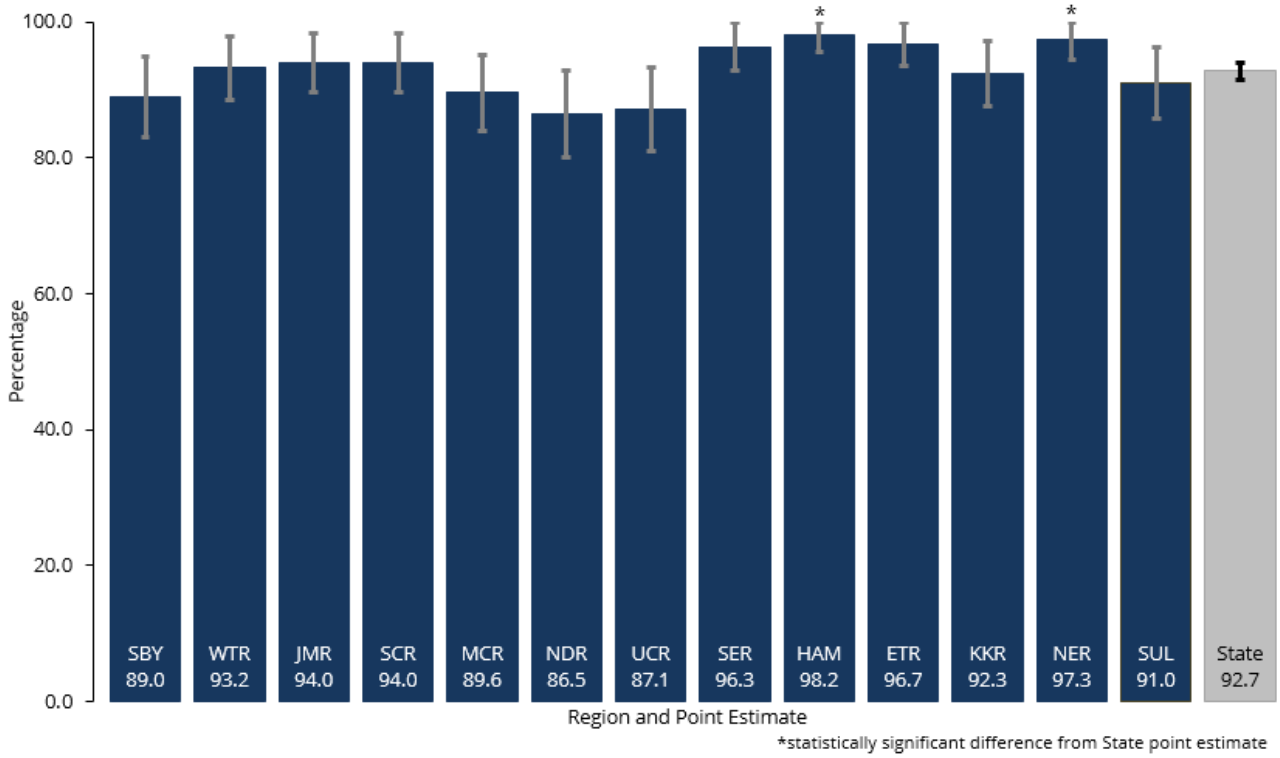


2018 Immunization Status Survey of 24-Month-Old Children in Tennessee:
Percentage of children with complete Hepatitis A (HAV) series (2 doses)
by health department region
(point estimates and 95% confidence intervals, n=1481)



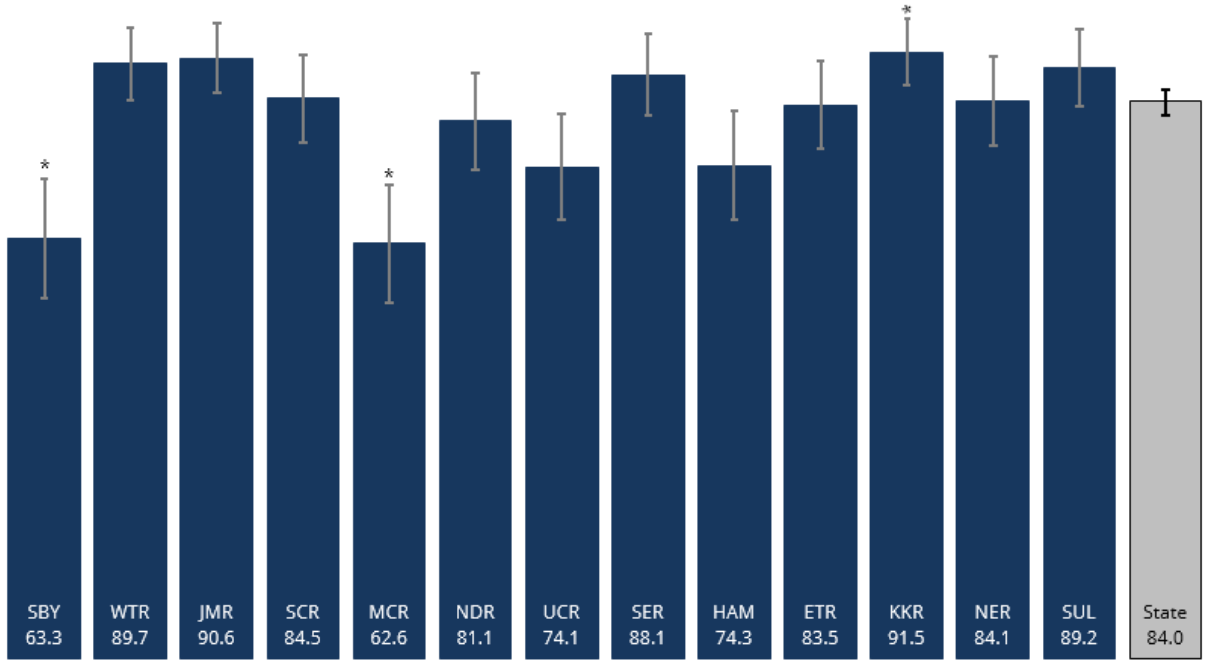
*statistically significant difference from State point

2018 Immunization Status Survey of 24-Month-Old Children in Tennessee:
Percentage of children with complete Hepatitis B (HBV) series (>3 doses)
by health department region
(point estimates and 95% confidence intervals, n=1481)



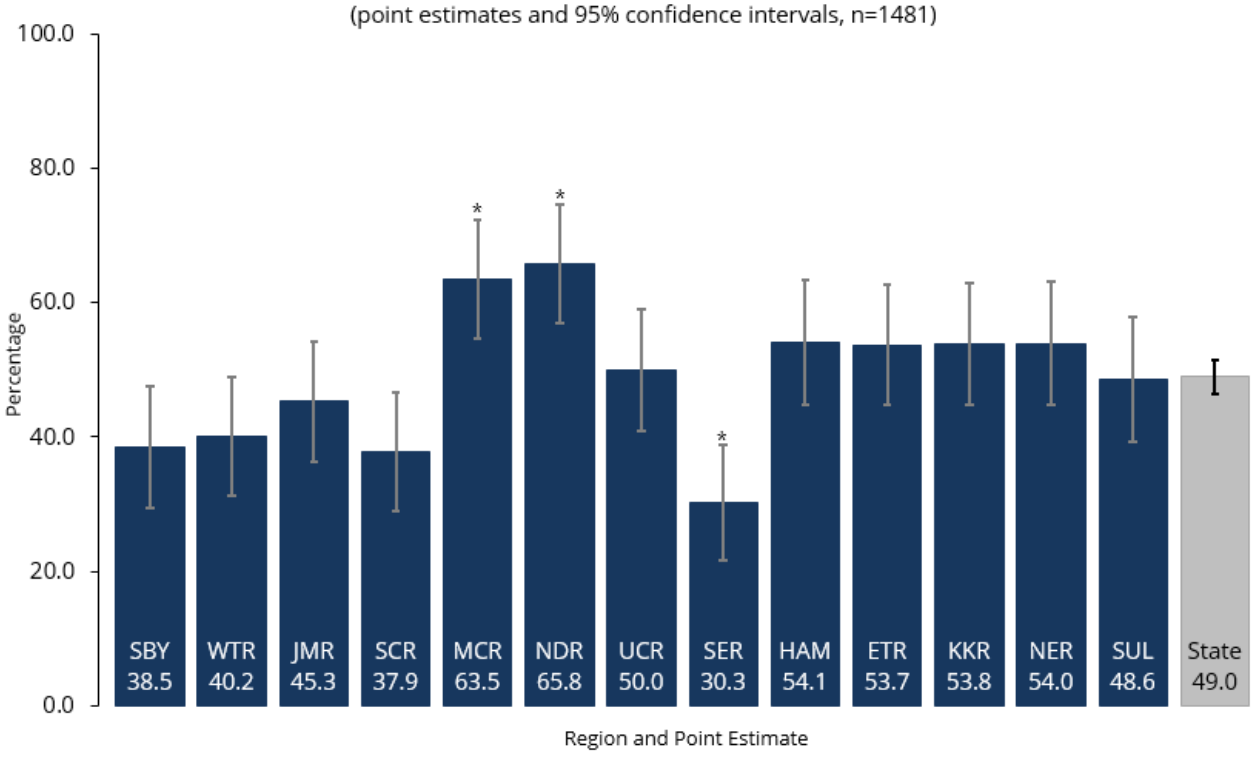
*statistically significant difference from State point estimate

2018 Immunization Status Survey of 24-Month-Old Children in Tennessee:
Percentage of children with birth dose of hepatitis B (HBV) by third day of life
by health department region
(point estimates and 95% confidence intervals, n=1481)



*statistically significant difference from State point estimate

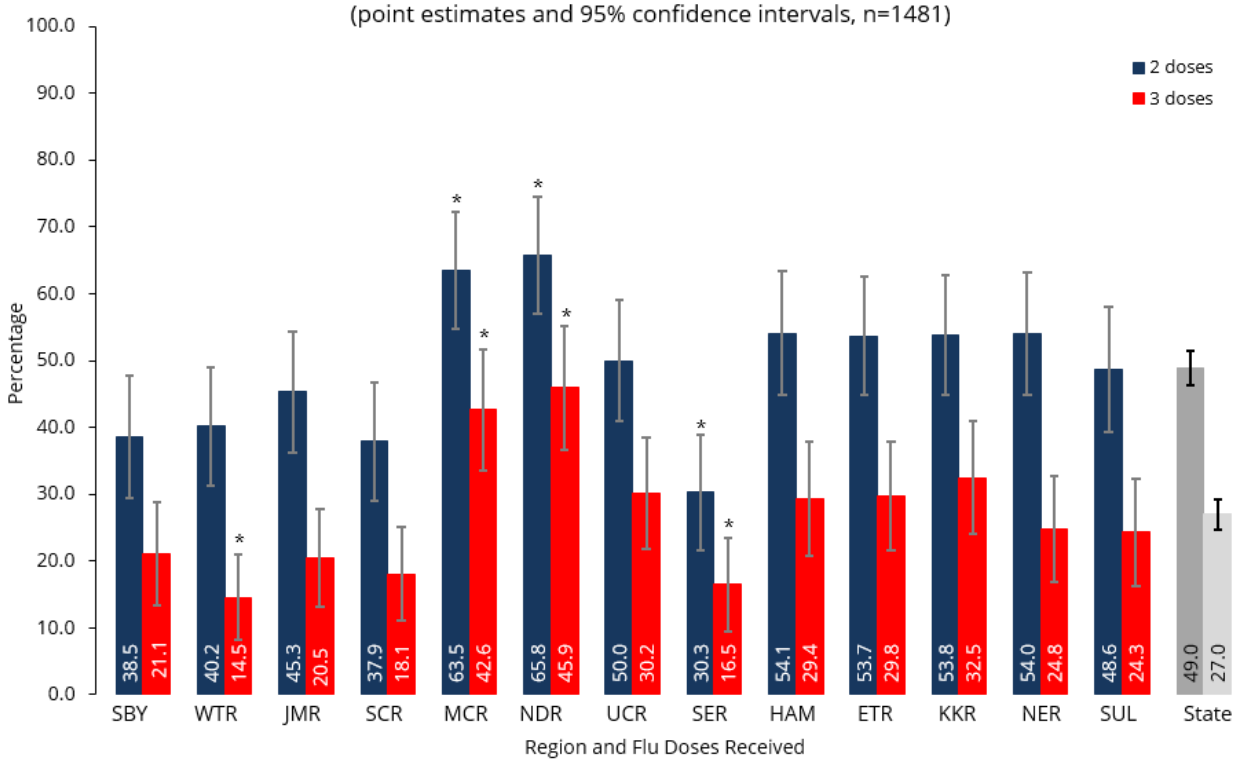
2018 Immunization Status Survey of 24-Month-Old Children in Tennessee:
Percentage of children with 2 doses of Influenza vaccine by health department region
(point estimates and 95% confidence intervals, n=1481)



*statistically significant difference from State point estimate

2018 Immunization Status Survey of 24-Month-Old Children in Tennessee:
Percentage of children with 2 or 3 doses of Influenza vaccine
by health department region

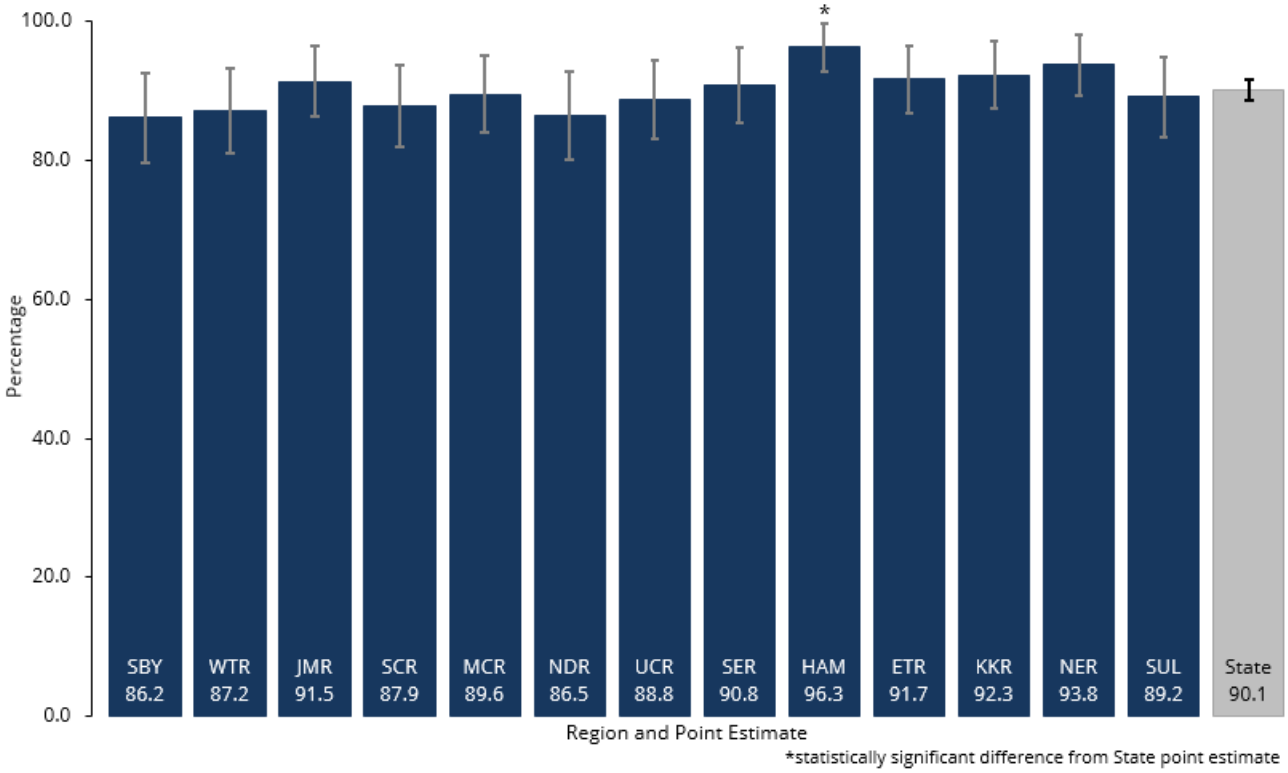
(point estimates and 95% confidence intervals, n=1481)



*statistically significant difference from State point

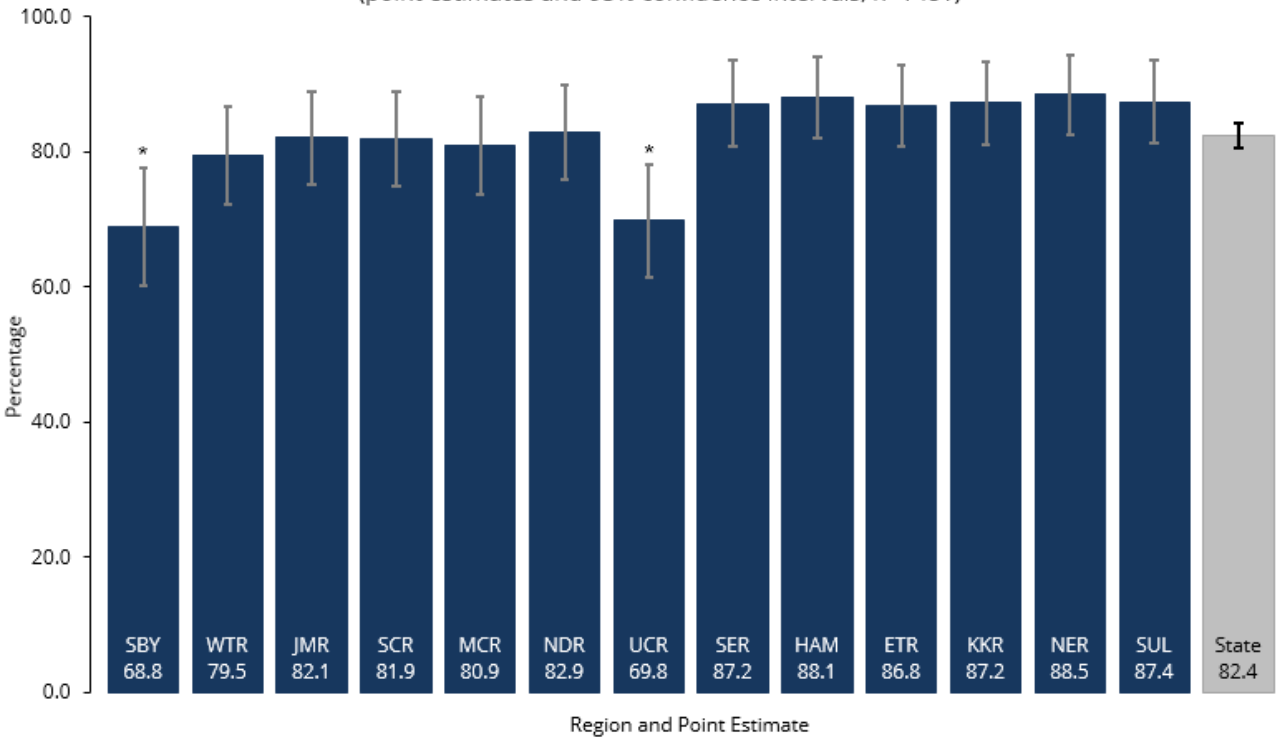
2018 Immunization Status Survey of 24-Month-Old Children in Tennessee:
Percentage of children with complete measles, mumps, and rubella (MMR) series (1 dose)
by health department region

(point estimates and 95% confidence intervals, n=1481)



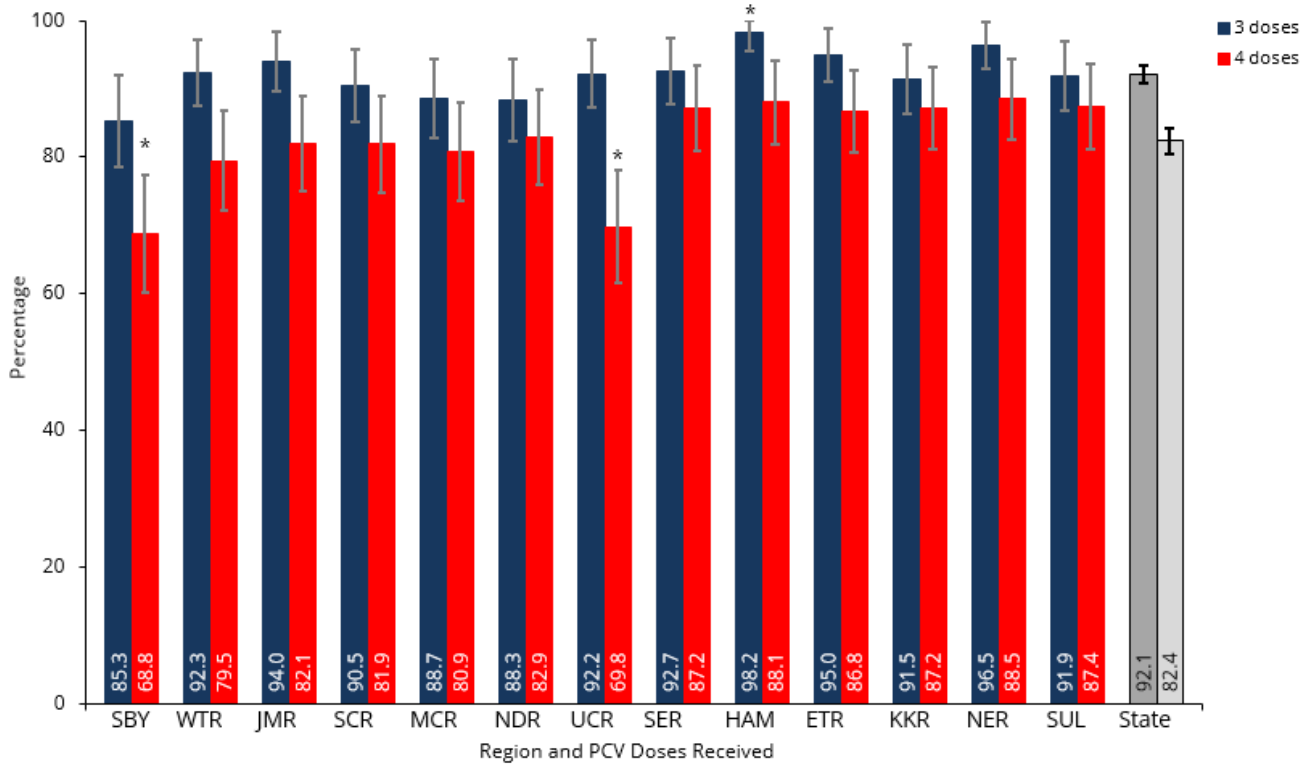
*statistically significant difference from State point estimate

2018 Immunization Status Survey of 24-Month-Old Children in Tennessee:
Percentage of children with complete PCV series (4 doses) by health department region
(point estimates and 95% confidence intervals, n=1481)



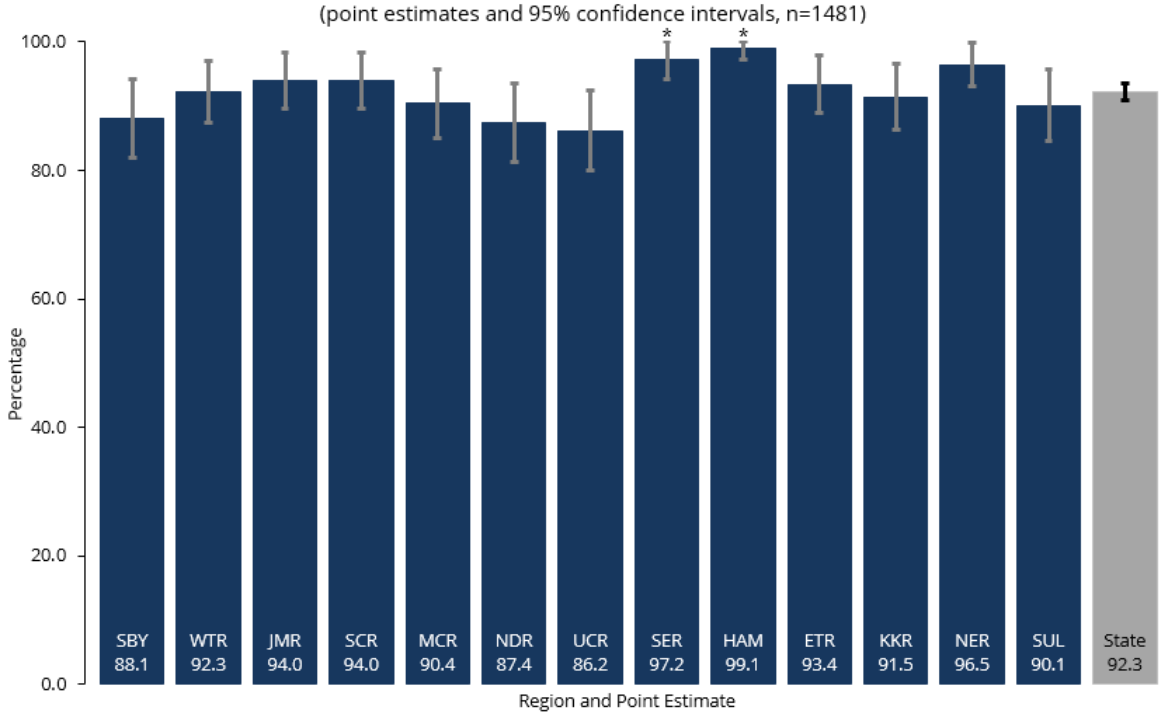
* statistically significant difference from State point estimate

2018 Immunization Status Survey of 24-Month-Old Children in Tennessee:
Percentage of children with 3 or 4 doses of PCV by health department region
(point estimates and 95% confidence intervals, n=1481)



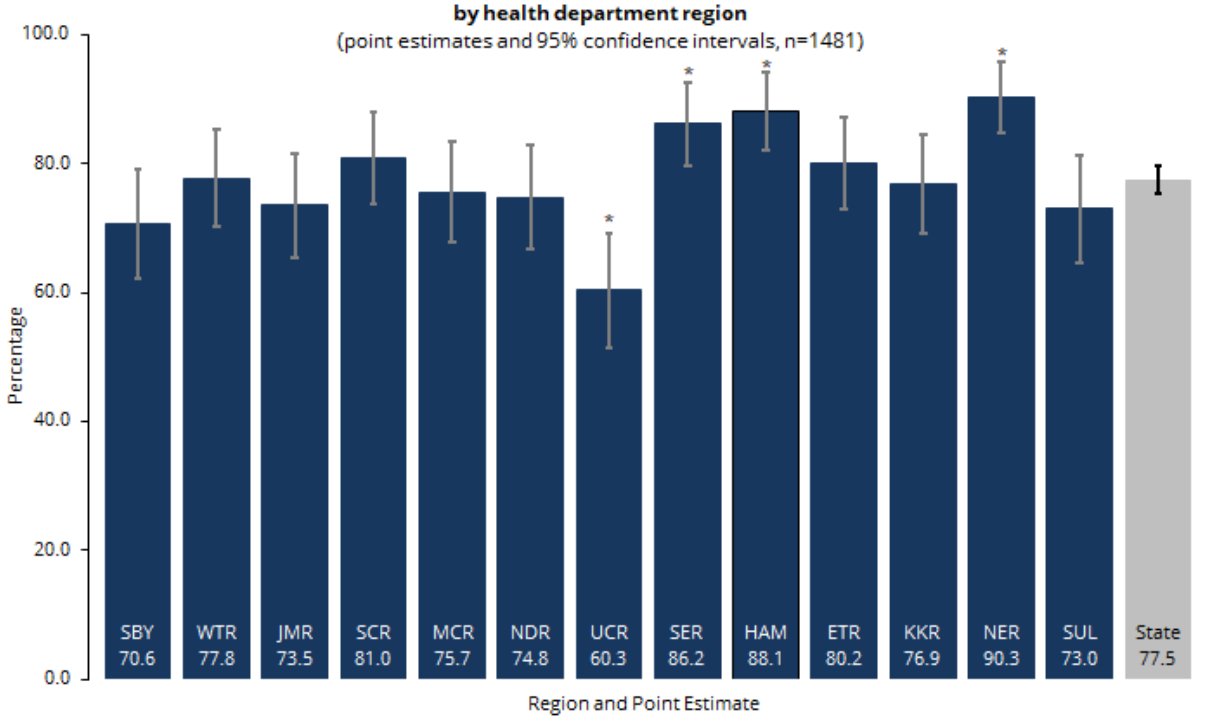
*statistically significant difference from State point

2018 Immunization Status Survey of 24-Month-Old Children in Tennessee:
Percentage of children with complete polio (IPV) series (3 doses) by health department region
(point estimates and 95% confidence intervals, n=1481)



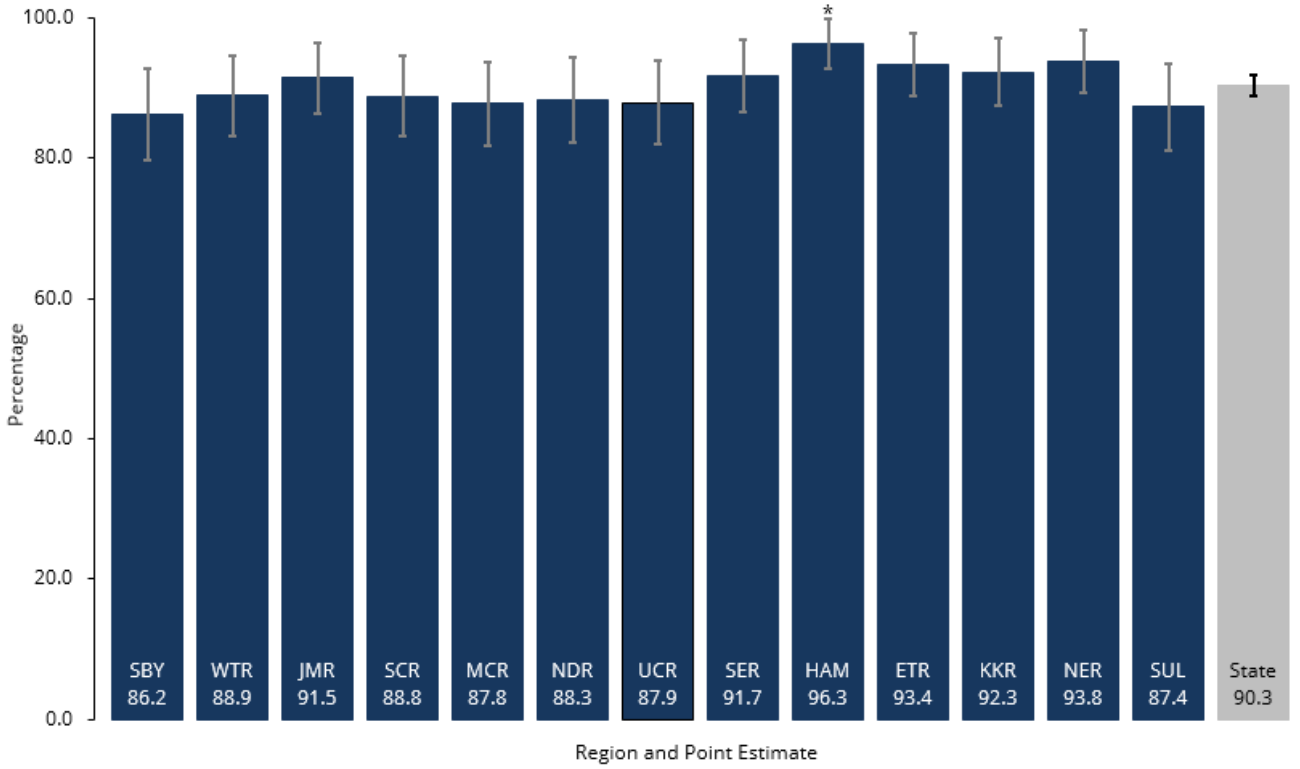
*statistically significant difference from State point estimate

2018 Immunization Status Survey of 24-Month-Old Children in Tennessee:
Percentage of children with complete Rotavirus (RTV) series
(either ≥2 or ≥3 dosese dependong on brand)
by health department region
(point estimates and 95% confidence intervals, n=1481)



*statistically significant difference from State point estimate

2018 Immunization Status Survey of 24-Month-Old Children in Tennessee:
Percentage of children with complete Varicella vaccine (1 dose) by health department region
(point estimates and 95% confidence intervals, n=1481)



* statistically significant difference from State point estimate

Appendix 3

2018 Immunization Status Survey of 24 Month Old Children in Tennessee

Individual Health Department Region Charts with Coverage Rates for All Vaccines Assessed

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West Tennessee Region	...39
Jackson-Madison County	...40
South Central Region	...40
Mid-Cumberland Region	...41
Nashville-Davidson County	...41
Upper Cumberland Region	...42
Southeast Region	...42
Hamilton County	...43
East Tennessee Region	...43
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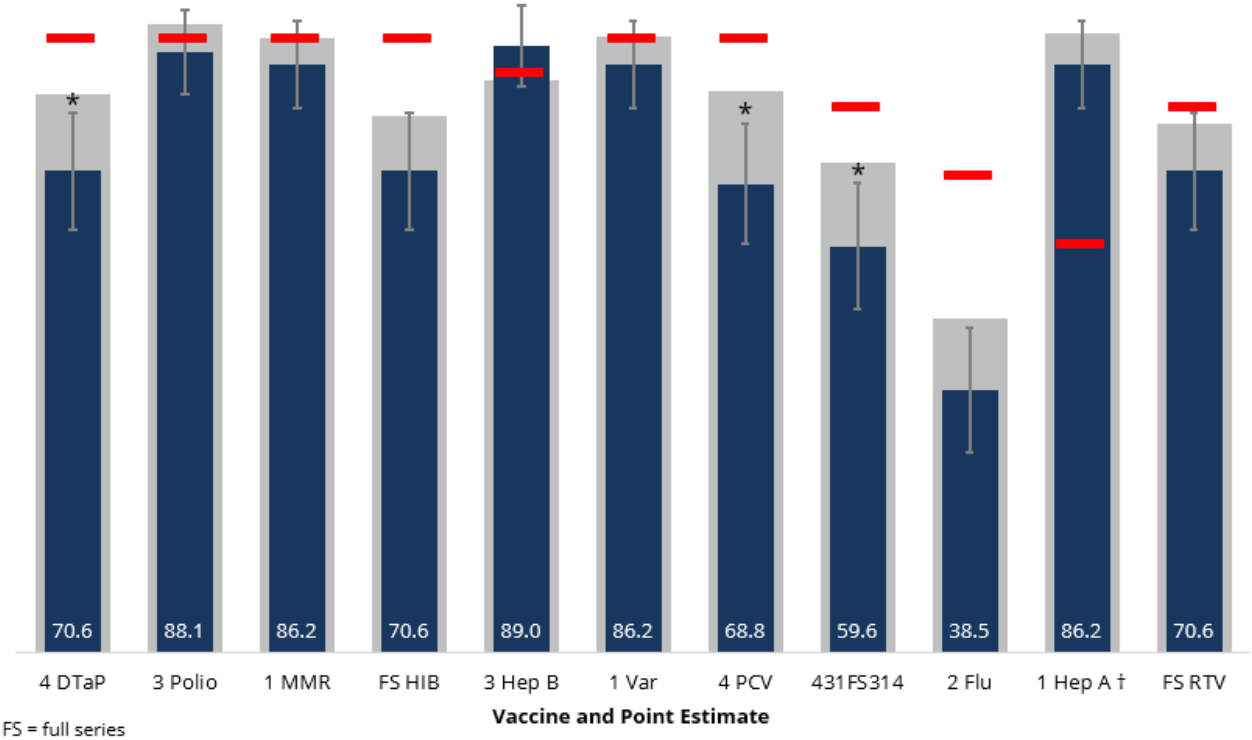
Sullivan County	...45

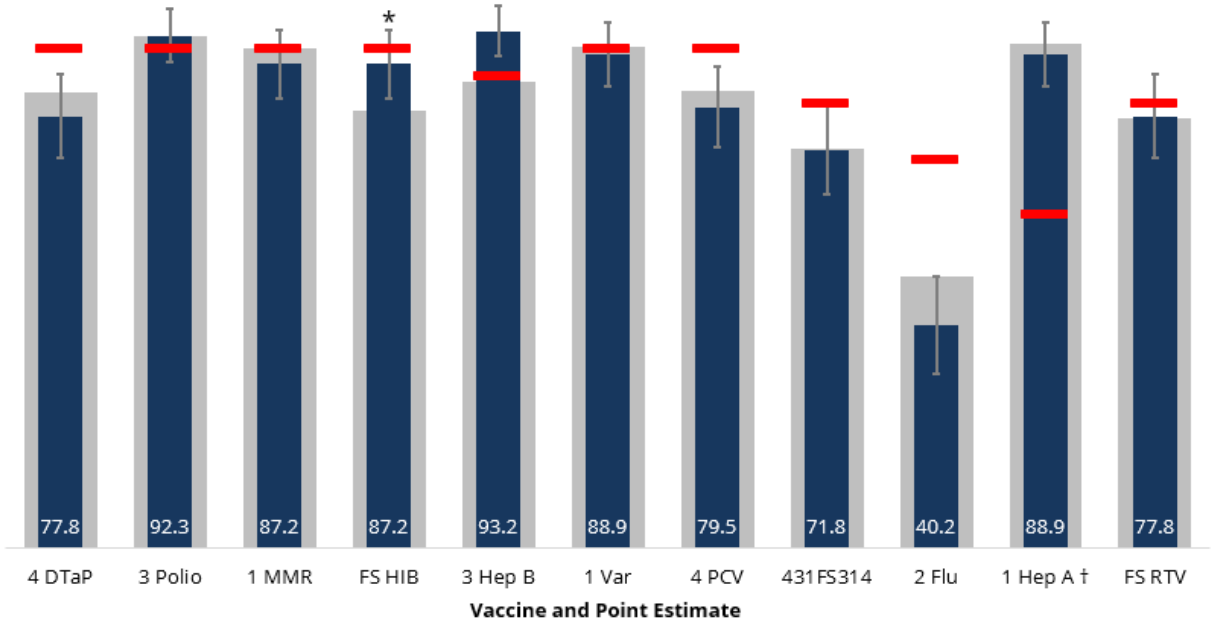
2018 Immunization Status Survey of 24-Month-Old Children in Tennessee:
Percentage of children complete in Shelby County (SBY) by vaccine
(point estimates and 95% confidence intervals, n=109)



FS = full series
† HP2020 Goal reflects 2 dose completion
* Statistically significantly different from State %

State % SBY % HP 2020 Goal

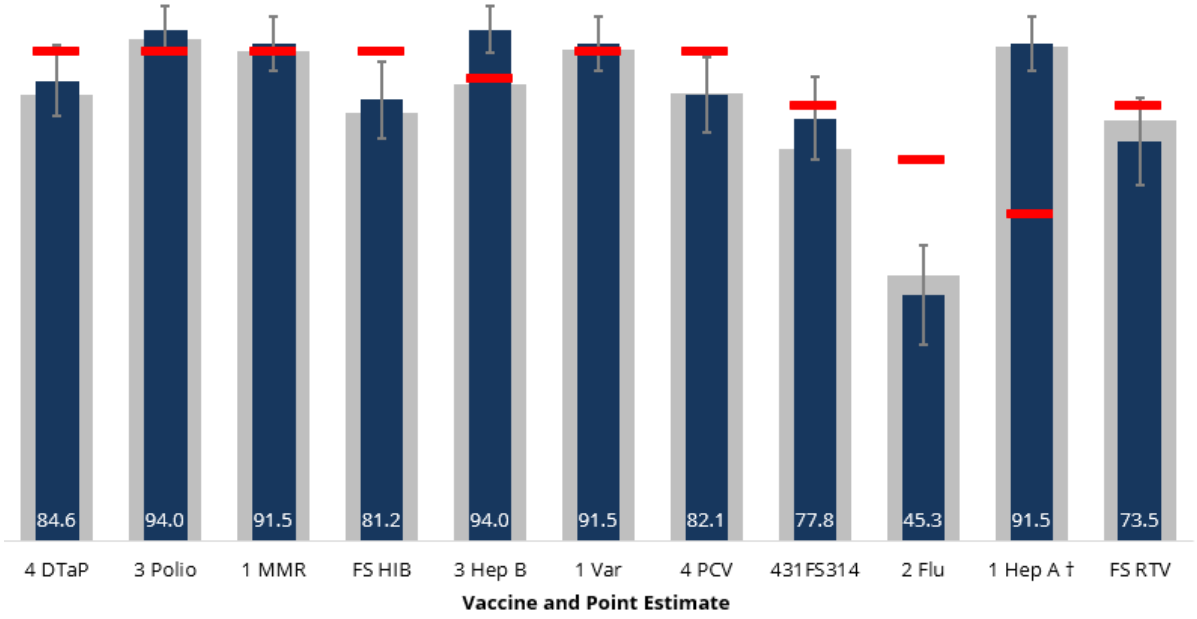
2018 Immunization Status Survey of 24-Month-Old Children in Tennessee:
Percentage of children complete in West Tennessee Region (WTR) by vaccine
(point estmates and 95% confidence intervals, n=117)



FS = full series
† HP2020 Goal reflects 2 dose completion
* Statistically significantly different from State %

State % WTR % HP 2020 Goal

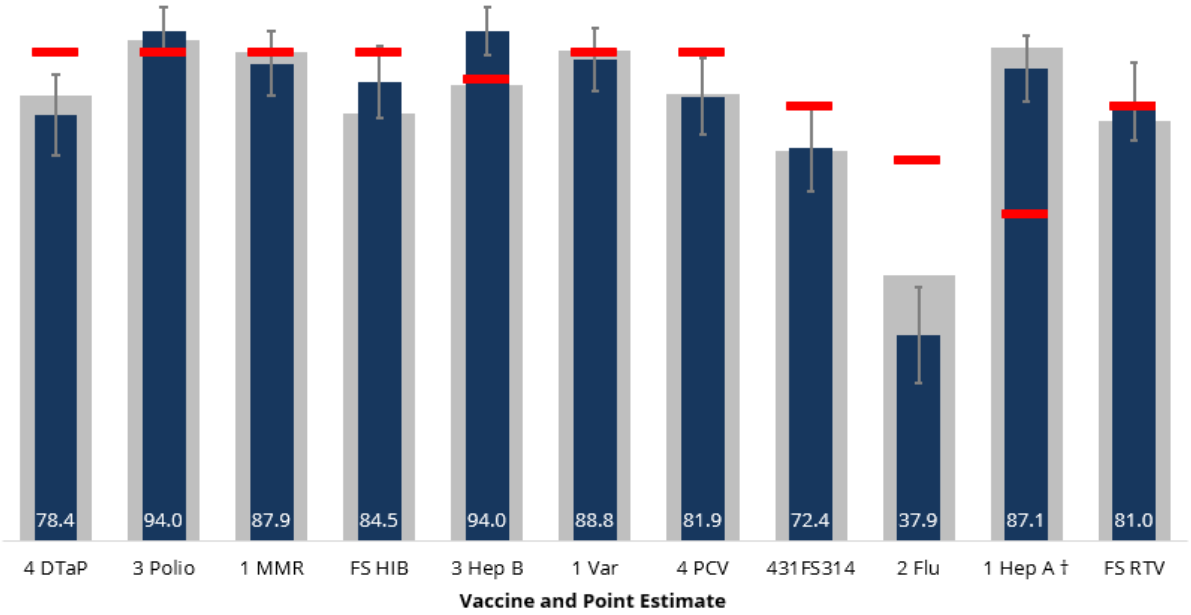
2018 Immunization Status Survey of 24-Month-Old Children in Tennessee:
Percentage of children complete in Jackson-Madison Region (JMR) by vaccine
(point estmates and 95% confidence intervals, n=117)



FS = full series
† HP2020 Goal reflects 2 dose completion
* Statistically significantly different from State %

State % JMR % HP 2020 Goal

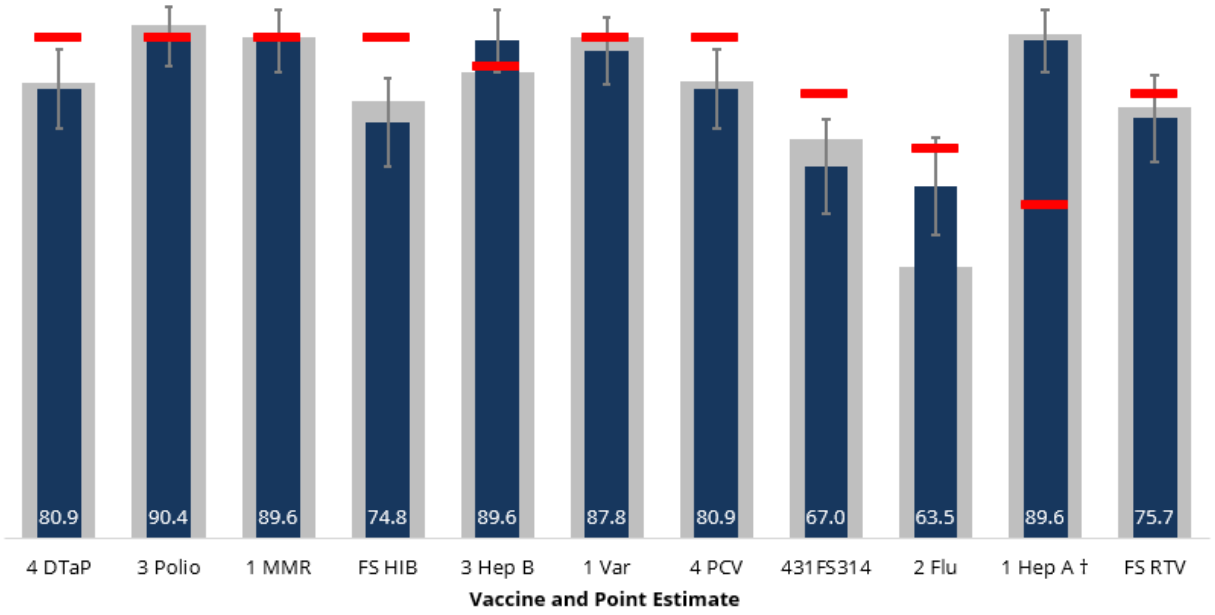
2018 Immunization Status Survey of 24-Month-Old Children in Tennessee:
Percentage of children complete in South Central Region (SCR) by vaccine
(point estimates and 95% confidence intervals, n=116)



FS = full series
† HP2020 Goal reflects 2 dose completion
* Statistically significantly different from State %

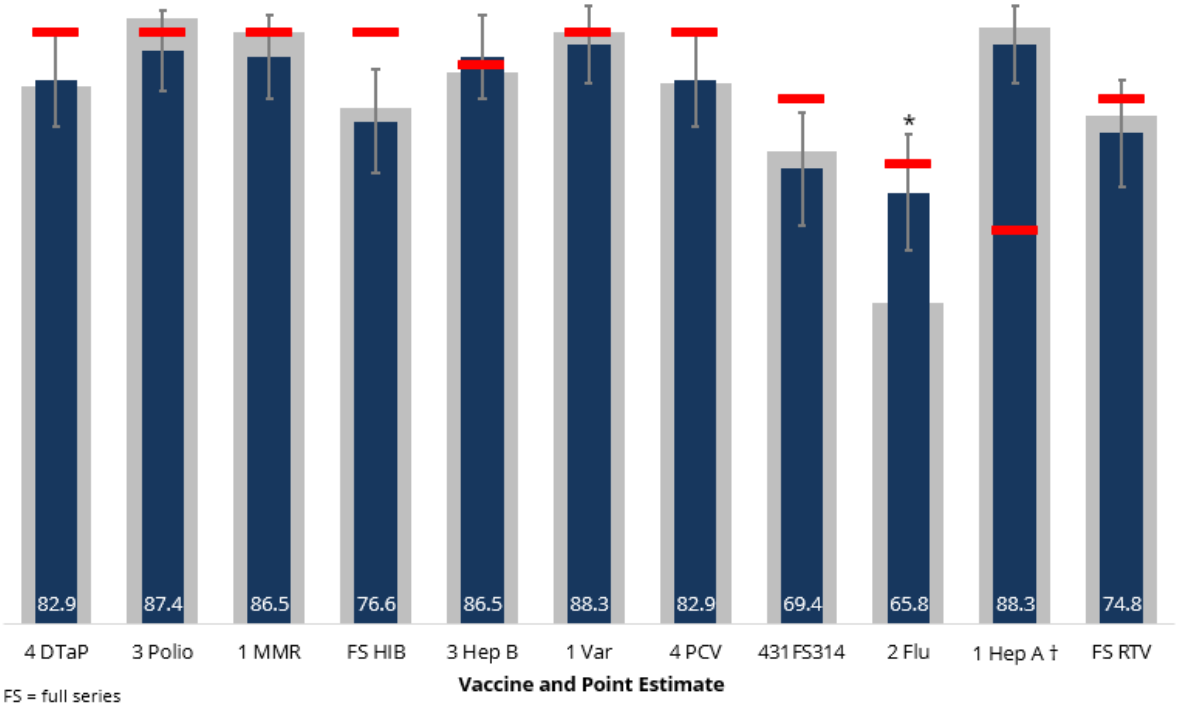
State % SCR % HP 2020 Goal

2018 Immunization Status Survey of 24-Month-Old Children in Tennessee:
Percentage of children complete in Mid-Cumberland Region (MCR) by vaccine
(point estimates and 95% confidence intervals, n=115)



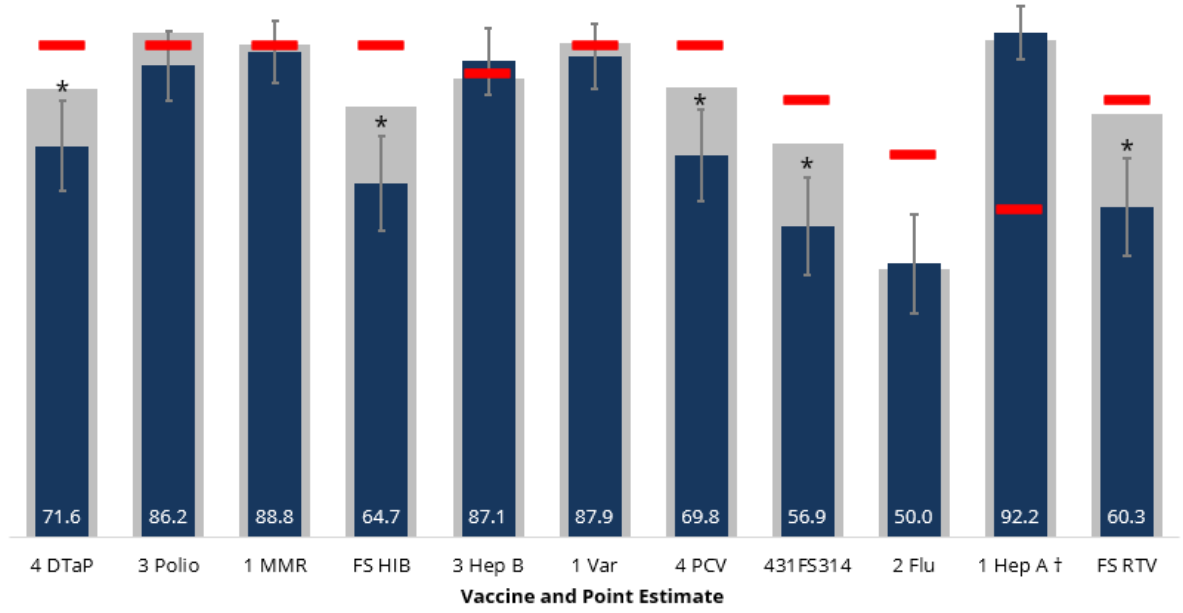
FS = full series
† HP2020 Goal reflects 2 dose completion
* Statistically significantly different from State %

2018 Immunization Status Survey of 24-Month-Old Children in Tennessee:
Percentage of children complete in Nashville-Davidson Region (NDR) by vaccine
(point estimates and 95% confidence intervals, n=111)



FS = full series
† HP2020 Goal reflects 2 dose completion
* Statistically significantly different from State %

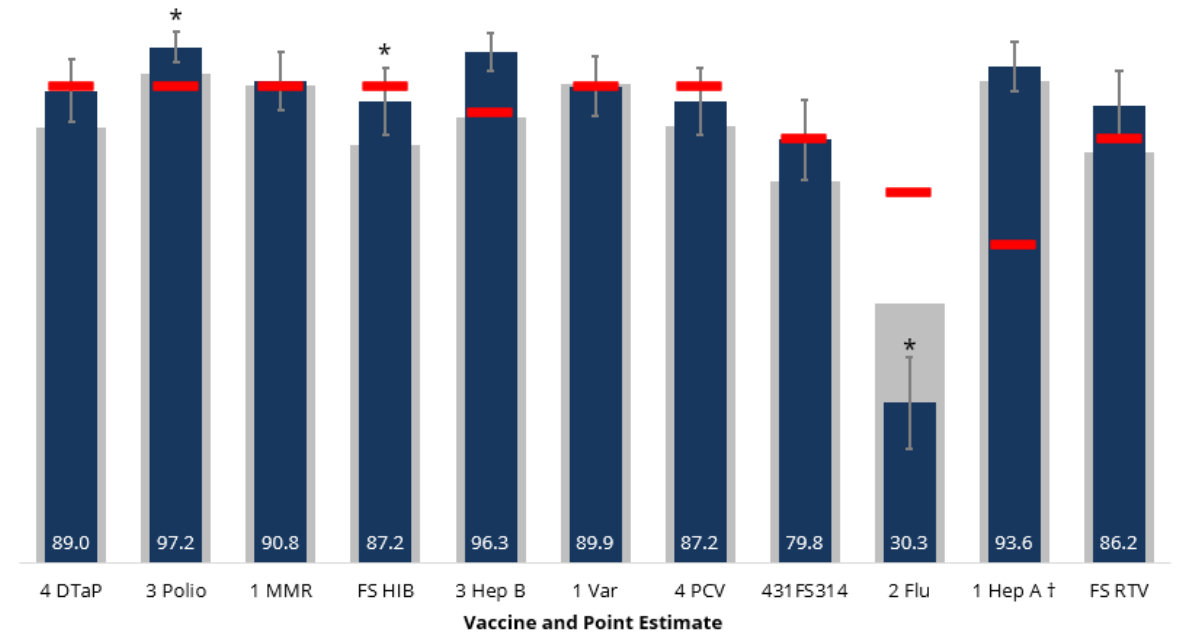
2018 Immunization Status Survey of 24-Month-Old Children in Tennessee:
Percentage of children complete in Upper Cumberland Region (UCR) by vaccine
(point estimates and 95% confidence intervals, n=116)



FS = full series
† HP2020 Goal reflects 2 dose completion
* Statistically significantly different from State %

State % UCR % HP 2020 Goal

2018 Immunization Status Survey of 24-Month-Old Children in Tennessee:
Percentage of children complete in Southeast Region (SER) by vaccine
(point estimates and 95% confidence intervals, n=109)

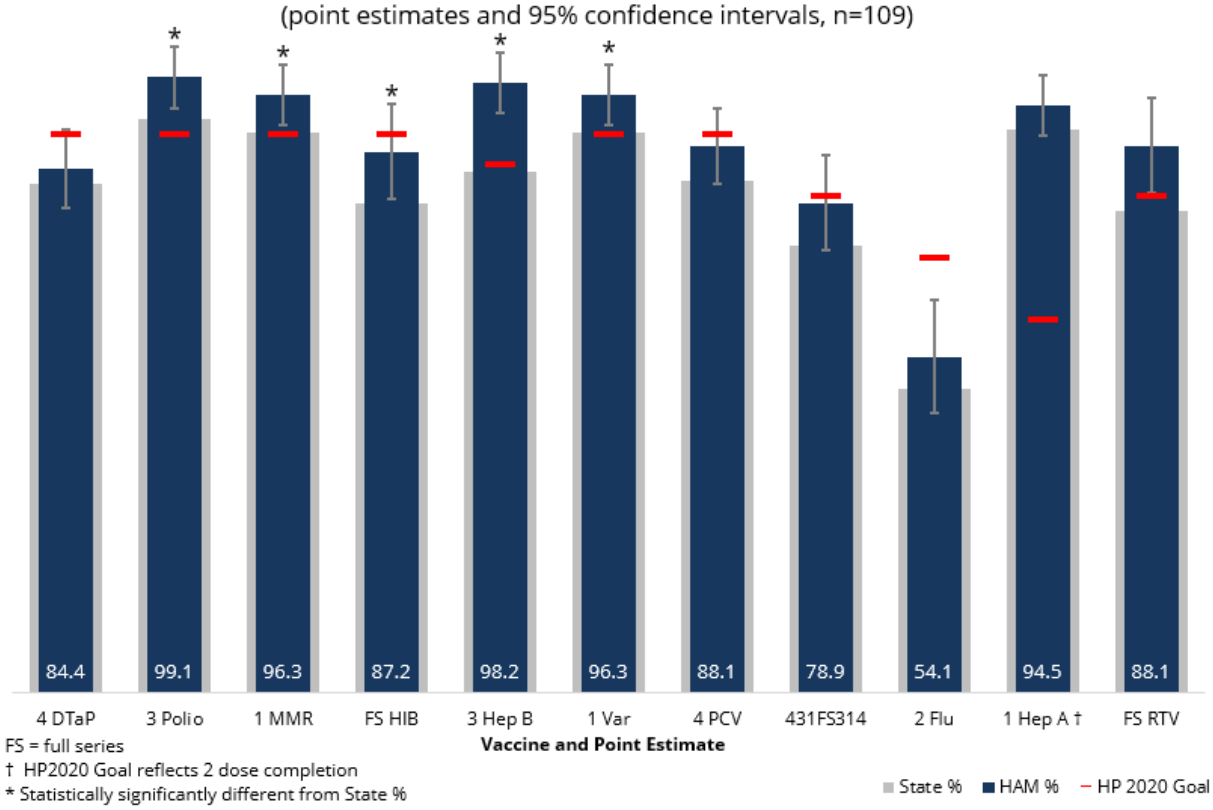


FS = full series
† HP2020 Goal reflects 2 dose completion
* Statistically significantly different from State %

State % SER % HP 2020 Goal

2018 Immunization Status Survey of 24-Month-Old Children in Tennessee: Percentage of children complete in Hamilton County (HAM) by vaccine

(point estimates and 95% confidence intervals, n=109)



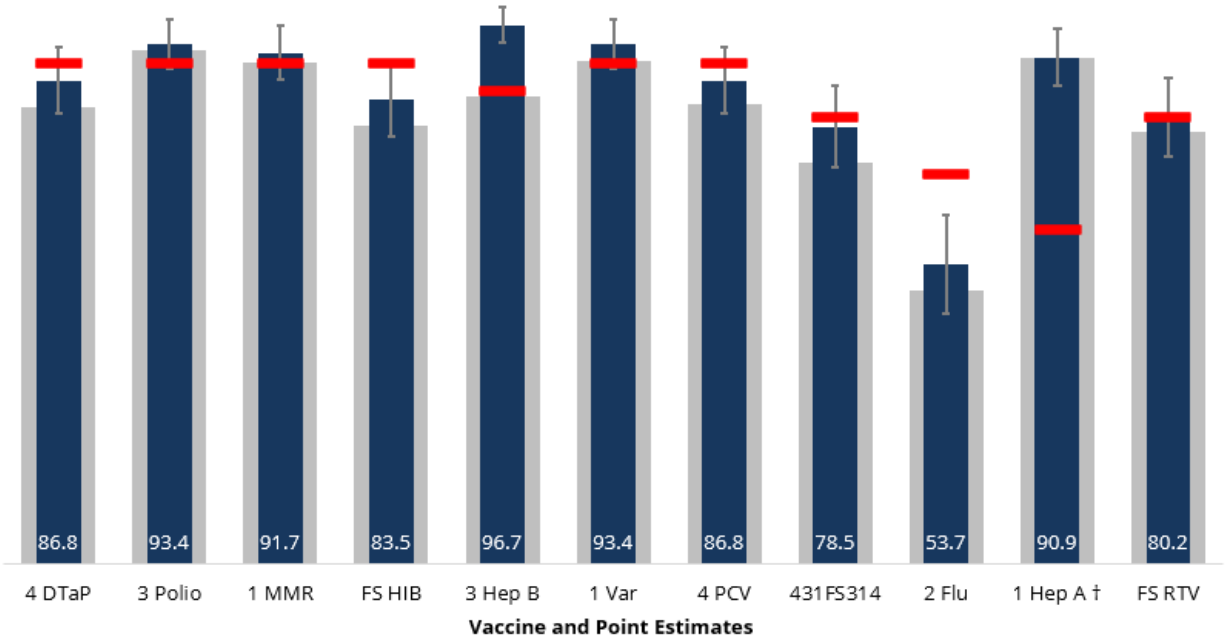
FS = full series

† HP2020 Goal reflects 2 dose completion

* Statistically significantly different from State %

2018 Immunization Status Survey of 24-Month-Old Children in Tennessee: Percentage of children complete in East Tennessee Region (ETR) by vaccine

(point estmates and 95% confidence intervals, n=121)

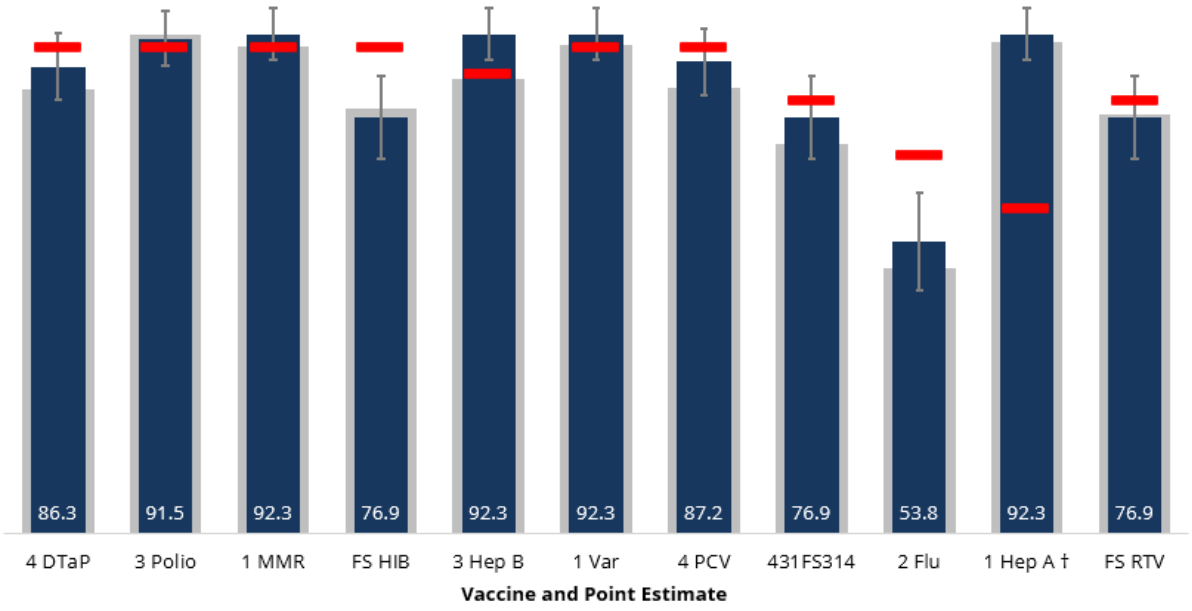


FS = full series

† HP2020 Goal reflects 2 dose completion

* Statistically significantly different from State %

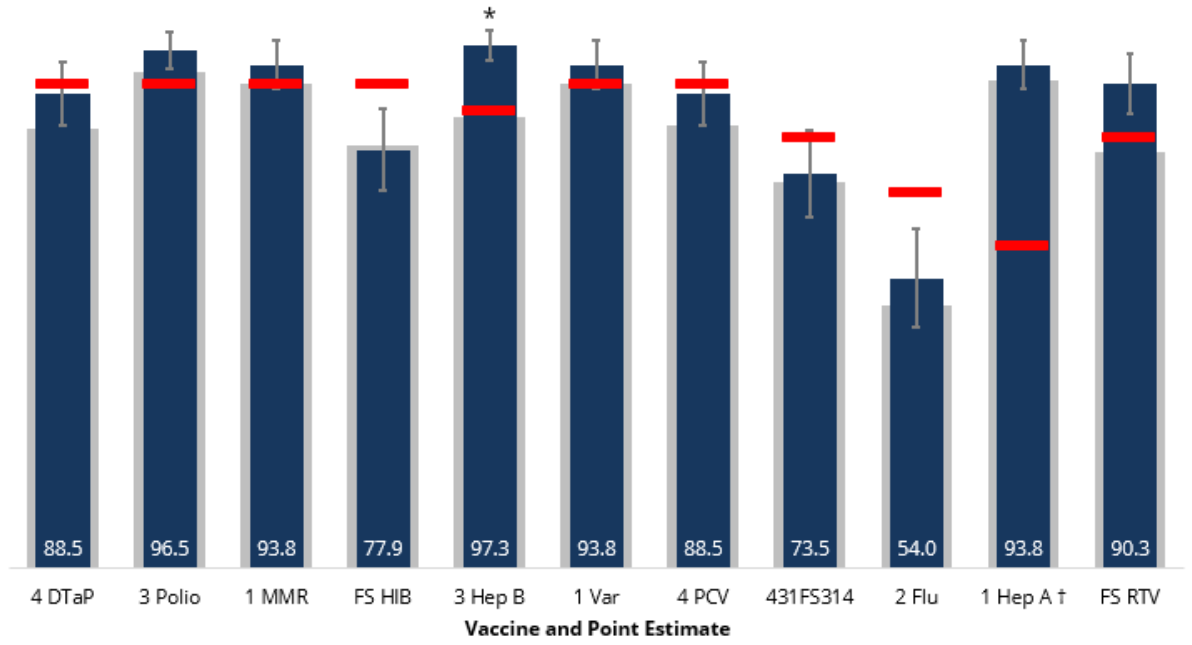
2018 Immunization Status Survey of 24-Month-Old Children in Tennessee:
Percentage of children complete in Knoxville-Knox Region (KKR) by vaccine
(point estimates and 95% confidence intervals, n=117)



FS = full series
† HP2020 Goal reflects 2 dose completion
* Statistically significantly different from State %

State % KKR % HP 2020 Goal

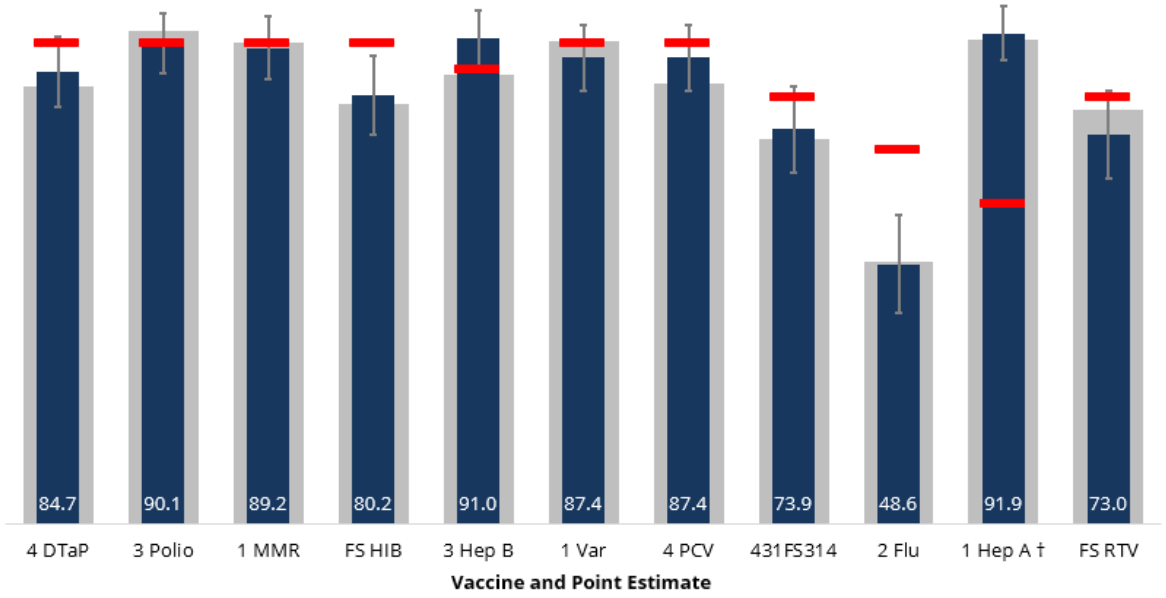
2018 Immunization Status Survey of 24-Month-Old Children in Tennessee:
Percentage of children complete in Northeast Region (NER) by vaccine
(point estmates and 95% confidence intervals, n=113)



FS = full series
† HP2020 Goal reflects 2 dose completion
* Statistically significantly different from State %

State % NER % HP2020 Goal

2018 Immunization Status Survey of 24-Month-Old Children in Tennessee:
Percentage of children complete in Sullivan County (SUL) by vaccine
(point estimates and 95% confidence intervals, n=111)



FS = full series
† HP2020 Goal reflects 2 dose completion
* Statistically significantly different from State %

State % SUL % HP 2020 Goal

Appendix 4

2018 Immunization Status Survey of 24 Month Old Children in Tennessee

Additional Statewide Charts for Specific Groups

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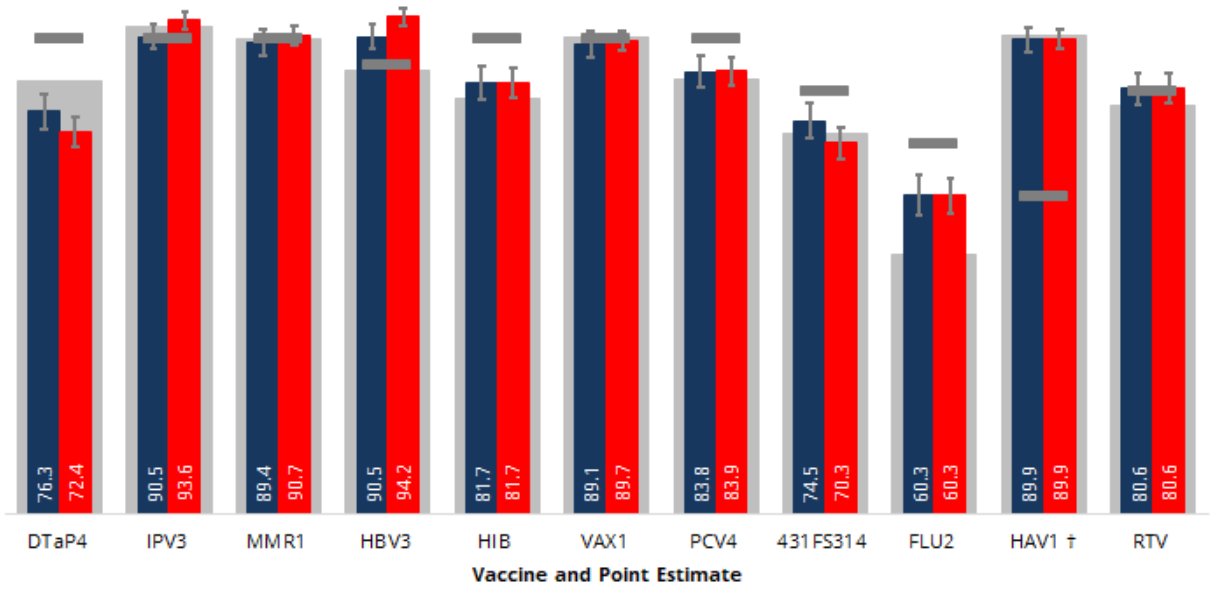
Immunization levels by vaccine and TennCare enrollment status	...47
On-time 4:3:1:FS:3:1:4 completion by TennCare enrollment status, 2010-2018	...47
Immunization levels by vaccine and WIC enrollment status	...48
On-time 4:3:1:FS:3:1:4 completion by WIC enrollment status, 2010-2018	...48
Trends in on-time immunization coverage disparities (Black vs. White, 2010-2018)	...49

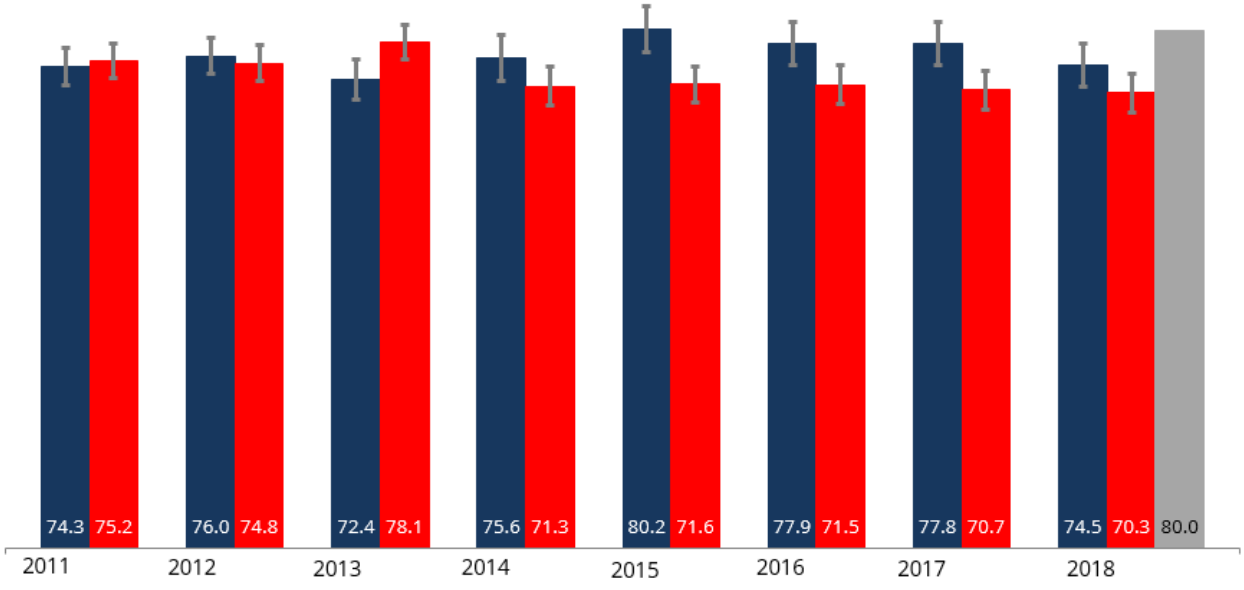
2018 Immunization Status of 24-Month-Old Children in Tennessee:
Statewide percentage of children with age-appropriate immunization levels by vaccine and Tenncare enrollment status
(point estimates and 95% confidence intervals, n=1481)



FS = full series
† HP2020 Goal reflects 2 dose completion
* Statistically significantly different from State %

State % TNCare - TNCare + HP 2020 Goal

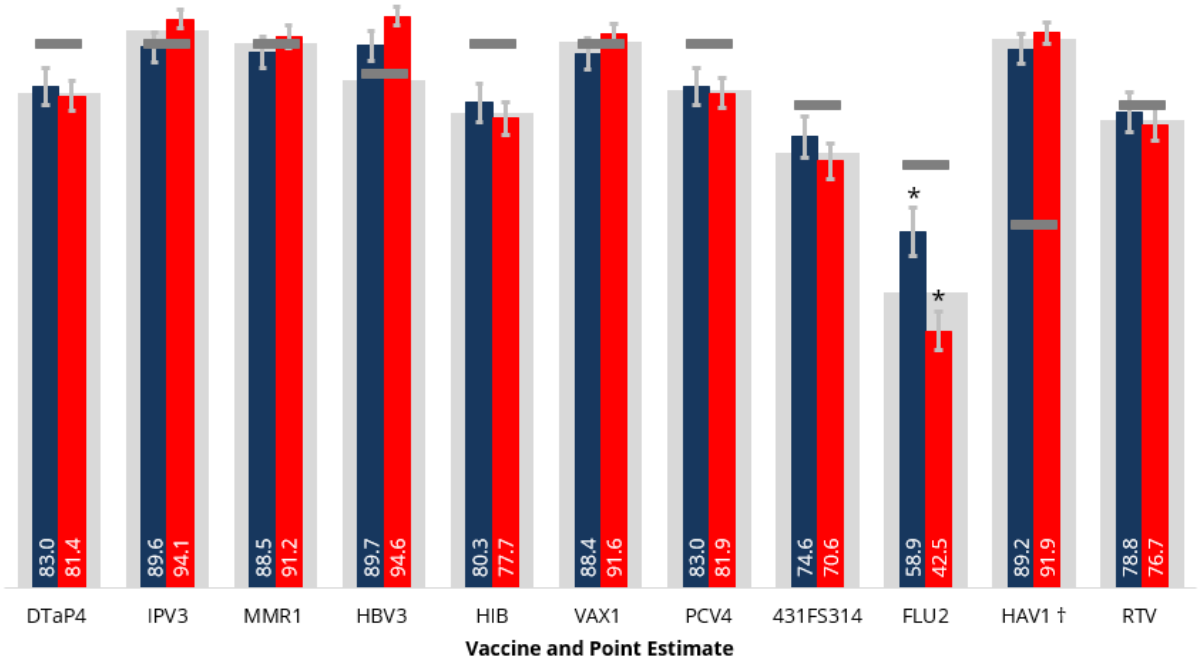
2018 Immunization Status of 24-Month-Old Children in Tennessee:
On-time 4:3:1:FS:3:1:4 completion by TennCare status, 2011-2018
(point estimates and 95% confidence intervals, n=1481)



FS = full series

TNCare - TNCare + HP 2020 Goal

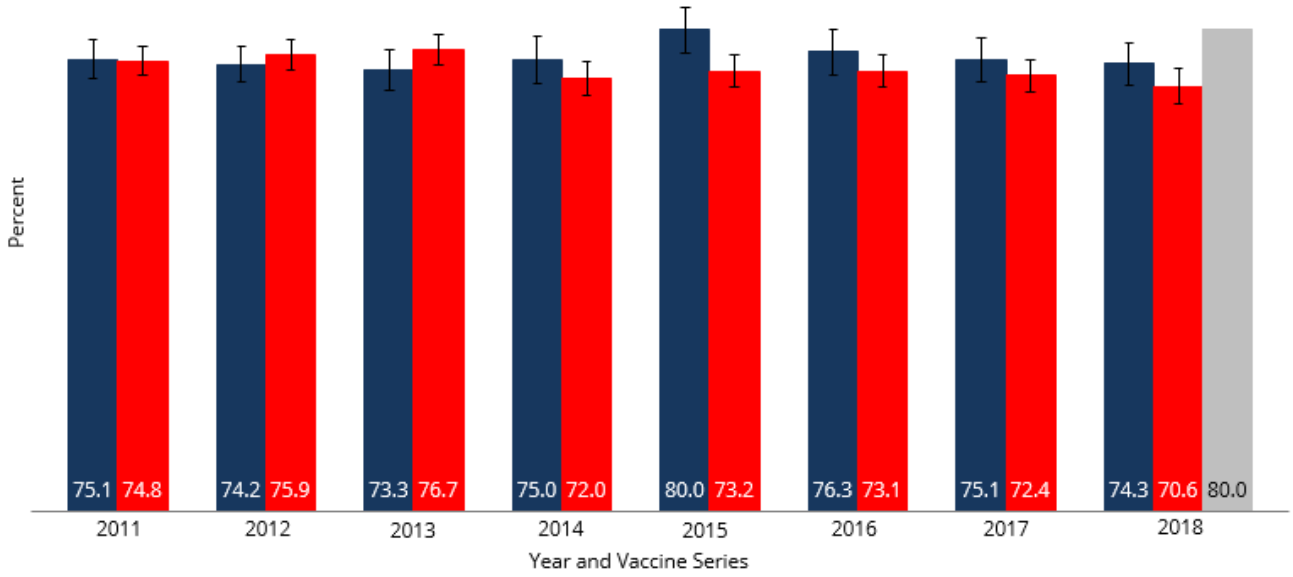
2018 Immunization Status of 24-Month-Old Children in Tennessee:
Statewide percentage of children with age-appropriate immunization levels by vaccine and WIC enrollment status
(point estimates and 95% confidence intervals, n=1481)



FS = full series
† HP2020 Goal reflects 2 dose completion
* Statistically significantly different from State %

State % WIC - % WIC + % HP 2020 Goal

2018 Immunization Status of 24-Month-Old Children in Tennessee:
On-time 4:3:1:FS:3:1:4 immunization coverage by WIC status, 2011-2018
(point estimates and 95% confidence intervals, n=1481)

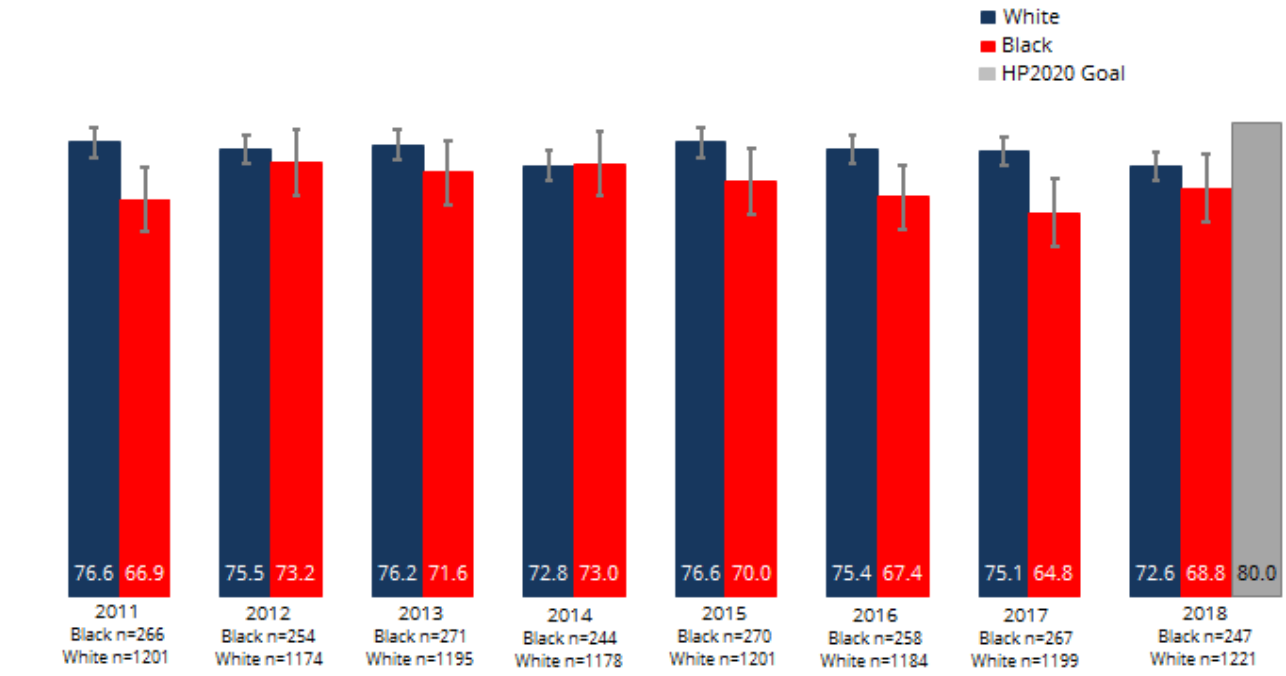


FS = full series

WIC - WIC + HP 2020 Goal

2018 Immunization Status of 24-Month-Old Children in Tennessee: Statewide percentage of children with age-appropriate 4:3:1:FS:3:1:4 immunization levels by race

(point estimates and 95% confidence intervals)



Appendix 5

2018 Immunization Status Survey of 24 Month Old Children in Tennessee

Data Tables for Selected Analyses

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Series Complete (4:3:1:FS:3:1:4)	...51
Series Complete (4:3:1:FS:3:1:4) by Provider Type	...51
Series Complete (4:3:1:FS:3:1:4) by Race	...52
Series Complete (4:3:1:FS:3:1:4) by Number of Older Siblings	...52
Series Complete (4:3:1:FS:3:1:4) by TennCare Enrollment	...53
Series Complete (4:3:1:FS:3:1:4) by WIC Enrollment	...53

2018 Series (4:3:1:FS:3:1:4) by Region

Region	Complete	%	Incomplete	%
Northeast TN	83/113	73.5	30/113	26.5
East TN	95/121	78.5	26/121	21.5
Southeast TN	87/109	79.8	22/109	20.2
Upper Cumberland	66/116	56.9	50/116	43.1
Mid-Cumberland	77/115	67.0	38/115	33.0
South Central	84/116	72.4	32/116	27.6
West TN	84/117	71.8	33/117	28.2
Shelby County	65/109	59.6	44/109	40.4
Davidson County	77/111	69.4	34/111	30.6
Knox County	90/117	76.9	27/117	23.1
Hamilton County	86/109	78.9	23/109	21.1
Madison County	91/114	77.8	23/114	20.2
Sullivan County	82/111	73.9	29/111	26.1
Total	1067/1481	72.0	414/1481	28.0

2018 Series Complete (4:3:1:FS:3:1:4) by Provider Type

Region	Public		Private		Public and Private	
	Complete	%	Complete	%	Complete	%
Northeast TN	4/4	100.0	73/96	76.0	6/11	54.5
East TN	2/4	50.0	84/102	82.4	9/14	64.3
Southeast TN	2/6	33.3	72/82	87.8	12/18	66.7
Upper Cumberland	3/4	75.0	54/90	60.0	9/18	50.0
Mid-Cumberland	2/5	40.0	69/90	76.7	6/10	60.0
South Central	1/2	50.0	61/80	76.3	22/28	78.6
West TN	11/13	84.6	48/68	70.6	23/31	74.2
Shelby County	2/2	100.0	51/75	68.0	12/23	52.2
Davidson County	0/0	0.0	67/93	72.0	6/6	100.0
Knox County	2/5	40.0	77/91	84.6	11/18	61.1
Hamilton County	0/1	0.0	72/91	79.1	13/16	81.3
Madison County	10/14	71.4	55/70	78.6	25/31	80.6
Sullivan County	1/4	25.0	69/85	81.2	12/17	70.6
Total	40/64	62.5	852/1113	76.5	166/241	68.9

Series Complete (4:3:1:FS:3:1:4) by Race

Region	White		Black		Other	
	Complete	%	Complete	%	Complete	%
Northeast TN	75/102	73.5	4/4	100.0	4/7	57.1
East TN	86/112	76.8	6/6	100.0	3/3	100.0
Southeast TN	76/96	79.2	8/9	88.9	3/4	75.0
Upper Cumberland	63/111	56.8	1/2	50.0	2/3	66.7
Mid-Cumberland	74/105	70.5	6/11	54.6	0/3	0.0
South Central	78/108	72.2	5/7	71.4	1/1	100.0
West TN	73/100	73.0	15/21	71.4	0/0	0.0
Shelby County	29/44	65.9	34/63	54.0	3/4	75.0
Davidson County	54/80	67.5	23/31	74.2	4/6	66.7
Knox County	78/99	78.8	8/13	61.5	4/5	80.0
Hamilton County	70/90	77.8	20/26	76.9	1/1	100.0
Madison County	53/68	77.9	36/50	72.0	2/2	100.0
Sullivan County	77/106	72.6	4/4	100.0	1/1	100.0
Total	886/1221	72.6	170/247	68.8	28/40	70.0

Series Complete (4:3:1:FS:3:1:4) by Number of Older Siblings

Region	0 Siblings		1 Siblings		2+ Siblings	
	Complete	%	Complete	%	Complete	%
Northeast TN	39/49	79.6	24/32	75.0	20/31	64.5
East TN	38/43	88.4	26/38	68.4	31/40	77.5
Southeast TN	38/46	82.6	31/36	86.1	18/27	66.7
Upper Cumberland	26/37	70.3	28/50	56.0	12/29	41.4
Mid-Cumberland	30/38	79.0	29/45	64.4	17/30	56.7
South Central	31/37	83.8	31/42	73.8	22/37	59.5
West TN	35/40	87.5	24/36	66.7	25/41	61.0
Shelby County	27/42	64.3	26/41	63.4	12/26	46.2
Davidson County	35/44	79.6	17/31	54.8	25/36	69.4
Knox County	35/44	80.0	30/37	81.1	25/36	69.4
Hamilton County	35/41	85.4	32/41	78.1	19/27	70.4
Madison County	46/51	90.2	23/32	71.9	22/34	64.7
Sullivan County	29/38	76.3	32/40	80.0	20/31	64.5
Total	444/550	80.7	353/501	70.5	268/425	63.1

Series Complete (4:3:1:FS:3:1:4) by TennCare Enrollment

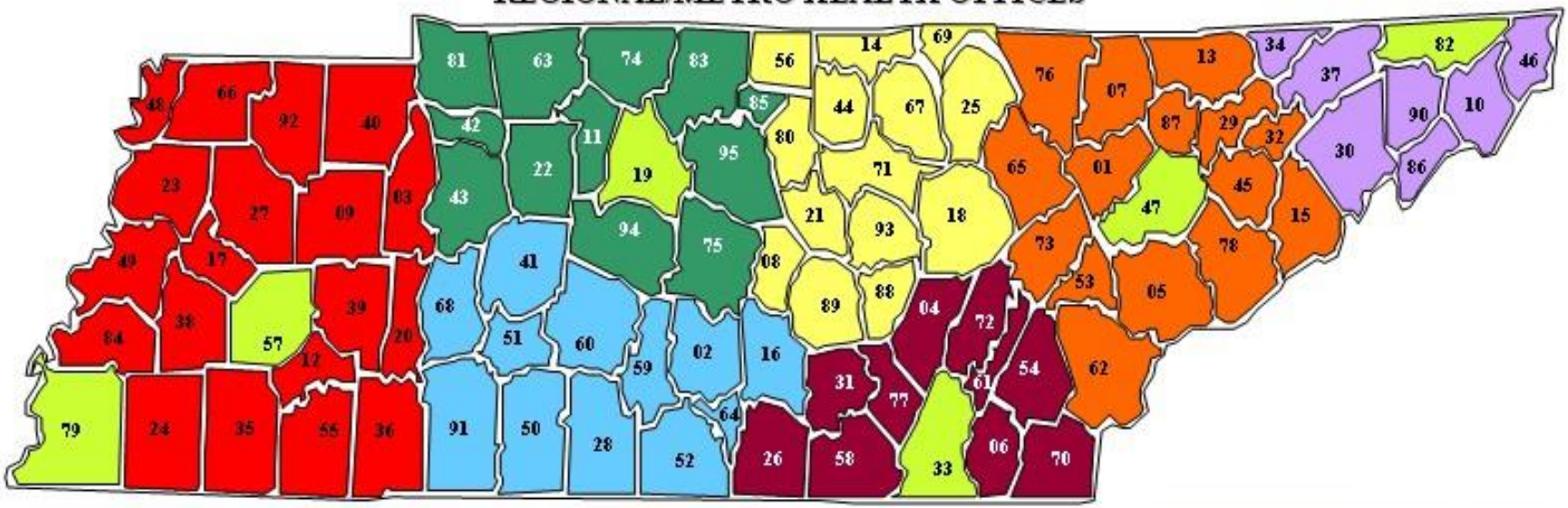
Region	Enrolled		Not Enrolled	
	Complete	%	Complete	%
Northeast TN	58/81	71.6	25/32	78.1
East TN	61/80	76.3	34/41	82.9
Southeast TN	56/73	76.7	31/36	86.1
Upper Cumberland	43/76	56.6	23/40	57.5
Mid-Cumberland	23/37	62.2	54/78	69.2
South Central	49/67	76.6	35/52	67.3
West TN	59/84	70.2	25/33	75.8
Shelby County	34/57	59.6	31/52	59.6
Davidson County	30/44	68.2	47/67	70.1
Knox County	47/64	73.4	43/53	81.1
Hamilton County	38/56	67.9	48/53	90.6
Madison County	58/77	75.3	33/40	82.5
Sullivan County	55/76	72.4	27/35	77.1
Total	611/869	70.3	456/612	74.5

Series Complete (4:3:1:FS:3:1:4) by WIC Enrollment

Region	Enrolled		Not Enrolled	
	Complete	%	Complete	%
Northeast TN	61/84	72.6	22/29	75.9
East TN	65/86	75.6	30/35	85.7
Southeast TN	54/71	76.1	33/38	86.9
Upper Cumberland	49/83	59.0	17/33	51.5
Mid-Cumberland	26/40	65.0	51/75	68.0
South Central	54/72	75.0	30/44	68.2
West TN	56/80	70.0	28/37	75.7
Shelby County	37/63	58.7	28/46	60.9
Davidson County	35/50	70.0	42/61	68.9
Knox County	38/53	71.7	52/64	81.2
Hamilton County	40/57	70.2	46/52	88.5
Madison County	59/78	75.6	32/39	82.0
Sullivan County	59/80	73.7	23/31	74.2
Total	633/897	70.6	434/584	74.3

Appendix 6

TENNESSEE DEPARTMENT OF HEALTH
REGIONAL/METRO HEALTH OFFICES



West		Mid Cumberland		South Central		Southeast		Upper Cumberland		East		North East	
#	County	#	County	#	County	#	County	#	County	#	County	#	County
03	Benton	11	Cheatham	02	Bedford	04	Bledsoe	08	Cannon	01	Anderson	10	Carter
09	Carroll	22	Dickson	16	Coffee	06	Bradley	14	Clay	05	Blount	30	Greene
12	Chester	42	Houston	28	Giles	26	Franklin	18	Cumberland	07	Campbell	34	Hancock
17	Crockett	43	Humphreys	41	Hickman	31	Grundy	21	DeKalb	13	Claiborne	37	Hawkins
20	Decatur	63	Montgomery	50	Lawrence	54	McMinn	25	Fentress	15	Cocke	46	Johnson
23	Dyer	74	Robertson	51	Lewis	58	Marion	44	Jackson	29	Grainger	86	Unicoi
24	Fayette	75	Rutherford	52	Lincoln	61	Meigs	56	Macon	32	Hamblen	90	Washington
27	Gibson	81	Stewart	59	Marshall	70	Polk	67	Overton	45	Jefferson		
35	Hardeman	83	Sumner	60	Maury	72	Rhea	69	Pickett	53	Loudon		
36	Hardin	85	Trousdale	64	Moore	77	Sequatchie	71	Putnam	62	Monroe		METROS
38	Haywood	94	Williamson	68	Perry			80	Smith	65	Morgan	#	County
39	Henderson	95	Wilson	91	Wayne			88	Van Buren	73	Roane	19	Davidson
40	Henry							89	Warren	76	Scott	33	Hamilton
48	Lake							93	White	78	Sevier	47	Knox
49	Lauderdale									87	Union	57	Madison
55	McNairy											79	Shelby
66	Obion											82	Sullivan
84	Tipton												
92	Weakley												