



# **RESULTS OF THE 2021 IMMUNIZATION STATUS SURVEY OF 24-MONTH-OLD CHILDREN IN TENNESSEE**



## **Acknowledgements**

Birth data were provided by the Tennessee Department of Health, Office of Vital Records and Statistics. Immunization data were collected by county and regional health department nurses, immunization representatives and disease investigation staff. Data entry, analysis and reporting were conducted by staff of the Tennessee Vaccine-Preventable Diseases and Immunization Program. Survey data were collected using REDCap electronic data capture tools hosted at the Tennessee Department of Health. REDCap (Research Electronic Data Capture, <http://projectredcap.org/>) is a secure web-based application designed to support data capture.

## Table of Contents

	Page
<b>Definitions of Abbreviations in Charts</b>	<b>6</b>
<b>Executive Summary</b>	<b>7</b>
<b>General Information and Results:</b>	<b>12</b>
Table 1. ACIP List of Diseases to Prevent through Vaccination of Children < 24 Months of Age	<b>13</b>
Table 2. Catch-Up Guidance for PCV and Hib, Centers for Disease Control and Prevention	<b>16</b>
Table 3. Demographics of 2021 Sample Population, Excluding Oversampled Black Children	<b>18</b>
Table 4. Vaccine Refusal Reasons by Region, Tennessee	<b>19</b>
Figure 1. Six-Year Trend of Refusals by Reason, Tennessee	<b>19</b>
Table 5. Unable to Locate by Region, Tennessee	<b>20</b>
Figure 2. 4:3:1:FS:3:1:FS Immunization Rate Trends	<b>20</b>
Figure 3. Percent of 24-month Old Children with On-time 4:3:1:FS:3:1:4 Series	<b>21</b>
Figure 4. Statewide Trend of Complete 4:3:1:FS:3:1:FS Series	<b>22</b>
Figure 5. Percent of 24-month Old Children With On-Time 4:3:1:FS:3:1:FS Series by Region	<b>22</b>
Figure 6. Comparison of Healthy People 2020 objectives to Vaccination Completion Rates	<b>23</b>
Figure 7. Statewide Trend of Complete Immunization for Individual Vaccines	<b>24</b>
Figure 8. Percentage and Count of Children with Seasonal Influenza Vaccine	<b>25</b>
Figure 9. Percentage of Children Who Received Influenza Vaccination in First Year of Life	<b>26</b>
Figure 10. Statewide Percentage of Children with Age-Appropriate Levels by Vaccine and Race	<b>27</b>
Figure 11. 4:3:1:FS:3:1:FS Immunization Level Trends, by Race, Tennessee	<b>28</b>
Figure 12. Statewide Percentage of Children with Age-Appropriate Influenza by Race	<b>28</b>
Figure 13. Percentage of Children who Received Influenza Vaccination in First Year of Life by Race	<b>29</b>
Figure 14. Comparison of Children Complete for the 4:3:1:FS:3:1:FS Series by Provider Type	<b>30</b>
Table 6. Prevalence of Three Risk Factors for Delayed Immunizations, by Provider Type	<b>30</b>
Figure 15. Comparison of Children Complete for the 4:3:1:FS:3:1:FS Series with Zero, One, or Two or more Siblings	<b>31</b>
Figure 16. Percentage of Children With Complete Diphtheria, Tetanus, Pertussis (DTaP) Three Dose vs Four Dose Series	<b>32</b>
Figure 17. Percentage of Children with Complete Hib Series with ACIP vs CDC Catch-Up Schedule	<b>33</b>
Figure 18. Percentage of Children with Complete PCV Series with ACIP vs CDC Catch-Up schedule	<b>33</b>
<b>Summary of Key Findings</b>	<b>34</b>
<b>Appendices</b>	
<b>1: Vaccine Series and Individual Vaccine Charts</b>	<b>40</b>
DTaP & Polio	<b>41</b>
MMR & <i>Haemophilus influenzae</i> type b	<b>42</b>
Hepatitis B (Three-Dose Coverage) & Hepatitis B (birth dose)	<b>43</b>
Varicella & Pneumococcus	<b>44</b>
4:3:1:FS:3:1:FS series & Hepatitis A	<b>45</b>
Rotavirus & Influenza (Two-Dose Coverage)	<b>45</b>

## IMMUNIZATION STATUS SURVEY – 2021

<b>2:</b>	<b>Individual Health Department Region Charts (West→East)</b>	<b>47</b>
	Memphis- Shelby County	48
	West Tennessee Region	48
	Jackson-Madison County	49
	South Central Region	49
	Mid-Cumberland Region	50
	Nashville-Davidson County	50
	Upper Cumberland Region	51
	Southeast Region	51
	Chattanooga- Hamilton County	52
	East Tennessee Region	52
	Knoxville-Knox County	53
	Northeast Region	53
	Sullivan County	54
<b>3:</b>	<b>Data Tables for Selected Analyses</b>	<b>55</b>
	Series Complete (4:3:1:FS:3:1:FS) by Region	56
	Series Complete (4:3:1:FS:3:1:FS) by Provider Type	56
	Series Complete (4:3:1:FS:3:1:FS) by Race	57
	Series Complete (4:3:1:FS:3:1:FS) by Number of Older Siblings	57
	Series Complete (4:3:1:FS:3:1:FS) by TennCare Enrollment	58
	Series Complete (4:3:1:FS:3:1:FS) by WIC Enrollment	58
<b>4:</b>	<b>Regional One Page Summaries</b>	<b>59</b>
	Memphis- Shelby County	60
	West Tennessee Region	61
	Jackson-Madison County	62
	South Central Region	63
	Mid-Cumberland Region	64
	Nashville-Davidson County	65
	Upper Cumberland Region	66
	Southeast Region	67
	Chattanooga- Hamilton County	68
	East Tennessee Region	69
	Knoxville-Knox County	70
	Northeast Region	71
	Sullivan County	72
<b>5:</b>	<b>Map of Regional and Metropolitan Health Departments in Tennessee</b>	<b>73</b>

## Definitions of Abbreviations in Charts

### 1. Vaccines

- a. DTaP: diphtheria, tetanus, acellular pertussis vaccine
- 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 vaccine
- g. VAR: varicella (chickenpox) vaccine
- h. PCV: pneumococcal conjugate vaccine
- i. 4:3:1:FS:3:1:FS: Combined Full Series (DTaP, IPV, MMR, Hib, HBV, VAR, and PCV)
- j. FLU: seasonal influenza vaccine
- k. RTV: rotavirus vaccine

### 2. Public Health Regions

- a. Rural, multi-county regions
  - i. WTR: West Tennessee Region
  - ii. SCR: South Central Region
  - iii. MCR: Mid-Cumberland Region
  - iv. UCR: Upper Cumberland Region
  - v. SER: Southeast Region
  - vi. ETR: East Tennessee Region
  - vii. NER: Northeast Region
- b. Metropolitan, single county regions
  - i. MSR: Memphis-Shelby County Region
  - ii. JMR: Jackson-Madison County Region
  - iii. NDR: Nashville-Davidson County Region
  - iv. CHR: Chattanooga-Hamilton County Region
  - v. KKR: Knoxville-Knox County Region
  - vi. SUL: Sullivan County Region

## Executive Summary

The annual Immunization Status Survey of 24-month-Old Children (Immunization Status Survey) in Tennessee is conducted by the Tennessee Department of Health's (TDH) Vaccine-Preventable Diseases and Immunization Program (VPDIP) to track progress toward achieving the national Healthy People objectives for immunization coverage with routinely recommended early childhood vaccines. This survey is composed of random, statistically valid samples drawn from birth certificates of infants born in each of the 13 health department regions. The children sampled for the survey were born during the first quarter of 2019 and celebrated their second birthdays between January 1 and March 31, 2021. The results of the survey are aggregated to give statewide statistics on immunization coverage rates in Tennessee and track the progress toward achieving at least 90% on-time immunization with each routinely recommended vaccine for before age two years.

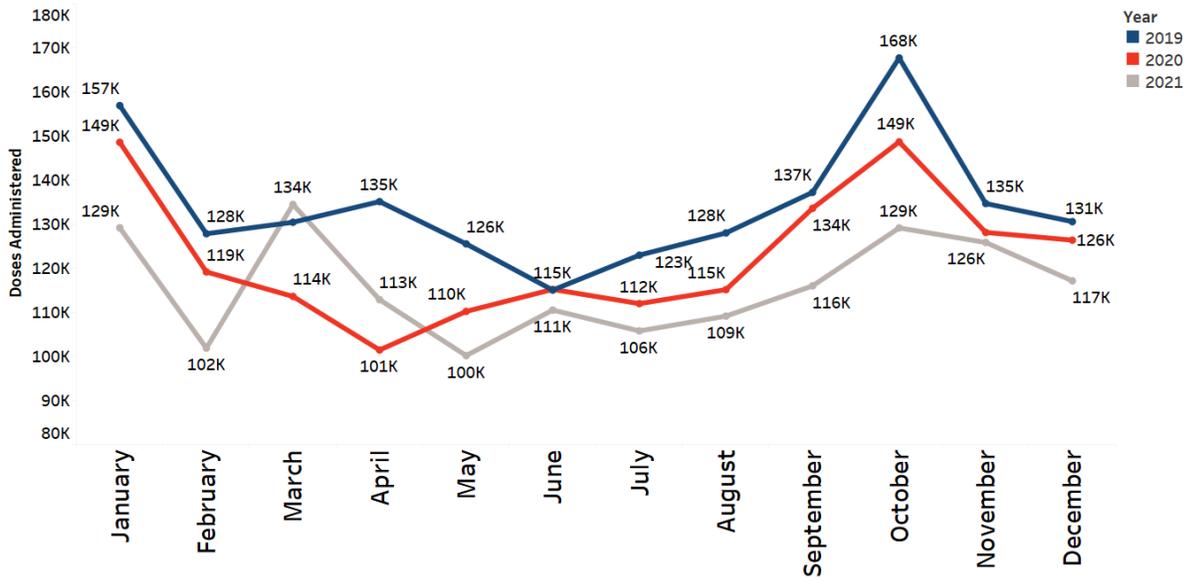
Historically, Tennessee's vaccination rates have remained relatively high, but have not achieved the Healthy People objectives. In 2021, Tennessee met three out of the 12 HP2020 objectives and none the three HP2030 objectives. Tennessee ranks in the bottom 20% of states for the completion of seven vaccine series ranking 41<sup>st</sup> in the nation and fifth out of eight in Region 4 of the United States Department of Health and Human Services, which includes Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, Tennessee, and South Carolina.<sup>1,2</sup> In addition to analyses of individual vaccine series completion rates, this report analyzes racial disparity of vaccination rates among 24-month old children, which are historically lower for black children compared to white children. The survey also analyzes seasonal flu immunization rates, which are significantly lower than the HP2020 objective, and vaccine exemption trends, which have been historically high in Tennessee.

The COVID-19 pandemic has had a considerable negative impact on the vaccination rate of children in Tennessee. To better understand the impact of the pandemic on childhood immunization rates, TDH analyzed monthly 2019, 2020, and 2021 childhood vaccination rates of children aged zero to two years utilizing data from the Tennessee Immunizations Information System (TennIIS). As shown in the figure below, TennIIS data demonstrates a 1 to 26% decline in early-childhood immunizations during the COVID-19 pandemic. This decline was most notable in March (-13%) and April 2020 (-26%), when uncertainty around the SARS-CoV-2 virus resulted in an apprehensive population with limited access to health care resources. While immunization rates later in 2020 largely returned to 2019 levels, and vaccination rates between 2020 and 2021 increased overall, the difference between vaccination rates in 2019 before the COVID-19 pandemic and the vaccination rates in 2021 during the height of the pandemic are cause for concern. Although 2020 rates come close to pre-pandemic figures we have yet to see instances where pre-pandemic data has been exceeded. Simply meeting pre-pandemic figures is insufficient due to the large declines we observed during the pandemic. Rates that exceed those observed in 2019 would be an indication of return to pre-pandemic immunization status. Because the pandemic caused many children to fall behind in their routine childhood immunizations, additional measures are needed to ensure that these individuals catch-up in their routine childhood immunizations to stay healthy. Unfortunately, these catch-up vaccinations have not yet occurred, leaving Tennessee's children and communities more vulnerable to vaccine-preventable disease outbreaks. Notably, there is approximately a five-fold increase in the number of children that have received no doses of recommended vaccines in 2021, leaving them and others vulnerable to vaccine preventable diseases.

Identifying and immunizing children who have fallen behind on routine immunizations is a high priority. These efforts will mitigate vaccine-preventable disease outbreaks by protecting this important population.

IMMUNIZATION STATUS SURVEY – 2021

Total Number of Childhood Vaccine Doses Administered to Ages 0-2 Years in 2019 compared to 2020, by Month, as Reported in TennIIS



In 2020, there were almost 140,000 fewer doses of childhood vaccines administered to children aged 24 months or less than in 2019. In 2021, there were almost 80,000 fewer doses of childhood vaccines administered to children aged 24 months or less than in 2020. In total, **almost 220,000 (13.6%) fewer doses of childhood vaccines have been administered to Tennessee children during this timeframe.** These data emphasize the need to catch-up on routine vaccinations to achieve pre-pandemic vaccination levels.

### Healthy People Comparison

The Healthy People initiative is designed to guide national health promotion and disease prevention efforts to improve the health of the nation. Released by the United States Department of Health and Human Services (HHS) every decade since 1980, Healthy People identifies science-based objectives with targets to monitor progress and focus action. Healthy People 2020 (HP2020) included 12 immunization-related objectives. Implemented across the nation began in 2010 with the expectation that the objectives would be achieved by 2020. In 2020, new HP2030 objectives, including three immunization-related objectives were developed.

In 2021, Tennessee did not meet any of the HP2030 objectives: one dose MMR by age two years (target of 90.8%), four doses DTaP by age two years (target of 90.0%), and children with no doses of recommended vaccines by age two years (target of <1.3%). Although HP2030 reduced the number of objectives from 12 to three and adjusted the age of evaluation from 19-35 months to 24 months, VPDIP will continue to evaluate all childhood immunizations and use HP2020 benchmarks. It is important to note that the data analyzed in this report were retrieved from the first quarter of the 2021 calendar year (January, February, and March), during the COVID-19 pandemic. Tennessee has been greatly impacted by the COVID-19 pandemic. Almost two million cases of COVID-19 have been reported in Tennessee with many more cases likely going unreported. Of the reported cases of COVID-19 in 2021, 114,657 cases were in children aged 10 years and younger. As mentioned, the increased burden of COVID-19 in Tennessee has resulted in decreases in childhood immunizations. The following table summarizes Tennessee’s 2021 Immunization Status Survey results alongside national HP2020 objectives and HP2030 objectives:

Results of Immunization Status Survey Compared to Healthy People 2020 and 2030 Objectives

Antigen	TN 2021 (24 months)	HP2020 Objective (19-35 months)	HP2030 Objective (24 months)
Diphtheria, Tetanus, Pertussis (DTaP)	77.5%	90%	90%
Poliomyelitis (Polio)	89.8%	90%	N/A
Measles, Mumps, Rubella (MMR)	87.5%	90%	90.8%
Hepatitis B (HBV)	91.5%	90%	N/A
Hepatitis B, birth dose	85.9%	85%	N/A
Haemophilus influenzae, type B (HIB)	82.1%	90%	N/A
Varicella (VAR)	87.5%	90%	N/A
Pneumococcus (PCV)	91.6%	90%	N/A
Full Series	75.2%	80%	N/A
Hepatitis A (HAV)*	*86.9%	N/A	N/A
Rotavirus (RTV)	76.5%	80%	N/A
Influenza (Flu)	54.6%	70%	N/A

Indicates value is above HP2020 objective.

**Bold text indicates value is above HP2030 objective.**

\*Hepatitis A is excluded from HP2020 objective comparisons as Tennessee measures receipt of one dose, while the HP2020 objective goal references two doses

### Year Over Year Comparison: The Impact of COVID-19

The long-term effects that COVID-19 has had on public health, immunization rates, and vaccine preventable diseases are not yet known. During the pandemic there has been a concerning reversal of the positive momentum in childhood vaccine rates previously reported in the state. It is important to note that the data analyzed in the 24-Month-Old Survey were retrieved from the first quarter of each calendar year (January,

## IMMUNIZATION STATUS SURVEY – 2021

February, and March). Therefore, in 2020, data collection occurred before COVID-19 truly began to impact Tennessee as the first case of COVID-19 in Tennessee was not identified until March 5, 2020.

In 2019, Tennessee met only three of the HP2020 objectives; Polio (91.0%) HBV (91.4%), and PCV (91.9%). In 2020, vaccine rates improved. Tennessee met five of the HP2020 objectives: Polio (92.5%), MMR (91.2%), HBV (93.0%), VAR (90.6%), and PCV (94.1%) and had increased rates in five other vaccine series. However, in 2021, Tennessee again only met three of the HP2020 objectives; HBV (91.5%), birth dose HBV (85.9%), and PCV (91.6%). Additionally, all but two vaccine series have decreased vaccination rates. Increasing rates and positive momentum of childhood vaccination rates in Tennessee is an immediate priority.

### Year Over Year Comparison of Tennessee’s Immunization Status Survey

Antigen	Immunization Status Survey (2019)	Immunization Status Survey (2020)	Immunization Status Survey (2021)	Increase/ Decrease (2020 to 2021)
Diphtheria, Tetanus, Pertussis (DTaP)	80.1%	80.9% ▲	77.5% ▼	- 3.4%
Poliomyelitis (Polio)	91.0%	92.5% ▲	89.8% ▼	- 2.7%
Measles, Mumps, Rubella (MMR)	88.3%	91.2% ▲	87.5% ▼	- 3.7%
Hepatitis B (HBV)	91.4%	93.0% ▲	91.5% ▼	- 1.5%
Hepatitis B, birth dose	81.4%	80.4% ▼	85.9% ▲	+ 5.5%
Haemophilus influenzae, type B (HIB)	84.8%	86.1% ▲	82.1% ▼	- 4.0%
Varicella (VAR)	87.3%	90.6% ▲	87.5% ▼	- 3.1%
Pneumococcus (PCV)	91.9%	94.1% ▲	91.6% ▼	- 2.5%
Full Series	76.6%	78.2% ▲	75.2% ▼	- 3.0%
Hepatitis A (HAV)*	87.7%	90.4% ▲	86.9% ▼	- 3.5%
Rotavirus (RTV)	77.3%	76.7% ▼	76.5% ▼	- 0.2%
Influenza (Flu)	47.7%	51.3% ▲	54.6% ▲	+ 3.3%

▲ Indicates value is above previous year’s value

▼ Indicates value is below previous year’s value

\*Hepatitis A is excluded from HP2020 objective comparisons as Tennessee measures receipt of one dose, while the HP2020 objective goal references two doses.

## Racial Disparity

Black children were less likely to be fully immunized for all twelve of the recommended CDC vaccinations, the difference being more prominent in DTaP, HIB, 4:3:1:FS:3:1:FS, Influenza, and RTV compared to their white peers. Completion of the full childhood series (4:3:1:FS:3:1:FS) has been consistently lower for black children than white children, a difference that was statistically significant in 2021. The series completion rate was 15.8% lower among black children (61.9%) when compared to white children (77.7%). Additionally, in 2021, 35.0% of black children received at least two doses of influenza vaccine compared to 58.3% of white children.

## Influenza Vaccination

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 their second birthday. Influenza rates among children increased in 2020 and followed suit in 2021 with two dose coverage increasing from 51.3% to 54.6% and three dose coverage increasing from 31.3% to 32.7%.

### **Trends in Vaccination Refusals**

In 2021, vaccine refusals increased from 2.7% to 3.1% (44/1495). The percentage of children who did not receive one or more vaccinations due to medical reasons remained consistently low (<1.0%), while religious and philosophical refusals have continued to fluctuate. In 2021, 1.1% (n=17) of refusals were religious refusals and 1.7% (n=26) were philosophical.

### **Discussion**

Tennessee currently meets three of the 12 HP2020 objectives but does not meet the three HP2030 targets for 24-month-old children. While vaccination rates among children in Tennessee have increased in recent years, the COVID-19 pandemic has had a considerable negative impact on the vaccination rate of children. Tennessee has seen month-over-month decreases in immunization rates in 24-month-old children in 2021 in comparison to 2019 and 2020, with decreases as low as 26% in some months. The results from this report represent the current impact that the COVID-19 pandemic has had on Tennessee immunization rates. Should this trend continue in coming years state and local communities could find themselves at risk for increased morbidity and mortality from vaccine preventable diseases. Efforts should be made to provide vaccinations to children who have fallen behind with routine childhood vaccinations for Tennessee to minimize outbreak risk of highly infectious, yet vaccine-preventable, diseases. Providers are encouraged to recall patients who have missed vaccinations and provide vaccinations at every opportunity, regardless of the reason for an office visit. Efforts around immunization education, addressing vaccine hesitancy and countering vaccine misinformation, are important. Vaccine refusals increase risk for morbidity and mortality from vaccine-preventable diseases.

## Introduction

An annual Immunization Status Survey of 24-month-old Children in Tennessee is conducted by the Tennessee Department of Health's (TDH) Vaccine-Preventable Diseases and Immunization Program (VPDIP) to track progress toward achieving at least 90% on-time immunization with each routinely recommended vaccine for before age two years. The survey is composed of random, statistically valid samples drawn from birth certificates of infants born in each of the 13 health department regions, which are aggregated to give statewide statistics on immunization coverage rates in Tennessee.

### Safety and Efficacy of Immunizations

The United States has the safest and most effective vaccine supply in its history. Prior to licensure, rigorous clinical trials are carried out by the vaccine manufacturers and reviewed by the Food and Drug Administration (FDA). Vaccines are recommended only when proven to be safe, effective, and beneficial. After licensure, vaccines continue to be monitored for rare adverse reactions. The majority of vaccinated children never experience an adverse reaction. The most frequently reported adverse reactions are minor and include soreness at injection site, a rash, or a mild fever that subsides within a one to two days.<sup>3</sup>

Vaccines help the body build immunity against disease. Because of the success of vaccines, many diseases that were historically commonplace have become rare or have been eliminated from the United States. By vaccinating a child, benefits also extend to others. Individuals who cannot develop immunity from vaccines, have medical conditions that do not allow them to be vaccinated, and babies who are too young to be vaccinated rely on the immunity of those around them to protect them from serious infectious diseases.<sup>4</sup>

### Value of Immunizations

Timely routine vaccination of children protects community health, prevents outbreaks, and saves money and 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. In Tennessee, over 600 providers across the state are administering VFC vaccines and there is at least one VFC provider in each of Tennessee's 95 counties. The CDC has reported that the routine vaccines already given to U.S. children born between 1994 and 2018 **will prevent an average of 419 million childhood illnesses and prevent the premature death of 936,00 of these children over their lifetimes.**<sup>5</sup> The CDC calculates that vaccination of each U.S. birth cohort according to the current immunization schedule yields a net savings of nearly \$406 billion in direct medical costs and \$1.9 trillion in total costs to society.<sup>6</sup> With roughly two percent of the U.S. population living in Tennessee, this suggests Tennessee has benefitted from the prevention of approximately 8.4 million cases of disease in the past decade, with **annual savings of \$8.1 billion in direct medical costs and \$38 billion in total costs to society.**

In Tennessee specifically, 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.<sup>7,8</sup> These diseases not only place Tennesseans at risk for significant morbidity and mortality, but 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.

**Vaccines Assessed**

This survey assesses vaccine completion according to the Advisory Committee on Immunization Practices’ (ACIP) recommendations for protection against ten serious illnesses before the age of 24 months: diphtheria, tetanus, pertussis (combined as DTaP), poliomyelitis (IPV), measles, mumps, rubella (combined as MMR), *Haemophilus influenzae* type B (HIB), hepatitis B (HBV), varicella (VAR), and pneumococcus (PCV). Combined, these are known as the 4:3:1:FS:3:1:FS series.<sup>9</sup> Additionally, this survey analyzes completion of hepatitis A (HAV), rotavirus (RTV), and seasonal influenza (Flu) vaccines.

Table 1. ACIP List of Diseases to Prevent through Vaccination of Children < 24 Months of Age

<b>Disease(s)</b>	<b>Possible complications of disease</b>
<b>Diphtheria, Tetanus, Pertussis</b>	<i>Diphtheria</i> : upper airway obstruction, pneumonia, respiratory failure, death
	<i>Tetanus</i> : spasms of respiratory and skeletal muscles, death
	<i>Pertussis</i> : outbreaks; severe, long-term cough, vomiting, breathlessness, death in infants
<b>Poliomyelitis</b>	Paralysis, death
<b>Measles, Mumps, Rubella</b>	<i>Measles</i> : outbreaks; ear infections, pneumonia, cardiac and neurologic problems, encephalitis, death
	<i>Mumps</i> : outbreaks; decreased fertility, meningitis, arthritis, hearing impairment
	<i>Rubella</i> : arthritis, encephalitis, birth defects
<b><i>Haemophilus influenzae</i> type B</b>	Pneumonia, meningitis, neurologic problems, death
<b>Hepatitis B</b>	Fulminant hepatitis, jaundice, liver cancer, cirrhosis, premature death
<b>Varicella (chickenpox)</b>	Rash illness, severe disease in immunocompromised, birth defects, encephalitis, death
<b>Pneumococcus (certain strains)</b>	Ear infections, pneumonia, meningitis, blood stream infections, death
<b>Hepatitis A</b>	Outbreaks: fever, nausea, jaundice, death
<b>Influenza</b>	Outbreaks: secondary pneumonia, exacerbation of chronic diseases, hospitalizations, death
<b>Rotavirus</b>	Outbreaks in daycare settings, dehydration, hospitalization, death

**Special Vaccine Considerations**

***Hepatitis A vaccine (HAV)***

HAV is a two-dose series, starting on or after the first birthday. As the recommended dose spacing is six months, 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. HAV will not be compared to HP2020 objectives in this report, as the HP2020 objective reflects completion of the 2-dose series. Tennessee was one state impacted by a multi-state epidemic of acute hepatitis A that began in 2017 and spanned more than two and a half years. Over the course of the outbreak, 3,036 Tennesseans were infected, 1,839 were hospitalized, and 28 died as a result of their illness.

## IMMUNIZATION STATUS SURVEY – 2021

### ***Hepatitis B vaccine (HBV) birth dose***

In 2016, the CDC revised its guidance to recommend routine administration of a hepatitis B birth dose within 24 hours of life (rather than prior to hospital discharge). A birth dose of hepatitis B vaccine is defined in the Immunization Status Survey of 24-month-old Children as a dose given within the first three days of life. Birth dose hepatitis B is a key strategy to eliminate transmission of the hepatitis B virus from an infected mother to her infant. The Vaccine Preventable Diseases and Immunizations Program (VPDIP) manages the cases of more than one hundred infants who are exposed to the hepatitis B virus through their infected mothers each year. These infants are at high risk of chronic liver disease and early death, which can be avoided with appropriate vaccination.

### ***Influenza vaccine (FLU)***

Influenza vaccine (FLU) is given annually to children aged six months and older; two doses should be given during a child's first influenza season. Because protection is conferred only after two doses, this survey measures the proportion of children who have received two or more doses by their second birthday. The vast majority of children who die each year from influenza failed to receive an annual influenza vaccination.

### ***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 25<sup>th</sup> month of life in order to be considered complete and on-time. This classification by HIB products administered reduces the degree of overestimation of on-time completion demonstrated by past reports.

### ***Rotavirus vaccine (RTV)***

As with HIB vaccine, two rotavirus vaccine products are available with different dosing schedules. Rotateq<sup>®</sup> (Merck), requires three doses; Rotarix<sup>®</sup> (GSK) requires two doses. Mixed brand schedules require three 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.

## **Healthy People 2020 objectives**

Healthy People 2020 (HP2020) objectives were established by the federal Department of Health and Human Services (HHS) to provide national targets for population health that were to be achieved prior to January 1, 2020. These objectives included vaccine coverage rates among children 19-35 months of age and were tracked nationally through the National Immunization Survey (NIS). Although HP2020 ended, TDH continues to strive to reach or exceed each of these targets as quickly as possible and maintain those high rates of immunization coverage among children.

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

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

## Healthy People 2030 Objectives

Healthy People 2030 (HP2030) objectives are established by the federal Department of Health and Human Services (HHS) to provide national targets for population health to be achieved prior to January 1, 2030. These objectives include vaccine coverage rates among children 2 years of age and are tracked nationally through the National Immunization Survey (NIS). TDH aims to reach or exceed each of these targets as quickly as possible and maintain those high rates of immunization coverage among children.

The following objectives for the percentage of children immunized by 2 years of age have been established by HP2030 and are relevant comparisons to the results of this survey:

- 90% complete DTaP vaccination with four or more doses
- 90.8% complete MMR vaccination with one or more doses
- ≤1.3% of children receive 0 doses of recommended vaccinations

Although HP2030 has established new objectives, Tennessee did not meet all objectives of HP2020 and will continue to use relevant HP2020 objectives as comparison measures in this report.

## Methods

The survey is composed of random, statistically-valid samples drawn from birth certificates of 121 infants born during the first quarter of 2019 in each of Tennessee's 13 public health jurisdictions. These children celebrated their second birthdays between January 1 and March 31, 2021. Oversampling for black children (n=21) 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 2019 in that region. Vaccine information made available through the Tennessee Immunization Information System (TennIIS) for all sampled children is provided to local or state public health staff. The staff attempted to locate each child and confirm immunization histories with parents or guardians and healthcare providers. All information is tracked in a secure, online database system, REDCap. Statewide immunization rates are calculated, as well as rates for the six major metropolitan counties and seven rural regions. County rates within the rural regions are not calculated due to the small number of children sampled in each county. Complete on-time immunization in the 2021 survey of Tennessee 24-month-old children is defined as receipt of four doses of diphtheria, tetanus, and acellular pertussis (DTaP) vaccine, three doses of inactivated polio virus (IPV) vaccine, one dose of measles, mumps, and rubella (MMR) vaccine, three *or* four doses of *Haemophilus influenzae* type b (HIB) vaccine (depending on brand received) *or* any child clinically considered complete for HIB based on the CDC's "catch-up" schedule, three doses of hepatitis B (HBV) vaccine, one dose of varicella (VAR) vaccine and four doses of pneumococcal conjugate (PCV) vaccine *or* any child considered complete for PCV based on the CDC's "catch-up" schedule. Combined, these are known as the 4:3:1:FS:3:1:FS series. Additionally, this survey analyzes hepatitis A vaccine (HAV), rotavirus vaccine (RTV), and seasonal influenza (Flu) vaccines.

### Vaccine Completion Logic

Complete on-time immunization in this survey is defined as having received four doses of DTaP vaccine, three doses of IPV vaccine, one dose of MMR vaccine, three *or* four doses of HIB vaccine (depending on brand received *or* any child clinically considered complete on a "catch-up" schedule), three doses of HBV vaccine, one dose of VAR vaccine and four doses of PCV vaccine (*or* any child considered complete for PCV based on the CDC's "catch-up" schedule).

This survey accounts for the vaccine brand, if known, and classifies a child as complete only if the appropriate number of doses have been administered. If any documented HIB dose was given as the four-dose product, then only receipt of four doses was considered as a complete series. In the absence of documentation of vaccination brand, receipt of four doses of HIB is classified as series completion. Likewise, if any documented RTV dose was

## IMMUNIZATION STATUS SURVEY – 2021

given as the three-dose product, then only receipt of three doses was considered as a complete series. In the absence of documentation of vaccination brand, three doses of RTV is classified as series completion. 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.

In 2019, additional analyses were included to account for the HIB and PCV catch-up schedules. Prior to 2019, counts of vaccinations were used to calculate series completion for both HIB and PCV; however, this inaccurately captured completion for these vaccines due to the unique vaccination schedules that exist when a child receives their first dose after the recommended age, but prior to 24 months. By assessing completion based upon requirements for the age of first vaccination, HIB and PCV completeness more accurately mirrors ACIP forecasting and clinical decision-making.

Table 2. Catch-Up Guidance for PCV and HIB, Centers for Disease Control and Prevention<sup>10</sup>

Age at Dose 1	Age at Dose 2	Age at Dose 3	Recommendation
<b>PCV</b>			
< 12 months old	< 12 months old	< 12 months old	<b>Needs 4th dose 8 weeks later</b>
< 12 months old	Between 7-11 months old		<b>Needs 3rd dose 8 weeks later</b>
> 12 months old			<b>Needs 2nd dose 8 weeks later</b>
24-25 months			<b>No additional dose needed</b>
<b>HIB</b>			
< 12 months old	< 12 months old	< 12 months old	<b>Needs 4th dose 8 weeks later</b>
< 12 months old	Between 12-14 months old		<b>Needs 3rd dose 8 weeks later</b>
< 12 months old	> 15 months old		<b>No additional dose needed</b>
Between 12-14 months			<b>Needs 2nd dose 8 weeks later</b>
> 15 months old			<b>No additional dose needed</b>

### Program Enrollment

The survey captures the immunizing provider type (public, private or both), TennCare (Medicaid) participation, and enrollment in the Women, Infants and Children (WIC) nutrition program for each child. 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.

### Statistical Notes

The survey is designed to allow valid statistical comparisons of the populations in each of the 13 health department regions; 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 grey bands on the 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-estimates being compared have at least a 95% chance of representing true differences in the populations being compared (statistically significantly different). When CIs overlap, differences are not considered to be statistically significant.

### **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, use of the results of this survey for county-level estimates is not appropriate.

## **Results**

### **The 2021 Sample Population**

The statewide sample consisted of 1,571 children and an additional 21 oversampled black children for inclusion in the racial disparity analysis. Children who moved out of the state, for whom the birth record was sealed (e.g., through adoption or placement in foster care), for whom the parents or guardians refused to participate in the survey, and children who had died were excluded from the survey. Of the 1,571 sampled births, 97 records were excluded from the final analysis: parents of 14 refused to participate; 74 had moved out of state; and eight had been adopted, placed in foster care or were in state custody. None of the 21 oversampled children were excluded from the racial disparity analysis. The point estimates reported in this survey were based upon the 1,495 analyzed sample population: the 1,571 sampled births minus the 97 excluded records. When reporting on racial analysis, the oversampled population is included in the denominator. Due to small sample size, children of other races (n=31 or 2.1% of children sampled) were not included in analysis. The final number of children included in the racial analysis sample was 1,464 (1,495 + 21 oversampled records – 31 other races = 1,464 total records).

The children sampled were 80.7% white, 17.2% black, and 2.1% other races. Of these, 7.5% (n=112) considered themselves Hispanic/Latino. This survey does not differentiate between Hispanic whites and non-Hispanic whites; for that reason, racial disparity based upon Hispanic ethnicity was not analyzed. The majority (82.2%) of children received all their vaccinations from a private medical provider, while 10.2% received vaccinations from both a health department and a private medical provider. Another 2.3% of children received vaccinations at a health department alone and 5.3% of children did not report they had received vaccinations. Of the children sampled, 51.4% had been enrolled in TennCare, 66.1% had been enrolled in WIC, and 47.4% had been enrolled in both TennCare and WIC.

Over one-third (32.1%) of all mothers of sampled children had a high-school diploma, 0.4% had an unknown education level, 11.4% had less than a high-school diploma, and 56.1% had more than a high-school diploma. The father's education level was unknown for 15.0%, 10.6% had less than a high-school diploma, 30.2% had a high-school diploma, and 44.2% had more than a high-school diploma. Of the 1,495 children, 580 (39.3%) had no siblings, 464 (31.4%) had one sibling, and 433 (29.3%) had two or more siblings. The number of siblings is known to negatively impact completion of vaccinations.

IMMUNIZATION STATUS SURVEY – 2021

Table 3. Demographics of 2021 sample population, including oversampled black children (n=1495)

<b>Race</b>			<b>Vaccination Source</b>		
	<b>N</b>	<b>%</b>		<b>N</b>	<b>%</b>
Black	257	17.2	Private Medical Provider	1214	82.2
White	1207	80.7	Health Department	34	2.3
Other	31	2.1	Both	151	10.2
Hispanic*	112	7.5	Missing	78	5.3
<b>Siblings</b>			<b>Program Enrollment</b>		
	<b>N</b>	<b>%</b>		<b>N</b>	<b>%</b>
0	580	39.3	WIC	988	66.1
1	464	31.4	TennCare	769	51.4
2+	433	29.3	Both	709	47.4
<b>Maternal Education</b>			<b>Paternal Education</b>		
	<b>N</b>	<b>%</b>		<b>N</b>	<b>%</b>
Unknown	6	0.4	Unknown	224	15.0
< High School Diploma/ GED	171	11.4	< High School Diploma/ GED	158	10.6
High School Diploma/ GED	480	32.1	High School Diploma/ GED	452	30.2
> High School Diploma/ GED	838	56.1	> High School Diploma/ GED	661	44.2

\*This survey does not distinguish between Hispanic whites and non-Hispanic whites.

**Vaccine Refusals**

There were 44 (2.9%) documented vaccine refusals reported among the analyzed records (Table 4). Seventeen parents claimed religious exemption, 26 claimed philosophical objection, and 1 claimed medical exemptions. Regionally, vaccine-refusals ranged from 0.7% to 7.0% of the sampled populations. Fifteen of the 44 children whose parent’s refused vaccines were partially immunized (ranging from 1-22 total doses). Parents of one of the seven partially immunized children cited religious reasons, seven cited philosophical reasons, and one cited a medical reason for refusal of vaccines.

Over the past several years, the percentage of parents refusing immunizations has fluctuated, but there has been an annual incremental increase overall. While medical refusals have remained consistent over the past five years (≤ 0.5% of refusals per year), refusals for philosophical and religious reasons have increased, with religious exemptions increasing at a higher rate than philosophical exemptions (Figure 1). In 2015, parents of 10 (0.7%) children claimed religious exemption compared to 17 (1.1%) in 2021, and parents of 17 (1.1%) children claimed philosophical exemption compared to 26 (1.7%) in 2021.

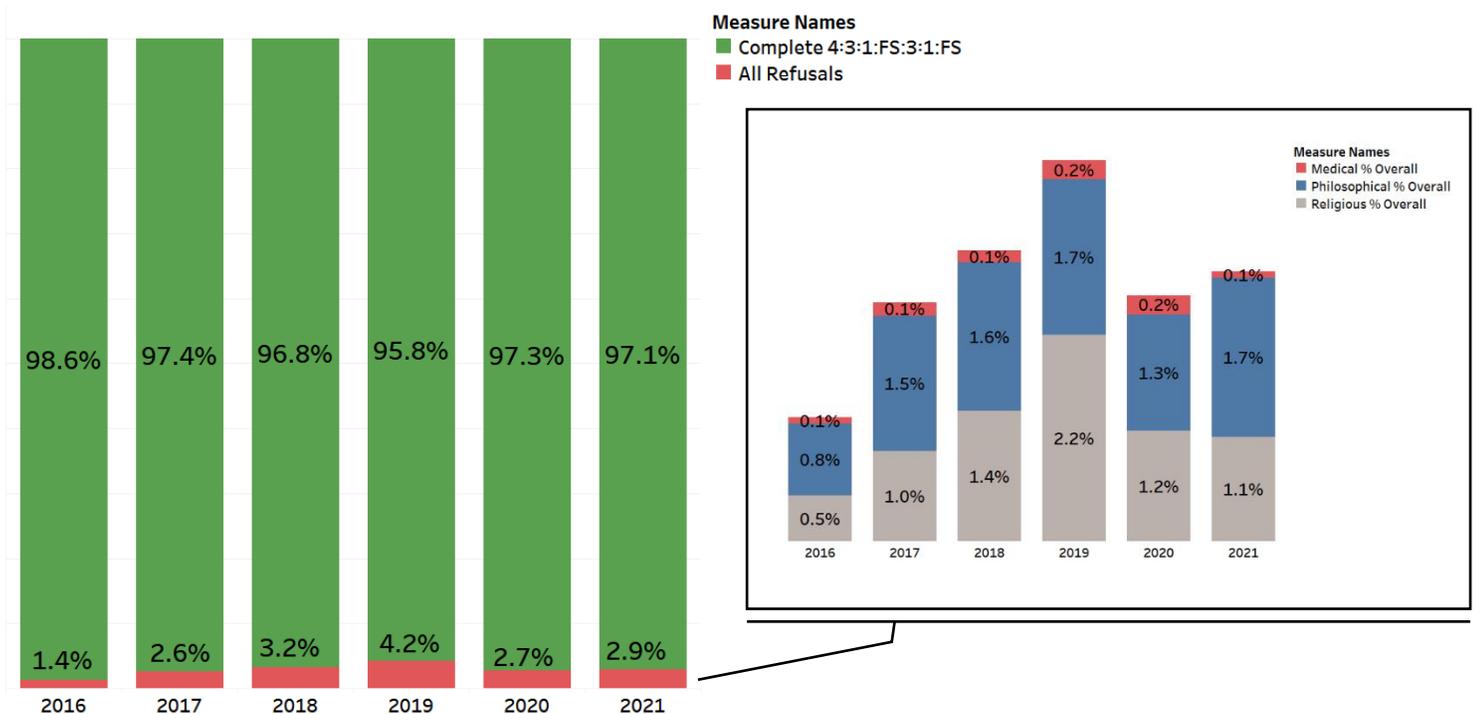
Tennessee TCA 1200-14-01-.29 describes minimum immunization requirements for attending childcare, pre-school, and public school. The state’s immunization requirements follow the current schedule published by the Centers for Disease Control and Prevention (CDC) and endorsed by the American Academy of Pediatrics (AAP) and American Academy of Family Physicians (AAFP). All 50 states have legislation requiring specified vaccines for students, including for attendance at childcare centers. Although some survey respondents claim philosophical exemption Tennessee is one of 35 states that does not allow philosophical objection or “personal belief exemption” as a reason for a child entering childcare or public school to be un- or under-vaccinated Therefore, parents of 24 month old children surveyed who claimed philosophical objection to vaccines must choose to declare a religious exemption or provide their children with the required vaccinations prior to school entry. Notably, **there are no major religions, apart from those that use prayer in lieu of medicine, that have tenets that object to vaccinations.**

IMMUNIZATION STATUS SURVEY – 2021

Table 4. Vaccine Refusal Reasons by Region, Tennessee, 2021 (n=1495)

Region	N	Religious	%	Philosophical	%	Medical	%	Total	%
MSR	127	-	-	-	-	-	-	-	-
WTR	117	1	0.9	1	0.9	-	-	1	1.8
JMR	114	2	1.8	1	0.9	-	-	3	2.7
SCR	119	3	2.5	-	-	-	-	3	2.5
MCR	117	-	-	4	3.4	-	-	4	3.4
NDR	103	-	-	-	-	-	-	-	-
UCR	118	-	-	6	5.1	-	-	6	5.1
SER	110	1	0.9	4	3.6	1	0.9	5	5.4
CHR	115	1	0.9	-	-	-	-	1	0.9
ETR	118	3	2.5	1	0.9	-	-	4	3.4
KKR	115	3	2.6	5	4.4	-	-	8	7.0
NER	112	-	-	3	2.7	-	-	3	2.7
SUL	110	3	2.7	1	0.9	-	-	4	3.6
STATE	1495	17	1.1	26	1.7	1	0.1	44	2.9

Figure 1. Six-Year Trend of refusals by reason, Tennessee, 2021.



**Unable to Locate**

Of the 1,495 children included in the survey, 57 had incomplete information in the Tennessee Immunization Information System (TennIIS) and could neither be located nor confirmed as having moved out of state. Overall, 0.8% (2/257) of black children and 12.9% (4/31) of other races were unable to be located, compared to 4.2% (51/1207) of white children. (See Table 5 for the breakdown of those unable to be located by region.)

IMMUNIZATION STATUS SURVEY – 2021

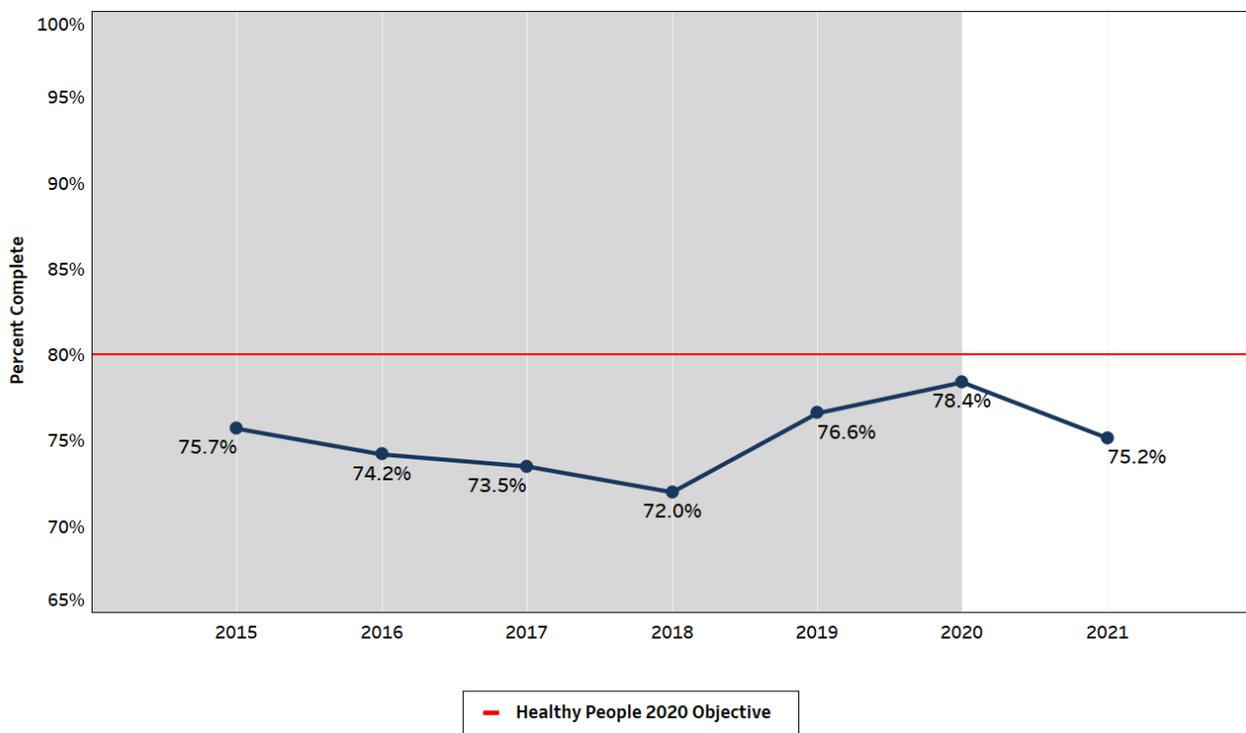
Table 5. Unable to Locate (UTL) by Region, Tennessee, 2021

Region	MSR	WTR	JMR	SCR	MCR	NDR	UCR	SER	CHR	ETR	KKR	NER	SUL	STATE
<b>Number sampled</b>	127	117	114	119	117	103	118	110	115	118	115	112	110	1495
<b>UTL</b>	2	-	3	15	6	2	10	2	-	3	5	6	4	57
<b>%</b>	1.6	-	2.6	12.6	5.1	1.9	8.5	1.8	-	2.5	4.3	1.7	3.6	3.8

**Statewide Results**

Complete 4:3:1:FS:3:1:FS series rates from 2015-2021 are shown in Figure 2. Complete 4:3:1:FS:3:1:FS series rates have fluctuated over the past decade but Tennessee has not met the HP2020 objective. Prior to the COVID-19 pandemic, Tennessee had observed the highest 4:3:1:FS:3:1:FS series completion in the past decade. This is likely due to change in methodology when determining completion of the 4:3:1:FS:3:1:FS series. Starting in 2020, 4:3:1:FS:3:1:FS series rates included catch-up HIB and catch-up PCV completion for those who received first dose after the ACIP recommended age but before 24 months. Years prior to the change in methodology are shaded in the figure below. The effects of the COVID-19 pandemic have negatively impacted the 4:3:1:FS:3:1:FS series completion rate and previous improvements have been lost.

Figure 2. 4:3:1:FS:3:1:FS Immunization Rate Trends, Tennessee, 2015-2021



IMMUNIZATION STATUS SURVEY – 2021

**Full Series**

The overall statewide coverage estimate for the full, recommended 4:3:1:FS:3:1:FS series was 75.2% (95% CI, 72.9-77.4) and is shown in Figure 3. The light blue bars represent the individual antigens that make up the 4:3:1:FS:3:1:FS series, the navy bar is the 4:3:1:FS:3:1:FS, and the dark grey bars represent the additional antigens assessed in the survey. The red lines represent HP2020 objectives for each antigen assessed and the lighter grey bands represent the 95% Confidence Intervals (CI). As shown in Figure 5, Memphis-Shelby County and Sullivan County regions were statistically significantly different from the statewide completion rate at 60.8% (95%CI, 52.0-69.7) and 86.5% (95%CI, 79.9-92.9) respectively. Nashville-Davidson County, Southeast, Chattanooga-Hamilton County, Knoxville-Knox County, and Sullivan County health department regions had point-estimates meeting the HP2020 objective of 80%. Appendix 2 contains region-specific charts of coverage rates for each vaccine and the 4:3:1:FS:3:1:FS series.

Figure 3. Percent of 24-month Old Children With On-Time 4:3:1:FS:3:1:FS (point estimate and 95% confidence intervals, n=1495)

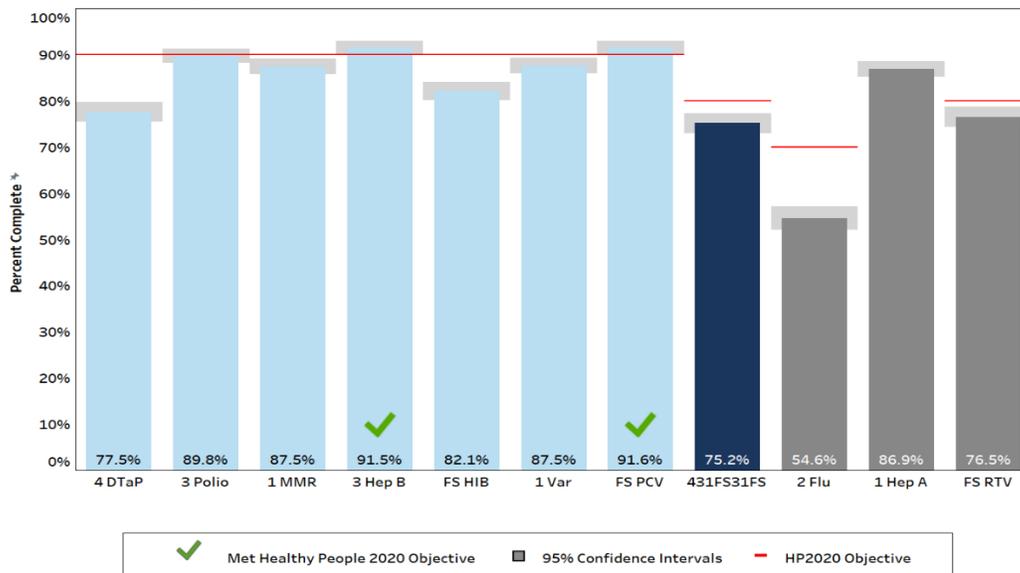


Figure 4. Statewide Trend of Complete 4:3:1:FS:3:1:FS Series, Tennessee, 2015-2021

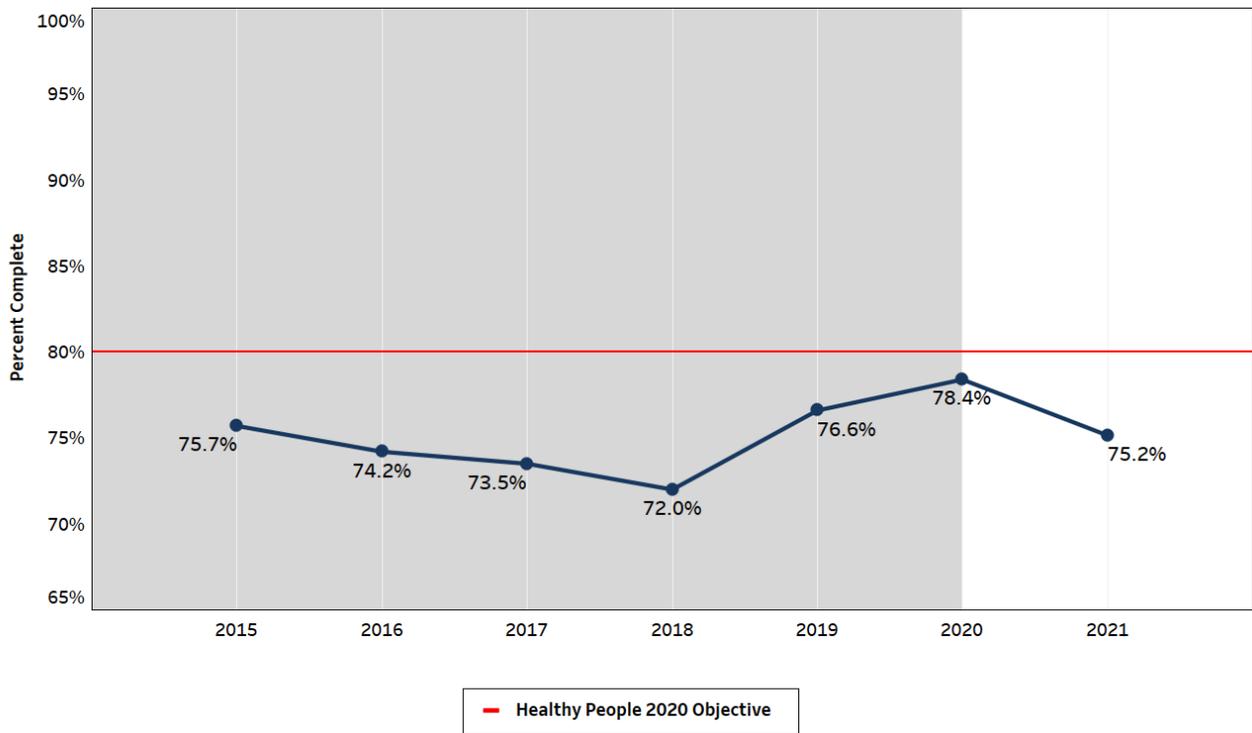
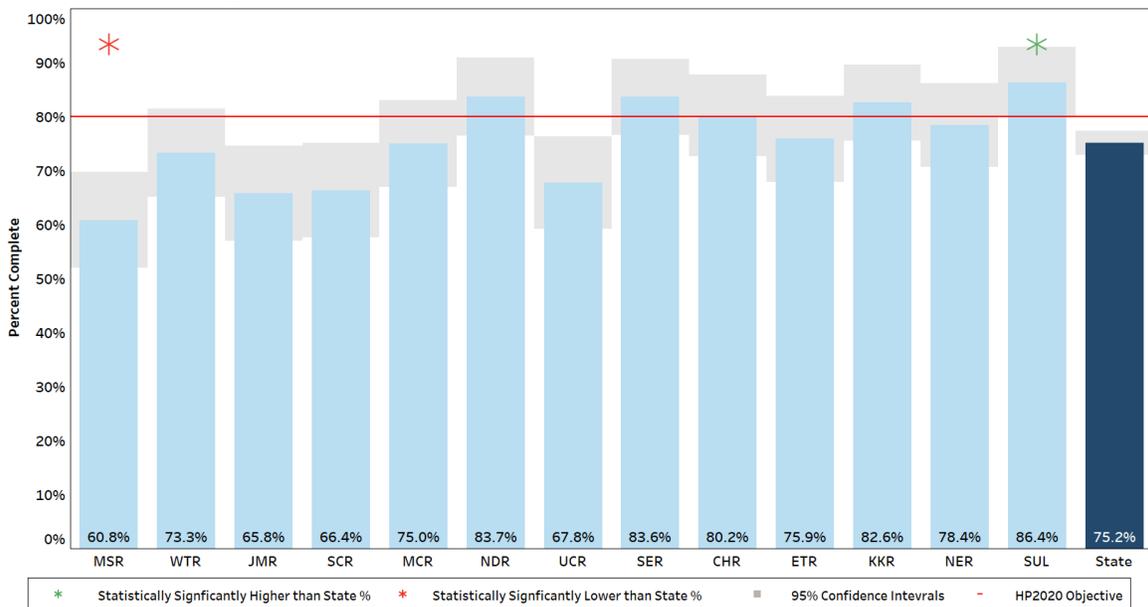


Figure 5. Percent of 24-month Old Children With On-Time 4:3:1:FS:3:1:FS Series by Health Department Region (point estimate and 95% confidence intervals, n=1495)



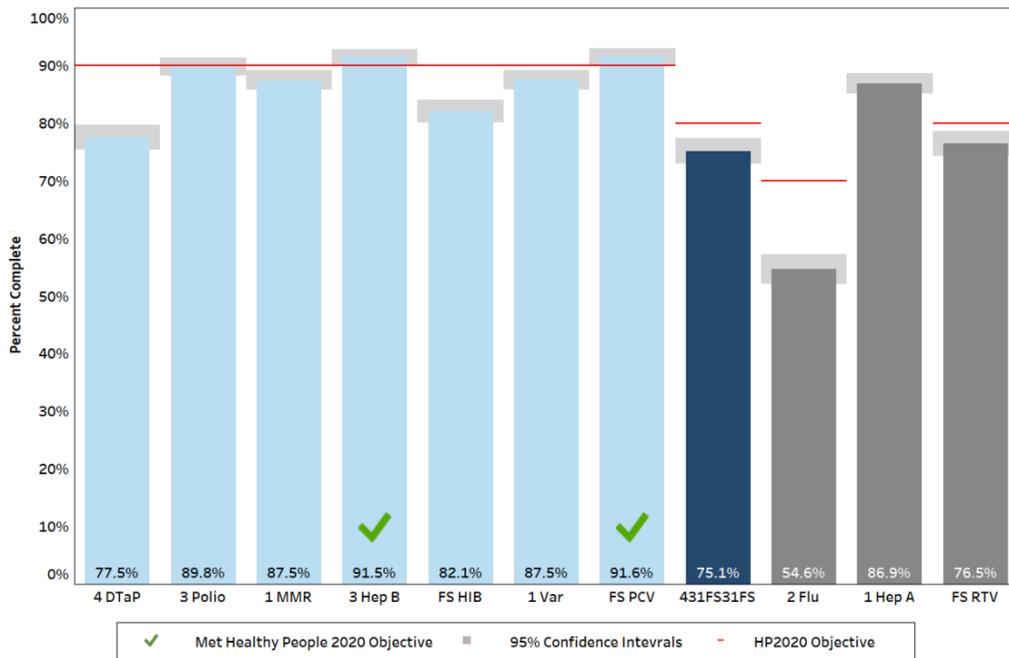
**Progress towards Healthy People 2030 Objectives**

Tennessee did not meet the HP2020 objective of 80% completion of the 4:3:1:FS:3:1:FS series in any year of the past decade. The state also failed to meet this objective for 2021 with the 4:3:1:FS:3:1:FS series completion being 75.2%. In 2021, Tennessee met three out of the twelve HP2020 objectives compared to 2020 where five were met. In 2021, Tennessee did not meet HP2030 objectives for either of the two individual vaccinations evaluated: DTaP above 90% (TN=77.5%) and MMR above 90.8% (TN=87.5%). At 2.3% Tennessee also failed to meet the HP2030 objective of limiting the percentage of children who receive zero doses of recommended vaccines by age two years to 1.3%. When compared to 2020 this is nearly a five-fold increase in the number of children that have received no doses of recommended.

The HP2020 objective for HAV is based upon completion of the two-dose series; however, Tennessee only measures one dose of HAV because children who receive the first dose by their second birthday must wait at least six months before receiving the second dose. As a result, the survey rate is not comparable to the HAV HP2020 objective.

Figure 6 shows the statewide and regional percentages of children immunized on-time with all vaccines in the 4:3:1:FS:3:1:FS series. Among the lowest completed vaccinations are DTaP and HIB, both of which require a final dose after 12 months of age. Influenza vaccination rates remain low with 54.6% of children having received at least two doses. The first dose of HAV vaccine was received by 86.9% (95% CI: 85.1-88.6) of children by 24 months of age.

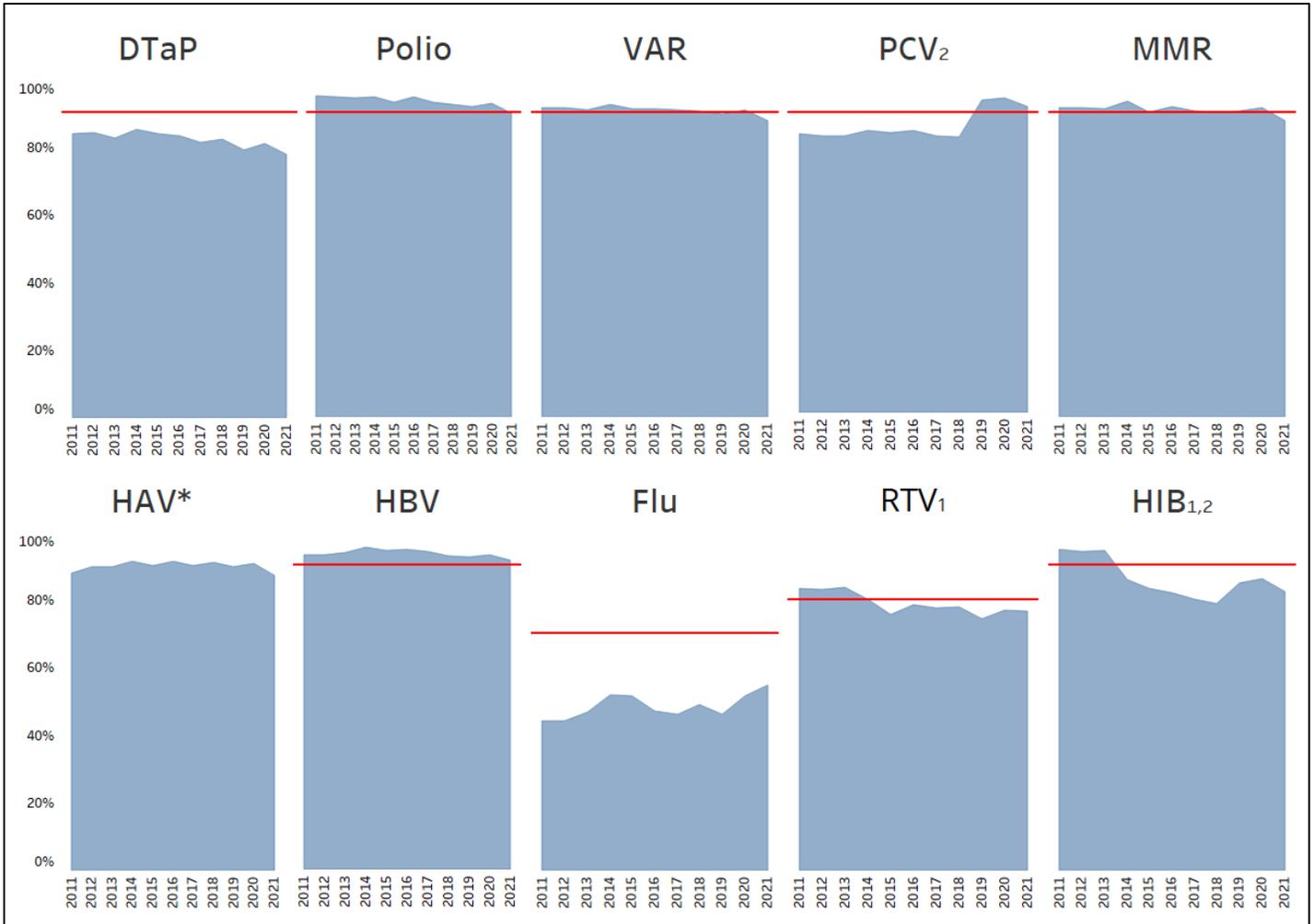
Figure 6. Comparison of Healthy People 2021 Objectives to Vaccination Completion Rates for 24-month Old Children in Tennessee, 2021 (point estimate and 95% CI, n=1495)



IMMUNIZATION STATUS SURVEY – 2021

Figure 7 shows the statewide trend for each individual vaccine series over the past decade. The red lines represent HP2020 objectives for each antigen assessed. Tennessee children have not met the HP2020 objective for DTaP and Influenza anytime in the past decade.

Figure 7. Statewide Trend of Complete Immunization for Individual Vaccines, Tennessee, 2011-2021



— Healthy People 2020 Objective

\*HAV is not compared to HP2020 objectives as the HP2020 objective reflects completion of the two dose series and this survey reflects completion of one dose.

<sup>1</sup>Decreases in RTV and HIB completion immunization rates from 2014 to 2015 likely due to change in methodology to account for vaccination brand

<sup>2</sup>Notable increase in HIB and PCV immunization rates in 2019 and 2020 are likely due to inclusion of children on CDC's catch-up schedule

## Seasonal Influenza Vaccination

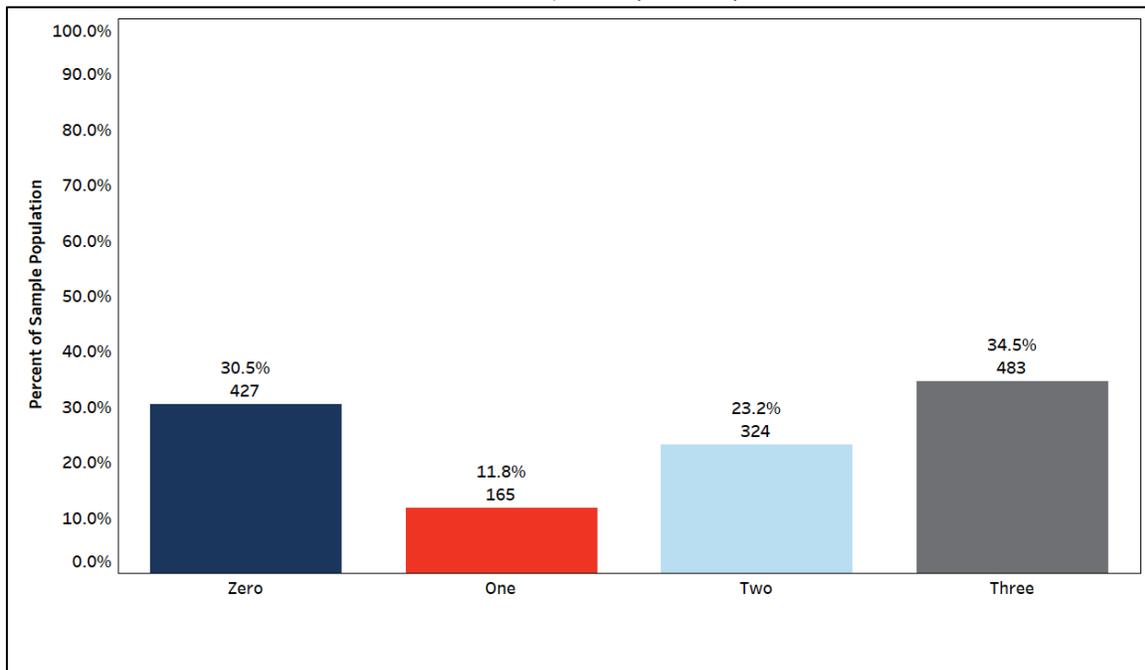
### *Impact on Pediatric Morbidity and Mortality*

Children younger than 2 years old are at high risk of developing serious flu-related complications. These complications include pneumonia, dehydration, exacerbation of chronic illnesses (such as asthma), brain dysfunction (encephalopathy), and death. During the 2019-20 flu season, 199 children were reported as dying from influenza within the United States; however, CDC statistical modeling suggests approximately 434 deaths may have occurred.<sup>11</sup>

The annual seasonal influenza vaccine helps save lives. Influenza vaccine was shown to reduce the risk of pediatric intensive care unit (PICU) admissions by 74% from 2010-2012. During the 2019-2020 flu season, proper flu vaccination of all people prevented an estimated 7.5million influenza illnesses, 3.7 million influenza-associated medical visits, 105,000 hospitalizations, and 6,300 influenza associated deaths<sup>12</sup>. Despite its benefits, influenza vaccine remains the least administered of the recommended immunizations in Tennessee. Only 65.8% of all children surveyed in 2021 had at least one dose of seasonal influenza vaccine, 54.6% had two doses, and 32.7% received the recommended three doses of influenza vaccine prior to the second birthday. Missed influenza vaccinations increase the risk of morbidity and mortality among Tennesseans of all ages.

Figure 8 shows the number of flu vaccines received per child. Flu vaccine is given annually to children aged six months and older; two doses should be given during a child’s first influenza season to confer protection. This survey measures the proportion of children who have received two or more doses by their second birthday. However, an additional dose after the initial two dose series of flu vaccine is recommended for children annually until age seven to be fully covered. As seen in the figure below, children in Tennessee are extremely under-vaccinated with the flu vaccine. The vast majority of children who die each year from influenza failed to receive an annual influenza vaccination.

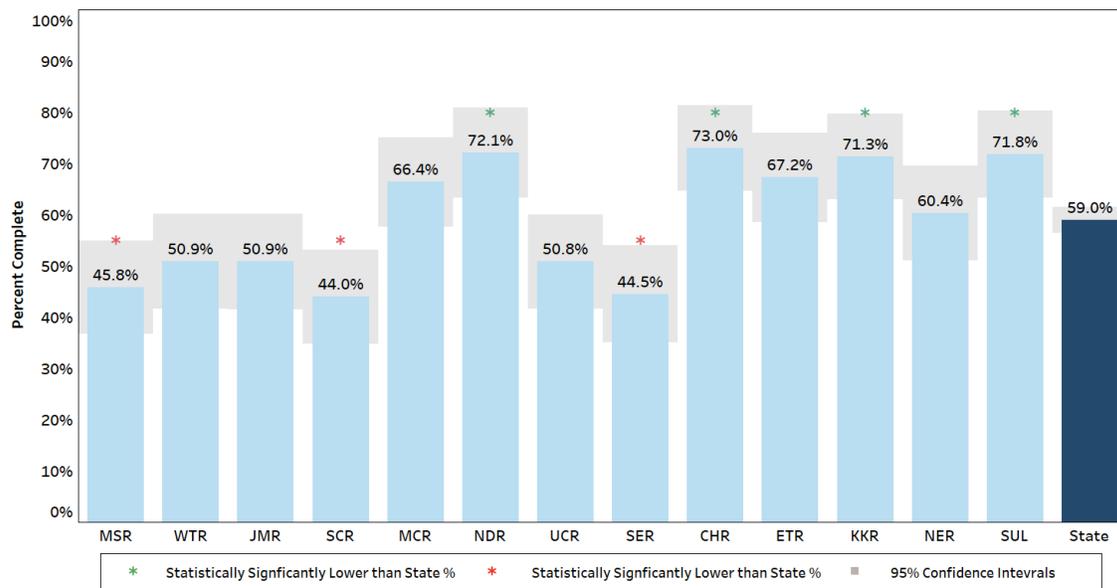
Figure 8. Percentage and Count (mutually exclusive) of Seasonal Influenza Vaccines in the First 24 Months of Age, Tennessee, 2021 (n=1399)



**Seasonal Influenza Vaccine in First Year of Life**

Of the 1,495 children surveyed, 59.0% (95% CI: 56.5-61.5) received their first flu vaccine between 6 months and one year of age. Flu data stratified by region can be seen in Figure 9. Memphis-Shelby County (45.8%, 95% CI: 36.8-54.9), South Central (44.0%, 95% CI: 34.8-53.1), and Southeast (44.5%, 95% CI: 35.1-53.9) were health department regions with statistically-significantly fewer children who received their first dose of influenza vaccine between 6 months and one year of age compared to the state rate. Nashville-Davidson County (72.1%, 95% CI: 63.4-80.9), Chattanooga-Hamilton County (73.0%, 95% CI: 64.6-81.4), Knoxville-Knox County (71.3%, 95% CI: 62.9-79.7), and Sullivan County (71.8%, 95% CI: 63.3-80.4) regions were the health department regions with statistically-significantly more children who received their first dose of influenza vaccine between 6 months and one year of age compared to the state rate.

Figure 9. Percentage of Children Who Received First Dose of Influenza Vaccine in First Year of Life, by Health Department Region, Tennessee, 2021 (point estimate and 95% CI, n=1495)



**Racial Disparity**

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 2019 in that region. All racial analyses included the 21 oversampled children. The 2021 survey population included 257 black and 1,207 white children. Due to small sample size, children of other races (n= 31) were excluded from this analysis. This survey does not differentiate between Hispanic whites and non-Hispanic whites; for that reason, racial disparity involving Hispanic ethnicity was not analyzed. The final sample for racial analysis consisted of 1,464 children.

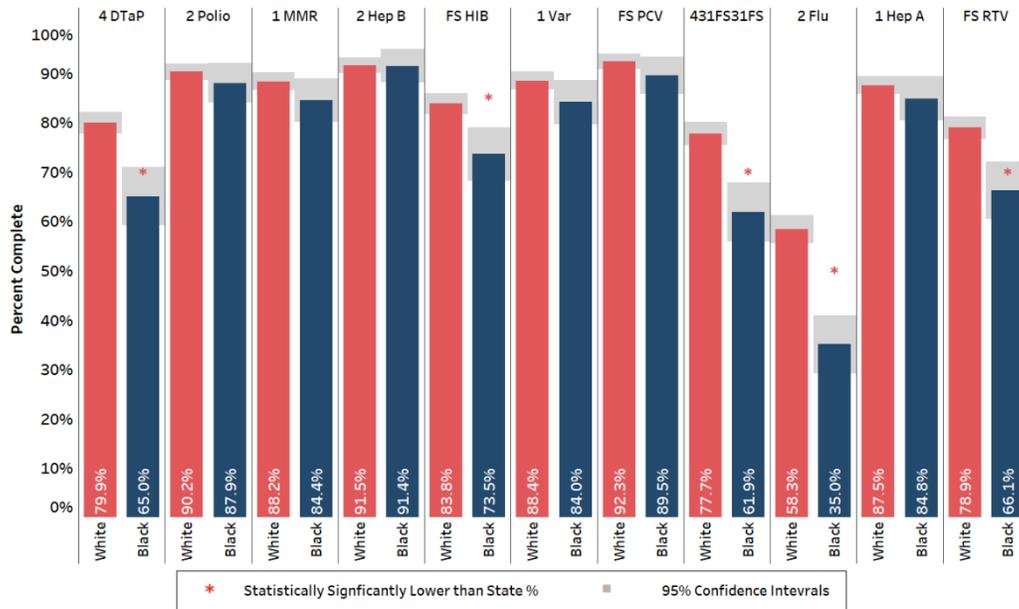
**Black children were less likely to be fully immunized for all twelve of the recommended CDC vaccinations and statistically significantly less likely to receive DTaP, Hib, 4:3:1:FS:3:1:FS, Flu, and RTV compared to their white peers.** Only 66.1% of black children were properly immunized with RTV vaccine compared to 78.9% of white children, and 35.0% of black children were immunized against influenza compared to 58.3% of white children.

IMMUNIZATION STATUS SURVEY – 2021

Of the 1,207 white children, 77.7% (95% CI: 75.4-80.1) completed the 4:3:1:FS:3:1:FS series, while 61.9% (95%CI: 55.9-67.8) of the 257 black children completed the series. Again in 2021 there was an increase in the racial disparity of 4:3:1:FS:3:1:FS immunization rates between black and white children. This gap continues to increase in comparison to previous years and is assumed to have also been severely impacted by the burden of COVID-19. Data comparison of vaccine completion rates and race can be seen in Figure 10. Trends of the 4:3:1:FS:3:1:FS series among black and white children can be seen in Figure 11.

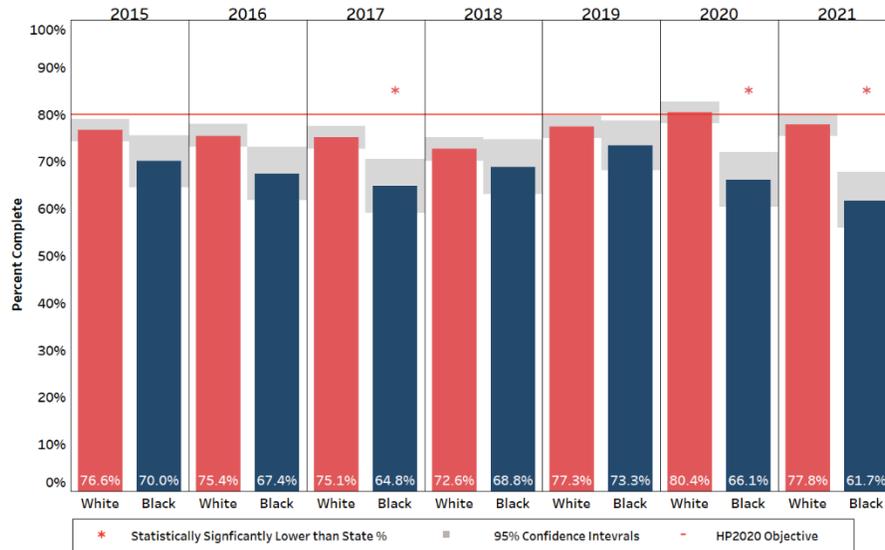
There is much speculation as to what could be causing the racial disparity in the overall 4:3:1:FS:3:1:FS series. It could be due to the consistent disparity in the DTaP completion rates or it could also be due to the frequency of routine doctor visits, WIC participation, etc. The results of the racial disparity analysis in the 2021 Immunization Status Survey warrant further analysis of racial disparity among 24-month-old children in Tennessee. Black children were less likely to be fully immunized on time with DTaP (65.0% black vs. 79.9% white), with this difference being statistically significant. Black children also had statistically significant lower vaccination completion rates for HIB (73.5% black vs. 83.8% white), with this difference being statistically significant. Black children also had statistically significant lower vaccination completion rates for HIB (73.5% black vs. 83.8% white).

Figure 10. Statewide Percentage of Children with Age-Appropriate Immunization Rates, by Vaccine and Race, Tennessee, 2021 (point estimates and 95% Confidence Intervals)



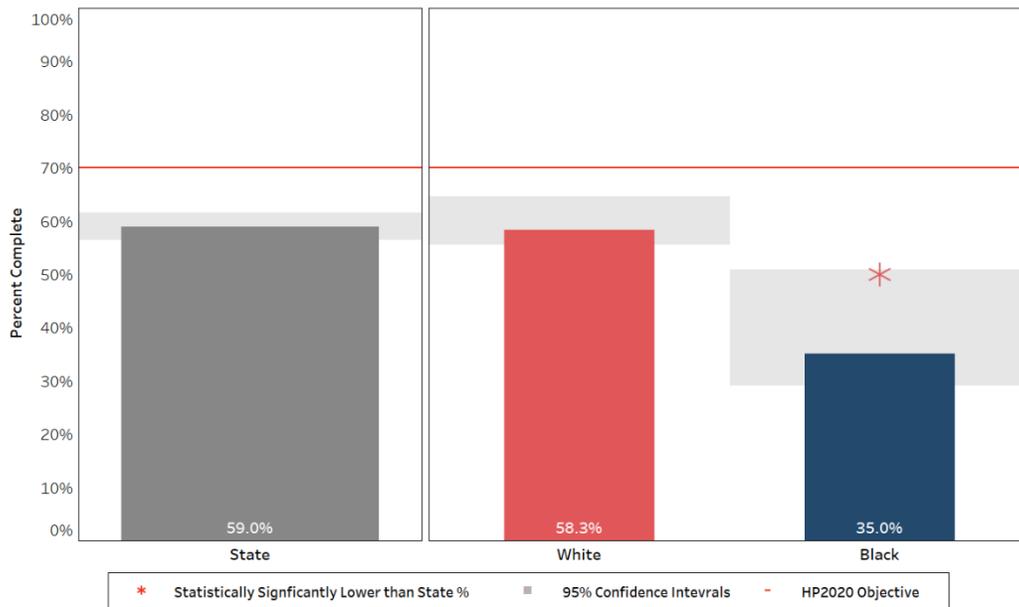
IMMUNIZATION STATUS SURVEY – 2021

Figure 11. 4:3:1:FS:3:1:FS Immunization Level Rates, by Race, Tennessee, 2015-2021 (point estimate and 95% CI)



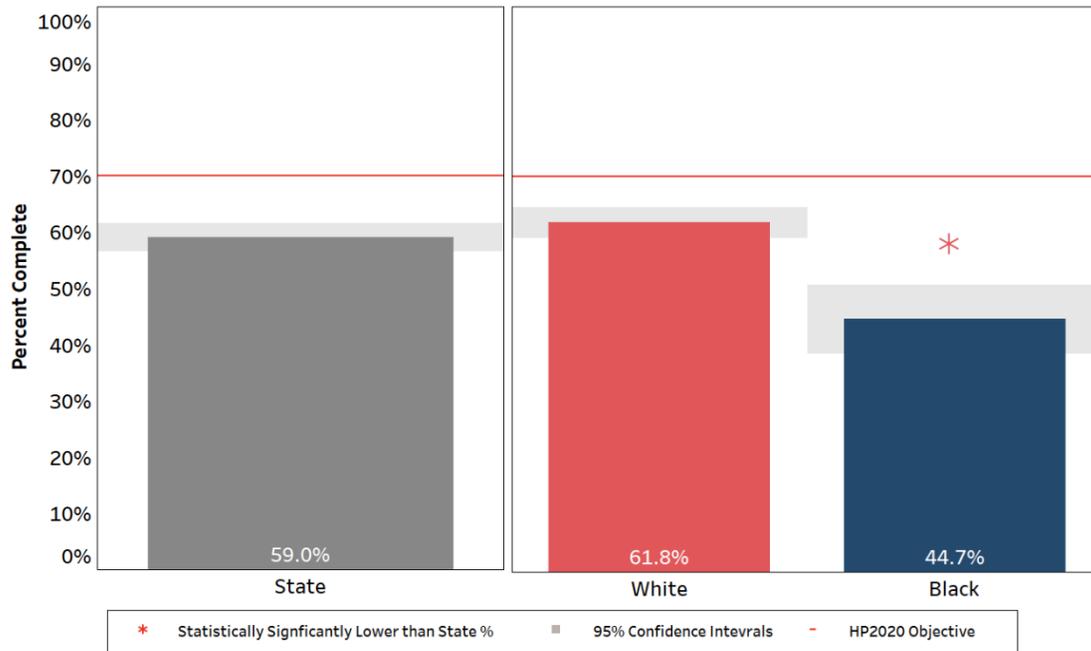
Influenza remains the individual vaccine with the most significant racial disparity. This difference has been documented annually since the first assessment of influenza coverage rates in 2007. In 2021, 35.0% (95% CI: 29.1-40.9) of black children received at least two doses of influenza vaccine compared to 58.3% (95% CI: 55.5-61.1) of white children. This data can be seen in Figure 12. The causes are likely multifactorial for the difference of 23.3%. Strategies to address the protection of this population are needed..

Figure 12. Statewide Percentage of Children with Two-Doses of Seasonal Influenza Vaccine, by Race, Tennessee, 2021 (point estimate and 95% CI, n=1,495)



The ACIP recommends all children over the age of 6 months receive annual influenza vaccine. Of the 1,495 surveyed children, 59.0% received their first dose between 6 months and one year of age. White children were more likely to receive their first dose of influenza vaccine before their first birthday than black children (61.8% compared to 44.7%, respectively). This data can be seen in Figure 13.

Figure 13. Percentage of Children Who Received First Influenza Vaccination in First Year of Life, by Race (point estimate and 95% CI, n=1495)



## Risk Factor Analysis

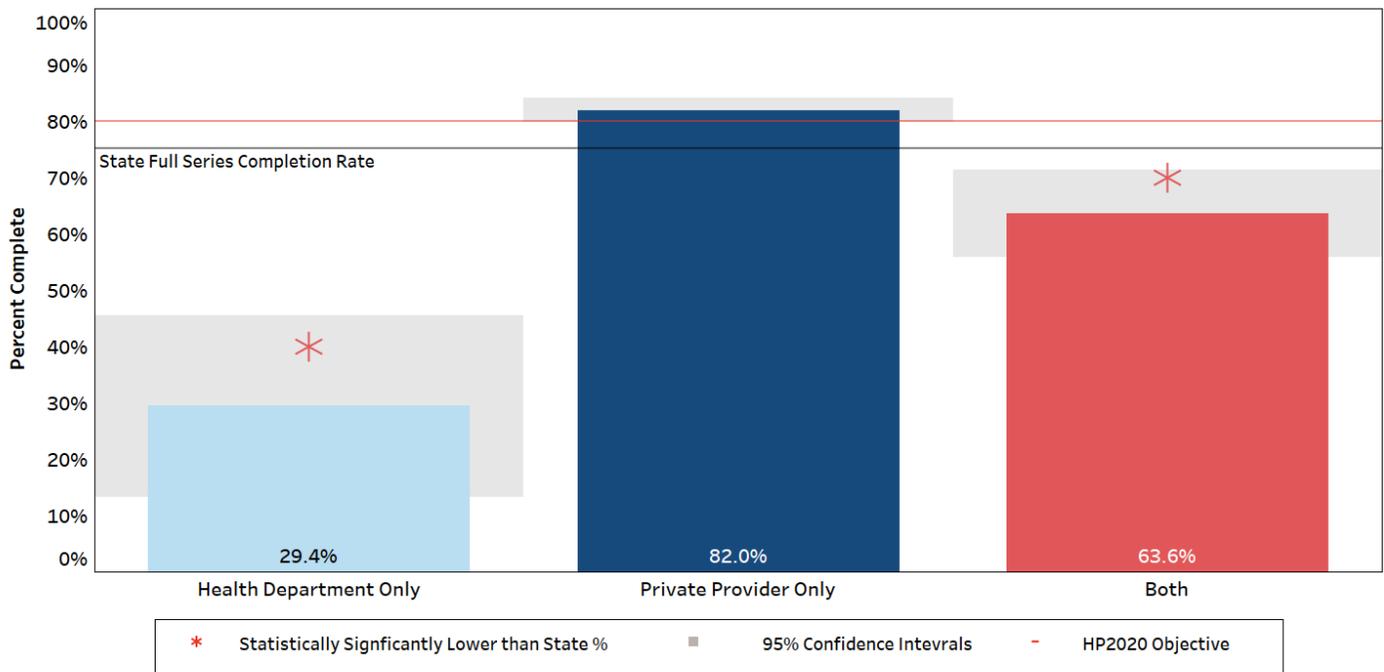
### Insurance Enrollment

Of the 1,495 children included in this survey, 988 (66.1%) were enrolled in TennCare, 769 (51.4%) were enrolled in WIC, and 709 (47.4%) were enrolled in both programs. Enrollment in both programs is permitted therefore the numbers of children enrolled in TennCare and WIC are not mutually exclusive of each other. In 2021, children who were covered by TennCare and WIC had 4:3:1:FS:3:1:FS series completion rates that were not significantly different from their non-enrolled peers. Of those enrolled in TennCare, 74.8% (95% CI: 72.1-77.5) were fully immunized, compared to 75.8% (95% CI: 72.1-79.6) of those not enrolled in TennCare. Similarly, 73.0% (95% CI: 69.8-76.2) of WIC enrollees were complete for the full 4:3:1:FS:3:1:FS series compared to 77.4% (95% CI: 74.4-80.5) of those not enrolled in WIC.

### Immunization Source

Of the children sampled, 1214 (82.2%) were immunized by a private medical provider, 34 (2.3%) children sampled were immunized by a health department only, 151 (10.2%) children sampled were immunized by both a private provider and a health department, and 78 (5.3%) children sampled had records that were missing an immunization source. Children who received vaccines exclusively from a private medical provider were statistically significantly more likely to be fully vaccinated (82.0%) compared to children vaccinated by a health department only (28.4%) or by a combination of private provider and health department (63.6%). This data can be seen in Figure 14.

Figure 14. Comparison of Children Complete for the 4:3:1:FS:3:1:FS Series by Immunization Provider Type, Tennessee, 2021 (point estimate and 95% confidence intervals, n=1495)



Children immunized in health departments were more likely to have risk factors for failure to receive immunizations compared to children who were only immunized by private medical providers. These risk factors include black race, having two or more siblings, and receipt of a first dose of any vaccine (except RTV and birth dose of hepatitis B) after the 120th day of life. This data can be seen in Table 6.

Table 6. Prevalence of Three Risk Factors for Delayed Immunizations, by Provider Type

	Black Race	2 or More Siblings	Age at first dose >120 days*	Any Risk Factor
Immunized Exclusively by Health Department	35.3% (12/34)	35.3% (12/34)	20.6% (7/34)	58.8% (20/34)
Immunized Exclusively by Private Medical Provider	15.2% (184/1214)	28.0% (340/1214)	2.0% (22/1214)	38.3% (465/1214)
Immunized by Health Department and Private Provider	24.5% (37/151)	35.1% (53/151)	6.0% (9/151)	51.7% (78/151)

\*excluding RTV and birth dose of Hep B

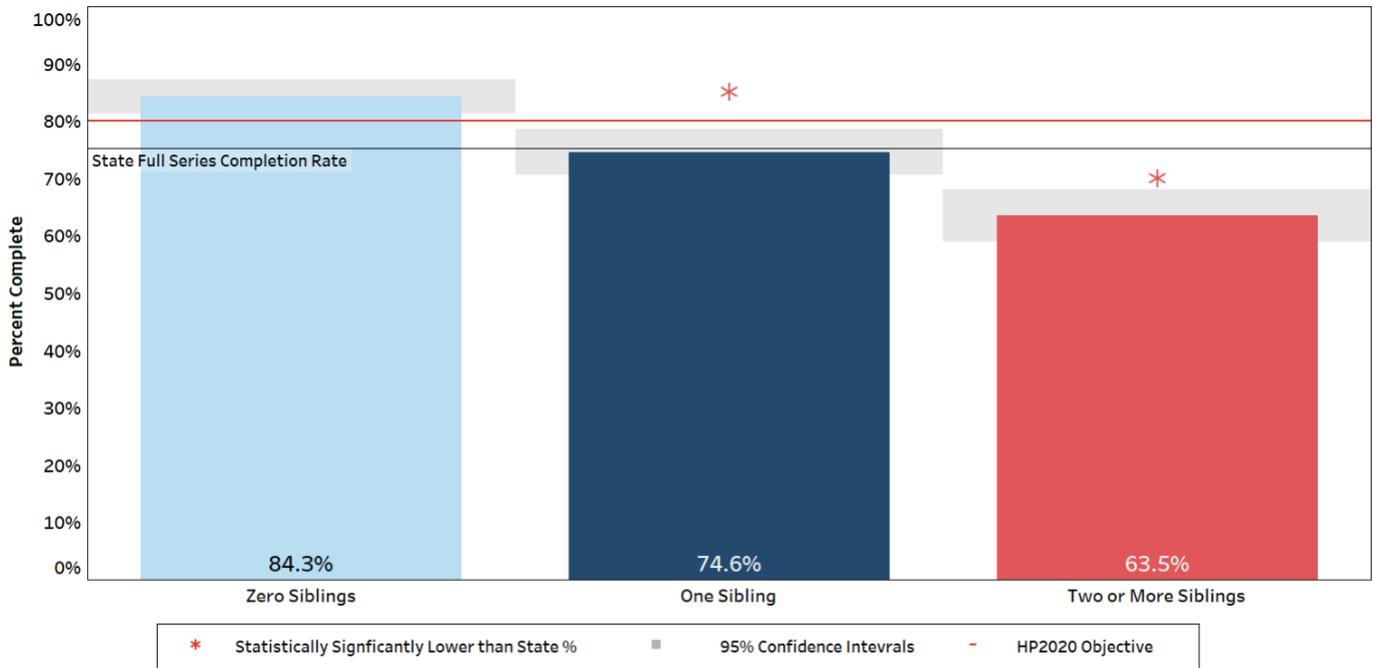
**Impact of Age at First Immunization on Immunization Completion**

Children who do not receive immunizations prior to 4 months of age are at risk of remaining under vaccinated at age 2 years. Of the children surveyed, 92.6% (1,367) began immunizations prior to 4 months of age and 80.3% of those children were completely immunized for the 4:3:1:FS:3:1:FS series by 24 months of age, compared to 32.5% (n= 13) of the 40 children who began immunizations after 4 months of age.

**Impact of Siblings on Immunization Completion**

Of the 1,495 children included in the survey, 580 (39.3%) had no siblings, 464 (31.4%) had one sibling, and 433 (29.3%) had two or more siblings. As the number of siblings increased, there was a statistically significant decrease in the percentage of children who were complete for the 4:3:1:FS:3:1:FS series. While 84.3% (95% CI: 81.3-87.2) of children with no siblings were complete, only 74.6% (95% CI: 70.6-78.5) with one sibling and 63.5% (95% CI: 59.0-68.1) with two or more siblings achieved series completion (figure 15).

Figure 15. Comparison of Children Complete for the 4:3:1:FS:3:1:FS Series with Zero, One, or Two or More Siblings (point estimate and 95% confidence intervals, n=1495)

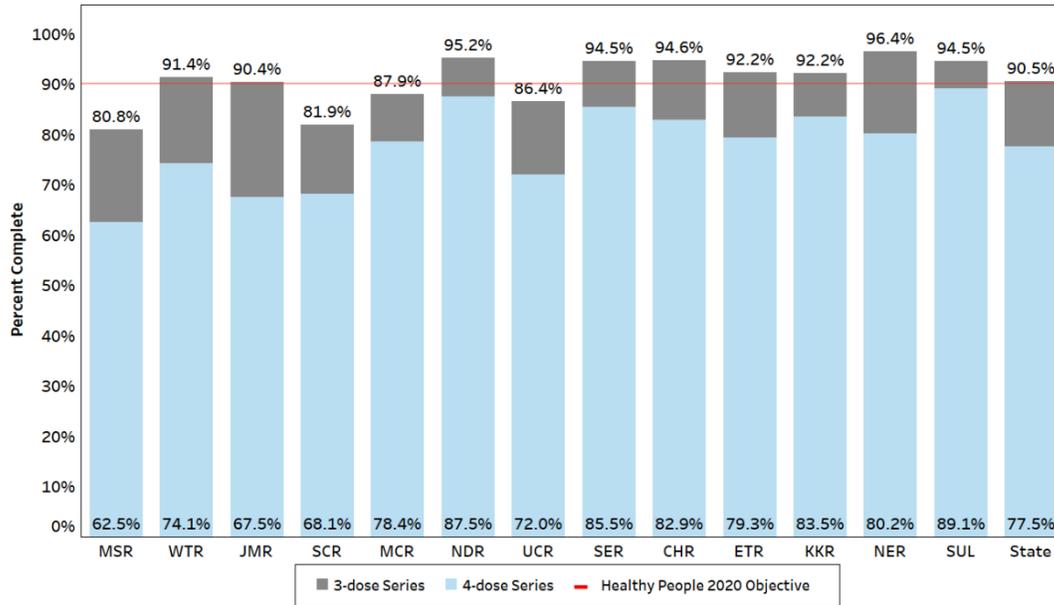


**Opportunities for Improvement**

**Fourth DTaP**

Figure 16 compares the regional percentages of children immunized with three and four doses of DTaP vaccine. The complete DTaP immunization rate for Tennessee was 77.5% (95% CI: 75.4-79.7); however, 90.5% (95% CI: 89.0-92.0) of children had at least three doses of DTaP. The regional differences between receipt of three doses of DTaP vaccine compared to receipt of four doses of DTaP vaccine ranges from 5.4% to 23.2%. For a child to be properly protected against diphtheria, tetanus, and pertussis, a fourth dose of DTaP is necessary between 15-18 months of age. If all children who had receive three doses of DTaP had received their fourth dose, Tennessee’s coverage would have increase by 13 % and surpassed the HP2020 objective for DTaP immunization (90%).

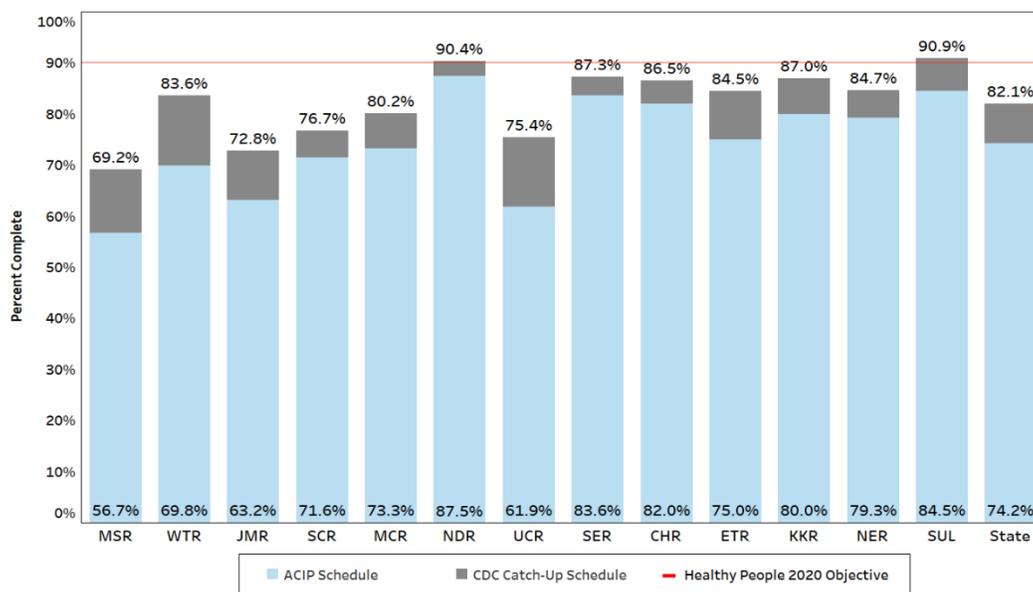
Figure 16. Percentage of Children with Complete Diphtheria, Tetanus, Pertussis (DTaP) Three Dose vs Four Dose Series by Health Department Region, TN, 2020 (point estimates and 95% confidence intervals, n=1495)



**CDC Catch-up vs ACIP schedule**

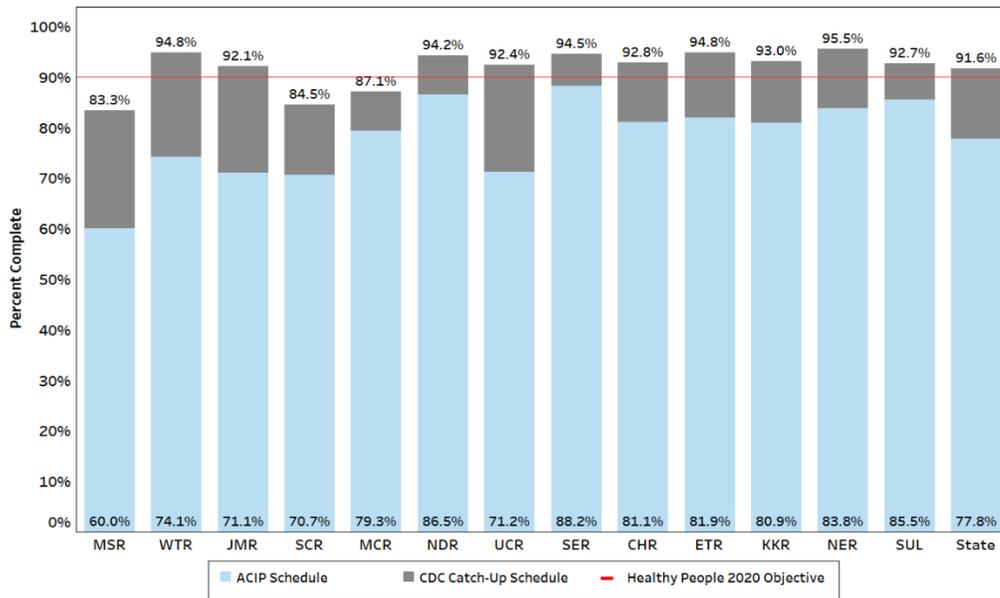
In 2019, a change in completion logic was made to account for children who began HIB or PCV vaccination outside of the ACIP-recommended age but prior to 24 months. This alternative vaccination timing is often referred to as a catch-up schedule. In 2021, 388 (26.0%) of the 1,495 children surveyed were vaccinated according to a catch-up schedule. Of these, 120 (30.9%) were considered complete for HIB vaccine. Of the 236 children vaccinated with PCV after the CDC recommended age, 218 (64.9%) were considered complete for PCV vaccine. When the catch-up schedule is considered, Tennessee exceeds the HP2020 objective for PCV vaccine coverage.

Figure 17. Percentage of Children with Complete HIB Series, by CDC Schedule, by Health Department Region, Tennessee, 2021 (n=1495)



IMMUNIZATION STATUS SURVEY – 2021

Figure 18. Percentage of Children with Complete PCV Series, by CDC Schedule, by Health Department Region, Tennessee, 2021 (n=1495)



## Summary of Key Findings

Below is the summary of coverage rates relative to Health People (HP) 2020 and 2030 objectives:

Measurement	TN 2021 (24 months)	TN NIS-Child 2020 (24 Months)	HP2020 Objective (19-35 months)	HP2030 Objective (24 months)
Complete 4:3:1:FS:3:1:4 series	75.2%	75.4%	80%	N/A
Each vaccine in 4:3:1:FS:3:1:4 (DTaP, IPV, MMR, Hib, HBV, VAR, PCV)	<p><b>Exceeded Goal:</b> Full series of PCV (91.6%)</p> <p><b>Below Goal:</b> 4 doses of DTaP (77.5%) Full series of HIB (82.1%) 1 dose of Varicella (87.5%) 1 dose of MMR (87.5%) 3 doses of IPV (89.8%)</p>	<p><b>Exceeded Goal:</b> 3 doses of IPV (98.0%) 3 doses of HBV (97.5%) Full series of HIB (90.3%) 1 dose of Varicella (96.1%) <b>1 dose of MMR (96.0%)</b></p> <p><b>Below Goal:</b> 4 doses of DTaP (81.4%) Full series of PCV (85.8%)</p>	90% rate for each of the 7 vaccines	90% rate for DTaP; 90.8% rate for MMR
Hepatitis A vaccine	1 dose HAV (86.9%) <i>not comparable to HP2020</i>	95.8%	N/A	N/A
Influenza vaccine	55.6% with 2 doses 32.7% with 3 doses	70.6%	70% appropriately immunized	N/A
Rotavirus vaccine	76.5%	N/A	80% with 2 doses	N/A
Hepatitis B birth dose	85.9%	N/A	85%	N/A
3 doses DTaP vs 4 doses of DTaP	90.5% (3 DTaP) vs 77.5% (4 DTaP)		N/A	N/A
HIB Completion ACIP vs CDC Catch-Up	74.2% (ACIP) vs 82.1% (Catch-up)		N/A	N/A
PCV Completion ACIP vs CDC Catch-Up	77.8% (ACIP) vs 91.6% (Catch-Up)		N/A	N/A

Indicates value met HP2020 objective.

**Indicates value is above HP2030 objective.**

## IMMUNIZATION STATUS SURVEY – 2021

- Tennessee’s statewide completion of the 4:3:1:FS:1:3:FS 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 receive a fourth dose of DTaP vaccine. This underscores the importance of patient reminder and recall messaging. As the fourth dose may be administered as early as age 12 months if at least 6 months has elapsed since the third dose, a recommendation to administer the fourth dose at the 12-month visit should be considered to achieve the HP2020 coverage goal.
- Hepatitis B has remained above the HP2020 objective of 90% as seen in the previous decade. This is potentially due to the initiation of the vaccine series administered by hospital staff within 24 hours of birth.
- Tennessee did not reach 80% coverage for the 4:3:1:FS:3:1:FS at any point in the past decade nor did it meet the goal in 2021; polio has fallen below the HP2020 objective for the first time in a decade.
- Black children were statistically significantly less likely than white children to be completely immunized according to CDC recommendations.
- In 2021, parents of 2.9% of the surveyed children reported refusing some or all immunizations, compared to 2.7% in 2020.
- In 2021, 2.3% of Tennessee children received zero doses of recommended vaccines, failing to meet the HP2030 objective of limiting the percentage of children who receive zero doses of recommended vaccines by age two years to 1.3%.

## Discussion

While overall vaccination rates among children in Tennessee remain relatively high, the threat of reintroduction of previously eliminated vaccine-preventable diseases across the United States demonstrate the importance of continued vigilance. Ensuring that every medically-eligible child is fully vaccinated on-time and according to the Centers for Disease Control and Prevention (CDC) recommended childhood immunization schedule is critical. Tennessee does not currently meet any of the HP2030 targets for the three vaccination-related measures for 24-month old children and did not meet three of five HP2020 goals last year.

While the vast majority of parents in Tennessee vaccinate their children on time and according to the CDC recommendations, a growing number do not. Of the 1,495 children surveyed, 2.8% (n=44) reported objection or exemptions. Religious exemption was cited by 1.1% of parents, philosophical exemption was cited by 1.7% of parents, and medical exemption was cited by 0.1% of parents. As Tennessee law allows only religious and medical exemptions in lieu of complete immunization as required for public school entry, philosophical objections often transition to complete vaccination or the declaration of religious exemptions prior to school entry.

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

- Continued parental and community education about the safety, efficacy, and critical importance of childhood immunization and the severity of the diseases they prevent
- Ready access to, and provision of, immunizations at every opportunity
- Reliable and readily accessible immunization records that ensure immunizations are provided on-time while avoiding duplication

### Impact of COVID-19 on Immunization Rates

The CDC noted a decline in overall vaccination rates as soon as one week after the United States declared a national state of emergency due to the COVID-19 pandemic. A smaller decline was recognized nationally in children  $\leq 24$  months old, likely due to heightened vaccination campaign efforts to promote early childhood vaccinations in the context of the pandemic.<sup>13</sup> However, during March–May 2020, DTaP and MMR doses administered declined an overall median of 15.7% and 22.3%, respectively, among children  $\leq 24$  months across the nation. During June–September 2020, after most stay-at-home orders had been lifted, the number of weekly routine pediatric vaccine doses administered increased initially, approaching or even surpassing baseline pre-pandemic levels. During June–September 2020, DTaP and MMR doses administered declined an overall median of 9.1% and 8.8%, respectively, among children  $\leq 24$  months or less across the nation. Although there was some improvement, there was not a sustained or prolonged increase in the number of weekly doses administered above pre-pandemic administration levels, which would have been necessary to catch up children who missed routine vaccinations. Even though a smaller decline was recognized and administered doses increased during late 2020 and 2021, the increase was not sufficient to achieve catch-up coverage leaving thousands of children at risk in 2021 and beyond.<sup>14</sup>

The timing of previous reports awarded only a partial assessment of the impact of the pandemic on childhood immunizations. The data presented in this report represent one of the first complete evaluations of the negative impact the COVID-19 pandemic has had on childhood vaccinations overall. The data contained in this report was collected from January 2021 – March 2021, during the height of the COVID-19 pandemic. Data on vaccination rates demonstrate the COVID-19 pandemic has had a significant negative impact in Tennessee, which is similar to reports from other states and national studies. The true impact of COVID-19 on the immunization rates of 24-month-old children in Tennessee is still in the early stages and will likely be expansive and long lasting. Every effort should be made to catch-up on these missing vaccinations to mitigate ongoing risks.

## **Key Strategies for Improving Immunization Rates Among 24-month-old Children**

### ***Parental and community education and messaging around the safety, efficacy, and critical importance of childhood immunization***

- Parents should seek credible sources of vaccine information and the advice of their child's medical provider when seeking information about vaccines.
- Public health and healthcare providers should provide strong and credible messages that "vaccines are safe, vaccines are effective, and vaccines save lives".

### ***Ready access to, and provision of, vaccinations at every opportunity***

- Maintain the federally-funded Vaccines for Children (VFC) Program to ensure 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. Expansion of this network of VFC Providers will provide more opportunities to vaccinate children.
- Medical providers should review vaccine records and administer missing vaccinations at every opportunity.
- The Tennessee Immunization Information System (TennIIS) is built with the ACIP forecaster for each child. Physicians should utilize TennIIS to identify gaps in immunizations, especially DTaP and Flu, at every opportunity.

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

- Continue to promote the Tennessee Immunization Information System, "TennIIS" ([www.TennesseeIIS.gov](http://www.TennesseeIIS.gov)). TennIIS is an online immunization registry that is available to all immunizing providers, including hospitals, clinics and pharmacies, and includes a suite of tools which may help to improve immunization rates among children and adults.
- Promote standards implemented in 2017 requiring 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.
- Remind all vaccinating providers to report all administered vaccination to TennIIS. 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. TennIIS is linked to the electronic health record (EHR) systems of hundreds of medical facilities and pharmacies statewide, allowing for seamless electronic immunization record reporting from those systems.
- Promote TennIIS to medical providers for a validated immunization certificate, which families use for daycare, school, college entry, and employment requirements. Provider participation in TennIIS is critical to build these lifelong records and to ensuring all Tennesseans are appropriately vaccinated.

### ***Policy***

- Educate decision-makers about the impact of non-medical exemptions on immunization rates. States without non-medical exemptions have higher overall immunization rates than states which allow non-medical exemptions.
- Provide updated provider guidance and recommendations helps to optimize each visit and ensure that children are completely protected from vaccine preventable diseases in a safe and timely schedule.

## **Recommendations to Improve Immunization Coverage in 24-month-old Children**

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

1. Vaccination records should be examined for completeness at every medical visit, regardless of the reason for the visit, and vaccinations should be provided at every opportunity. Given the significant reduction in vaccinations provided to children during the COVID-19 pandemic, it is critical to the health of all Tennesseans to ensure every child is fully vaccinated, according to the CDC recommended childhood vaccination schedule.
2. Medical providers should implement strategies that alert parents when their children 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.
3. Parents and providers should strictly adhere to the early infant schedule of immunizations at 2-, 4-, and 6-months. Doing so will enable providers to administer the 4<sup>th</sup> DTaP and all other needed immunizations as early as the first birthday, maximizing the number of opportunities to immunize children on time.
4. All vaccinating providers should enroll in, and report vaccinations to, TennIIS for every patient. 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. User guides and other TennIIS resources available through the training information posted at [www.TennesseeIIS.gov](http://www.TennesseeIIS.gov) may assist providers in recognizing opportunities to immunize their patients such as:
  - I. TennIIS provides individual patient forecasting of immunizations due, based upon the patient's immunization history.
  - II. TennIIS is able to generate patient reminders through the use of manual, auto dialer, 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.
  - III. Medical 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 the TennIIS website.
  - IV. There are more than 7,800 private medical provider offices enrolled in TennIIS. All immunizing providers should enroll and report immunizations to TennIIS. This will allow for more accurate shared clinical decision making and the most complete immunization record for Tennesseans.
5. VPDIP 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.
6. All parents, especially those enrolled in WIC and TennCare, should continue to receive immunization education, immunization record review, and immunization administration at every opportunity.
7. VPDIP will broadly communicate the results of this survey to public health leaders, VFC program participants and professional organizations, including immunizing providers. The VPDIP program should continue to identify opportunities to provide VFC providers with immunization education and strategies to improve immunization coverage across the state.
8. The importance of continuous quality improvement should be emphasized, and providers should be encouraged to participate in individualized quality improvement. The VFC Quality Assurance team and immunization field staff in each regional and metro public health department provide practice-level quality assessments and feedback to VFC providers with the lowest rates of 4<sup>th</sup> DTaP completion. The public should be continually reminded of the morbidity and mortality associated with seasonal influenza. Barriers to universal influenza immunization should be addressed and eliminated.
9. VPDIP should continue to seek partnerships with external organizations, such as the Tennessee Chapter of the American Academy of Pediatrics, TennCare, and Federally Qualified Rural Health Clinics (FQHCs) to ensure every medically eligible child is immunized on time.

## References

- <sup>1</sup>CDC. Vaccination Coverage by Age 24 Months Among Children Born in 2015 and 2016 – National immunization Survey-Child, United States, 2016-2018. *Morbidity and Mortality Weekly Report*, 68(41);913-918.
- <sup>2</sup>America's Health Rankings analysis of CDC, Behavioral Risk Factor Surveillance System, United Health Foundation, AmericasHealthRankings.org, Accessed 2022.
- <sup>3</sup>CDC. Ensuring the Safety of Vaccines in the United States. Centers for Disease Control and Prevention. 2013 Feb 01.
- <sup>4</sup>CDC. Parent's Guide to Childhood Immunizations; Part 3: More About Vaccines. Centers for Disease Control and Prevention: 22-29.
- <sup>5</sup>CDC. Benefits from Immunization During the Vaccines for Children Program Era — United States, 1994–2013. *Morbidity and Mortality Weekly Report*. 63(16);352-355.
- <sup>6</sup>CDC. Ten Great Public Health Achievements – United States 2001—2011. *Morbidity and Mortality Weekly Report*. 60(19);619-623.
- <sup>7</sup>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.
- <sup>8</sup>Flannery, B., Reynolds, S., et al. Influenza Vaccination Effectiveness against Pediatric Deaths: 2010-2014. *Pediatrics*. 2017, May; 139(5):e20164244.
- <sup>9</sup>American Academy of Pediatrics. Recommended Child and Adolescent Immunization Schedule for ages 19 years or younger, United States, 2019. Centers for Disease Control and Prevention. <https://www.cdc.gov/vaccines/schedules/hcp/imz/child-adolescent.html>
- <sup>10</sup>Recommended Child and Adolescent Immunization Schedule for Ages 18 Years or Younger–United States, 2019. Centers for Disease Control and Prevention. 2020 Jan 01.
- <sup>11</sup>CDC. Flu & Young Children. Centers for Disease Control and Prevention, National Center for Immunization and Respiratory Diseases: 2021 Oct 25.
- <sup>12</sup>CDC. What Are the Benefits of Flu Vaccination? Centers for Disease Control and Prevention, National Center for Immunization and Respiratory Diseases: 2020 Oct 6.
- <sup>13</sup>CDC. Effects of the COVID-19 Pandemic on Routine Pediatric Vaccine Ordering and Administration — United States, 2020. *Morbidity Mortal Weekly Report*, 2020;69:591–593.
- <sup>14</sup>Patel B, Murthy , Zell E, et al. Impact of the COVID-19 Pandemic on Administration of Selected Routine Childhood and Adolescent Vaccinations — 10 U.S. Jurisdictions, March–September 2020. *MMWR Morb Mortal Wkly Rep* 2021;70:840–845.

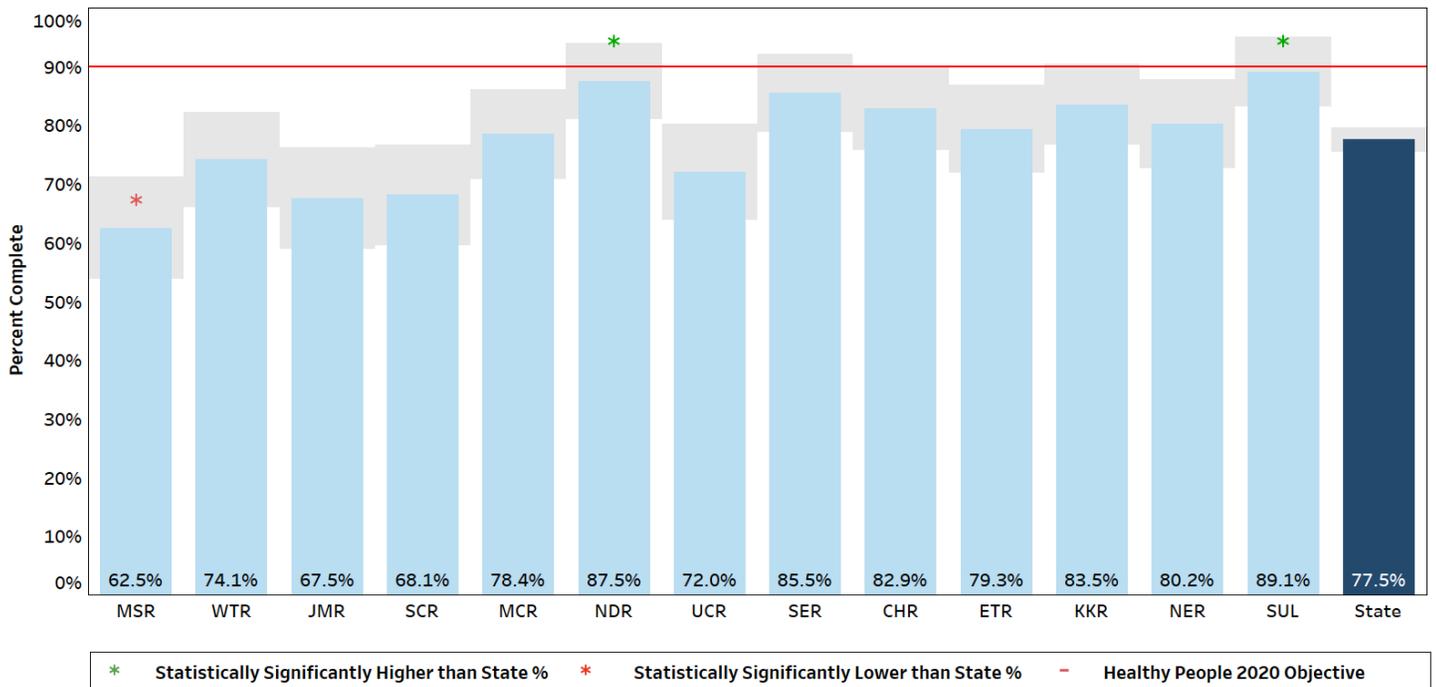
## **Appendix 1**

### **Regional Antigen Specific Results**

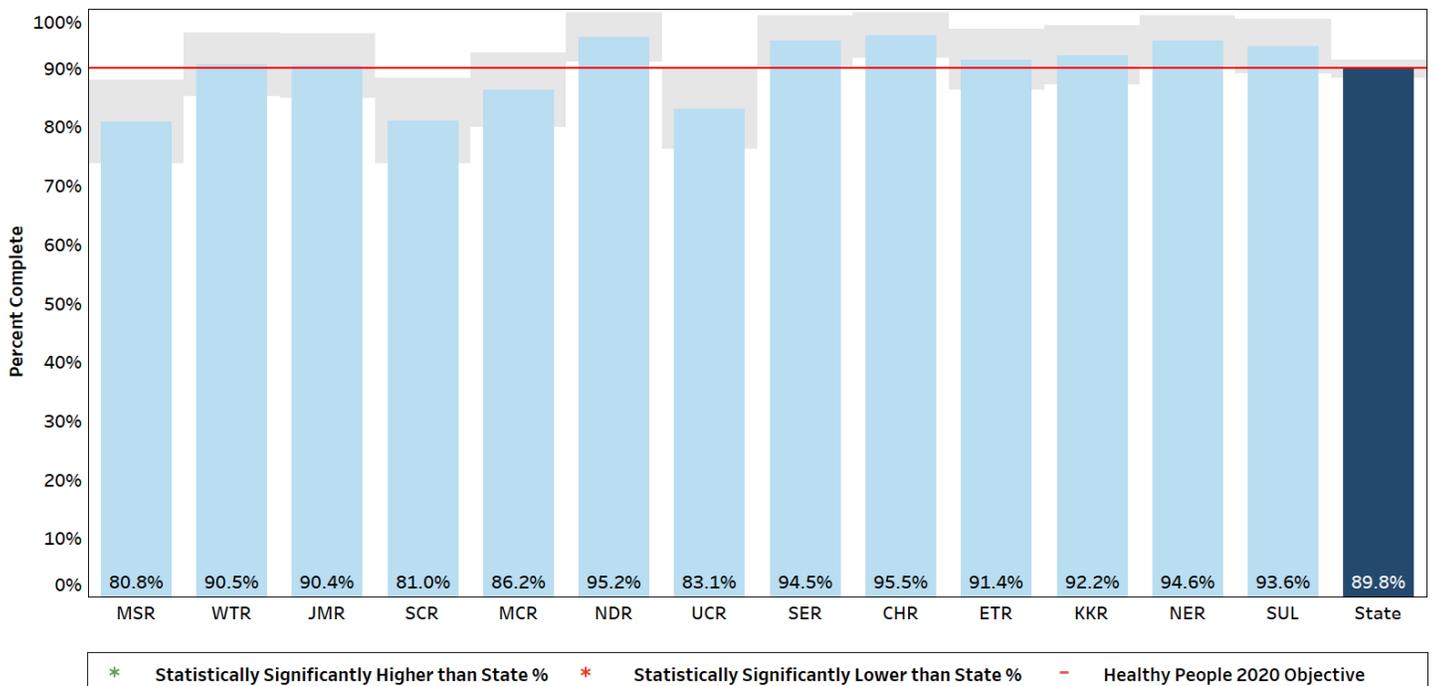
	Page
DTaP & Polio	41
MMR & <i>Haemophilus influenzae</i> type b	42
Hepatitis B (3-dose coverage) & Hepatitis B (birth dose)	43
Varicella & Pneumococcus	44
4:3:1:FS:3:1:FS series & Hepatitis A	45
Rotavirus & Influenza (2-dose coverage)	46

IMMUNIZATION STATUS SURVEY – 2021

Percentage of Children with Complete **Diphtheria, Tetanus, Pertussis (DTaP)** Series by Health Department Region, Tennessee, 2021 (point estimates and 95% confidence intervals, n=1495)

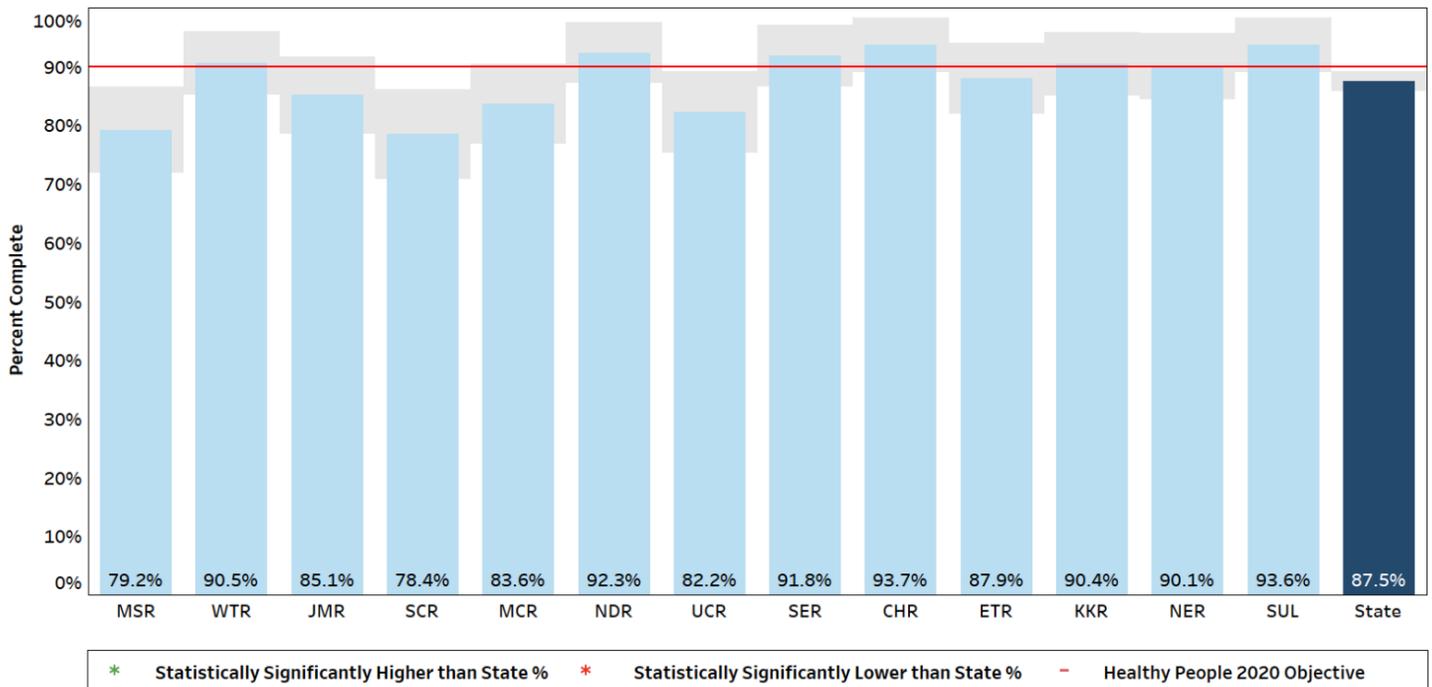


Percentage of Children with Complete **Polio (IPV)** Series by Health Department Region, Tennessee, 2021 (point estimates and 95% confidence intervals, n=1495)

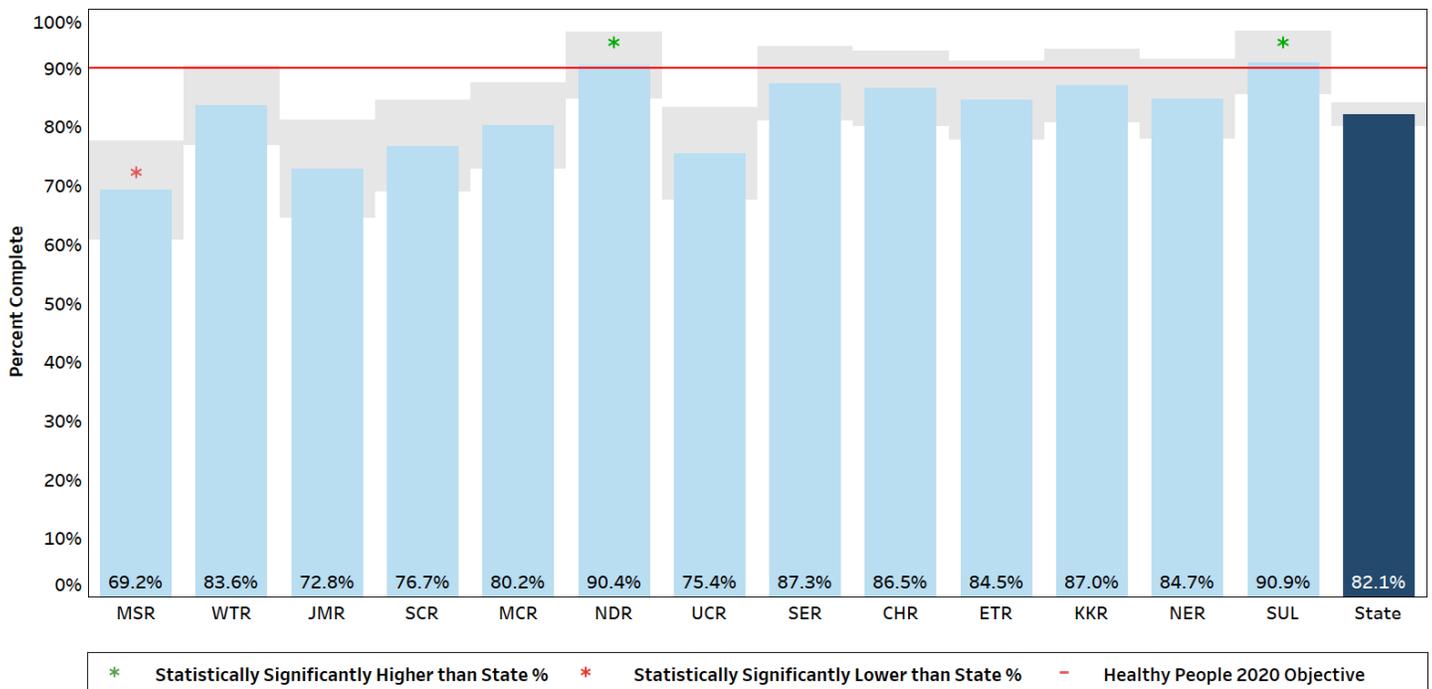


IMMUNIZATION STATUS SURVEY – 2021

Percentage of Children with Complete **Measles, Mumps, Rubella (MMR)** by Health Department Region, Tennessee, 2021 (point estimates and 95% confidence intervals, n=1495)



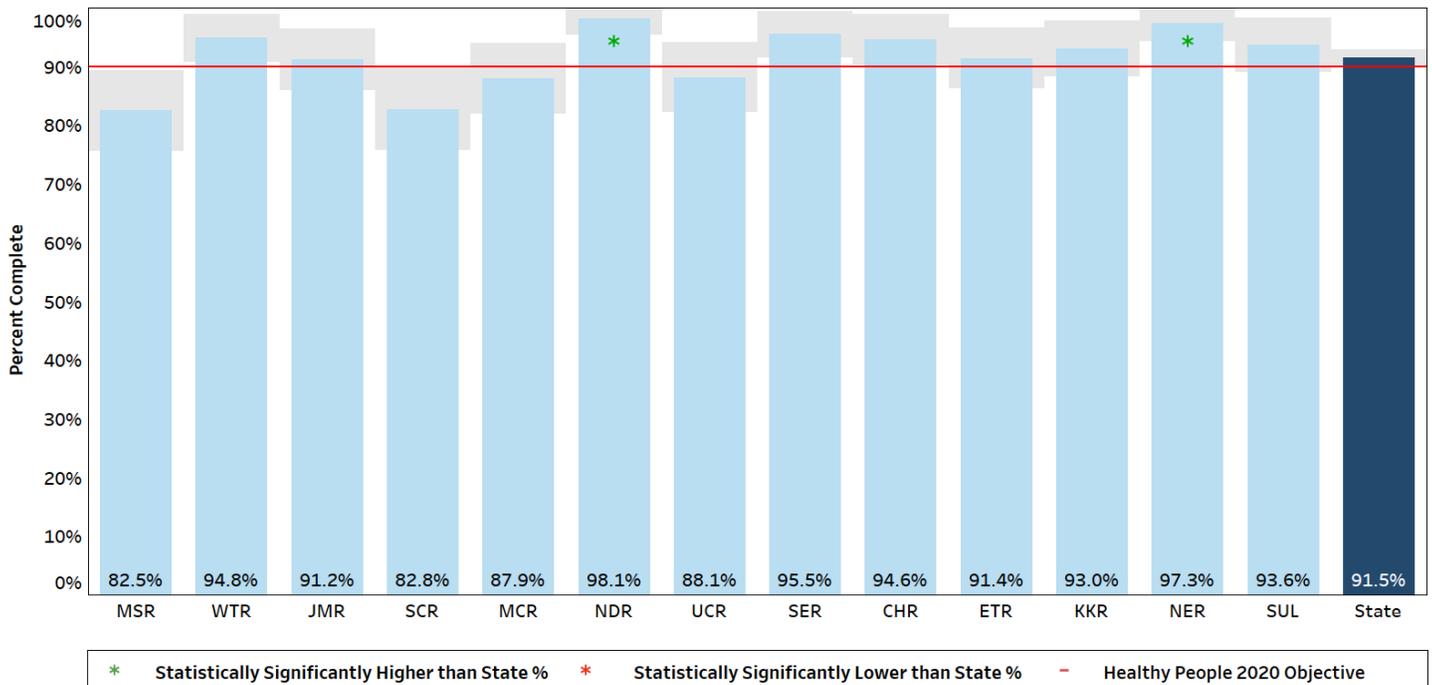
Percentage of Children with Complete **Haemophilus influenzae type B (HIB)<sup>f</sup>** Series by Health Department Region, Tennessee, 2021 (point estimates and 95% confidence intervals, n=1495)



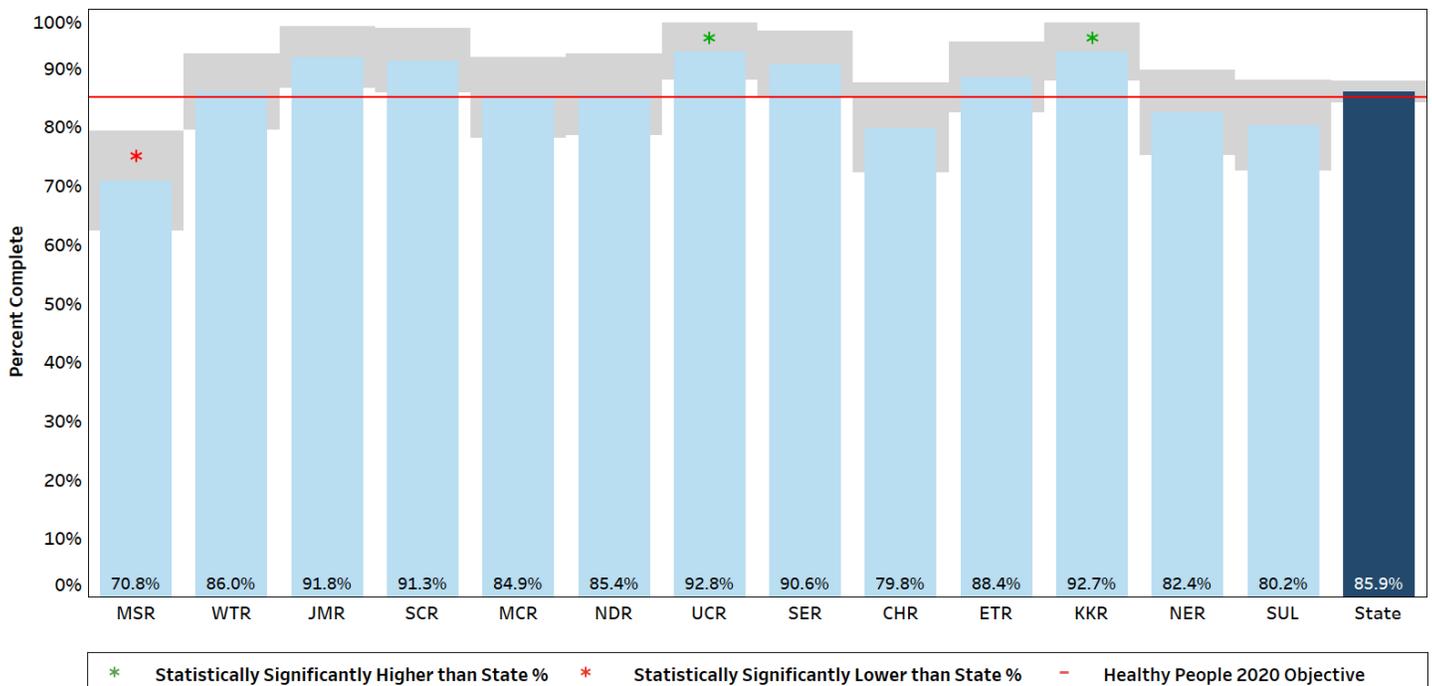
<sup>f</sup> Includes children on CDC catch-up schedule

IMMUNIZATION STATUS SURVEY – 2021

Percentage of Children with Complete **Hepatitis B (HBV)** Series by Health Department Region, Tennessee, 2021  
(point estimates and 95% confidence intervals, n=1495)

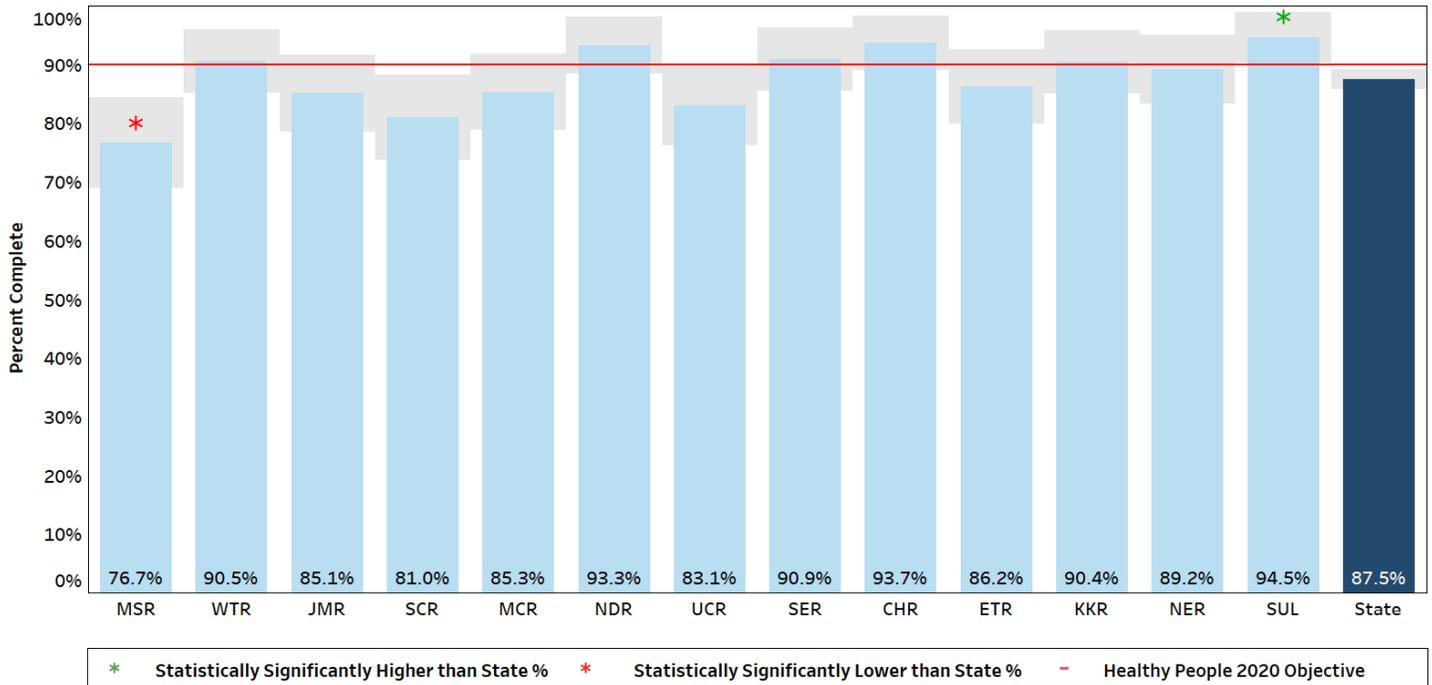


Percentage of Children with Complete **Birth Dose Hepatitis B (bHBV)** by Health Department Region, Tennessee, 2021  
(point estimates and 95% confidence intervals, n=1495)

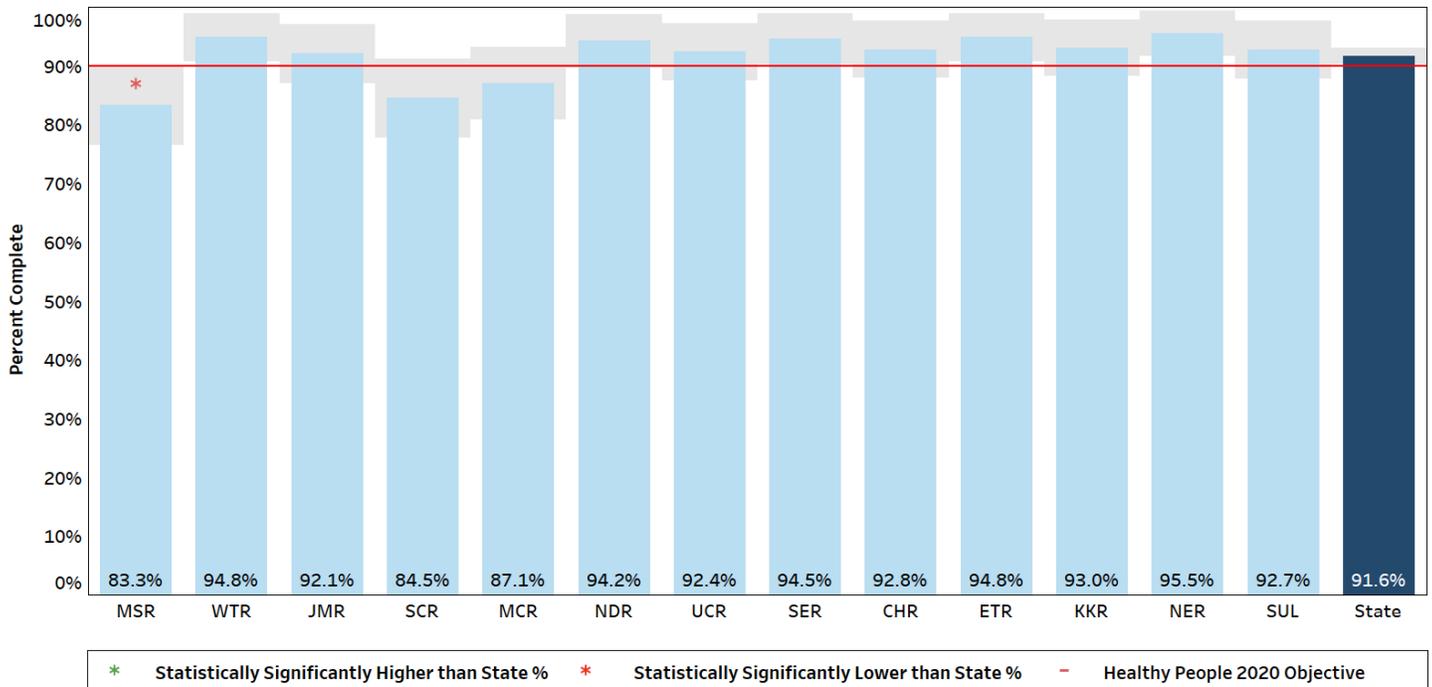


IMMUNIZATION STATUS SURVEY – 2021

Percentage of Children with Complete **Varicella (VAR)** Series by Health Department Region, Tennessee, 2021  
(point estimates and 95% confidence intervals, n=1495)



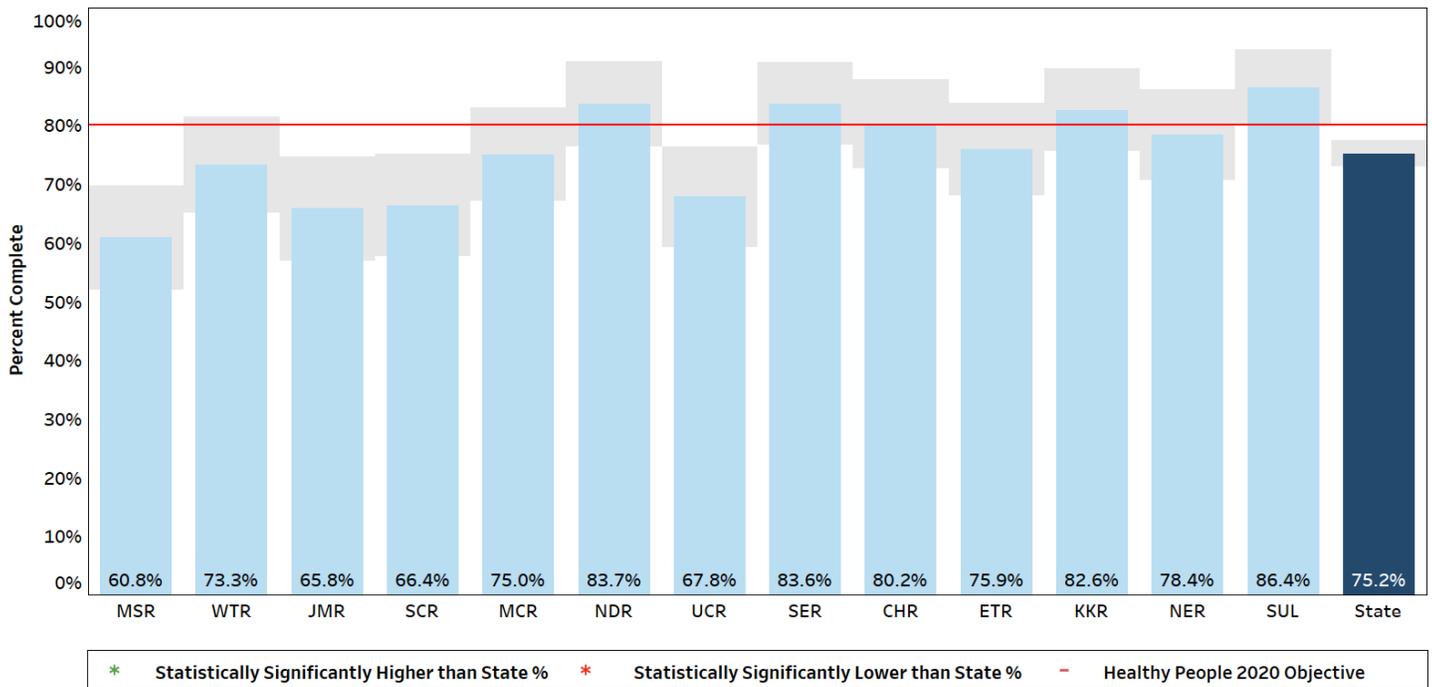
Percentage of Children with Complete **Pneumococcus (PCV)<sup>f</sup>** Series by Health Department Region, Tennessee, 2021  
(point estimates and 95% confidence intervals, n=1495)



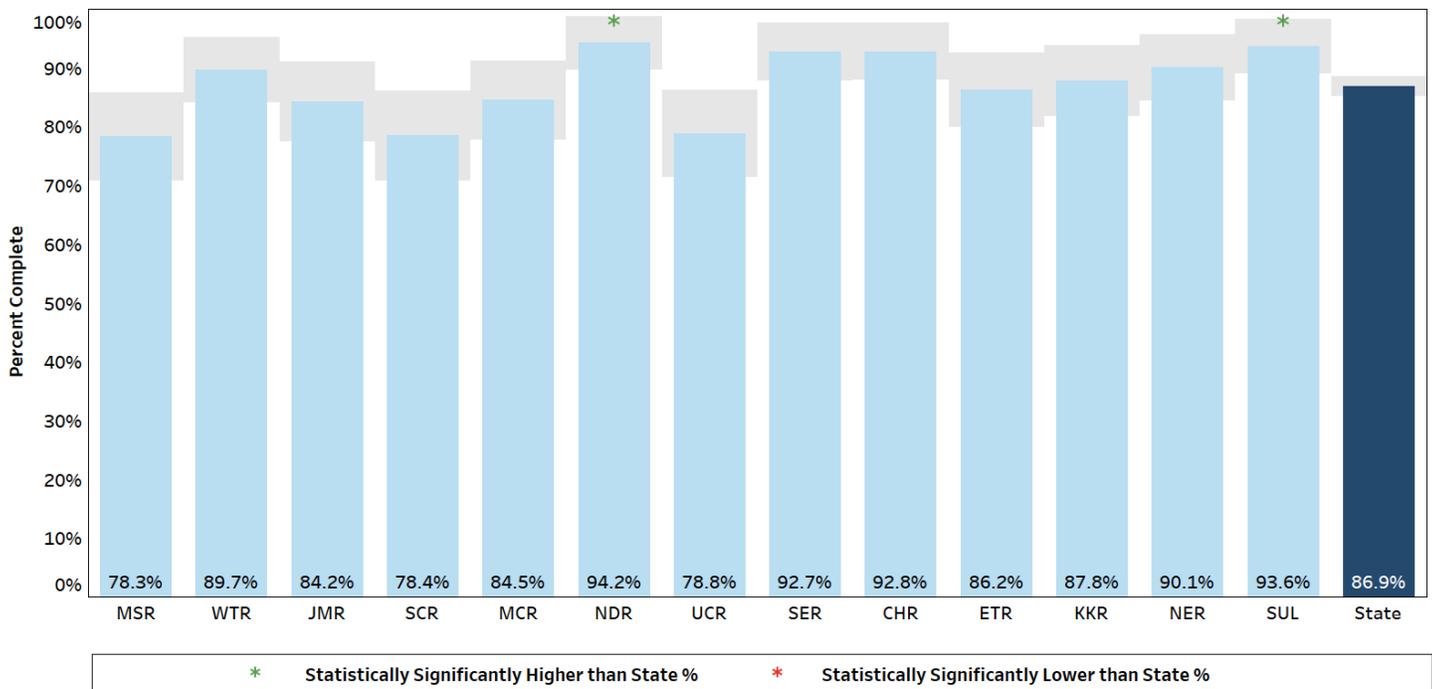
<sup>f</sup> Includes children on CDC catch-up schedule

IMMUNIZATION STATUS SURVEY – 2021

Percentage of Children with **Complete 4:3:1:FS:3:1:FS** Series by Health Department Region, Tennessee, 2021  
(point estimates and 95% confidence intervals, n=1495)

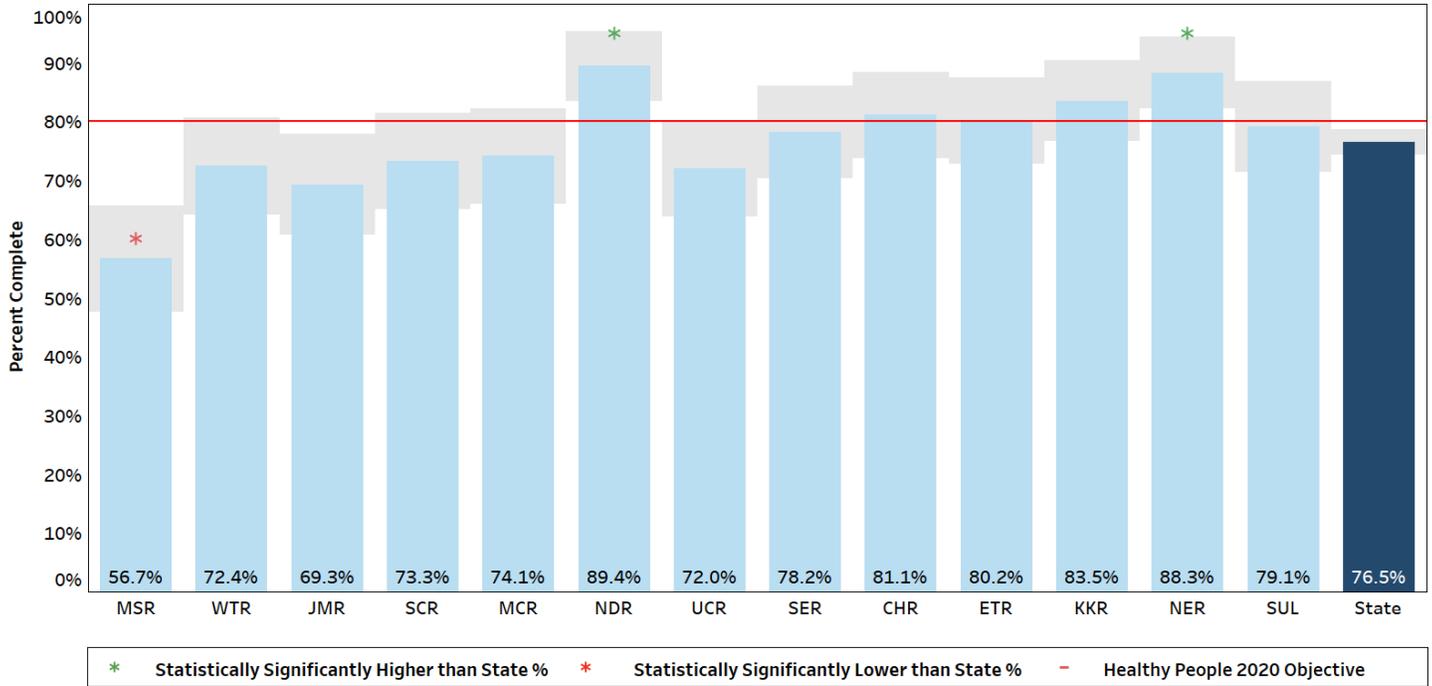


Percentage of Children with Complete **Hepatitis A (HAV)** Series by Health Department Region, Tennessee, 2021  
(point estimates and 95% confidence intervals, n=1495)

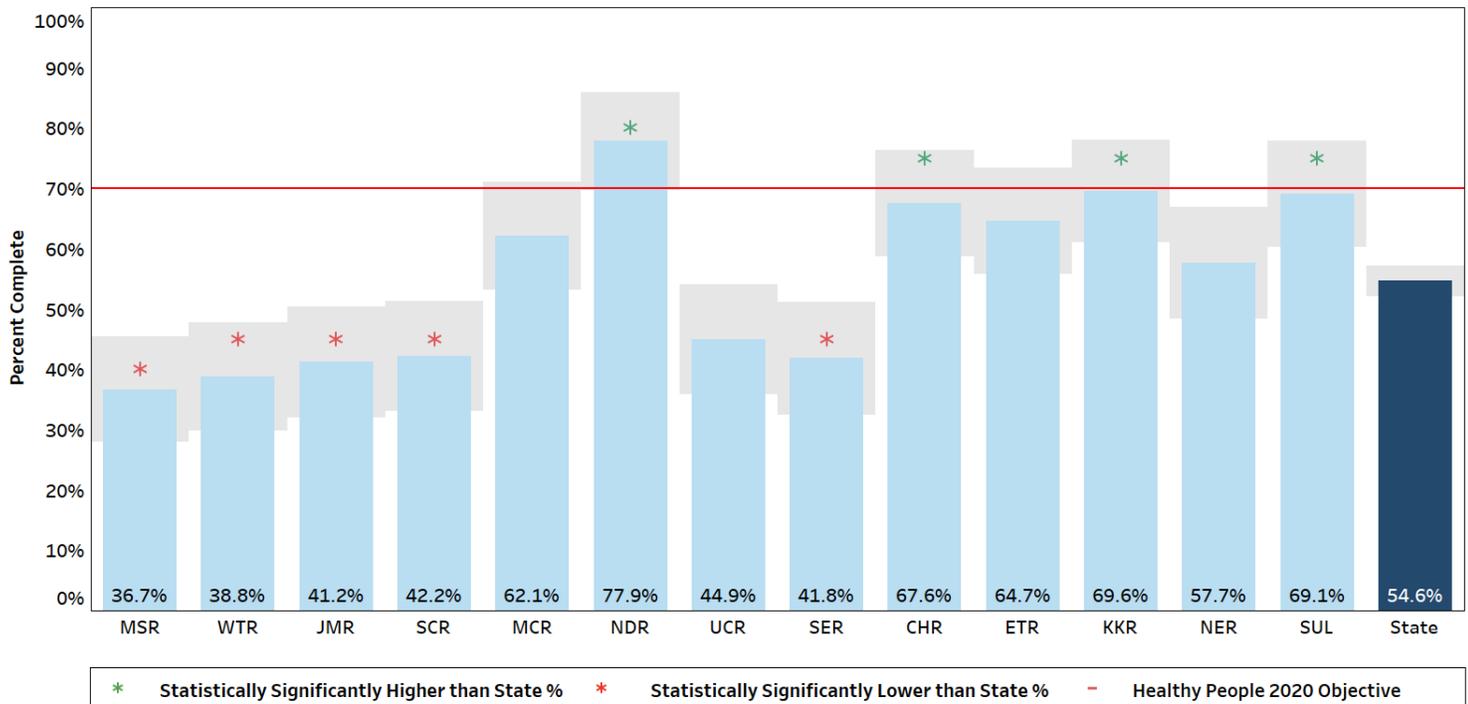


IMMUNIZATION STATUS SURVEY – 2021

Percentage of Children with Complete **Rotavirus (RTV)** Series by Health Department Region, Tennessee, 2021  
(point estimates and 95% confidence intervals, n=1495)



Percentage of Children with Complete **Influenza (FLU)** Series by Health Department Region, Tennessee, 2021  
(point estimates and 95% confidence intervals, n=1495)



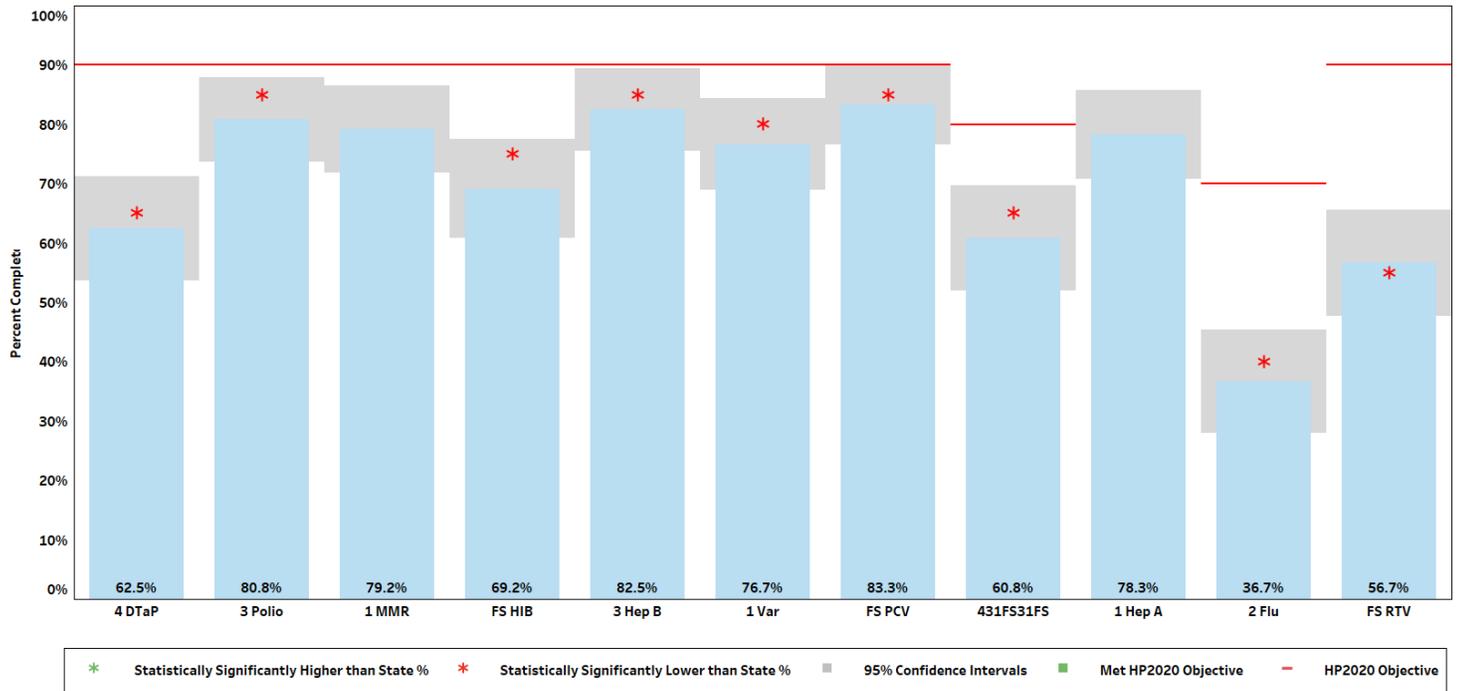
**Appendix 2**

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

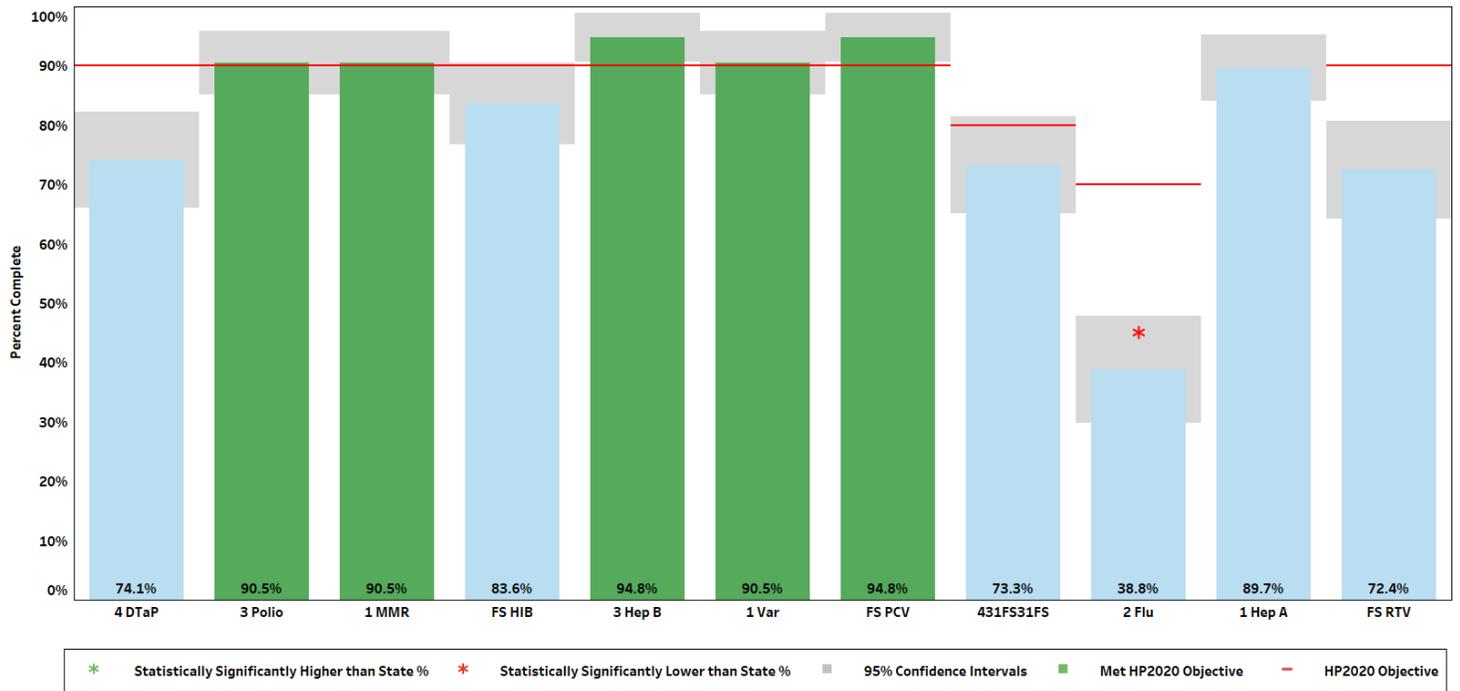
	Page
Memphis-Shelby County	48
West Tennessee Region	48
Jackson-Madison County	49
South Central Region	49
Mid-Cumberland Region	50
Nashville-Davidson County	50
Upper Cumberland Region	51
Southeast Region	51
Chattanooga-Hamilton County	52
East Tennessee Region	52
Knoxville-Knox County	53
Northeast Region	53
Sullivan County	54

IMMUNIZATION STATUS SURVEY – 2021

Percent of Children Complete in **Memphis-Shelby County (MSR)** by Vaccine (point estimates and 95% confidence intervals, n=127)

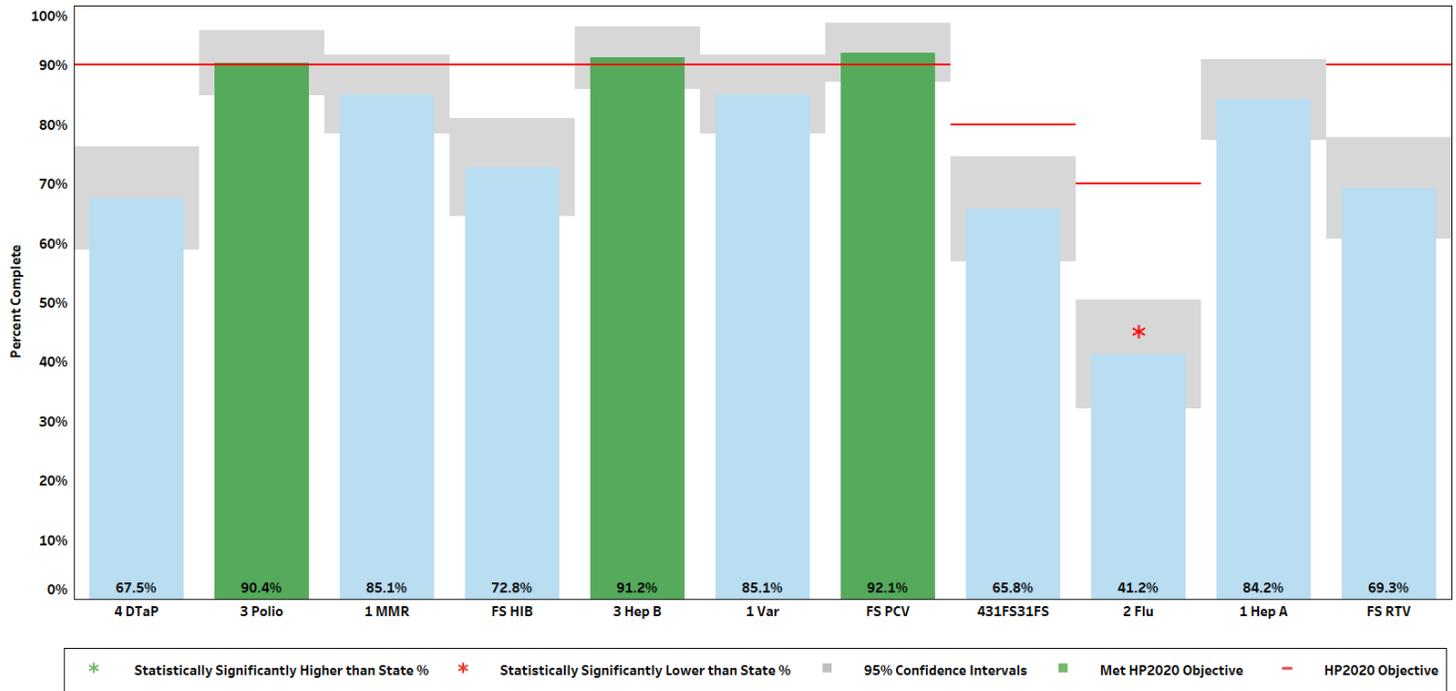


Percent of Children Complete in **West Tennessee Region (WTR)** by Vaccine (point estimates and 95% confidence intervals, n=117)

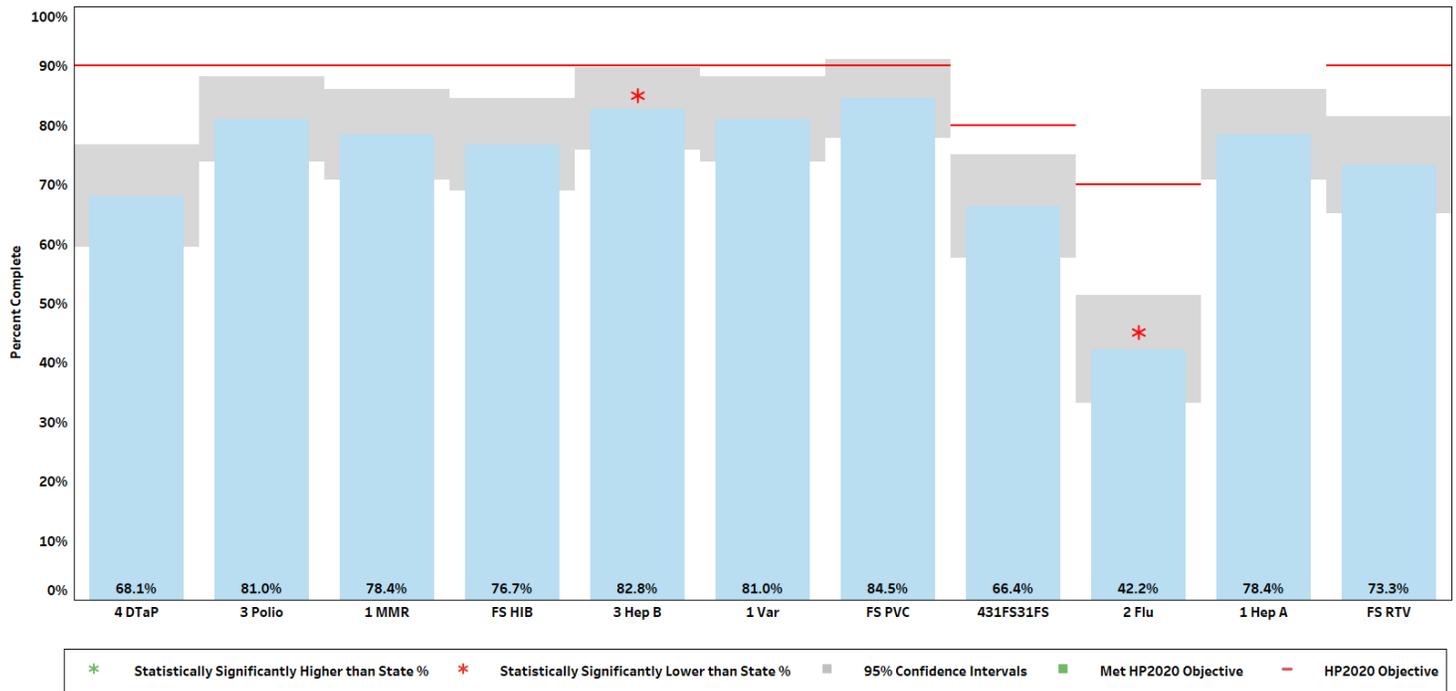


IMMUNIZATION STATUS SURVEY – 2021

Percent of Children Complete in **Jackson-Madison Region (JMR)** by Vaccine (point estimates and 95% confidence intervals, n=114)

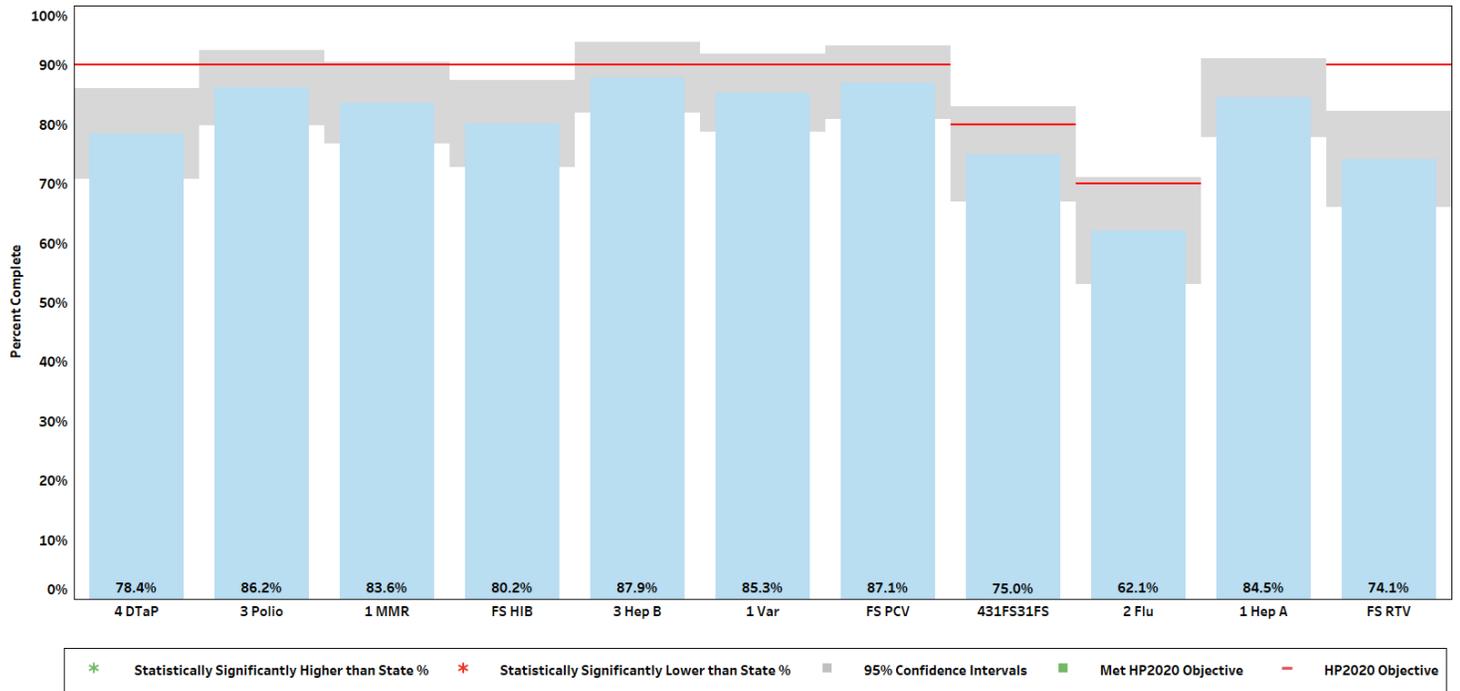


Percent of Children Complete in **South Central Region (SCR)** by Vaccine (point estimates and 95% confidence intervals, n=119)

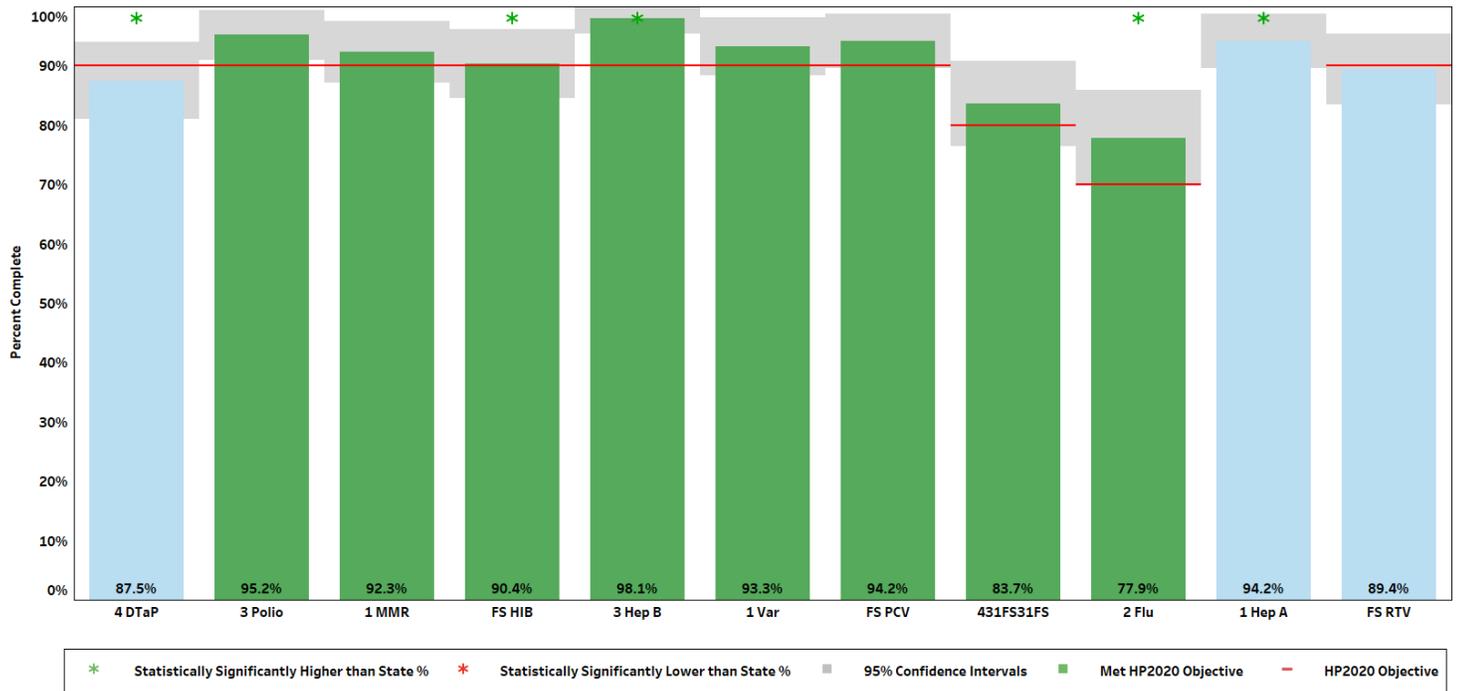


IMMUNIZATION STATUS SURVEY – 2021

Percent of Children Complete in **Mid-Cumberland Region (MCR)** by Vaccine (point estimates and 95% confidence intervals, n=117)

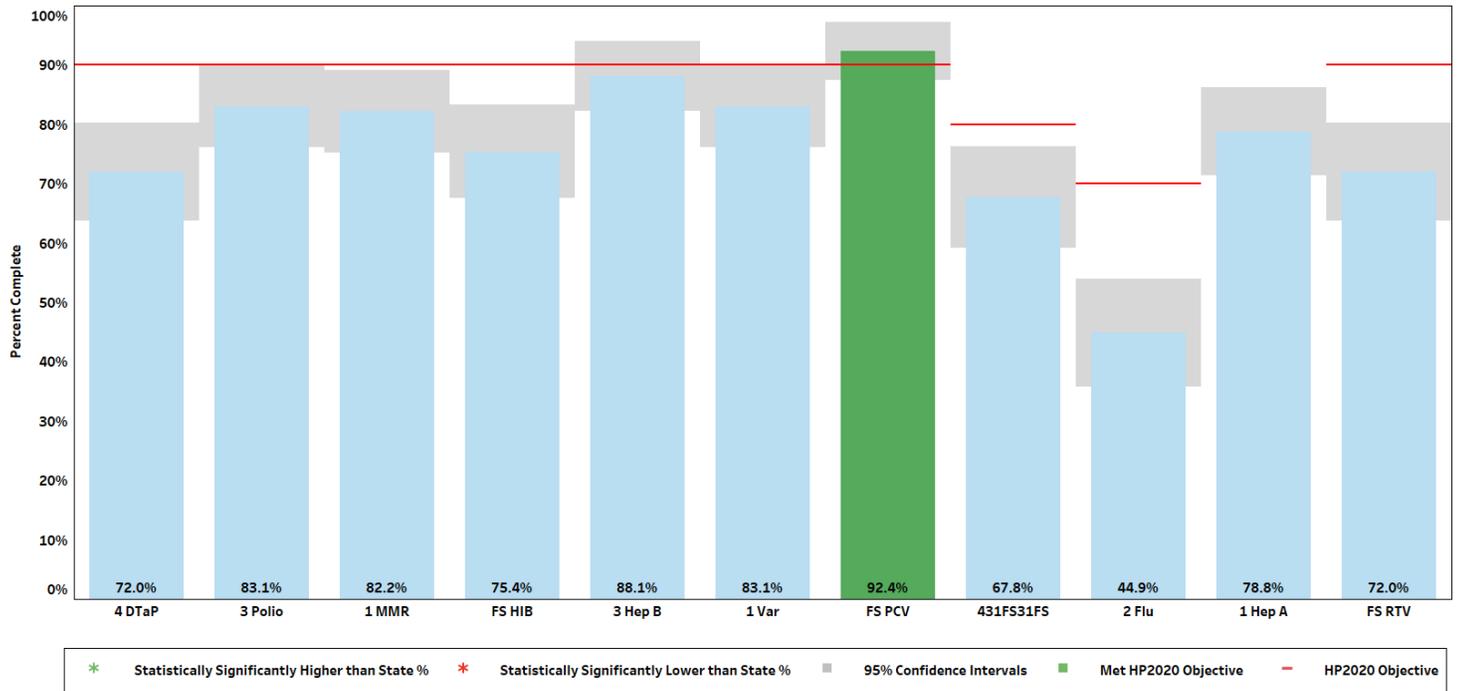


Percent of Children Complete in **Nashville-Davidson Region (NDR)** by Vaccine (point estimates and 95% confidence intervals, n=103)

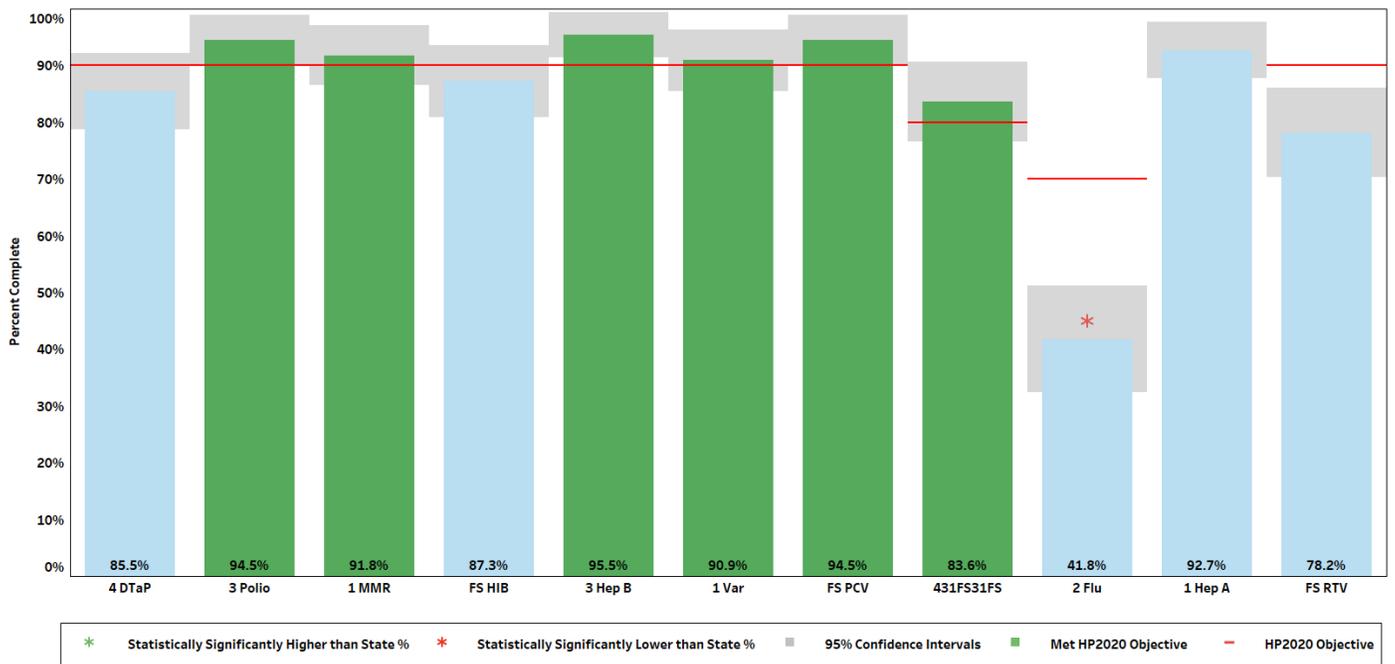


IMMUNIZATION STATUS SURVEY – 2021

Percent of Children Complete in **Upper Cumberland Region (UCR)** by Vaccine (point estimates and 95% confidence intervals, n=118)

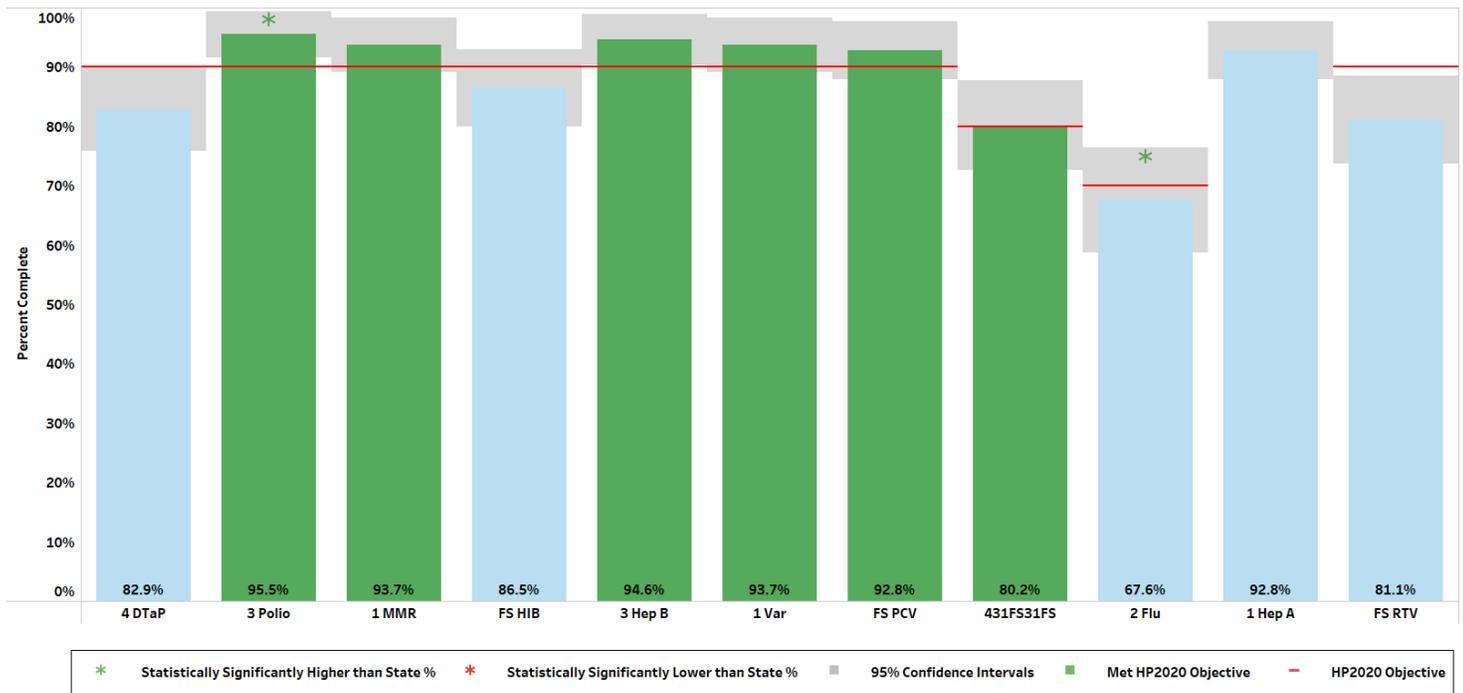


Percent of Children Complete in **Southeast Region (SER)** by Vaccine (point estimates and 95% confidence intervals, n=110)

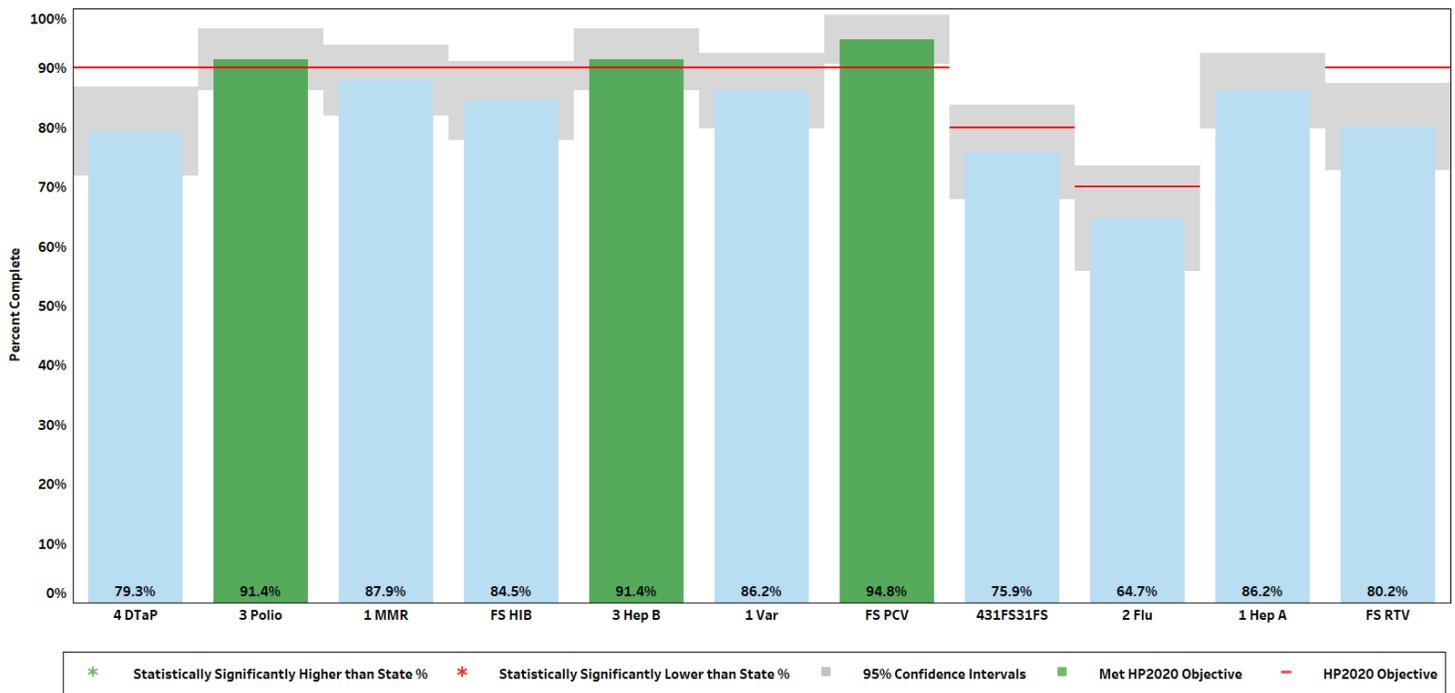


IMMUNIZATION STATUS SURVEY – 2021

Percent of Children Complete in **Chattanooga-Hamilton Region (CHR)** by Vaccine (point estimates and 95% confidence intervals, n=115)

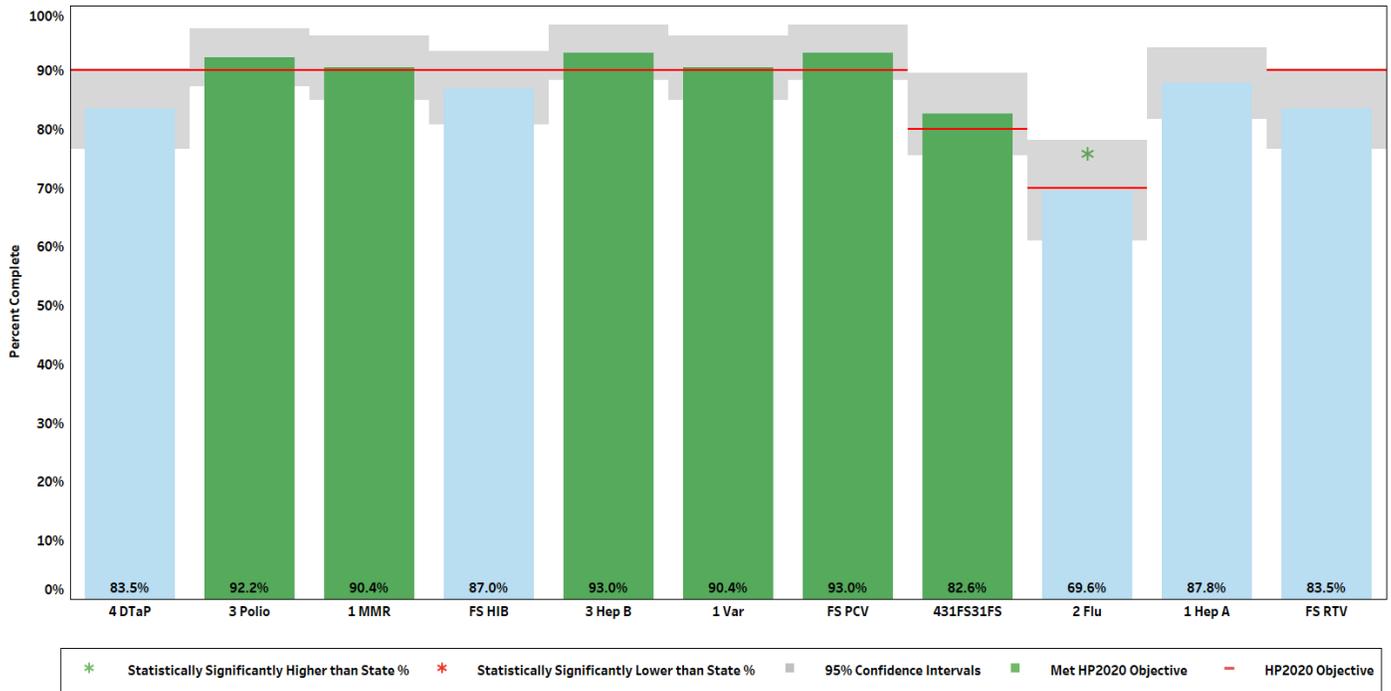


Percent of Children Complete in **East Tennessee Region (ETR)** by Vaccine (point estimates and 95% confidence intervals, n=118)

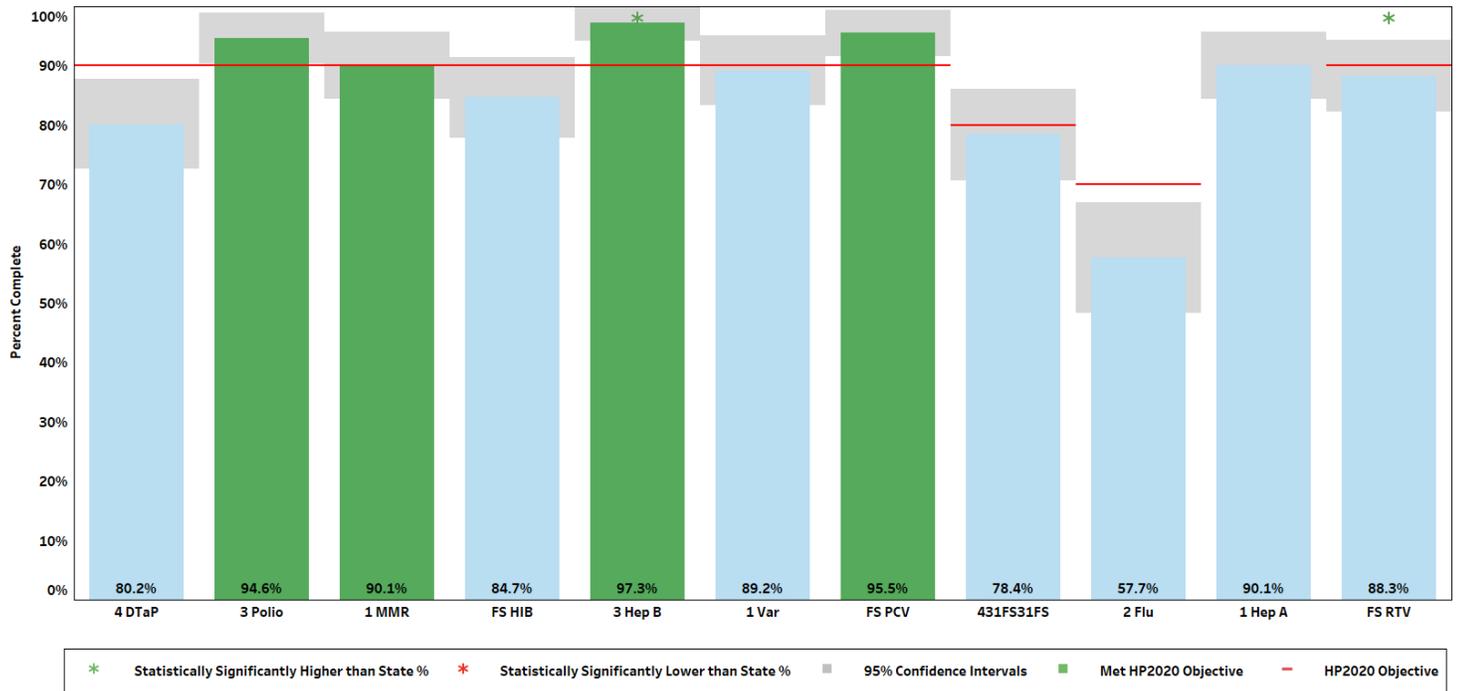


IMMUNIZATION STATUS SURVEY – 2021

Percent of Children Complete in **Knoxville-Knox County Region (KKR)** by Vaccine (point estimates and 95% confidence intervals, n=115)

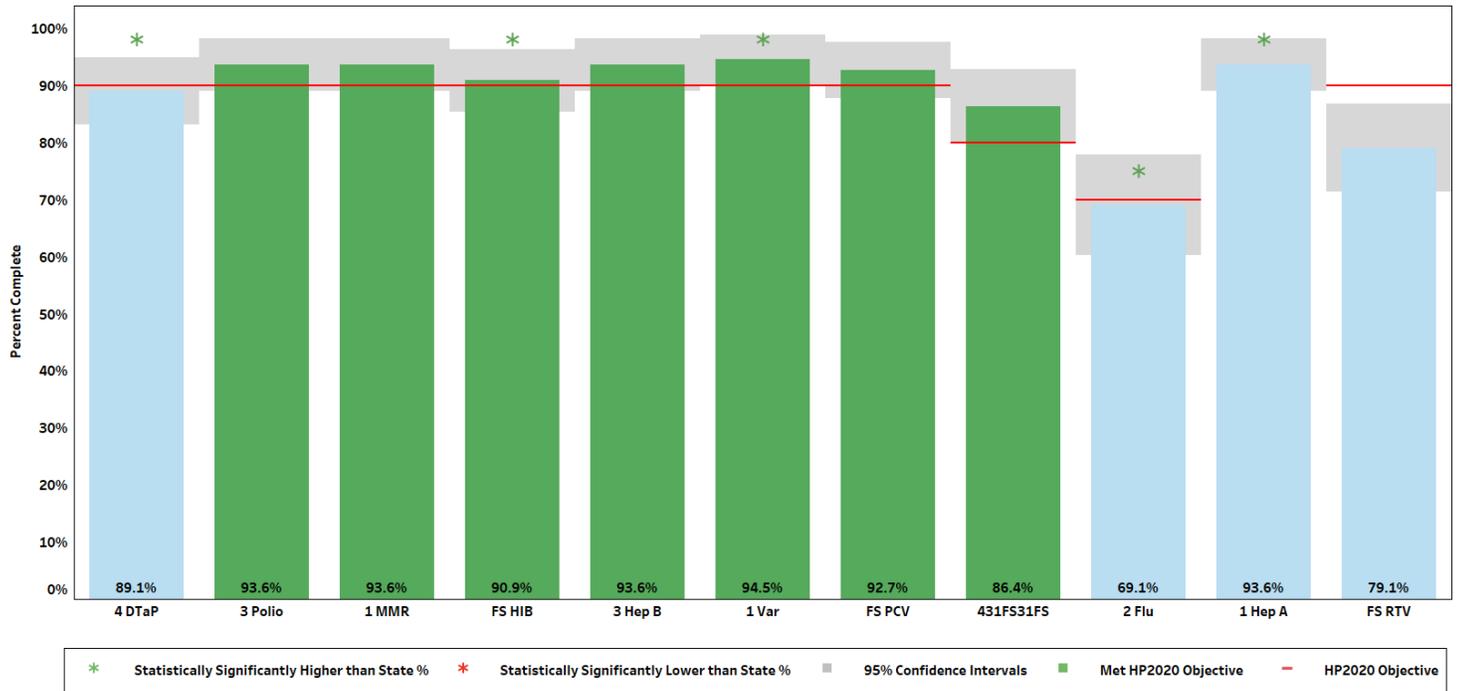


Percent of Children Complete in **Northeast Region (NER)** by Vaccine (point estimates and 95% confidence intervals, n=112)



IMMUNIZATION STATUS SURVEY – 2021

Percent of Children Complete in **Sullivan County Region (SUL)** by Vaccine (point estimates and 95% confidence intervals, n=110)



**Appendix 3**  
**Data Tables for Selected Analyses**

	Page
Series Complete (4:3:1:FS:3:1:FS)	56
Series Complete (4:3:1:FS:3:1:FS) by Provider Type	56
Series Complete (4:3:1:FS:3:1:FS) by Race	57
Series Complete (4:3:1:FS:3:1:FS) by Number of Older Siblings	57
Series Complete (4:3:1:FS:3:1:FS) by TennCare Enrollment	58
Series Complete (4:3:1:FS:3:1:FS) by WIC Enrollment	58

**2021 Series (4:3:1:FS:3:1:FS) by Region**

<b>Region</b>	<b>Complete</b>	<b>%</b>
Memphis-Shelby County	73/120	60.8
West TN	85/116	73.3
Madison County	75/114	65.8
South Central	77/116	66.4
Mid-Cumberland	87/116	75.0
Davidson County	87/104	83.7
Upper Cumberland	80/118	67.8
Southeast TN	92/110	83.6
Chattanooga-Hamilton County	89/111	80.2
East TN	88/116	75.9
Knox County	95/115	82.6
Northeast TN	87/111	78.4
Sullivan County	95/110	86.4
<b>Total</b>	<b>1110/1477</b>	<b>75.2</b>

Indicates value is above HP objective.

**2021 Series Complete (4:3:1:FS:3:1:FS) by Provider Type**

<b>Region</b>	<b>Public</b>		<b>Private</b>		<b>Public and Private</b>	
	<b>Complete</b>	<b>%</b>	<b>Complete</b>	<b>%</b>	<b>Complete</b>	<b>%</b>
Memphis-Shelby County	0/2	0	71/99	71.72	2/8	25.0
West TN	2/6	33.3	68/87	78.16	10/16	62.5
Madison County	3/10	30.0	55/68	80.9	16/30	53.3
South Central	0/2	0	66/87	75.86	11/14	78.6
Mid-Cumberland	1/1	100.0	80/98	81.6	5/6	83.3
Davidson County	0/1	0	82/95	86.3	4/6	66.7
Upper Cumberland	3/5	60.00	69/94	73.4	8/12	66.7
Southeast TN	0/0	-	82/92	89.1	10/14	71.4
Chattanooga-Hamilton County	0/0	-	84/104	80.8	4/6	66.7
East TN	0/4	0	79/95	83.2	9/13	69.2
Knox County	0/1	0	91/102	89.2	4/6	66.7
Northeast TN	1/1	100.0	79/93	85.0	7/14	50.0
Sullivan County	0/1	0.0	89/100	89.0	6/6	100.0
<b>Total</b>	<b>10/34</b>	<b>29.41</b>	<b>995/1214</b>	<b>81.2</b>	<b>96/151</b>	<b>63.6</b>

Indicates value is above HP objective.

**2021 Series Complete (4:3:1:FS:3:1:FS) by Race**

Region	White		Black		Other	
	Complete	%	Complete	%	Complete	%
Memphis-Shelby County	30/43	69.8	41/73	56.2	2/4	50.0
West TN	73/99	73.7	11/16	68.8	1/1	100.0
Madison County	46/62	74.2	27/50	54.0	2/2	100.0
South Central	72/108	66.7	5/7	71.4	0/1	0.0
Mid-Cumberland	75/99	75.8	11/15	73.3	1/2	50.0
Davidson County	63/70	90.0	19/28	67.9	5/6	83.3
Upper Cumberland	79/114	69.3	1/3	33.3	0/1	0.0
Southeast TN	87/104	83.7	3/4	75.0	2/2	100.0
Chattanooga-Hamilton County	65/78	83.3	20/29	68.9	4/4	100.0
East TN	88/116	84.1				
Knox County	89/104	85.6	4/8	50.0	2/3	66.7
Northeast TN	81/104	77.9	3/4	75.0	3/3	100.0
Sullivan County	90/105	85.7	3/3	100.0	2/2	100.0
Total	938/1206	77.8	148/240	61.7	24/31	77.4

Indicates value is above HP objective.

**2020 Series Complete (4:3:1:FS:3:1:FS) by Number of Older Siblings**

Region	0 Siblings		1 Sibling		2+ Siblings	
	Complete	%	Complete	%	Complete	%
Memphis-Shelby County	23/42	54.8	24/39	61.5	26/39	66.7
West TN	39/45	86.7	31/42	73.8	15/29	51.7
Madison County	36/42	85.7	20/32	62.5	19/40	47.5
South Central	31/40	77.5	25/33	75.8	21/43	48.8
Mid-Cumberland	40/47	85.1	28/39	71.7	19/30	63.3
Davidson County	43/45	95.6	30/37	81.1	14/22	63.6
Upper Cumberland	34/42	81.0	31/47	66.0	15/29	51.7
Southeast TN	45/49	91.8	26/33	78.8	21/28	75.0
Chattanooga-Hamilton County	39/43	90.7	22/30	73.3	28/38	73.7
East TN	33/38	86.8	36/50	72.0	19/28	67.9
Knox County	53/62	65.4	22/25	88.0	20/28	71.4
Northeast TN	29/37	78.4	28/29	96.6	30/45	66.7
Sullivan County	44/48	91.7	23/28	82.1	38/34	82.4
Total	489/580	84.3	346/464	74.6	275/433	63.5

Indicates value is above HP objective.

**2021 Series Complete (4:3:1:FS:3:1:FS) by TennCare Enrollment**

Region	Enrolled		Not Enrolled	
	Complete	%	Complete	%
Memphis-Shelby County	52/79	65.8	21/41	51.2
West TN	61/84	72.6	24/32	75.0
Madison County	53/88	60.2	22/26	84.6
South Central	58/75	77.3	19/41	46.3
Mid-Cumberland	52/66	78.8	35/50	70.0
Davidson County	50/64	78.1	37/40	92.5
Upper Cumberland	62/97	71.3	18/31	58.1
Southeast TN	67/79	84.8	25/31	80.7
Chattanooga-Hamilton County	41/59	69.5	48/52	92.3
East TN	64/82	78.1	24/34	70.6
Knox County	40/55	72.7	55/60	91.7
Northeast TN	62/81	76.5	25/30	83.3
Sullivan County	65/73	89.0	30/37	81.1
Total	727/972	74.8	383/505	75.8

Indicates value is above HP objective.

**2021 Series Complete (4:3:1:FS:3:1:FS) by WIC Enrollment**

Region	Enrolled		Not Enrolled	
	Complete	%	Complete	%
Memphis-Shelby County	45/65	69.2	28/55	50.9
West TN	49/68	72.1	36/48	75.0
Madison County	38/67	56.7	37/47	78.7
South Central	49/68	72.1	28/48	58.3
Mid-Cumberland	35/44	79.6	52/72	72.2
Davidson County	3/4	75.0	84/100	84.0
Upper Cumberland	49/73	67.1	31/45	68.9
Southeast TN	56/69	81.2	36/41	87.8
Chattanooga-Hamilton County	35/48	72.9	51/63	85.7
East TN	55/74	74.3	33/42	78.6
Knox County	34/44	77.3	61/71	85.9
Northeast TN	50/66	75.8	37/45	82.2
Sullivan County	53/65	81.5	42/45	93.3
Total	551/755	73.0	559/722	77.4

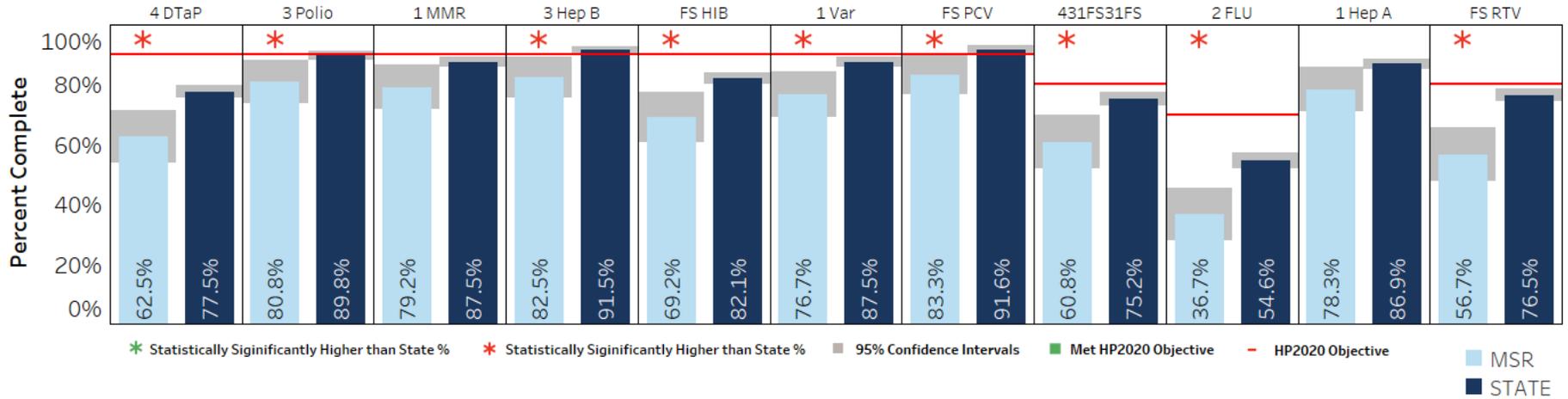
Indicates value is above HP objective.

**Appendix 4**  
**Regional One Page Summaries**

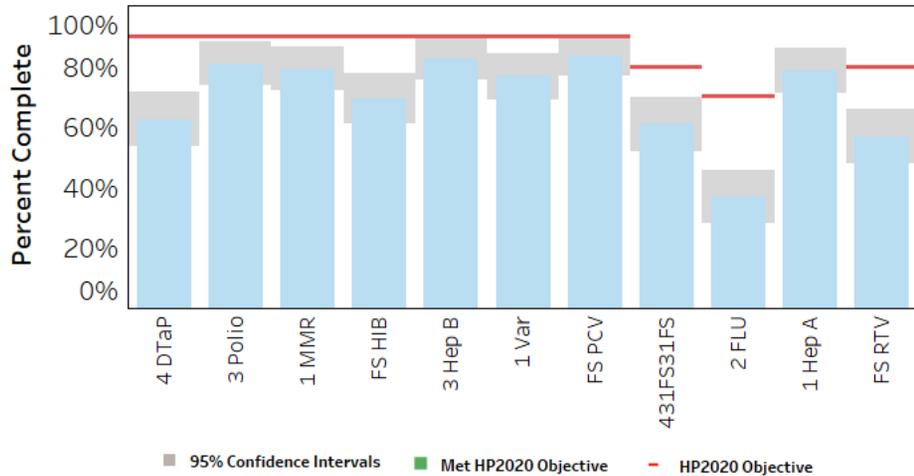
	Page
Memphis- Shelby County	60
West Tennessee Region	61
Jackson-Madison County	62
South Central Region	63
Mid-Cumberland Region	64
Nashville-Davidson County	65
Upper Cumberland Region	66
Southeast Region	67
Chattanooga- Hamilton County	68
East Tennessee Region	69
Knoxville-Knox County	70
Northeast Region	71
Sullivan County	72



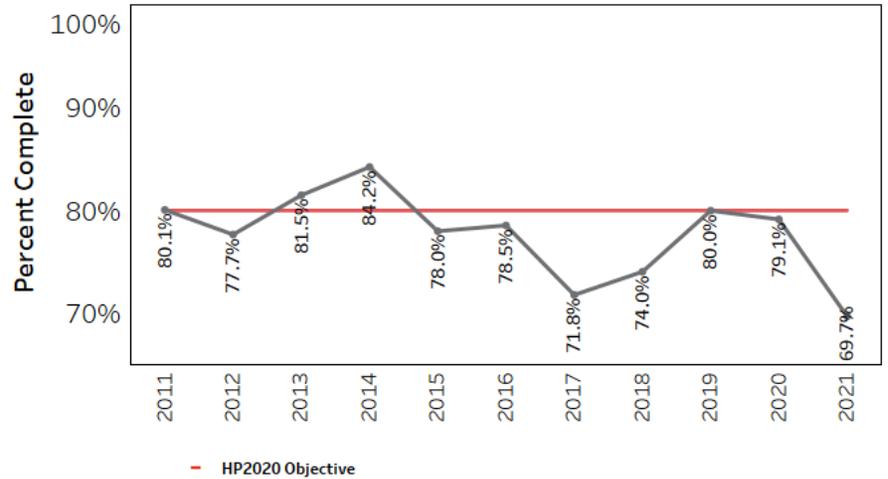
## Memphis-Shelby Region 24-Month-Old Survey, 2021



MSR Attainment of HP2020 Objective, by Vaccine, 2021

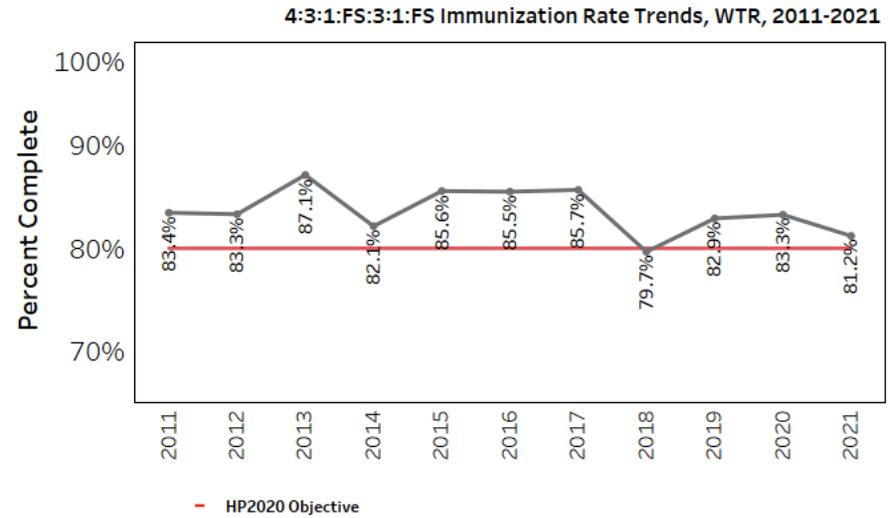
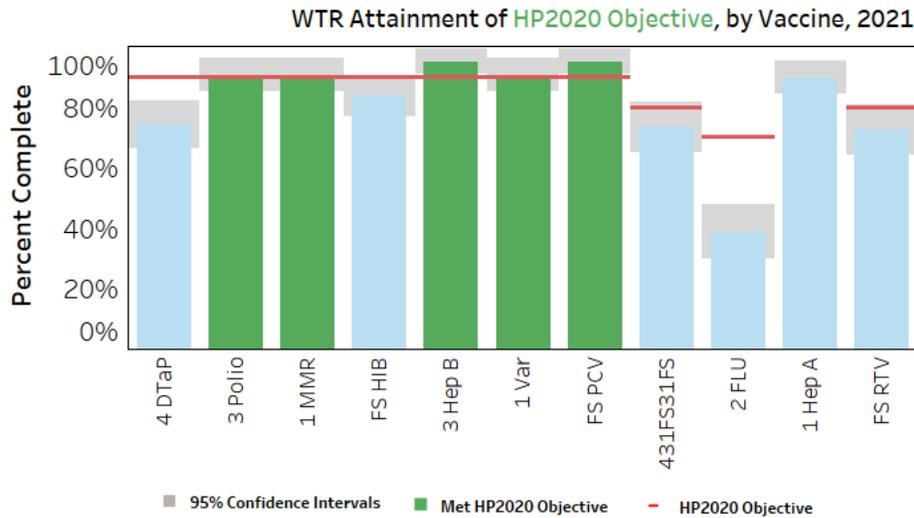
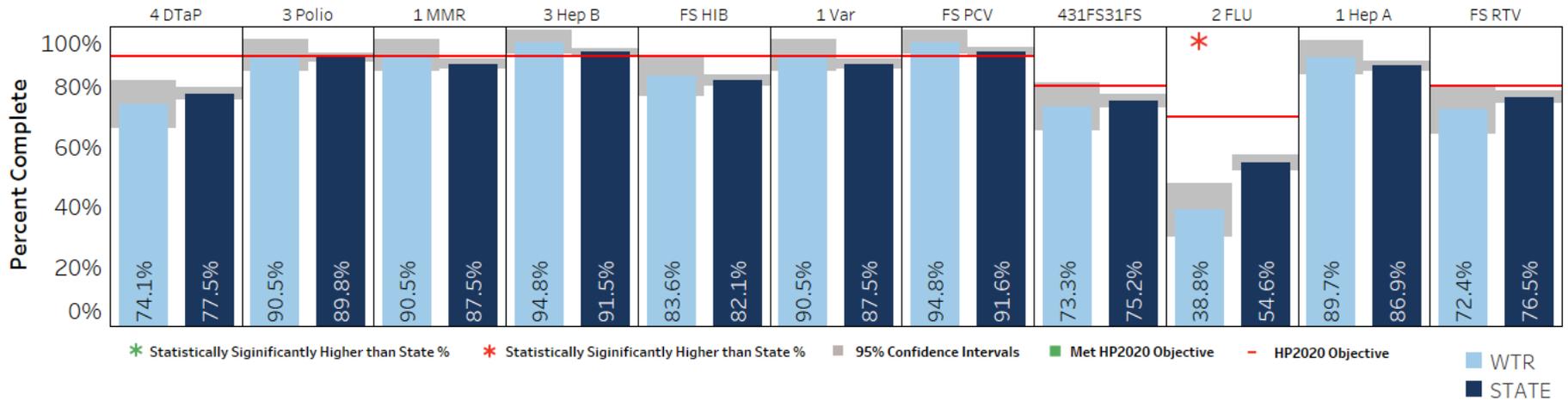


4:3:1:FS:3:1:FS Immunization Rate Trends, MSR, 2011-2021



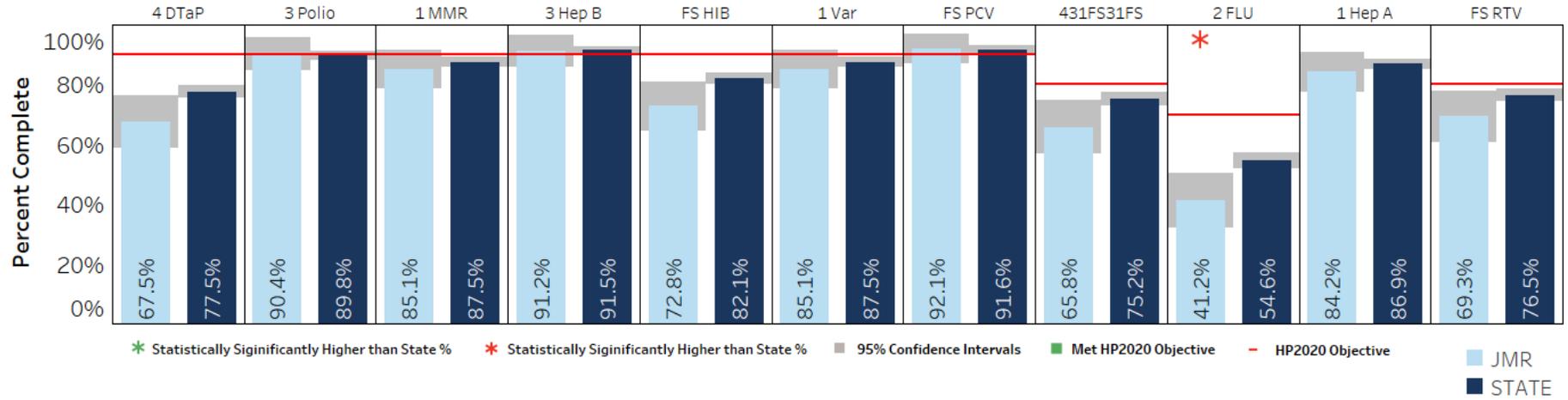


West Tennessee Region  
24-Month-Old Survey, 2021

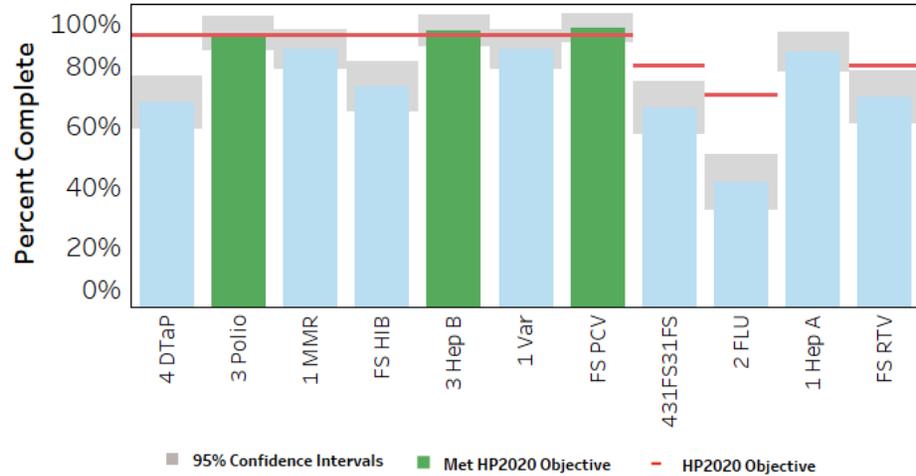




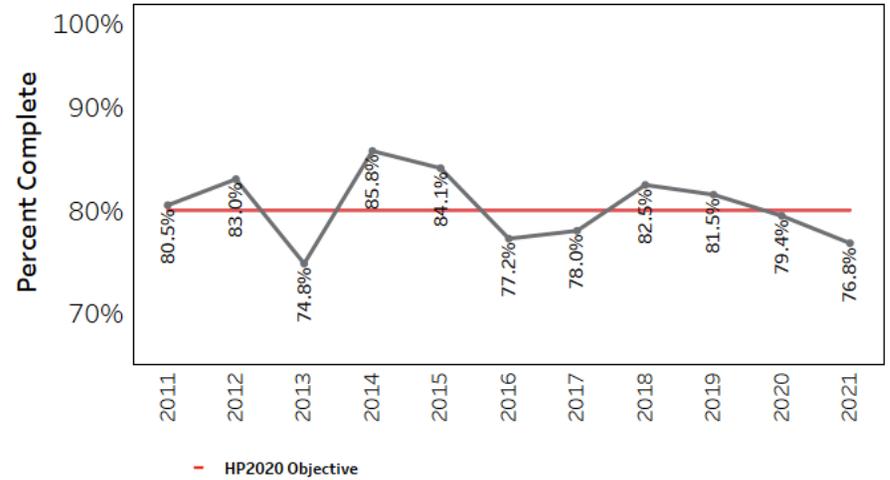
**Jackson-Madison Region**  
24-Month-Old Survey, 2021



JMR Attainment of HP2020 Objective, by Vaccine, 2021

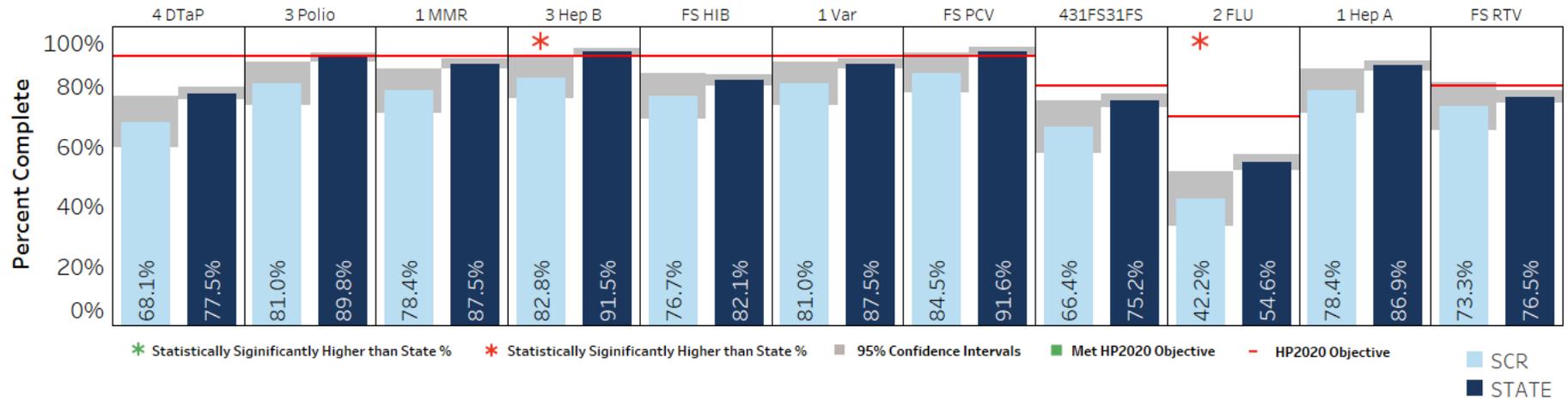


4:3:1:FS:3:1:FS Immunization Rate Trends, JMR, 2011-2021

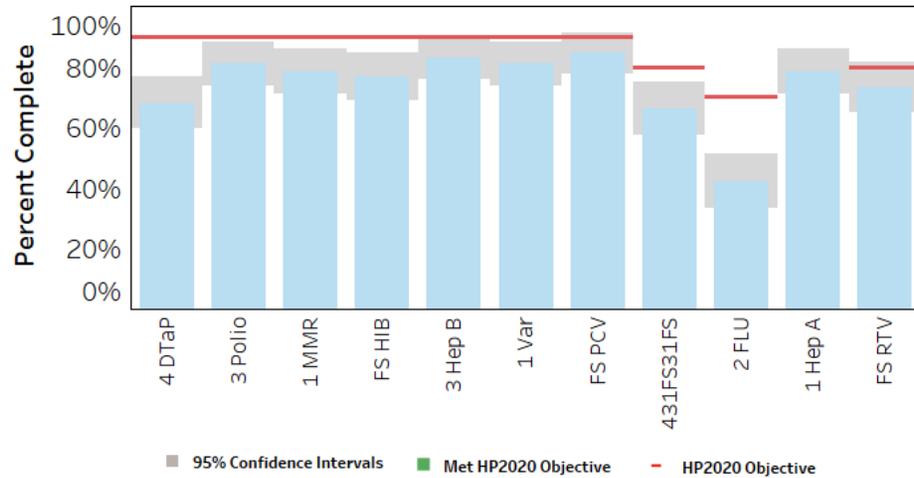




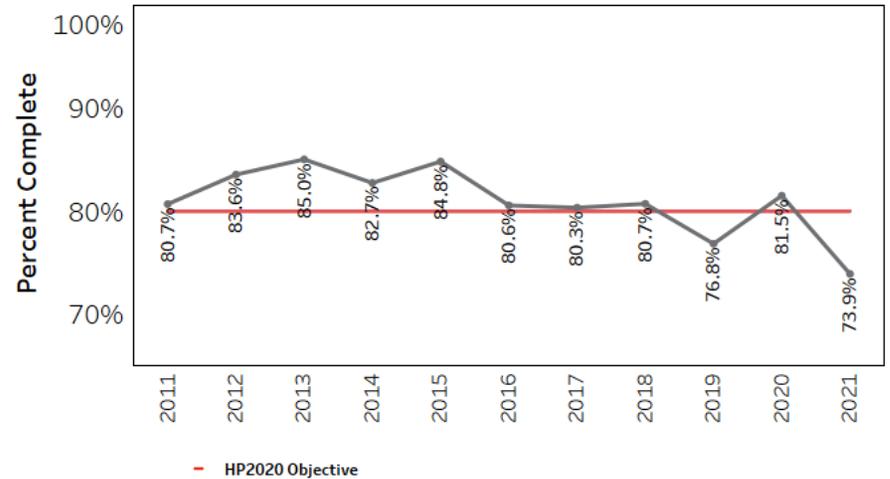
### South Central Region 24-Month-Old Survey, 2021



SCR Attainment of HP2020 Objective, by Vaccine, 2021

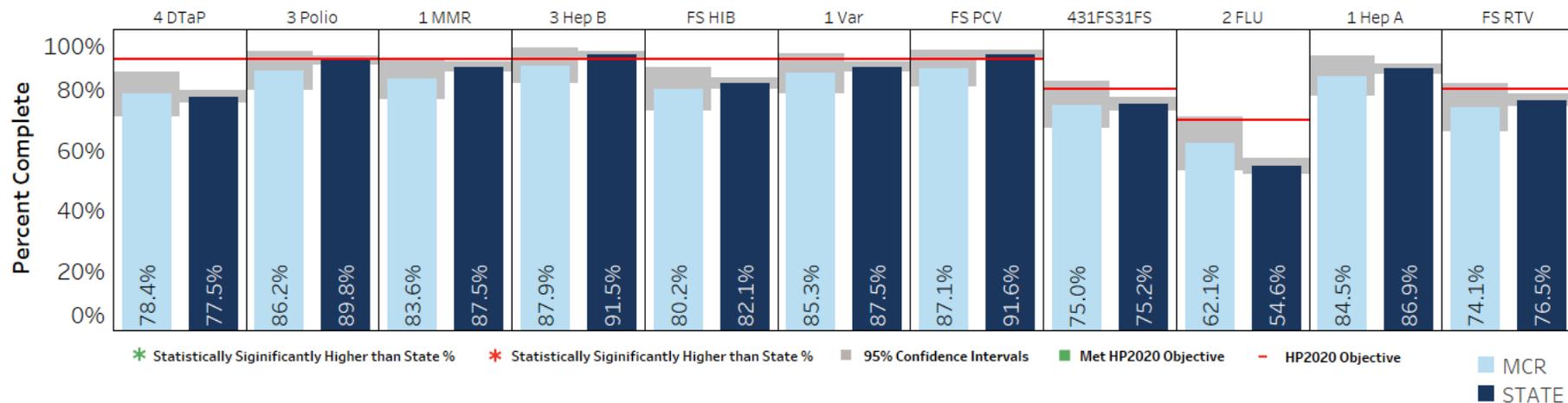


4:3:1:FS:3:1:FS Immunization Rate Trends, SCR, 2011-2021

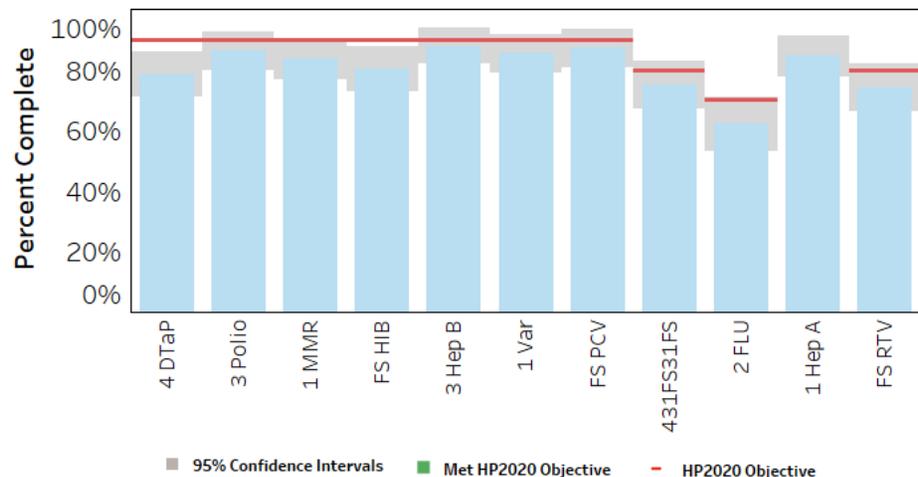




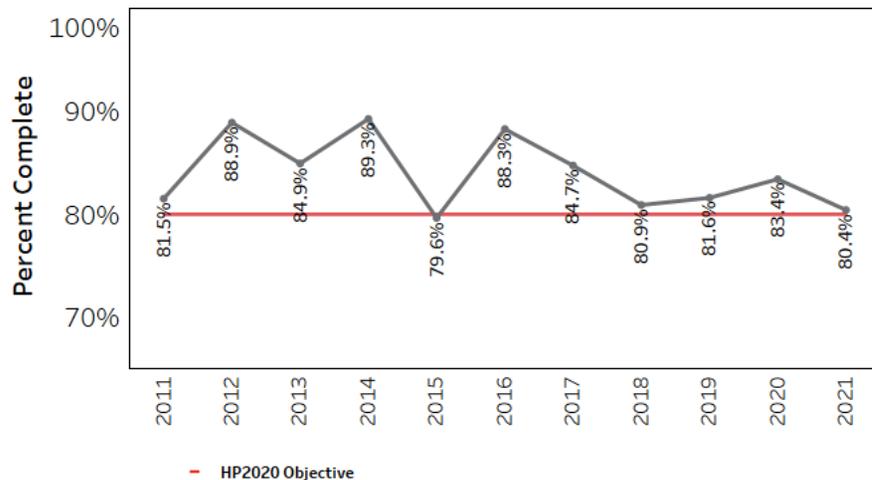
### Mid-Cumberland Region 24-Month-Old Survey, 2021



MCR Attainment of HP2020 Objective, by Vaccine, 2021

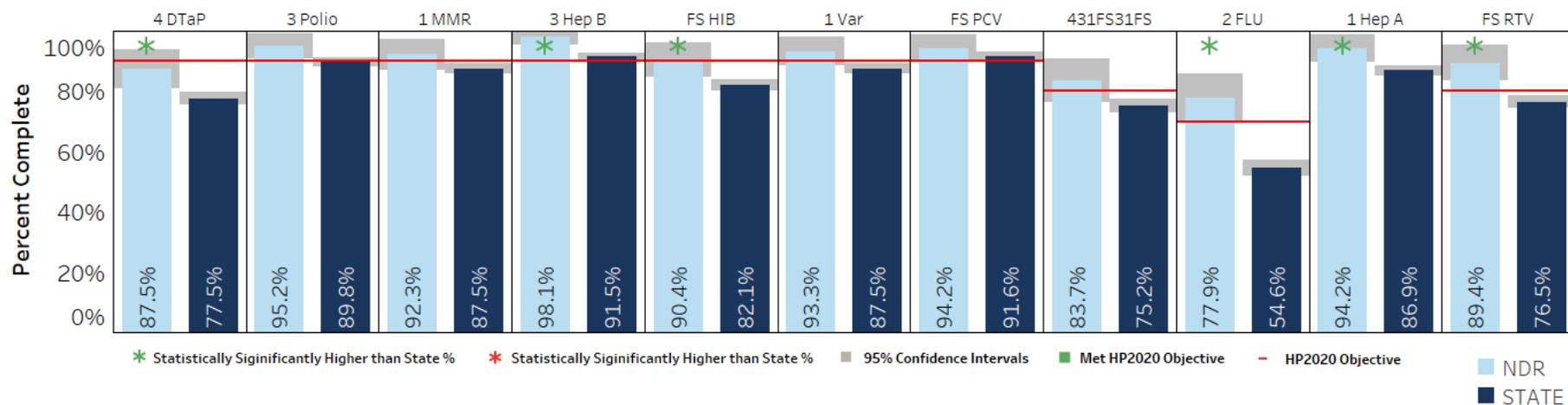


4:3:1:FS:3:1:FS Immunization Rate Trends, MCR, 2011-2021

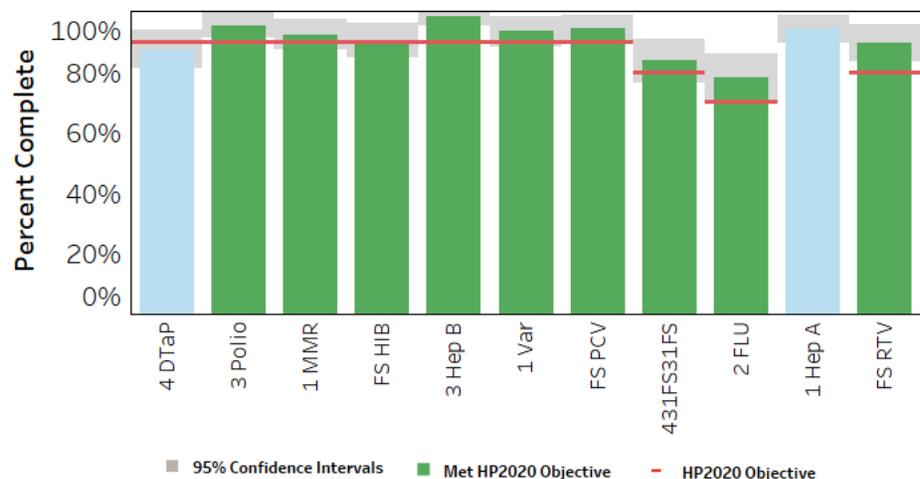




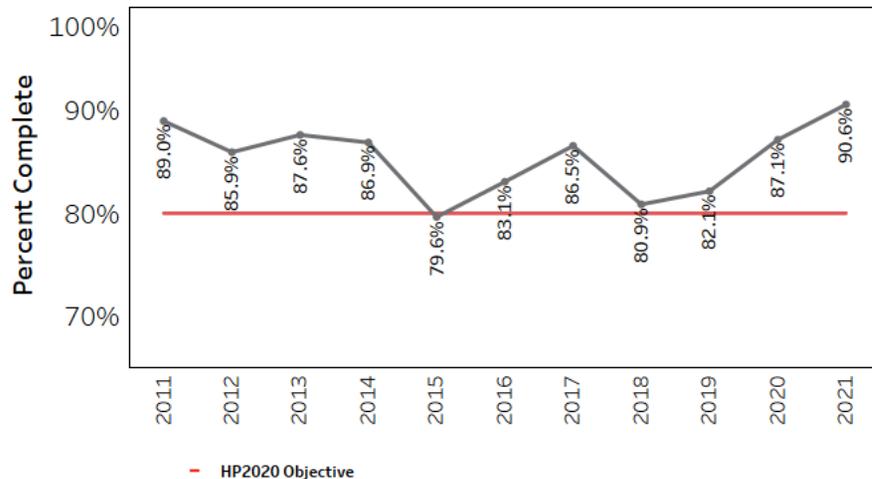
### Nashville-Davidson Region 24-Month-Old Survey, 2021



NDR Attainment of HP2020 Objective, by Vaccine, 2021

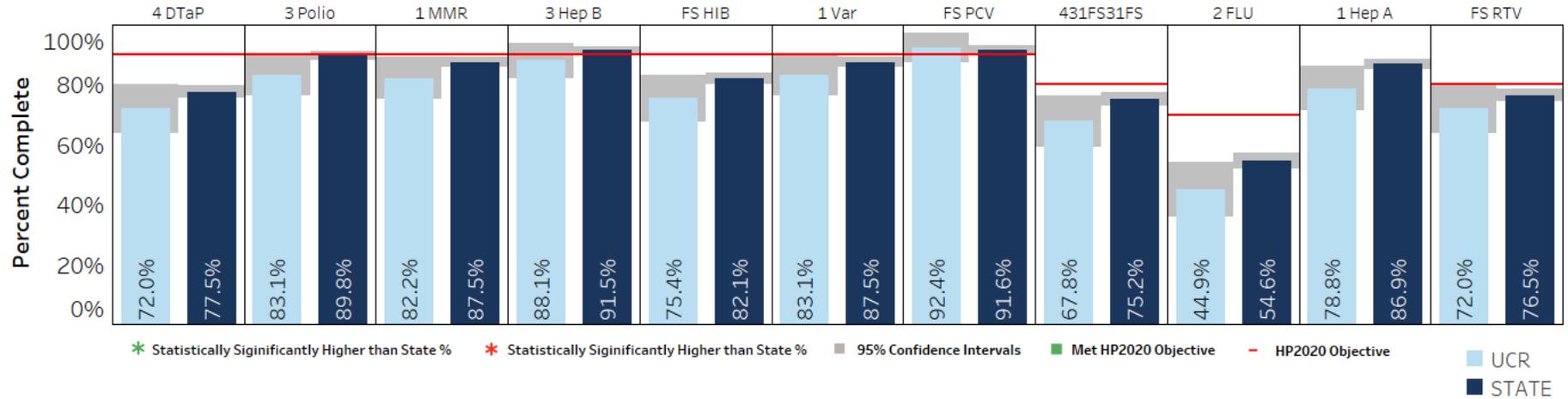


4:3:1:FS3:1:FS Immunization Rate Trends, NDR, 2011-2021

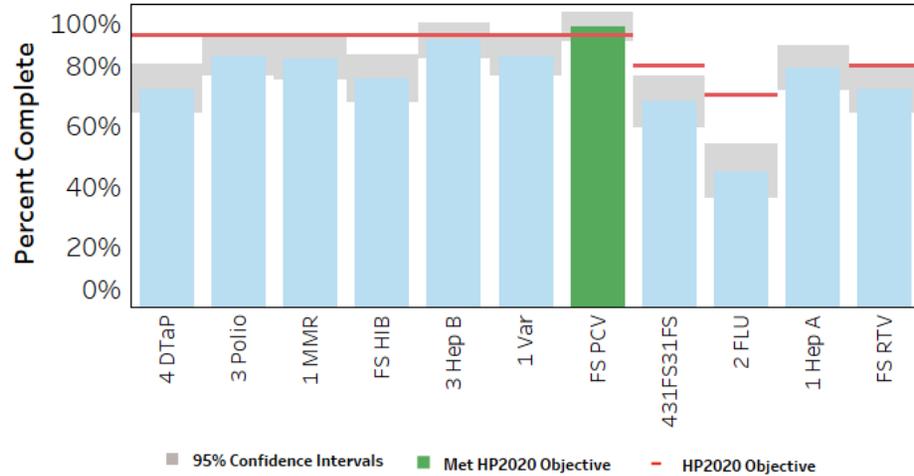




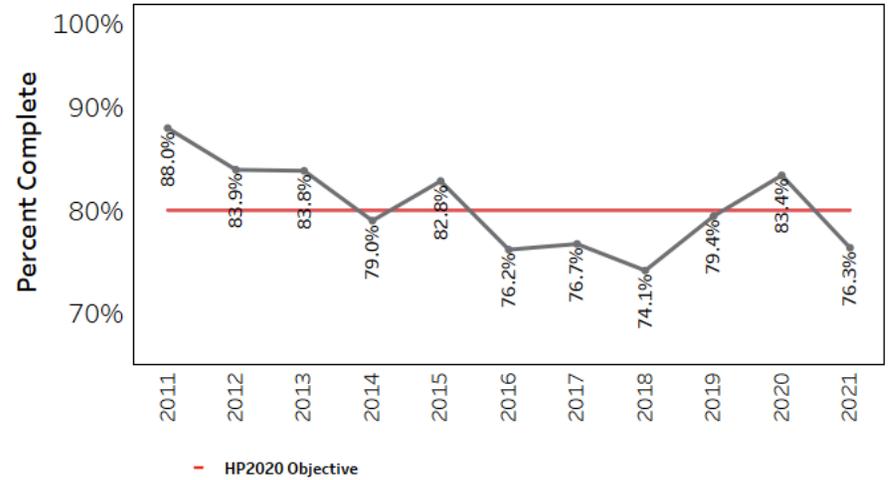
### Upper-Cumberland Region 24-Month-Old Survey, 2021



UCR Attainment of HP2020 Objective, by Vaccine, 2021

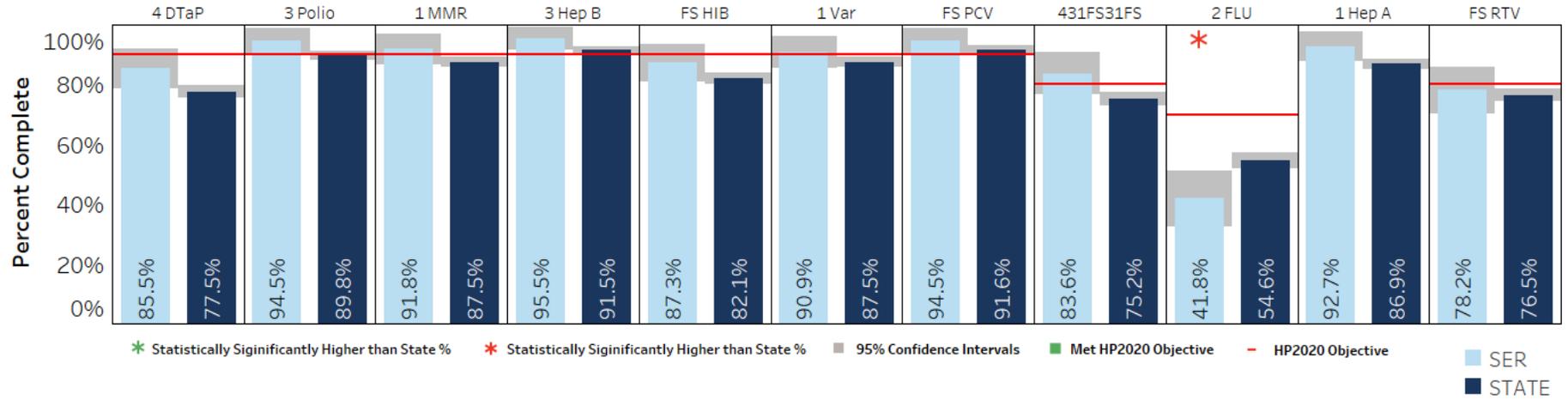


4:3:1:FS:3:1:FS Immunization Rate Trends, UCR, 2011-2021

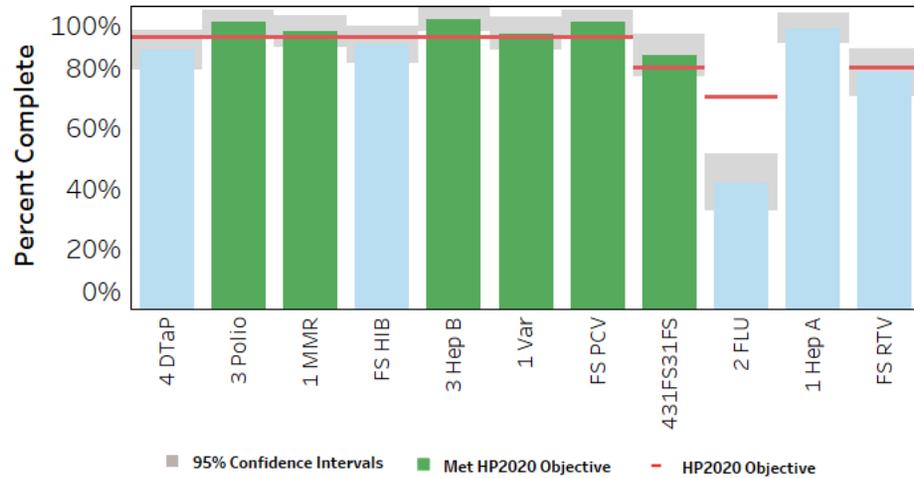




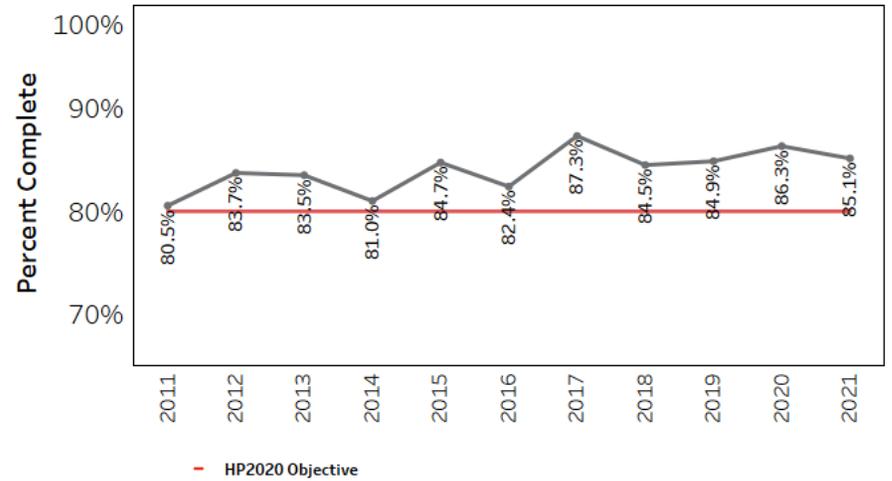
**Southeast Region**  
24-Month-Old Survey, 2021



SER Attainment of HP2020 Objective, by Vaccine, 2021

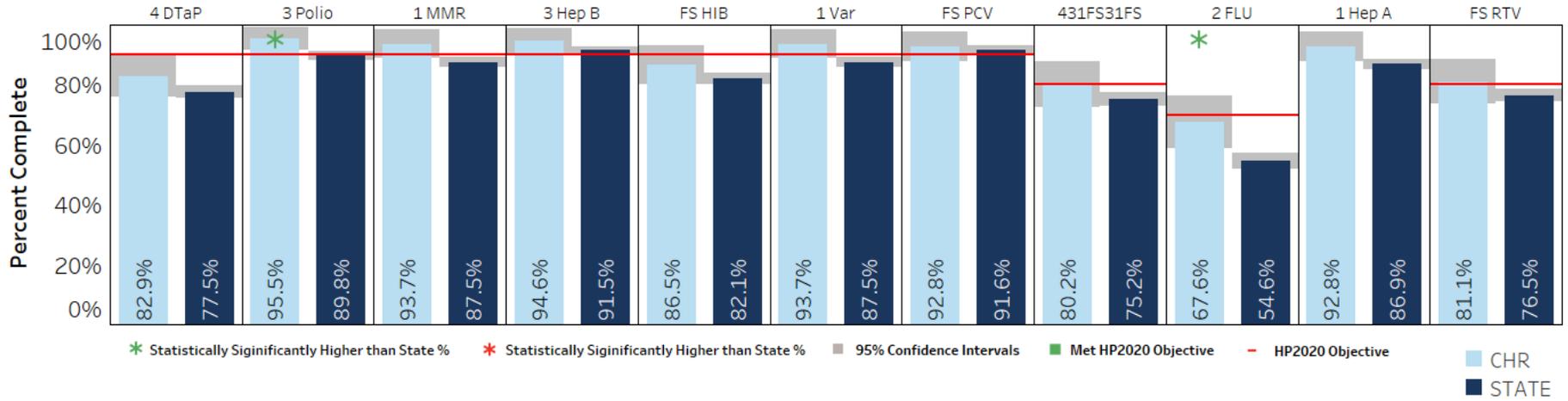


4:3:1:FS:3:1:FS Immunization Rate Trends, SER, 2011-2021

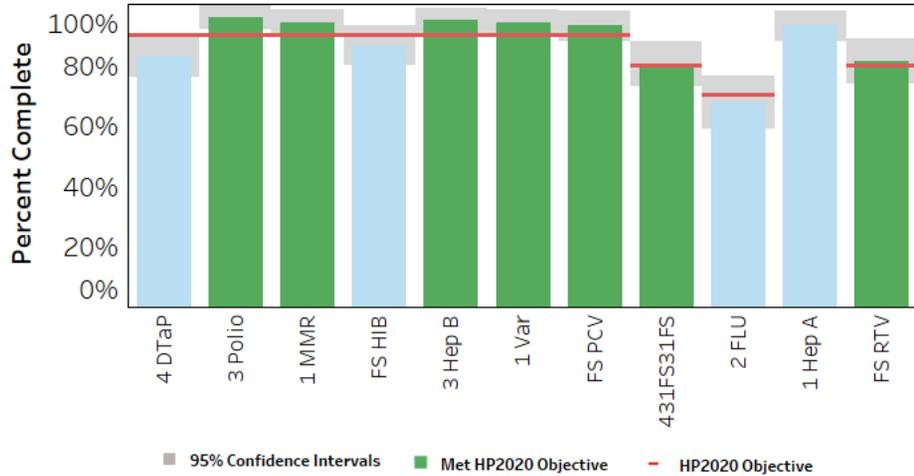




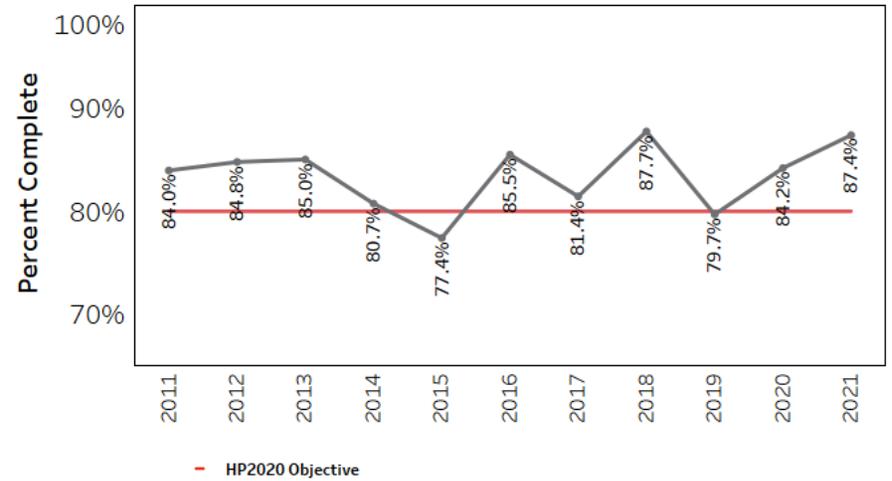
### Chattanooga-Hamilton Region 24-Month-Old Survey, 2021



CHR Attainment of HP2020 Objective, by Vaccine, 2021

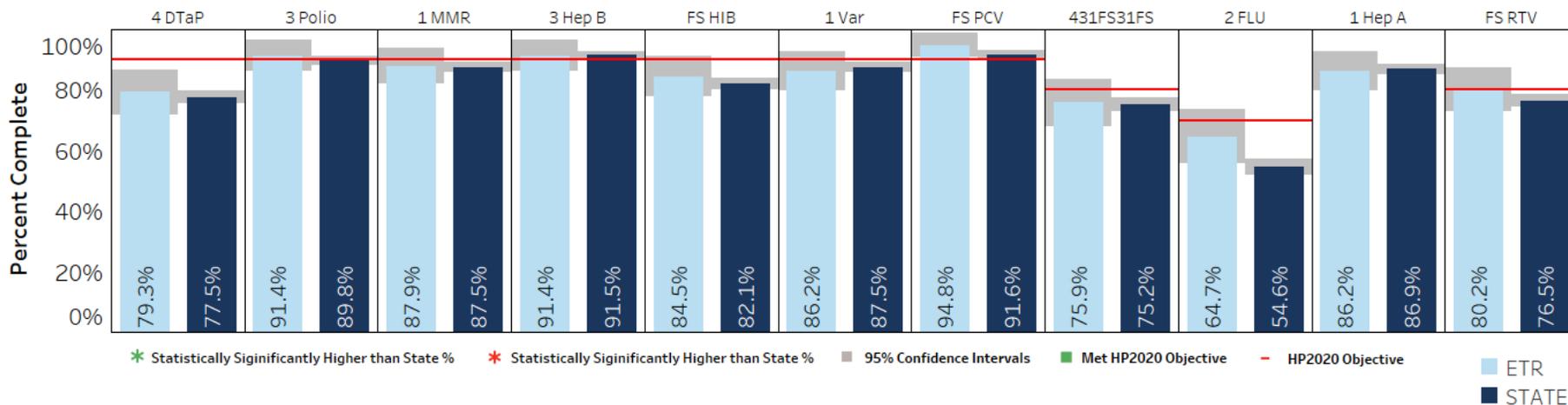


4:3:1:FS:3:1:FS Immunization Rate Trends, CHR, 2011-2021

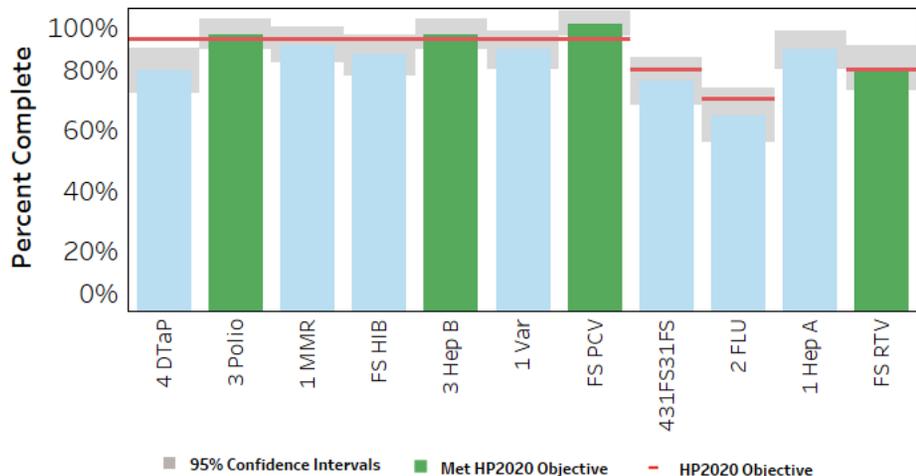




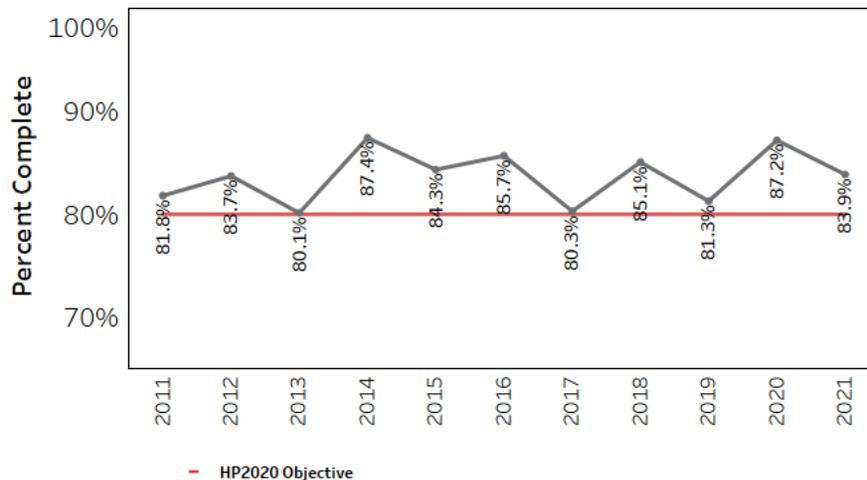
### East Tennessee Region 24-Month-Old Survey, 2021



ETR Attainment of HP2020 Objective, by Vaccine, 2021

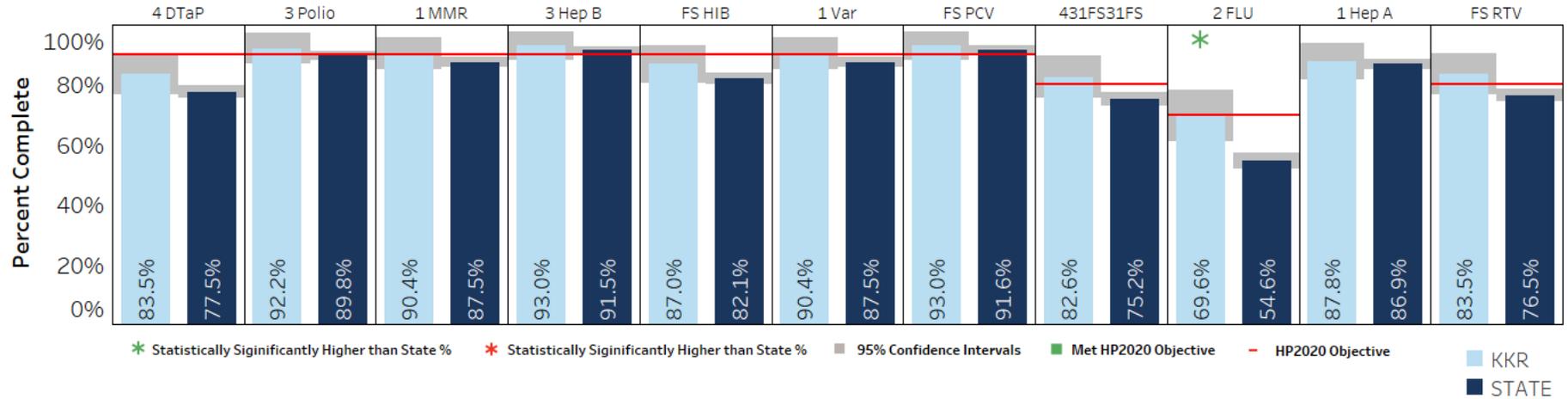


4:3:1:FS:3:1:FS Immunization Rate Trends, ETR, 2011-2021

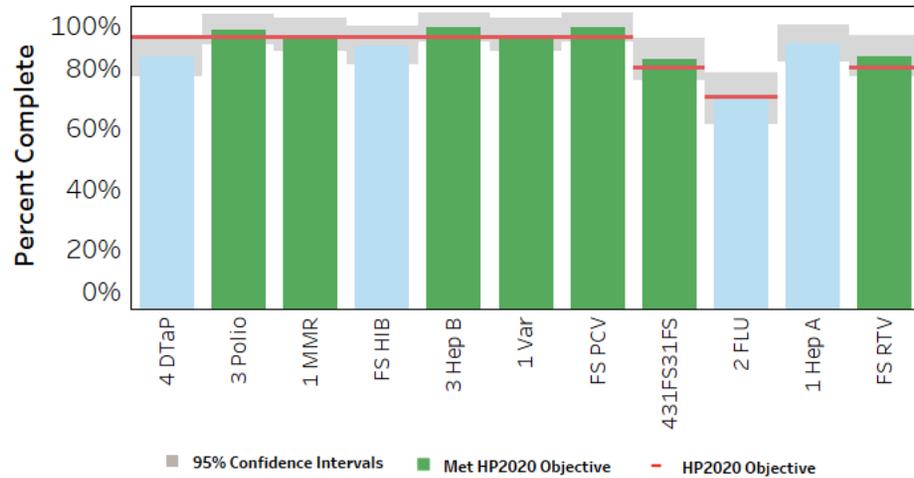




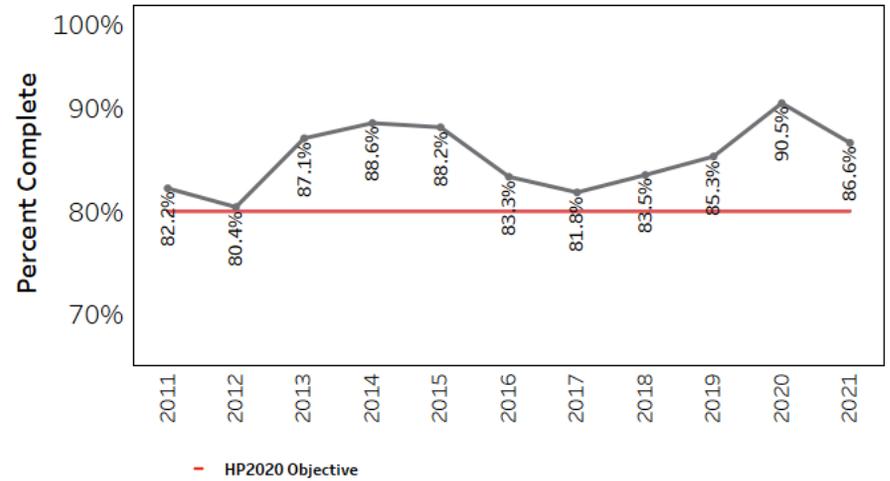
**Knoxville-Knox County Region**  
24-Month-Old Survey, 2021



KKR Attainment of HP2020 Objective, by Vaccine, 2021

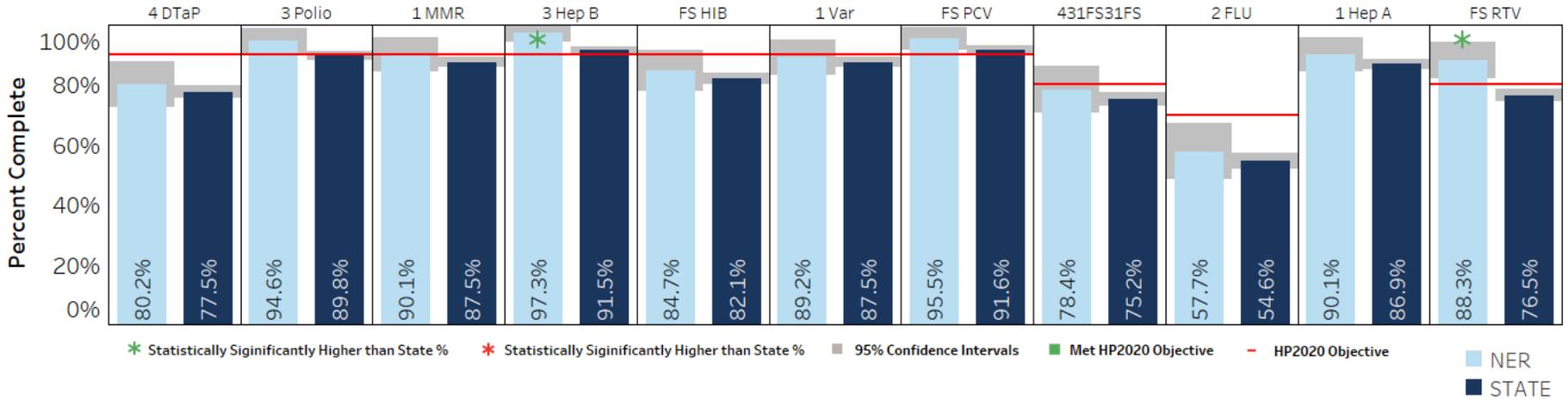


4:3:1:FS:3:1:FS Immunization Rate Trends, KKR, 2011-2021

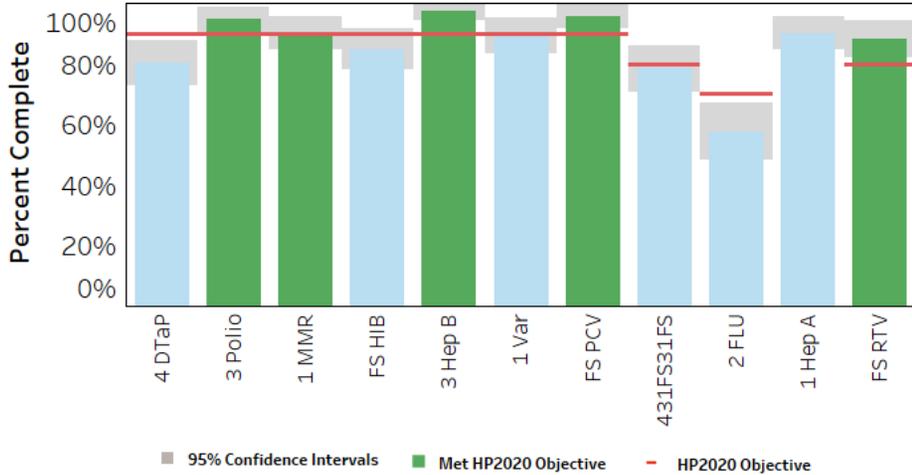




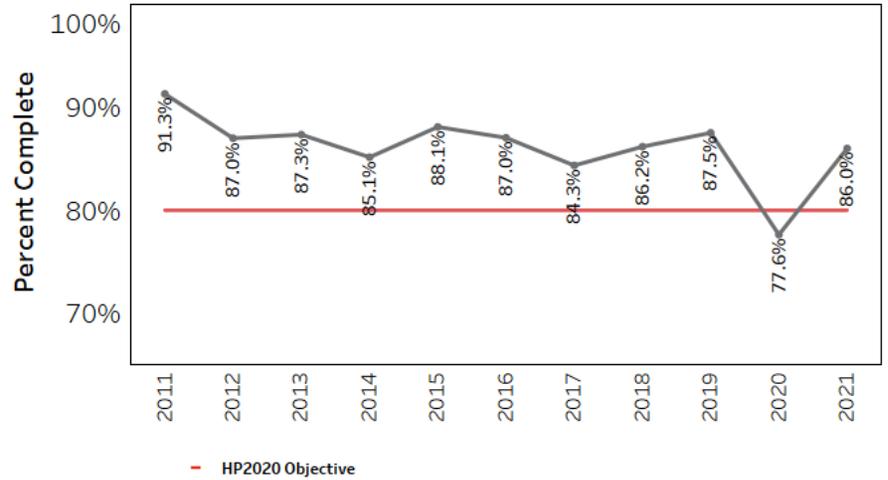
**Northeast Region**  
24-Month-Old Survey, 2021



NER Attainment of HP2020 Objective, by Vaccine, 2021

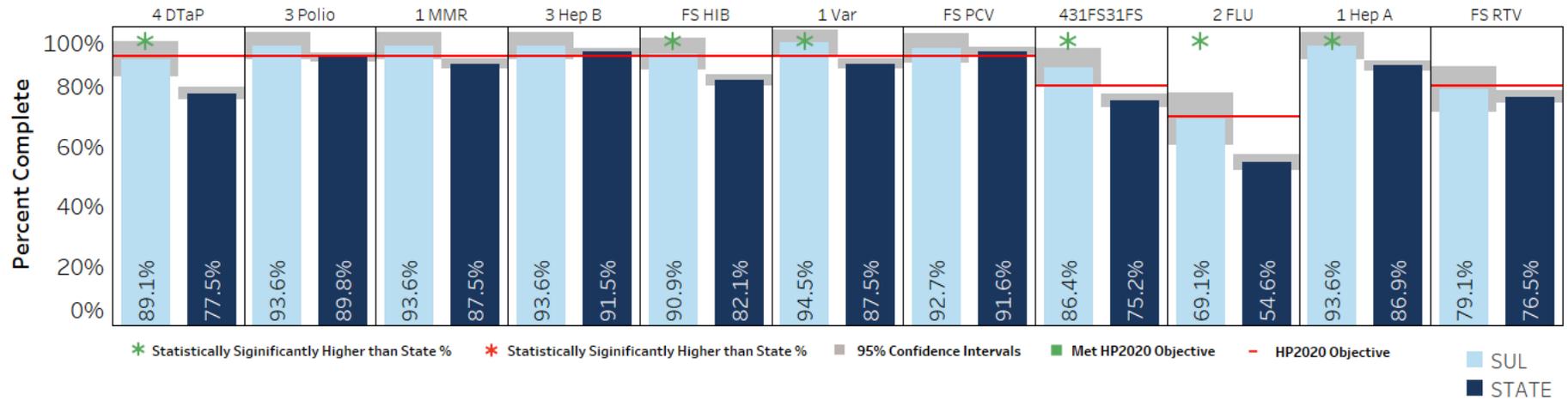


4:3:1:FS:3:1:FS Immunization Rate Trends, NER, 2011-2021

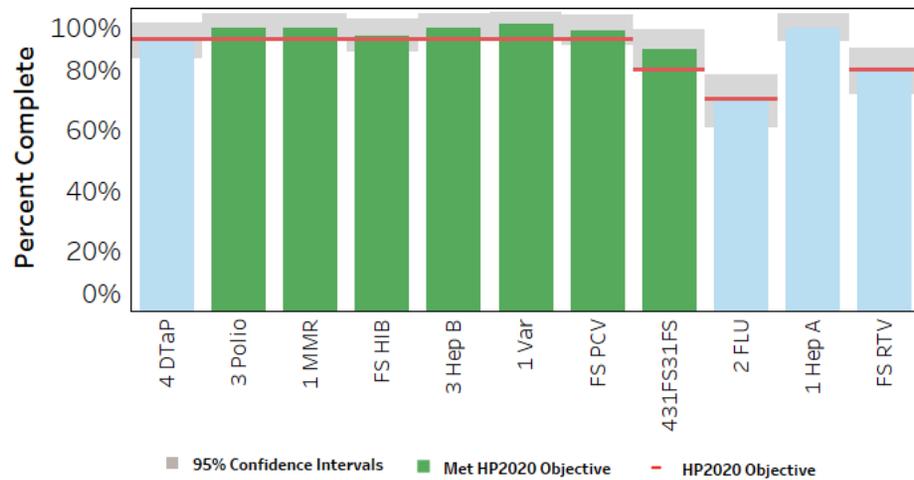




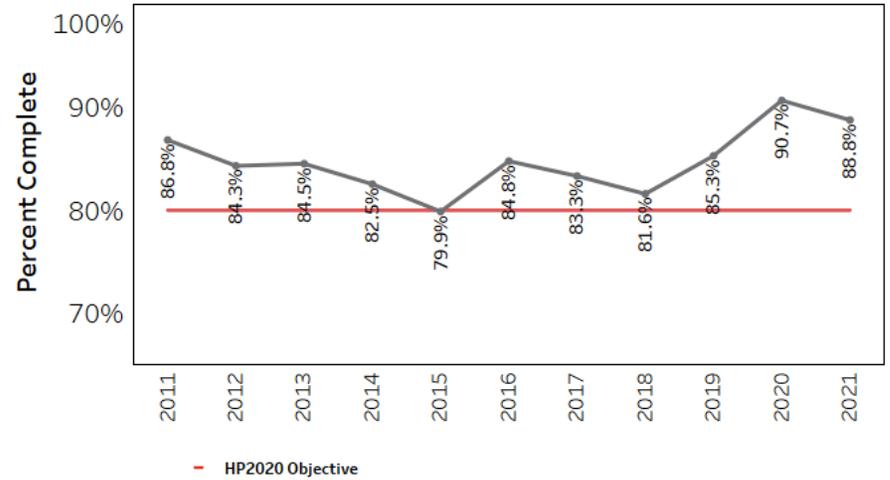
**Sullivan Region**  
24-Month-Old Survey, 2021



SUL Attainment of HP2020 Objective, by Vaccine, 2021

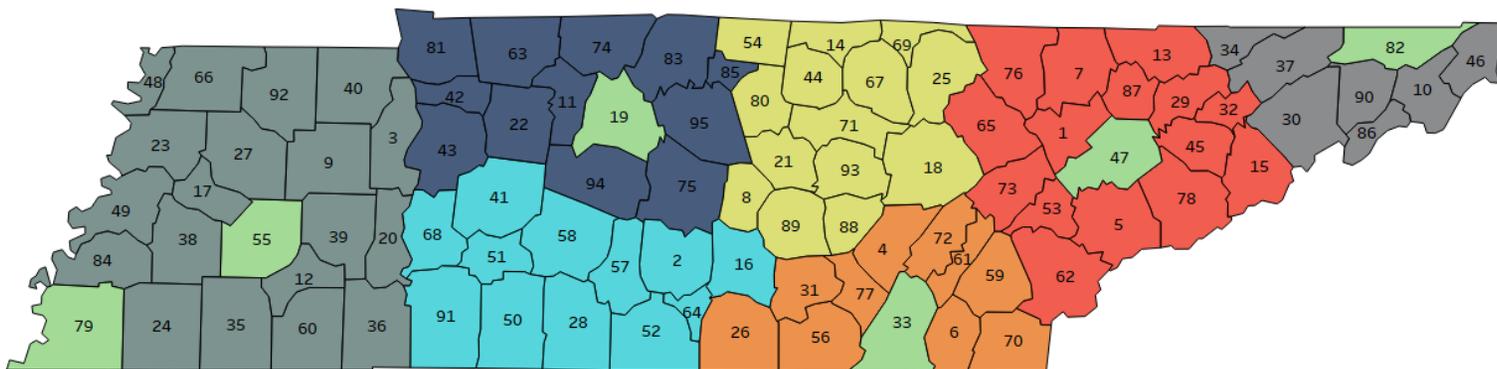


4:3:1:FS:3:1:FS Immunization Rate Trends, SUL, 2011-2021



### Appendix 5

## TENNESSEE DEPARTMENT OF HEALTH REGIONAL/METRO HEALTH OFFICES



West		Mid Cumberland		South Central		Southeast		Upper Cumberland		East		Northeast		Metros	
County	#	County	#	County	#	County	#	County	#	County	#	County	#	County	#
Benton	3	Cheatham	11	Bedford	2	Bledsoe	4	Cannon	8	Anderson	1	Carter	10	Davidson	19
Carroll	9	Dickson	22	Coffee	16	Bradley	6	Clay	14	Blount	5	Greene	30	Hamilton	33
Chester	12	Houston	42	Giles	28	Franklin	26	Cumberland	18	Campbell	7	Hancock	34	Knox	47
Crockett	17	Humphreys	43	Hickman	41	Grundy	31	DeKalb	21	Claiborne	13	Hawkins	37	Madison	55
Decatur	20	Montgomery	63	Lawrence	50	Marion	56	Fentress	25	Coke	15	Johnson	46	Sullivan	82
Dyer	23	Robertson	74	Lewis	51	McMinn	59	Jackson	44	Grainger	29	Unicoi	86		
Fayette	24	Rutherford	75	Lincoln	52	Meigs	61	Macon	54	Hamblen	32	Washington	90		
Gibson	27	Stewart	81	Marshall	57	Polk	70	Overton	67	Jefferson	45				
Hardeman	35	Sumner	83	Maury	58	Rhea	72	Pickett	69	Loudon	53				
Hardin	36	Trousdale	85	Moore	64	Sequatchie	77	Putnam	71	Monroe	62				
Haywood	38	Williamson	94	Perry	68			Smith	80	Morgan	65				
Henderson	39	Wilson	95	Wayne	91			Van Buren	88	Roane	73				
Henry	40							Warren	89	Scott	76				
Lake	48							White	93	Sevier	78				
Lauderdale	49									Union	87				
McNairy	60														
Obion	66														
Tipton	84														
Weakley	92														



Department of Health Authorization No.355798.  
This Electronic publication was promulgated at zero cost.  
February 2022