

# Spatiotemporal Analysis of Childhood Vaccine Coverage in Virginia pre and post COVID

This material is based upon work supported by the National Institute of Health under grant no. R01GM109718 and the US Centers for Disease Control and Prevention under grant no. 75D30119C05935

Rithika Devarakonda, Anil Vullikanti, Sifat Moon, and Achla Marathe

## Background and Methods

- Side effect of COVID is an increase in vaccine hesitancy from disruptions caused by social distancing
- Using APCD dataset with all insurance claims in Virginia from 2016-2020
- Spatiotemporal analysis tracks changes in data over time (2016-2020) and location (county level data based on Virginia zip codes)
- Filtered data for every vaccination using ICD procedural codes for mandatory childhood vaccines [1]
- CDC mandates require children to take a certain number of doses within an age range
- Can track how many doses a patient has taken within their medical ID
- Each patient is assumed to have taken at least one vaccine dose in the filtered data
- Transformed compiled yearly vaccination records to find every time a unique patient received a vaccine dose and average number of doses for an age group
- Dose entry data for every patient also contain their age, gender, race, and zip code
- Created a function to track and isolate patients who did not complete the recommended dose series within the correct timeframe
- Information on patients who did or did not complete the vaccine series used to compare proportion per year and pre and post COVID
- Created map visuals to represent the proportion of incomplete vaccination series based on zip codes to see if there was a pattern of vaccine hesitancy based on geographic trends across the five years

## Hib Vaccine Case Study Step 1

Year	Unique IDs	Total Doses	Proportion	Average Dose Taken per infant
2016	67043	116483	57.56	1.74
2017	74881	161892	46.25	2.16
2018	72296	151089	47.85	2.09
2019	63418	148691	42.65	2.34
2020	69736	190033	36.7	2.73

Figure 1. The number of infants (between ages 0-1) who took the Hib vaccine compared to how many total immunizations and average dose count were recorded for the age group.

Year	Unique IDs	Total Doses	Proportion	Average Dose Taken
2016	28229	36852	76.6	1.31
2017	37846	53880	70.24	1.42
2018	35129	48081	73.06	1.37
2019	33835	51683	65.47	1.53
2020	34418	60788	56.62	1.77

Figure 2. The number of individual one year olds (between ages 1-2) who took the Hib vaccine compared to how many total Hib immunizations and average dose count were recorded for the age group.

- Hib vaccine required for both infants and one year olds
- Found the number of unique patients compared to how many vaccinations were recorded per age group
- Average dose count is equal to aggregate number of vaccines taken for the age group divided by the unique patient count
- Infants are required to take at least 2 doses but can also take an optional 3rd dose
- Average dose count increased from 2016 to 2020 so more infants took a 3rd dose after COVID
- One year olds are required to take one vaccine, but the average dose count increased from 2016 to 2020
- Increased average dose count means that many one year olds are catching up on previously missed doses especially after COVID
- Next step is to find the proportion among the individual patients who have not completed their Hib vaccine series using transformed dose entry data

## Current Work

- Perform similar 3 step analysis on remaining 12 vaccines and compile all visuals and tables in one document
- Take closer look at the county level data to research why certain zip codes had a higher proportion of patients who did not complete their dose series or why some zip codes had no data present in the maps above

## References

[1] Baker MA, Nguyen M, Cole DV, Lee GM, Lieu TA. Post-licensure rapid immunization safety monitoring program (PRISM) data characterization. *Vaccine*. 2013 Dec 30;31 Suppl 10:K98-112. doi: 10.1016/j.vaccine.2013.04.088. PMID: 24331080.

## Hib Vaccine Case Study Step 2

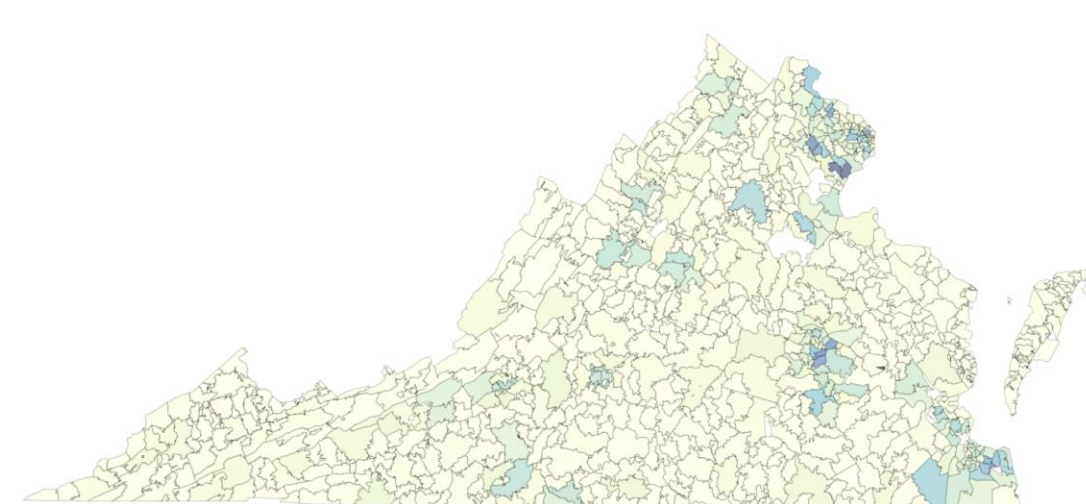
Year	Incompletes	Completes	Total IDs in Age Group	Incomplete Proportion	Complete Proportion
2016	21765	45278	67043	32.46	67.54
2017	18601	56280	74881	24.84	75.16
2018	19981	52315	72296	27.64	72.36
2019	17557	45861	63418	27.68	72.32
2020	10395	59341	69736	14.91	85.09

Figure 3. The number of infants who took at least 2 doses were counted in the complete column while the remaining patients did not and are counted in the incomplete column. Both columns sum up to the unique number of patients who are infants per year.

- Can only perform this analysis on age groups that are required to take multiple doses because patients in filtered APCD dataset have taken at least 1 dose
- Each vaccination record also includes the month in which they received a dose, so took into account patients born later in the year
- Created function to isolate infants who took first dose in November or December at 2 months to use the next years data to check for additional doses
- If doses found in next year, patients counted under the completes column for the year they took their first dose and were removed from the incompletes for current and next year
- Filtered out patients who only took one dose in the first two months for 2016 and the last two months for 2020 because of a lack of data for the years 2015 and 2021
- Results imply that among the infants who took at least one Hib vaccine, the majority of them completed the second dose
- As the years progressed the proportion of infants who took at least one Hib vaccine and continued to complete the second one also increased pre and post COVID

## Hib Vaccine Case Study Step 3

2016 Hib Incomplete Vaccination Percentage



2020 Hib Incomplete Vaccination Percentage

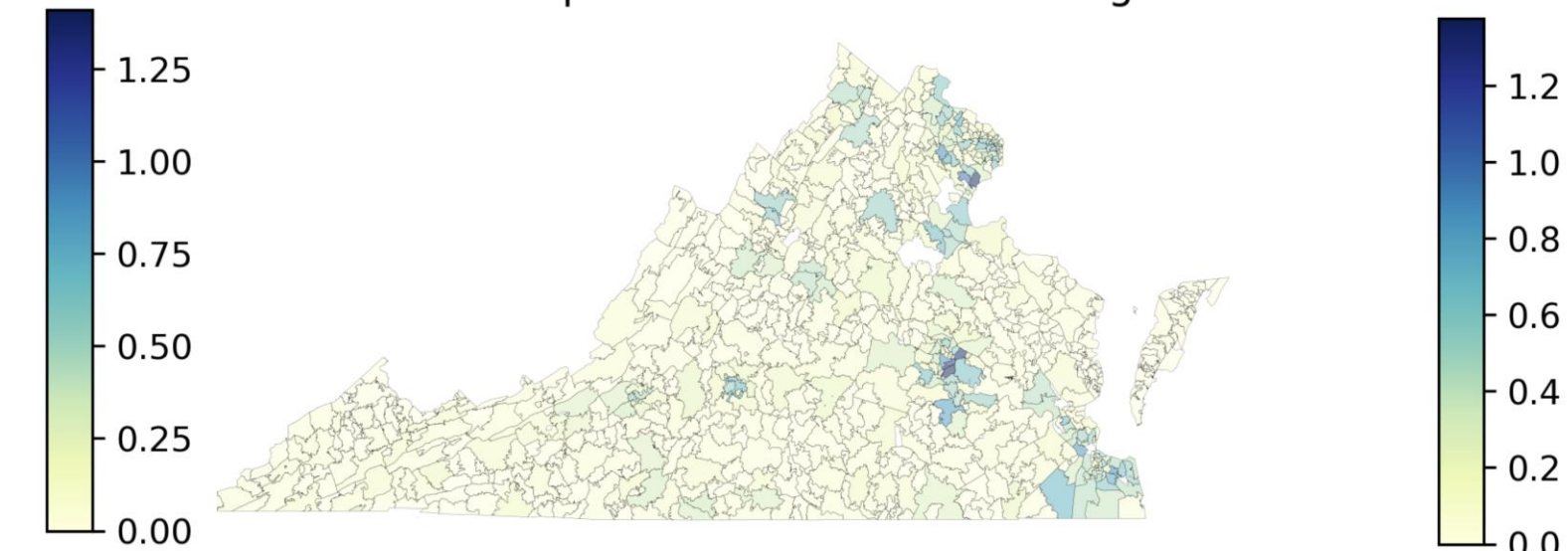


Figure 4. A map of Virginia by zip code in which a darker shade of blue according to the scale indicates a higher proportion of infants who did not complete the correct number of Hib vaccines within the CDC mandated time frame using data from 2016 and 2020

- Analyzed distribution of all patient locations who did not complete dose series using zip code data
- Map shaded according to the proportion of infants from the incomplete data compilation who lived in each Virginia county
- Counties that have a zero proportion imply that every infant completed their dose series or a lack of data
- Maps imply the geographic distribution of patients who did not complete their series remained similar in 2016 and 2020
- Some zip codes had a slight drop as the maximum percentage per county dropped from 1.25% to 1.20% as the years progressed

2020-2016 Hib Incomplete Vaccination Percentage

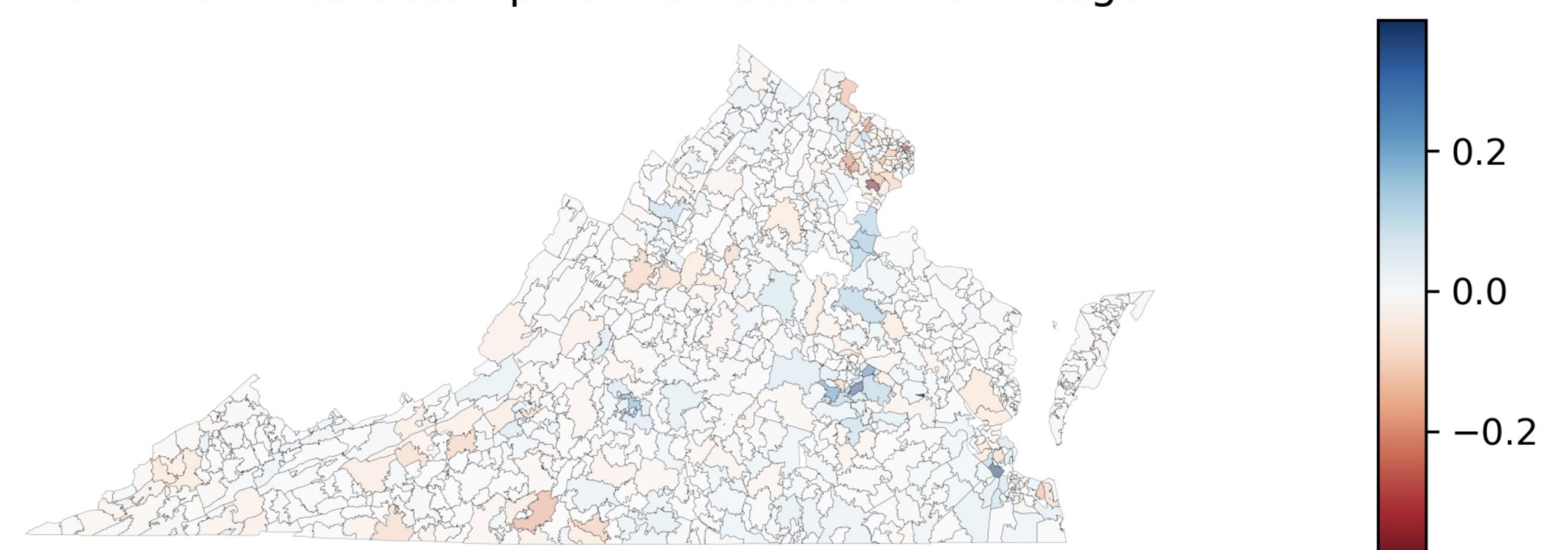


Figure 5. A map of every Virginia county by zip code containing the difference in proportion values from 2020 and 2016 to measure the changed percentage of infants who did not complete their dose series across time

- Found difference in proportion values per county to find changes in geographic distribution of infants who did not complete the Hib series between 2020 and 2016
- Majority of counties had little to a slightly higher proportion of patients who did not complete the correct dose series
- Counties with a higher population count near the top right had a drop in incomplete vaccination series, so more patients completed their dose series on time in 2020 compared to pre COVID