AIRA
AMERICAN IMMUNIZATION REGISTRY ASSOCIATION

Denominator Inflation

Takeaways from the IIS Data Analyst Collaborative (IDAC)

June 2024

IIS Data Analyst Collaborative (IDAC)

June 20, 2024

The IIS Data Analyst Collaborative (IDAC)

The IIS Data Analyst Collaborative (IDAC) is a discussion-based collaborative for people who work with immunization data to connect on important and timely topics. IDAC happens every other month on the third Thursday at 1 p.m. ET. There will be a different discussion topic every meeting. The goals for these collaboratives are to offer an opportunity to share and develop skills and insights, to help people who work with immunization data to connect and spark collaborations, and to create a supportive, engaged community of IIS data analysts.

CDC CC3 Learning Lab Project

Historical context

In 2001, in an effort to build and support capacity of IIS programs, CDC/NCIRD started a pilot volunteer group of IIS sites to explore the use of IIS data to achieve public health goals. High-level activities of the group to date are summarized below.

- 2004–2007: NCIRD formally established the IIS Sentinel Site Project. Six sites were funded to conduct vaccination studies and the data quality enhancements effort (Michigan, Minnesota, North Dakota, New York City, Oregon, Wisconsin) with a focus on pediatric populations.
- 2008–2012: Sites were increased to eight.
- 2013–2019: Sentinel site activities continued to cover pediatric populations.
- 2014–2019: Sentinel site activities expanded to include adult populations.
- Project team did evaluation work related to:
    - IIS/EHR Interoperability
    - IIS system functionality
    - Development of analytic methodologies that are specific to IIS data
    - Assessment of the impact of state-based policy changes on coverage
    - Interventions designed to improve coverage
    - The use of IIS to support immunization program activities
- The team developed a white paper on denominator inflation.

Current status

- Colorado, Iowa, Louisiana, Nevada, and Washington were added for 2019–2024.
- A Denominator Workgroup was established to:
    - Identify appropriate denominators for various IIS analyses when calculating vaccination coverage and assessing vaccination coverage by various geographic and sociodemographic factors

- Help analysts understand which denominators to use and where to find the source data
- Explain additional nuances describing limitations and biases of denominator data and their implications for interpreting vaccination coverage by various factors

Denominator Inflation Work by Peers

For this IDAC, AIRA asked three members of the community to present their knowledge and work regarding identifying and implementing solutions for denominator inflation (DI) in their jurisdiction. Conversation stemmed from these presentations.

Steve Robison, Oregon

- Developed an ogive weighting method for DI:
  - Non-linear weighting for DI, based off time since last immunization
- Focus as analysts on adjusting for DI in IIS data extracts
  - Not necessarily a fix for presence of DI in IIS
- Two other approaches:
  - Linear weighting based on time since last immunization
  - Inclusion of only those patients with immunization in the last five years
- The ogive weighting methodology was published in *Sage Journals*:
  - "Addressing Immunization Registry Population Inflation in Adolescent Immunization Rates," Sage Journals (2015)

Timothy Lo, California

- Application of ogive logarithmic denominator weighting in California
- Vaccination reporting in California mandated in 2023
- Compared four methods for adjusting DI and found ogive log weighting to be the most accurate to population denominator

Sarah Kangas, Wisconsin

- Dormant state indicator assigned to clients assumed to have left the state
- Not on user interface, stored in IIS databases, updated on a nightly refresh
- Clients with dormant indicator dropped off of provider and jurisdictional reports
- Stemmed from *Management of Patient Status in Immunization Information Systems Guide*, MIROW (2019)

Discussion

Mixed-denominator approach

- Mixed-denominator (MD) rate = [x*A + (1-x)*B]
  - The parameter "x" serves as a weighting factor that determines the relative importance given to the two denominators, A and B. When x is set to 1/2, it signifies an equal weighting assigned to both denominators.

- A is an IIS denominator, and B is a Census-ACS denominator

What are thoughts on expanding time period for weighting for 5 years to 10 years, specifically for adult populations?

- You can expand the time period, but it's important to consider the use of doing so. There is variability in mobility among adult populations. For example, much younger adults tend to be more transient compared to older populations. Rather than having a 10-year band for adult populations, consider creating adult strata and using different time periods (e.g., three years for 18- to 23-year-olds, 10 years for those older than 60).

Has this method been validated with any other population besides school-based?

- Oregon focuses on school-based populations or census estimates. For this weighting, Oregon felt that school-based populations would be more accurate. Oregon has not formally looked at any other populations.

Ogive weighting looks at time since last vaccination. Any consideration to use other features in IIS as well (e.g., deferral, contraindication)?

- Could consider creating a "time since last touch point" criteria. However, not all deferrals or contraindications are always captured. So practically, last immunization and "time since last touch point" might be the same.

Is the dormant state indicator affected by other patient statuses?

- The dormant state indicator is not impacted by any PAIS status. People can have a PAIS status as active, moved, inactive, or permanently inactive/deceased that is separate from their dormant state indicator.

Ogive Weighting

Steve Robison

Oregon Immunization Program

Steve.g.robison@oha.Oregon.gov

Background

Dealing with Denominator Inflation(DI) has two components:

- Reducing DI occurrence in IIS data
  - Who- IIS system
  - Goal- Better data
- Adjusting for DI in IIS data extracts
  - Who- Analyst
  - Goal- More accurate rates

- What we do as analysts is not a fix for DI, just a work-around for its presence in our IIS data.

Weighting Immunization Records for DI

- The underlying concept is that each client record in the IIS has a chance of being a ‘DI’ case.
- This DI chance can be estimated by looking at the amount of time since their last immunization.
- This approach is similar to how surveys weight their records.
- For analysts, it is a useful point of view to think of IIS not as population-complete counts, but as gigantic surveys- with biases and errors that need weighting.

Ogive and Other DI Weightings

- Ogive is a non-linear weighting for DI, based off time since last immunization.
- Two other approaches worth considering:
  - Linear weighting based on time since last immunization
  - Cut-off rule- such as inclusion only of clients with an immunization in the last five years.

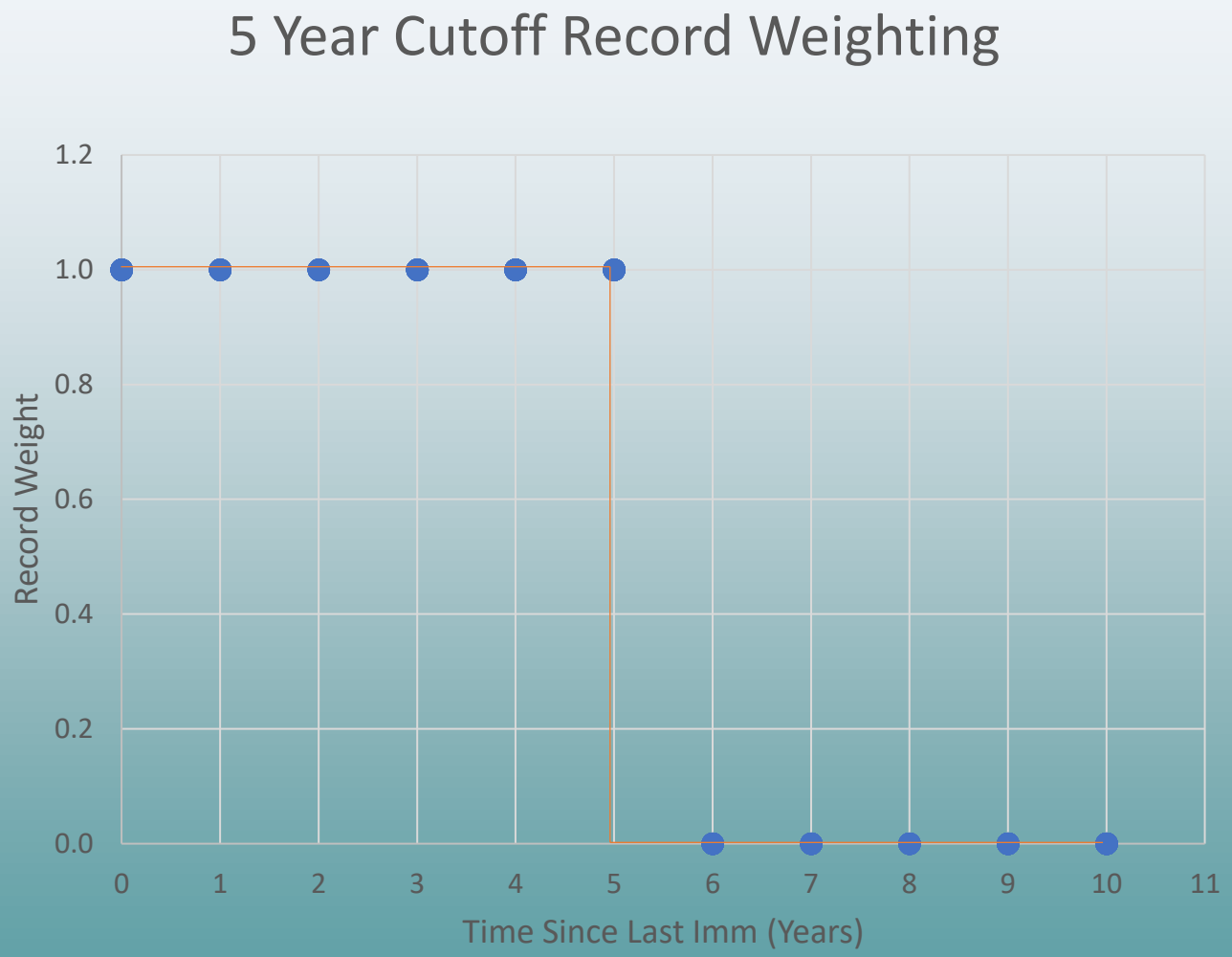
Challenge to IIS Record Weighting

- Medical personnel tend to like ‘black and white’ decision rules, rather than probability.
- It can be difficult to explain record weighting to many medical people (and many other non-analyst managerial types).
- A 5 year cutoff approach is thus much easier to explain.

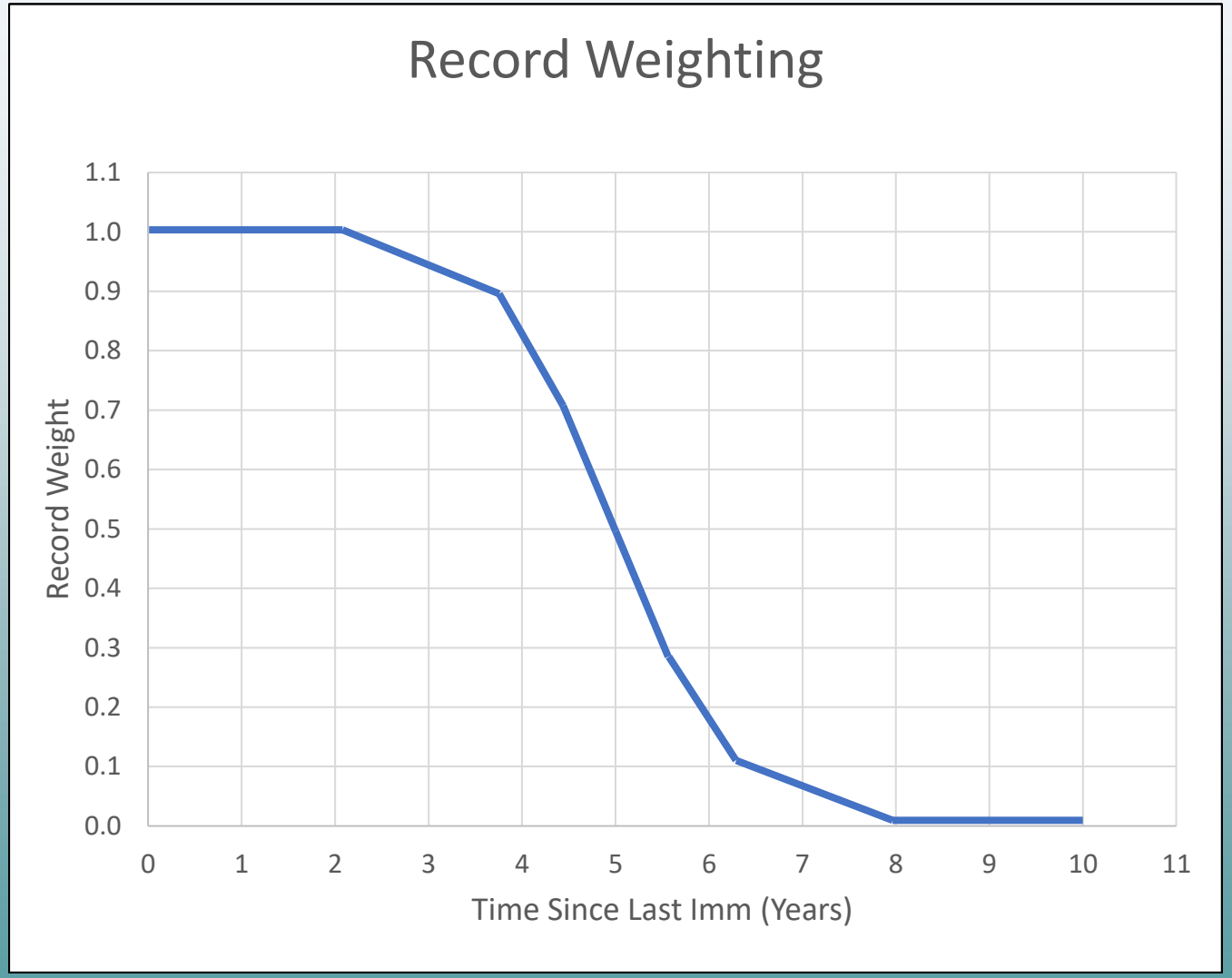
  BUT;

- A 5 year cutoff is also a form of probabilistic record weighting.

- 5 Year Cutoff is the same as weighting records either 1 or 0 based on time.
- This is intellectually hard to justify- as someone at 4.9 years is weighted one while someone at 5.1 years is weighted zero.
- DI itself should be continuous and smooth against time- not disjointed.



- Analytically, it is more in line with DI to average out the points of sudden change in weighting
- If you repeat that process enough, you get a reverse S-curve
- The appearance of this looks like a type of logarithmic curve called an ogive



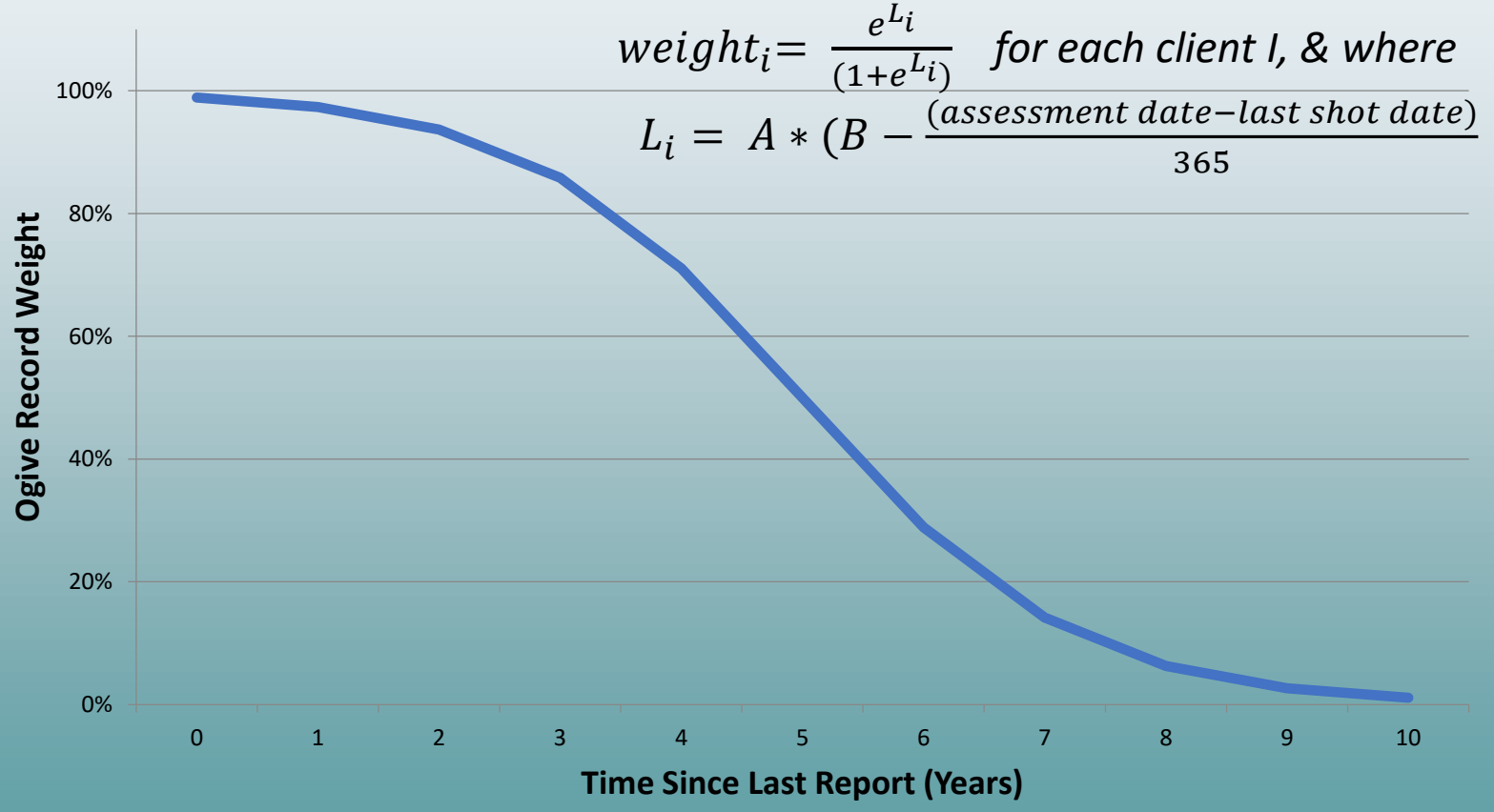
Ogive Weighting

- Ogive weighting is the ‘evolved’ form of the 5 year cutoff rule, that matches to DI being smooth and continuous with regard to time.
- The math is somewhat complex- but the concept is simple.

Ogive Weight Math

$$weight_i = \frac{e^{L_i}}{(1+e^{L_i})} \quad \textit{for each client I, \& where}$$

$$L_i = A * (B - \frac{(assessment\ date - last\ shot\ date)}{365}$$



Oregon Health Authority

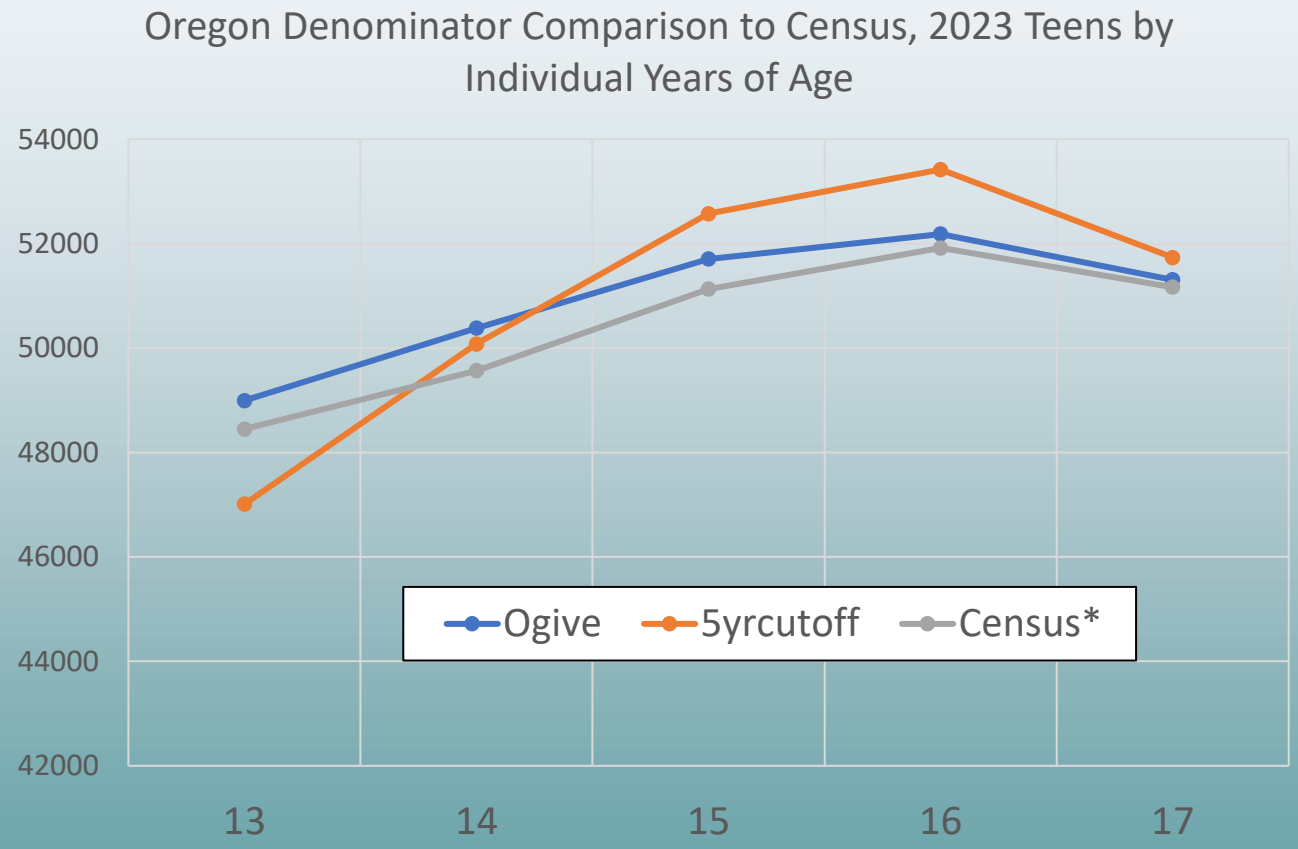
- Ogive weighting is conceptually more acceptably than a simple 5 year cutoff
- It also produces more accurate results when used in rate calculation

Caveats:

- For an IIS with fairly uniform population dynamics and IIS data capture, there may not be much difference between an ogive result and a five year cutoff result.

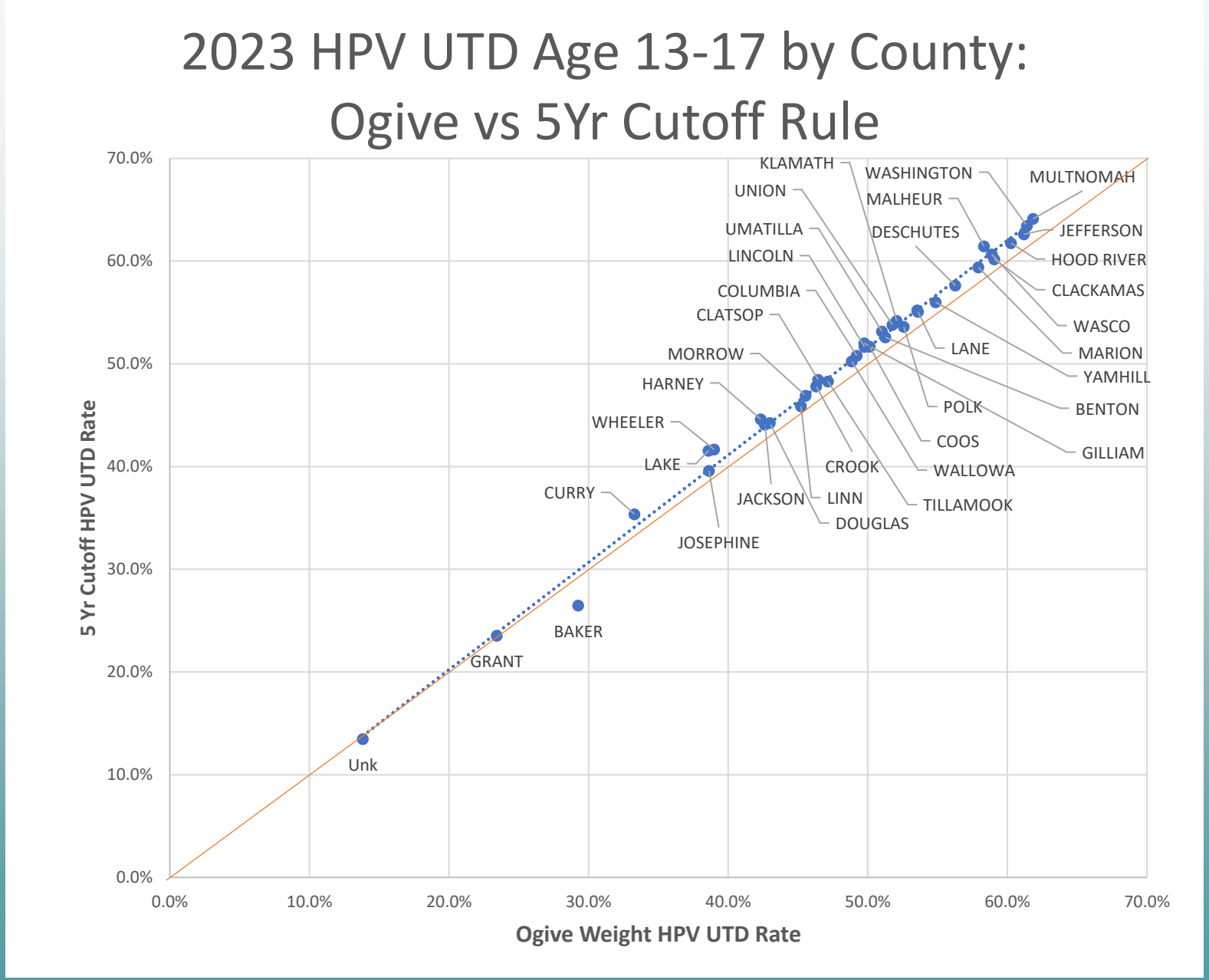
Oregon 2023 Results(1)

- Ogive is a better fit to 2023 teen Census counts
- Difference is not dramatic
- Average difference per year for ogive to Census: 469 teens
- Average difference per year for 5yr cutoff to Census: 1093 teens
- Overall, this is about a 1% error vs 2.2% error- not that much



*: projected from 7/1/22 Census estimates to end of year 2023; source: SC-EST2022-SYASEX

- Overall, while there is a small bias to 5 year cutoff rates, there is a high degree of concordance between ogive and 5yr cutoff rates.



Conclusion

- Ogive weighting is an evolved form of the 5 year cutoff rule.
- Ogive weighting is analytically more acceptable than a 5 year cutoff- but can be harder to explain to those trained in black & white decision rules (as most medical staff)
- Ogive weighting gives better results than a 5 year cutoff, but depending on IIS data capture and population, this advantage may be small.
- High degree of concordance possible between ogive and 5 year cutoff rates
- Most important thing is to use some DI adjustment in your rate process! Either ogive or 5yr cutoff are reasonable.

Application of Ogive Logarithmic Denominator Weighting in California

Timothy Lo, MPH

California Department of Public Health
Immunizations Branch

Background

- California bill AB 1797 effective 1/1/2023
  - Requires all healthcare providers to submit vaccination records to a registry
  - Will improve data quality in the California Immunization Registry (CAIR) with more complete reporting
- Prior to AB 1797, we were hesitant to use CAIR for coverage rates due to incomplete reporting
- Since AB 1797, we re-visited the idea of calculating and communicating coverage rates using CAIR data

Denominator Inflation

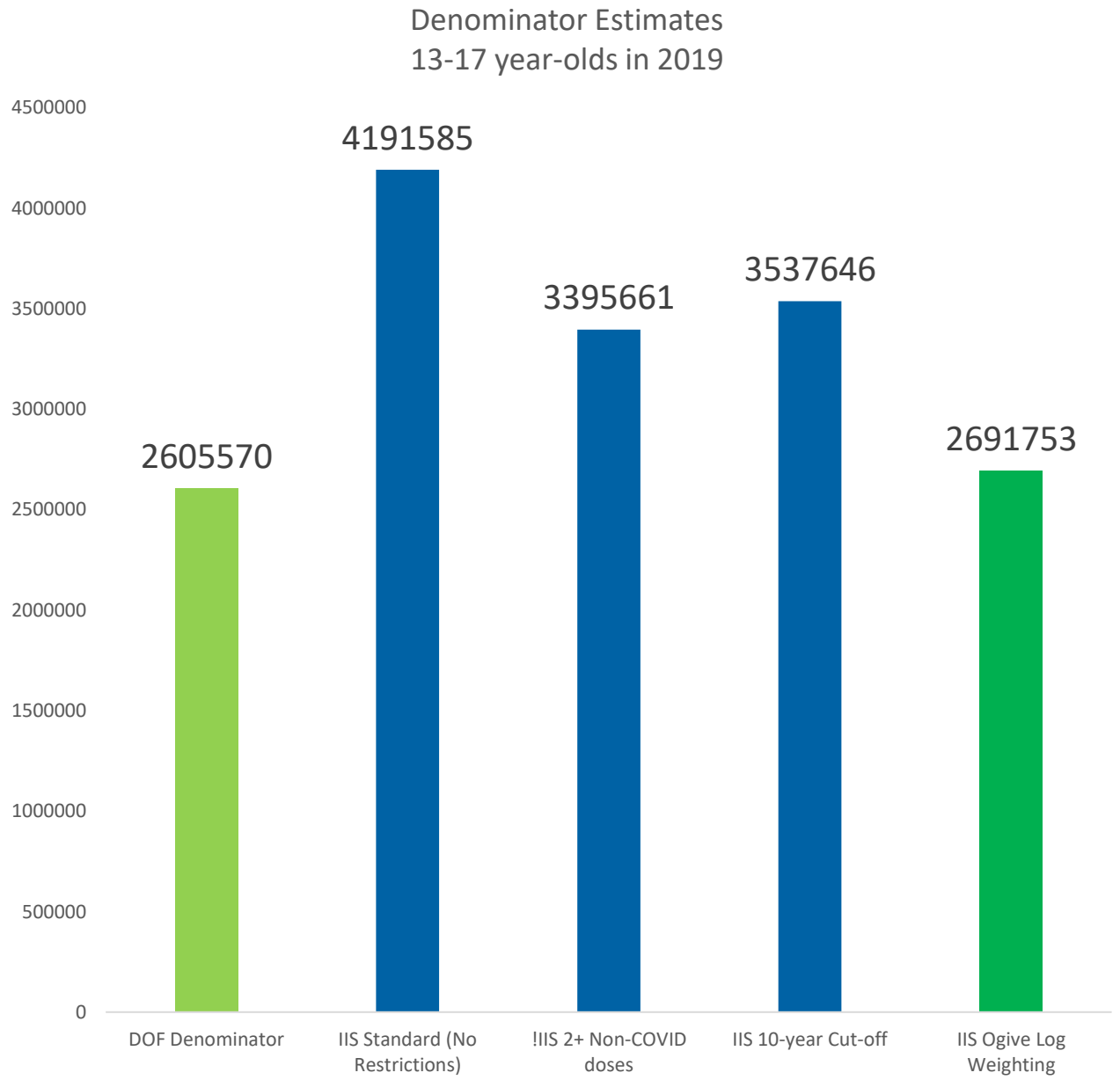
- Coverage rates using information immunization system (IIS) based denominators had been consistently lower than other estimates
- Denominator inflation was a known issue, especially in younger populations
  - Birth records
  - Patient movement
  - Fragmented records
- Explored ogive logarithmic weighting as a possible solution to denominator inflation

Analysis 1: Comparison of denominator estimation methodologies

- Analysis performed March 2023
- Objective: compare most known methods of estimating denominators using historical data
  - IIS Standard
    - Count of distinct persons in IIS of age, no restrictions
  - IIS 2+ non-COVID doses
    - Count of distinct persons in IIS of age with at least 2 non-COVID doses on record
  - IIS 10 year cut-off
    - Count of distinct persons in IIS of age with at least 1 recorded dose in the last 10 years
  - Department of Finance (DOF)
    - External denominator from Department of Finance
    - Used in existing rate calculations by state and local health jurisdictions (LHJ's)
  - Ogive Logarithmic Weighting
    - Persons in IIS of age are weighted based on how recent their last dose was (possible values 0 – 1), sum of weights

Analysis 1: Comparison of denominator estimation methodologies

- IIS-based Ogive Logarithmic weighting produced lower denominators and seems to alleviate denominator inflation

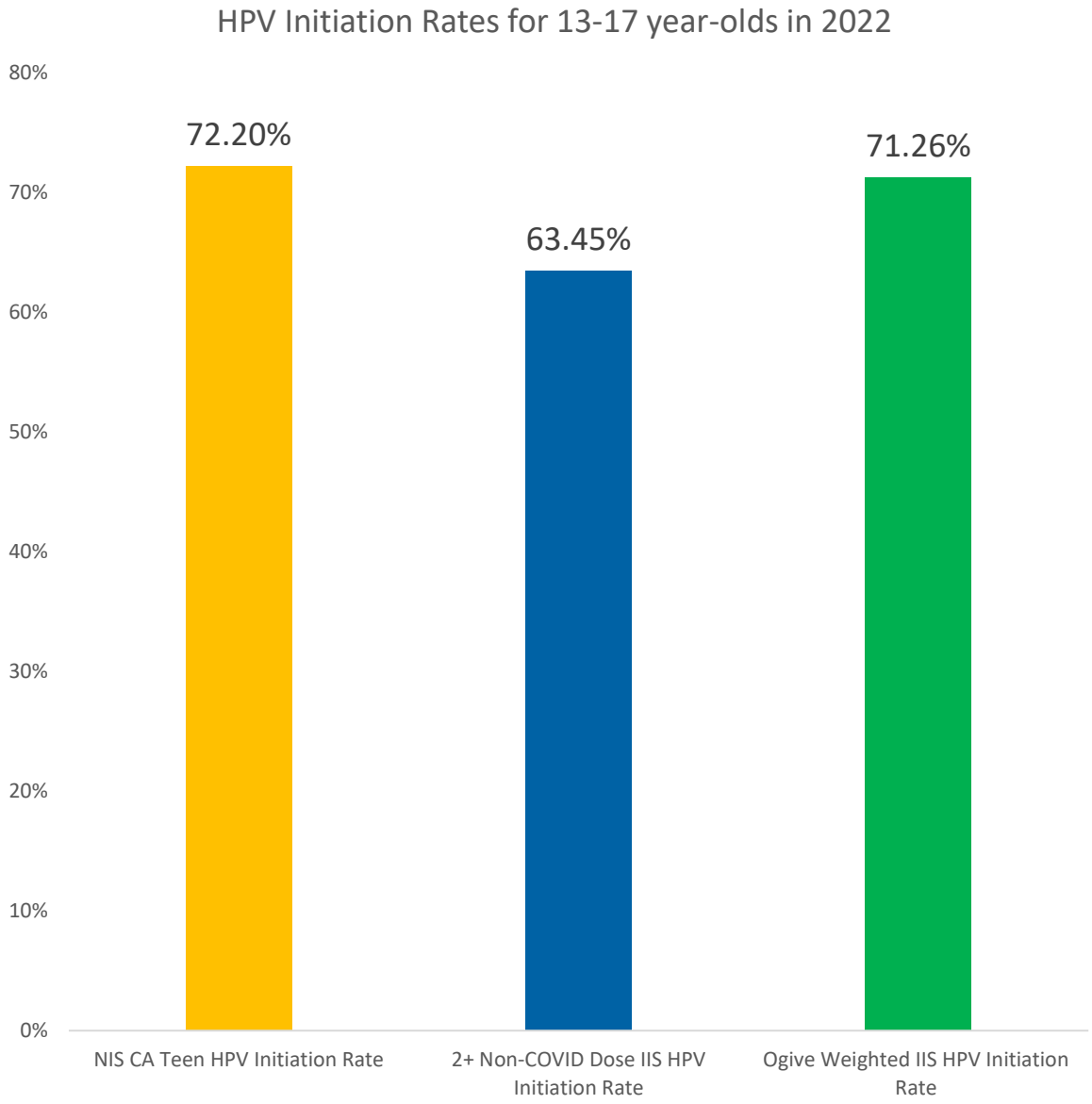


Analysis 2: 2022 HPV NIS Comparison

- Separate analysis performed May 2024
- Objective: compare estimated HPV Initiation (1+ doses) rates for 13-17y/o in 2022 to NIS-Teen rates
  - NIS-Teen is considered “gold standard”
    - We wanted to compare ogive logarithmic denominator methodology to NIS-Teen
  - Same birth cohort as NIS-Teen
    - Born between 1/1/2004 – 1/31/2010
  - Same vaccination date cut-off as NIS-Teen
    - HPV doses administered by 1/31/2023

Analysis 2: 2022 HPV NIS Comparison

- Ogive weighted denominator rate produced an HPV Initiation rate closer to NIS-Teen than the previously used 2+ Non-COVID denominator



Current implementation

- Ogive logarithmic weight (as of today) available as a data value for each person on recipient-level views on Snowflake
  - Can calculate denominators as needed
- Vaccine-specific dashboards available to local health jurisdictions (LHJs) that can show rates with ogive weighted denominator released March 2024
  - Created by external consultants under our direction

Can select for:

- Series initiation or completion
- Population or CAIR-based denominator
- County
- Age range

Estimates by:

- Age group
- Race/ethnicity
- HPI quartile

HPV Vaccine Recipients

⚠ PRELIMINARY REPORT. DO NOT SHARE

DASHBOARD INFORMATION

Data Refresh: 6/15/2024

Data analysts should consider several factors before using California Immunization Registry (CAIR) data to estimate vaccine coverage (see CAIR Data Analysis Considerations). The estimates shown in this dashboard are preliminary and should not be shared publicly at this time, but may be helpful for public health planning and surveillance.

Data for non-COVID vaccinations in CAIR are considered to an underestimate of actual vaccination rates. Although non-COVID vaccinations became reportable by all providers in January 2023 (see AB 1797 Immunization Registry FAQs), and the quality of CAIR data continues to improve over time, the data in CAIR are not a complete representation of all vaccine doses administered in California. Patients may have incomplete vaccination records in CAIR if they moved or changed providers, or if historical vaccinations were not imported into CAIR. CAIR data completeness can also vary by factors such as recipient age, provider reporting history, type of vaccination, region, population demographics and population migration.

If additional coverage estimates are needed, the CDC shares HPV vaccine coverage estimates using a variety of data sources in their TeenVaxView dashboard.

Vaccination Status: Up-to-Date

Population Denominator: CAIR2 Weighted Denominator

Recipient County: (All)

Admin County: (All)

Use the filters to explore the data by vaccine status, county, and age.

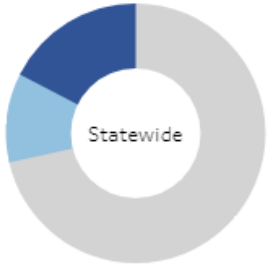
Coverage estimates (%) can be calculated using one of three denominators:

1. CAIR2 – denominator based on the cohort of people with a record in the registry
2. CAIR2 Weighted Denominator – denominator that weights individual records in the registry based on the time since the last reported immunization
3. Estimated CA Population – denominator based on the estimated population

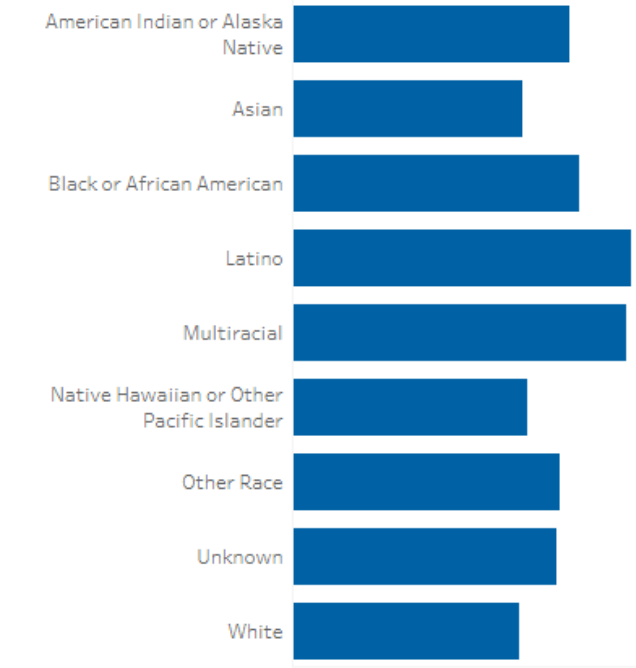
User Defined Age Group:
For recipients under 18 years of age, the user can define the age group

For a more detailed discussion of approaches to calculating coverage estimates including strengths and limitations, see analytics guide below
Analytics Guide

Initiated Series
- Up-to-Date Recipients
- Not Up-to-Date Recipients
- Not Initiated



Up-to-Date Coverage Estimates by Recipients by Race-Ethnicity

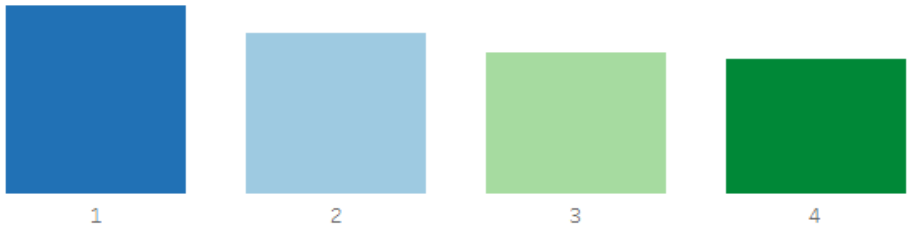


Up-to-Date Coverage Estimates by Recipients by Age Group

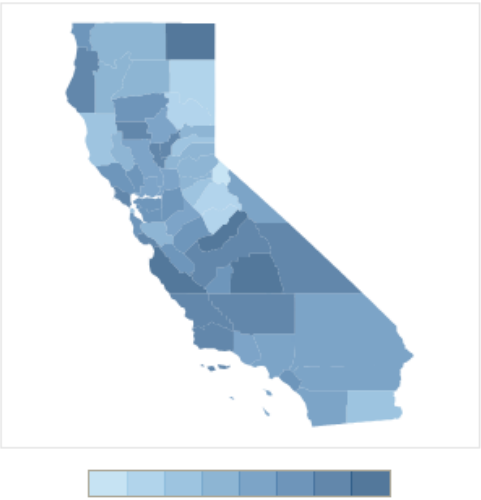
User Defined From Age: 13

User Defined To Age: 17

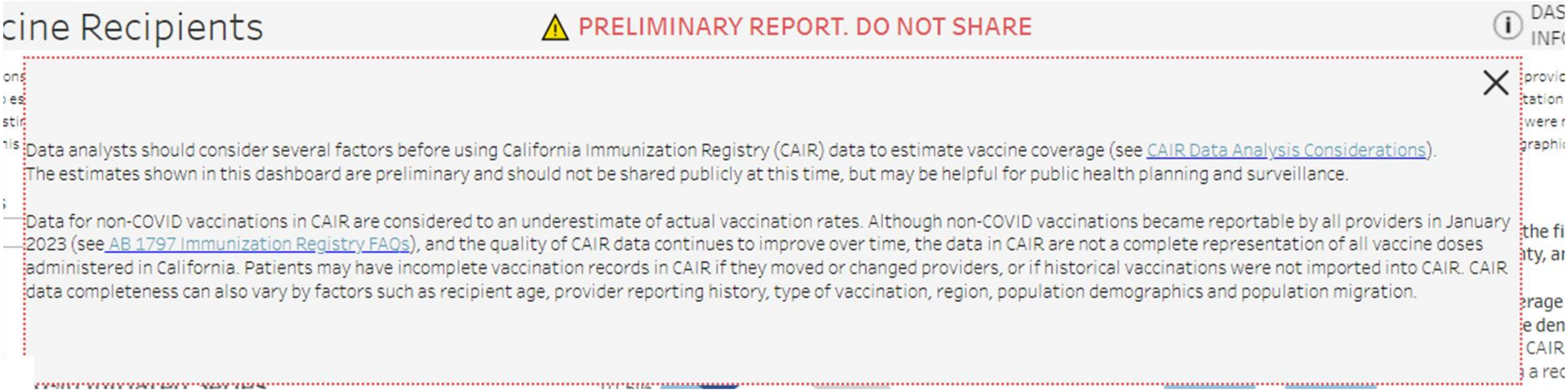
Up-to-Date Coverage Estimates by Recipients by HPI Quartile



Up-to-Date Coverage Estimates by Recipient County



Limitations



- Patients may have incomplete vaccination records in CAIR if they moved or changed providers, or if historical vaccinations were not imported into CAIR. CAIR data completeness can also vary by factors such as recipient age, provider reporting history, type of vaccination, region, population demographics, and population migration.

Future Efforts

- Communicate availability of dashboards to local health jurisdictions
  - Since release in March 2024, not much feedback
- **Provide training on appropriate usage**
- **Validate usage and estimations**
- Explore other methodologies

Special Thanks

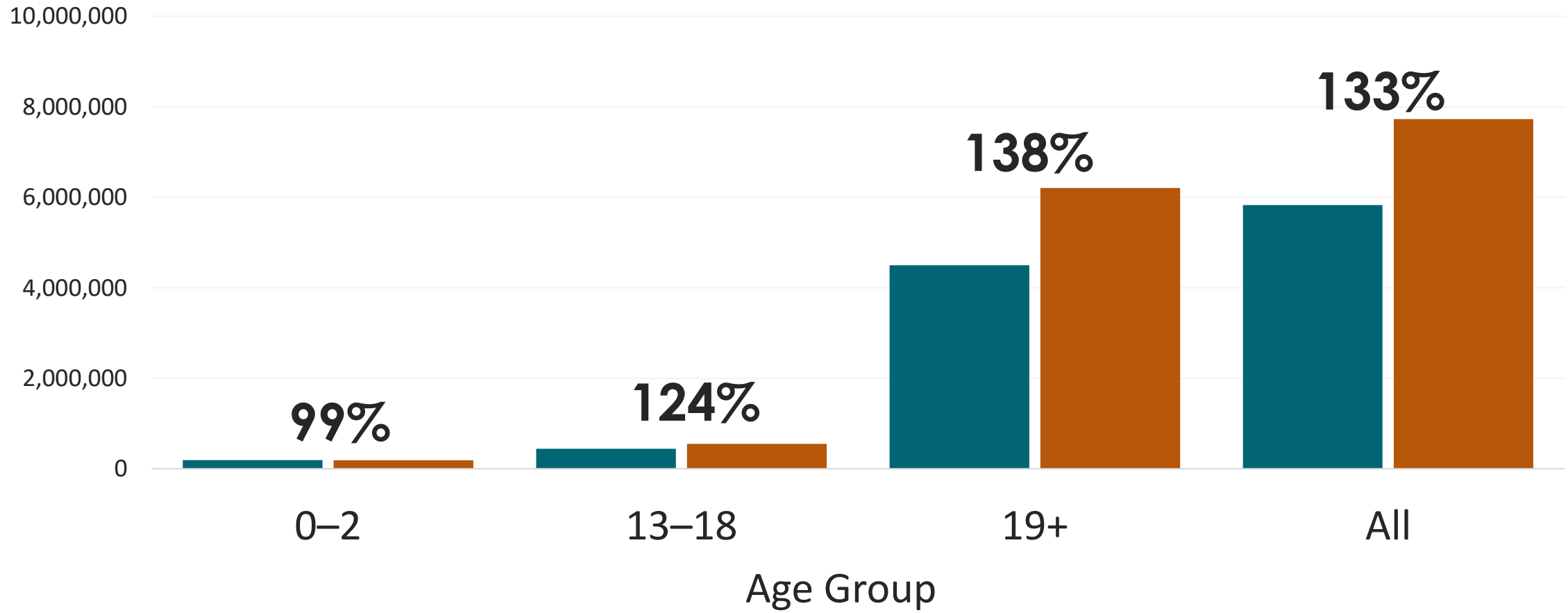
- Cynthia Yen
- Joshua Quint
- Cora Hoover
- Robert Schechter

Questions?

- Timothy.lo@cdph.ca.gov

DI is Worse in Older Cohorts

Wisconsin Census Population Estimate compared to the WIR Population



Dormant State

- Listed in WIR as DORMANT_IND
  - N = Non–dormant
  - Y = Dormant
- Only available to DPH WIR users

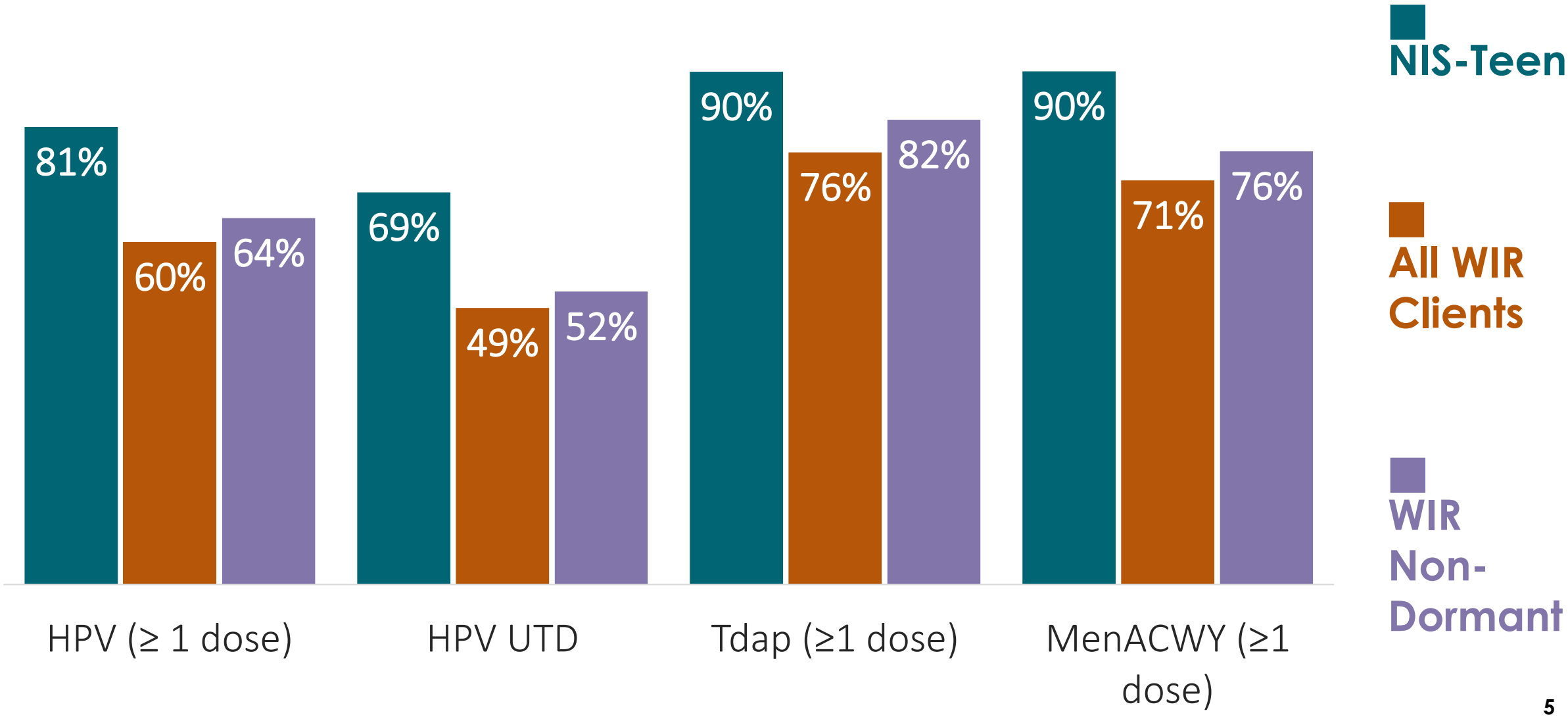
Dormant State Criteria

- Client age is at least 11 years old.
- No updates to the client record in at least 10 years.
- Record has not been queried in the last five years.

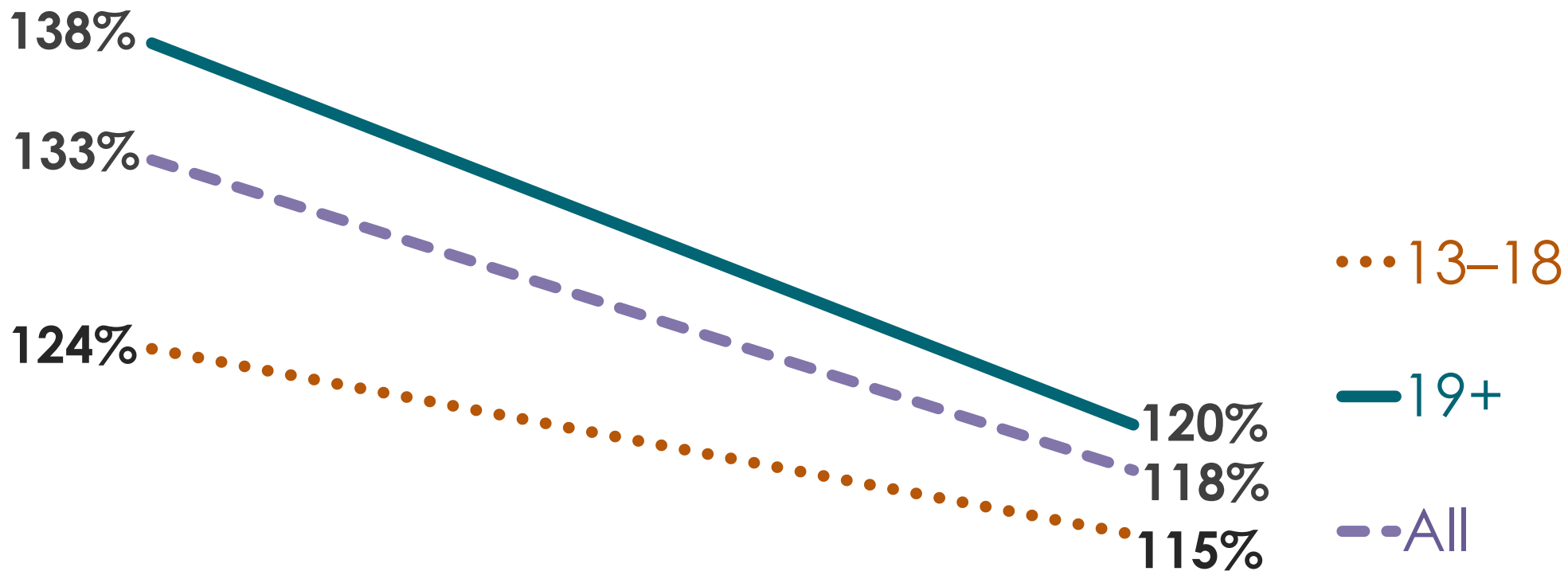
Measures

- Vaccination coverage assessments on:
  - MenACWY (≥1)
  - HPV (≥1)
  - HPV (UTD)
  - Tdap (≥1)

Removal of dormant client records increased adolescent vaccination rates



Removing dormant client records reduces DI across age groups



All WIR Clients

Non-Dormant WIR Clients