COMPARING IIS ADOLESCENT POPULATION DENOMINATORS:
A MULTI-STATE COLLABORATION

OREGON HEALTH AUTHORITY

Washington State Department of Health

CDPHE

CDPH — California Department of Public Health

Steve Robison, Oregon
Timothy Lo, California
Rachel Severson, Colorado
Kimberly Campbell, Colorado
Tyler Moore, Washington

BACKGROUND

- Immunization information systems (IIS) have the potential to provide up-to-date population numbers that are more accurate than any other source[1]

- Realistically, denominator inflation (DI) and incomplete reporting are issues that prevent extremely accurate IIS estimations
  - Incomplete reporting: can be due to lack of provider enrollment, gaps in state IIS reporting mandates, patient record locking, etc.
  - DI: more person records in IIS than population

- No collaborative project has been performed by multiple states that use IIS data to analyze the impact of denominator inflation on their states' vaccination rates

[1]: Analytic Guide For Assessing Vaccination Coverage Using An IIS, AIRA 2015

IIS Data Methodology?

- Sometimes it is curious how technology develops:
    - -Example-
    - The tin can was invented in 1809, but
    - The can-opener wasn't invented until 1850!

- IIS data population methodology is similar:
    - The first computerized immunization registry was in 1963;
    - Methods for using IIS data on a population-level are still being developed!

Study Objectives

- Many IIS recognize that DI limits the accuracy of their IIS-based immunization rates.

- Also many IIS want to use Census-based denominators with IIS-based numerators

- Our objective was to compare different DI adjustment methods against Census on a state and county level

- Study questions include:
  - Do different DI methods have similar fits to Census data?
  - Do IIS denominators and a Census denominator reflect the same reality? (high degree of concordance).
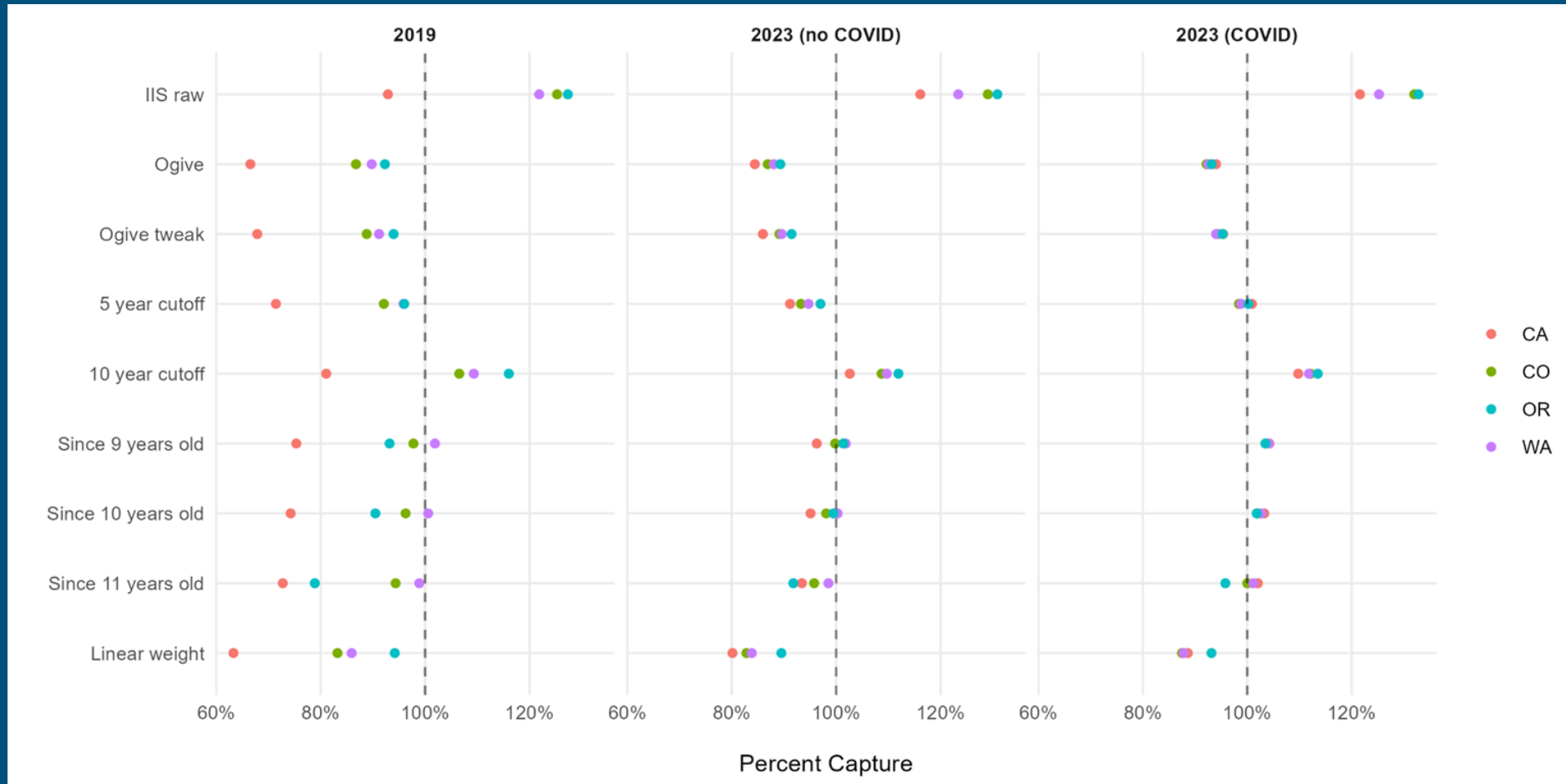
METHODS

- Gathered IIS vaccination data from four states

- Persons aged 13-17 as of 12/31/2019 and 12/31/2023
  - Pre and post COVID
  - Has at least one shot given 24 days post-birth in IIS.

- Nine different IIS-based denominator estimates were calculated

- DI was calculated at the state level for each IIS-based estimate
  - DI = IIS estimate / Census estimate

- Lin's Concordance Correlation Coefficient (CCC) was calculated at the county level
  - Compared different models to Census on the county level.

- Linear regression was also used to test differences between model estimates.

DI Adjustment Models

- Nine models tested against Census county populations, across 3 categories of adjustment methods
  - Raw IIS data (only req. is 1+ shot in IIS at least 24 days post-birth)
  - Age based
    - Shots given and reported since age 9; age 10; age 11.
  - Time based
    - Shots given and reported within the last 5 years; or within the last 10 years
  - Time weighting
    - Linear weight applied to client record based on time since last immunization
    - Non-linear weight (ogive curve) applied based on time since last immunization
    - Modified non-linear ogive, including a fixed floor to weight for modeling higher non-shot seeking

RESULTS

RESULTS: DI ESTIMATION

RESULTS: DI

- DI observations and calculations are well-aligned between all states.
- 2019 CA: IIS was still in implementation state-wide; substantial missing data.
- IIS raw consistently overestimates population (representation of innate DI issue)
- COVID effect on inflating IIS populations can be seen here.
- Linear and Ogive methods had the greatest DI reduction effects and produced lower population estimates than other methods. (not necessarily a good thing).
- 5 year cutoff also provided a substantial reduction in populations.
- 10 year cutoff did not adequately reduce DI in our data

How to Compare IIS to Census Denominators?

- We are relying on a Lin's Concordance Correlation Coefficient (LCCC) measure.
  - This method is different from simply comparing based on goodness of fit.

- LCCC was created for comparing different lab or test measures-
  - The scenario that led to LCCC - what if your lab is replacing test equipment?
  - Need to know that the new test equipment gives the same results as the old-
  - Often lab equipment needs to be calibrated- two pieces of equipment may give the same pattern of results but often are off by a scalar value.

- Our use of CCC is the same- answering the question of what if we replaced Census denominators with each of our IIS-data DI models?
  - Do we get the same pattern only with scalar differences?

Lin LI. A Concordance Correlation Coefficient to Evaluate Reproducibility. 1989. Biometrics.;45:255-682720055.
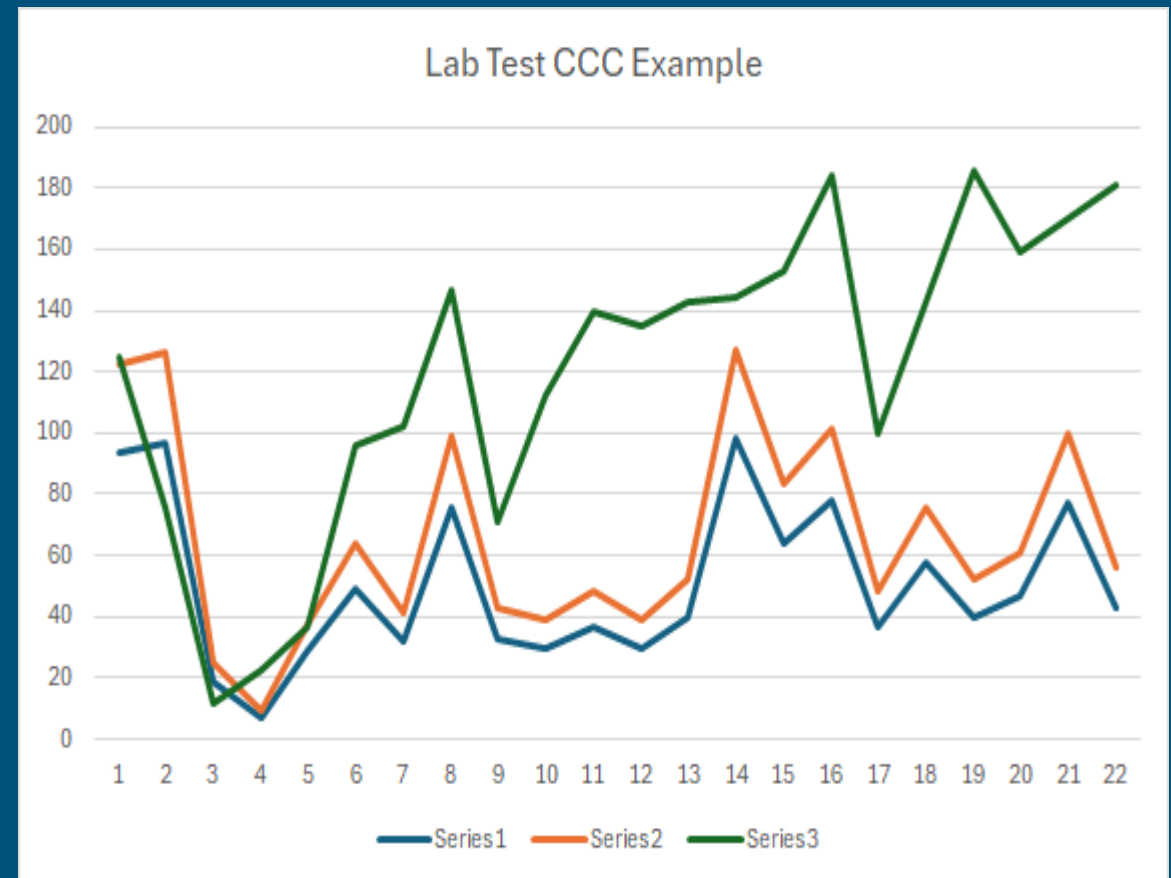
CCC Lab Test Example

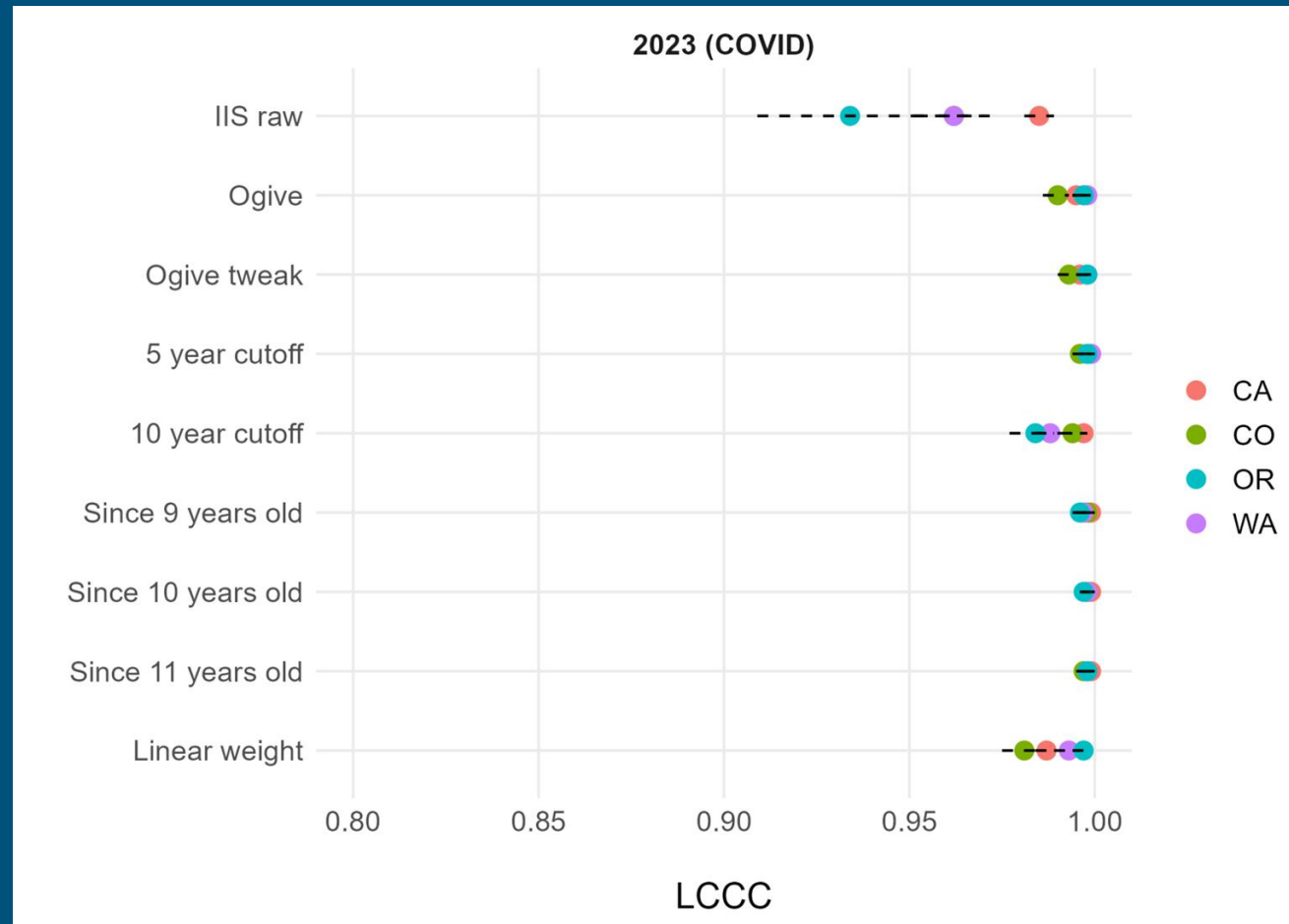Series 1 and 2 differ only by a scaling factor- these would have a CCC value close to 1.

Series 3 is both randomly different and increasing relative to the other series- not a good match- would have a much lower (~.6) CCC value.

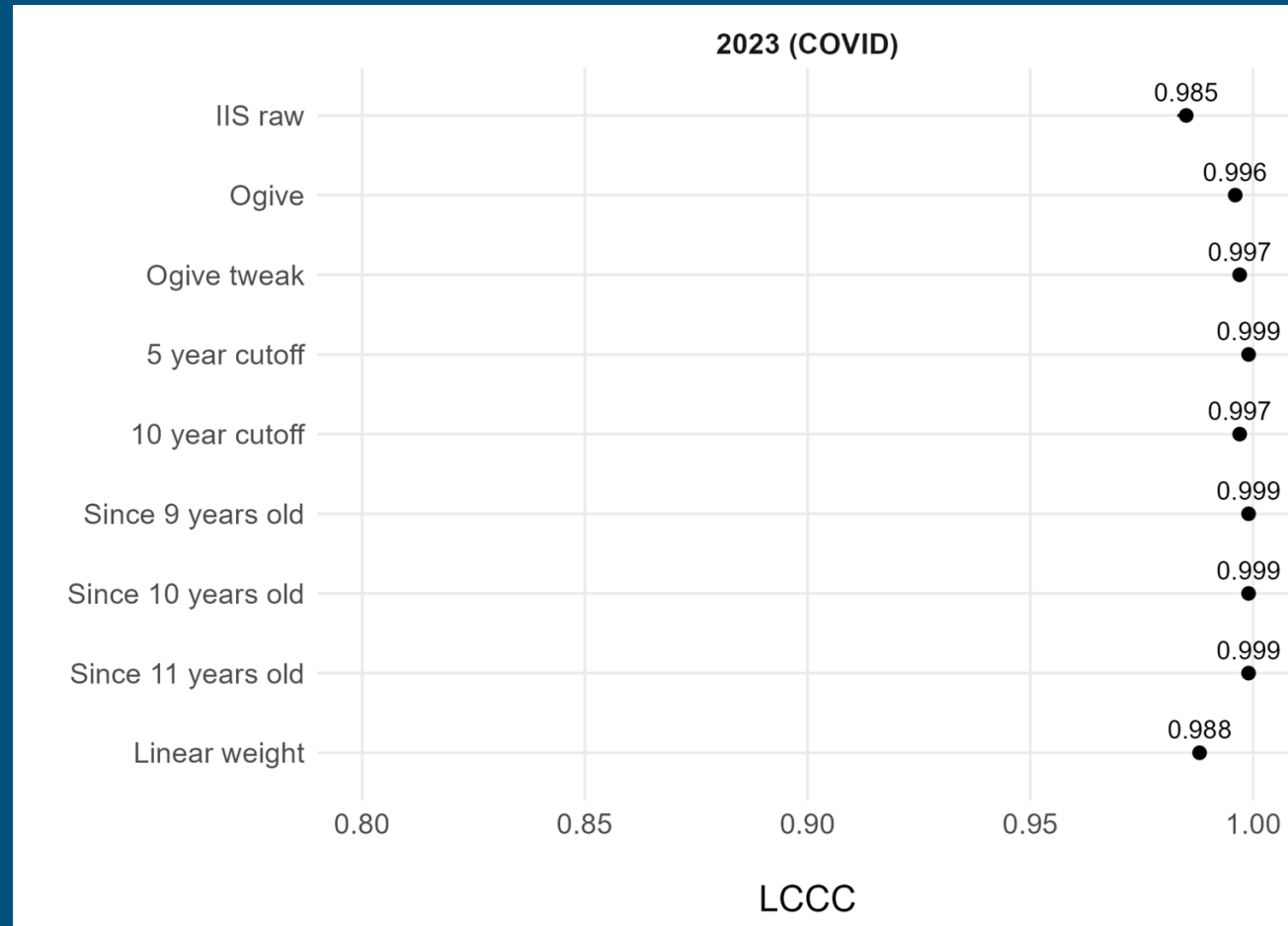Standards for interpreting CCC depend on setting- for IIS use, we suggest using a CCC scale from McBride(), where

>.99	Almost perfect
.95 - .99	Substantial
.90 - .95	Moderate

Lab Test CCC Example

McBride GB. A proposal for strength-of-agreement criteria for Lin's concordance correlation coefficient. NIWA client report: HAM2005-062. 2005 May;45:307-10.

RESULTS: LIN'S CCC BY STATE

RESULTS: LIN'S CCC COMBINED

RESULTS: LIN'S CCC COMBINED

Method	2023 (COVID)
IIS raw	0.985 (0.983-0.987)
Ogive	0.996 (0.995-0.996)
Ogive tweak	0.997 (0.996-0.997)
5 year cutoff	0.999 (0.999-1)
10 year cutoff	0.997 (0.996-0.997)
Since 9 years old	0.999 (0.999-0.999)
Since 10 years old	0.999 (0.999-1)
Since 11 years old	0.999 (0.999-1)
Linear weight	0.988 (0.987-0.99)

RESULTS: LIN'S CCC

- All IIS-based estimations show high concordance to census at the county level
  - Across counties, all methods seem to have a similar variation as Census
- What we have for a census population and IIS estimations seem to reflect the same reality
  - You can move from one to another
  - All methods look to be the 'comparable lab test equipments' by the earlier example.

RESULTS: LINEAR REGRESSION

Los Angeles, Orange, and San Diego counties in California were removed due to census population estimates falling outside of the range of the mean +/- three standard deviations.

RESULTS: LINEAR REGRESSION

Method	Slope	Y-intercept	Difference of slope from 1
5 year cutoff	1.00	-52.93	-0.0014
Since 11 years old	1.01	-97.91	0.0125
Since 10 years old	1.03	-32.26	0.0254
Since 9 years old	1.04	-15.21	0.0360
Ogive tweak	0.94	-39.42	-0.0563
Ogive	0.93	-54.02	-0.0688
10 year cutoff	1.10	39.22	0.0977
Linear weight	0.88	9.11	-0.1199
IIS raw	1.21	189.95	0.2059

Slope is closer to 1

Slope is further from 1

Numerators (Teaser)

- Numerators have high LCCC's compared to each other
- But different DI methods produce very different numerators!
- Important to use the same DI method for both numerators and denominators!
- Raw IIS rates here are lower; as are the 10yr cutoff.
- Census denominator with IIS raw numerator is still low;
- Other methods produce a tight cluster for rates, of 76% to 78%

1+ HPV Immunization Rates All States (2023, No COVID)

Method	Num	Denom	Rate	LCCC
OGIVEWEIGHTED	2,431,696	3,145,495	77%	1.0
IISRAW	2,722,644	4,303,231	63%	1.0
OGIVETWEAK	2,431,748	3,199,108	76%	1.0
5YEAR	2,641,389	3,392,190	78%	na
10YEAR	2,722,254	3,832,321	71%	1.0
SHOTSINCE9	2,721,696	3,587,000	76%	1.0
SHOTSINCE10	2,718,436	3,540,029	77%	1.0
SHOTSINCE11	2,700,099	3,463,665	78%	1.0
LINEARWEIGHT	2,311,481	3,001,469	77%	0.99
Census-IISraw	2,722,644	3,719,652	73%	na

DISCUSSION

- You can pick any you want as long as you understand the nuances of those methods and how they relate to other methods
  - "Scalar factor"

- This should give you a great deal of confidence in adjusted IIS estimates (OR lower your confidence about the Census, since it matches so well to our adjusted measures)

- The scalar factor for denominators is not the same as numerators
  - Numerators also have to worry about vaccination seeking populations

- "Do SOMETHING! Don't be distracted by chasing perfection" -Steve Robison

- Previously, we thought census might have different biases
  - This might not be the case; since CCC shows the same pattern at the county level

Disclaimers

CA is not officially using these methods in any public facing reports

CA's IIS is exploring these methods but is using census based denominators for public facing reports

Contact info

Tyler Moore, Washington: tyler.moore@doh.wa.gov

Steve Robison, Oregon: steve.g.robison@oha.oregon.gov

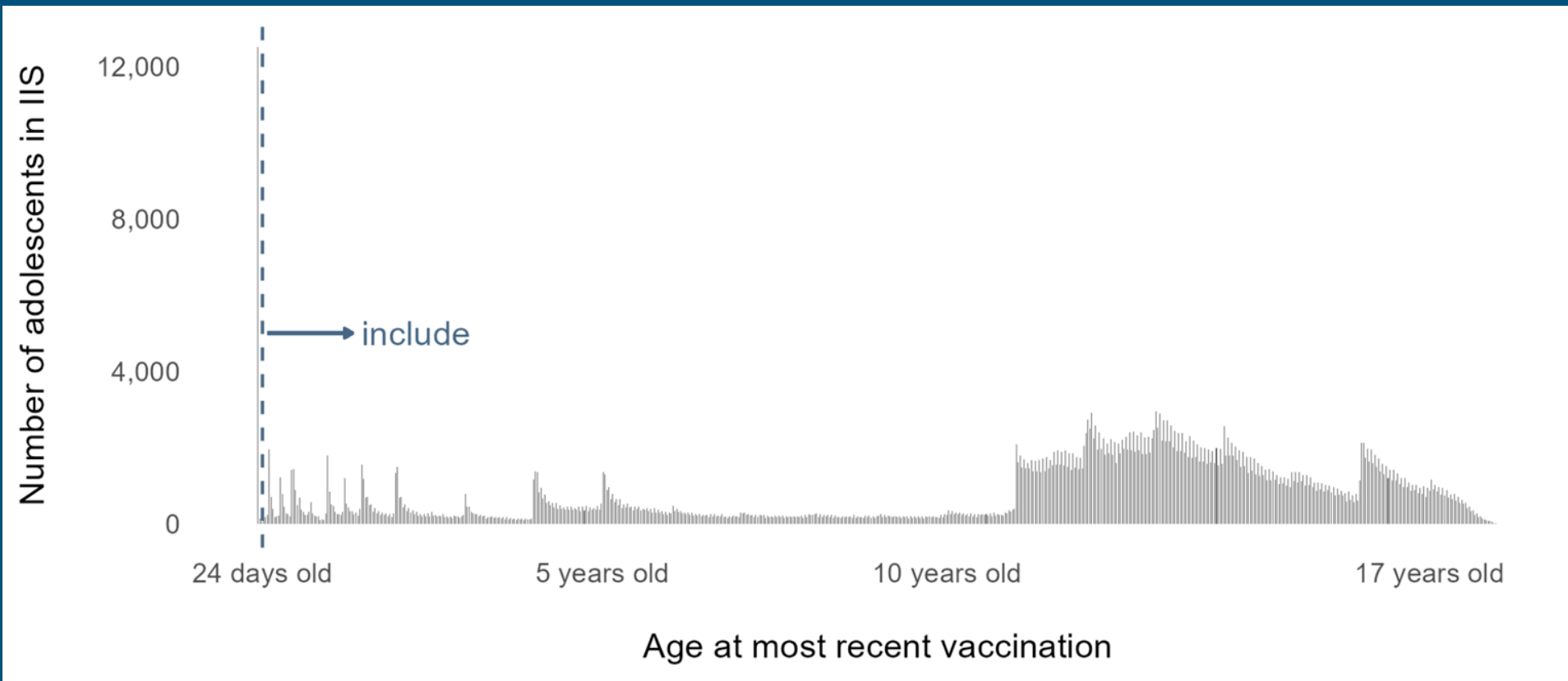Rachel Severson, Colorado: rachel.severson@state.co.us

Kimberly Campbell, Colorado: kimberly.campbell@state.co.us
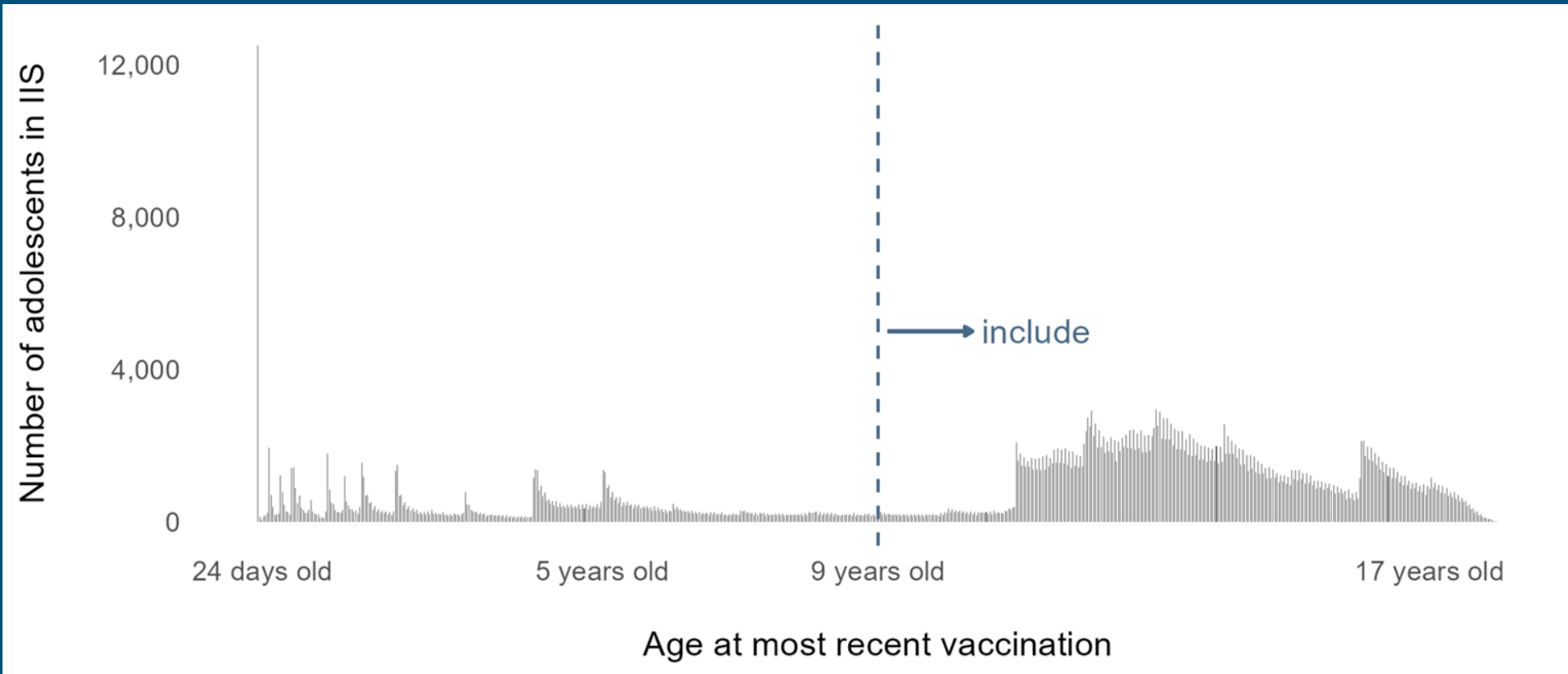
Timothy Lo, California: timothy.lo@cdph.ca.gov

Appendix

IIS-BASED DENOMINATOR ESTIMATES: IIS RAW

● IIS RAW: count of persons of age based on IIS vaccine administration records with at least one dose on record administered >24 days after date of birth should be included.

IIS-BASED DENOMINATOR ESTIMATES: SINCE 9 YEARS OLD

- SINCE 9 YEARS OLD: count persons w/ at least 1 vaccine administration record since the age of 9 as of the analysis date
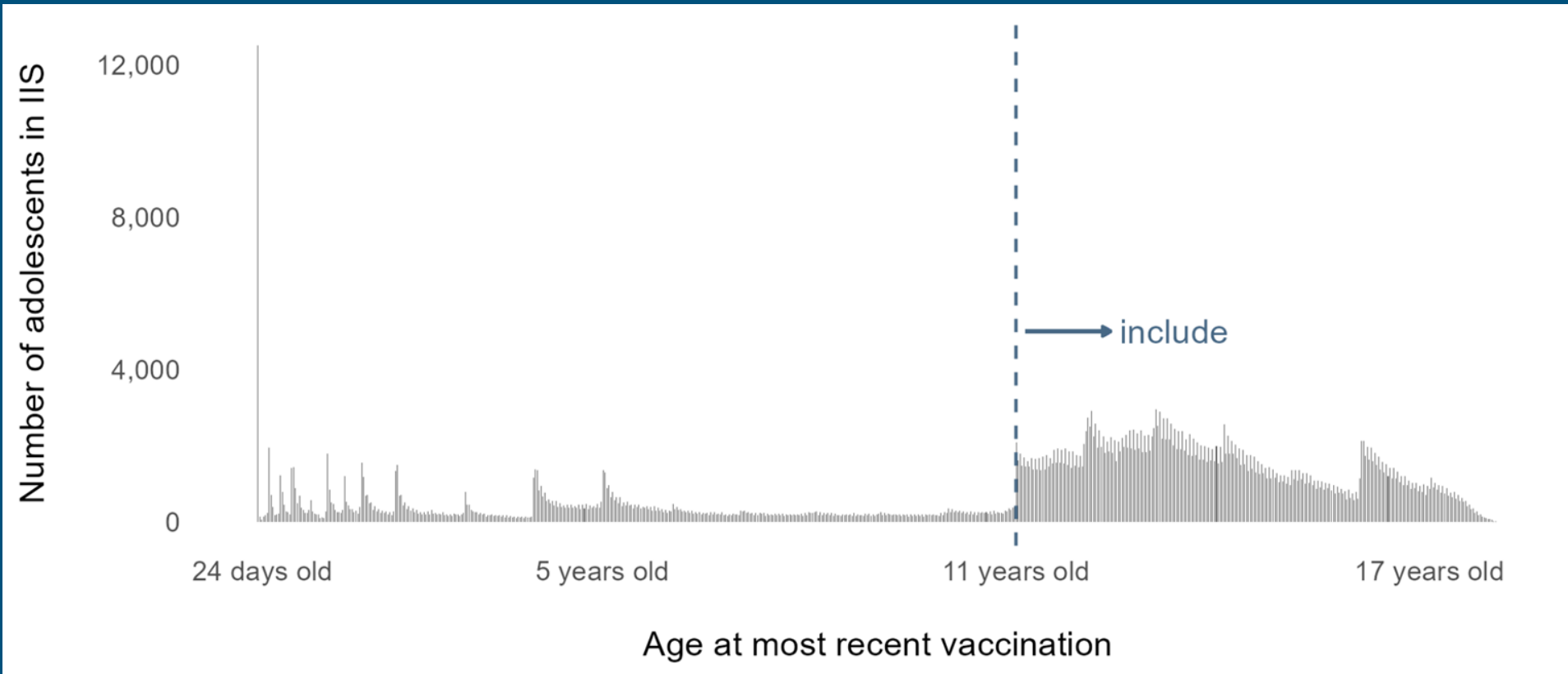
IIS-BASED DENOMINATOR ESTIMATES: SINCE 10 YEARS OLD

- SINCE 10 YEARS OLD: count persons w/ at least 1 vaccine administration record since the age of 10 as of the analysis date
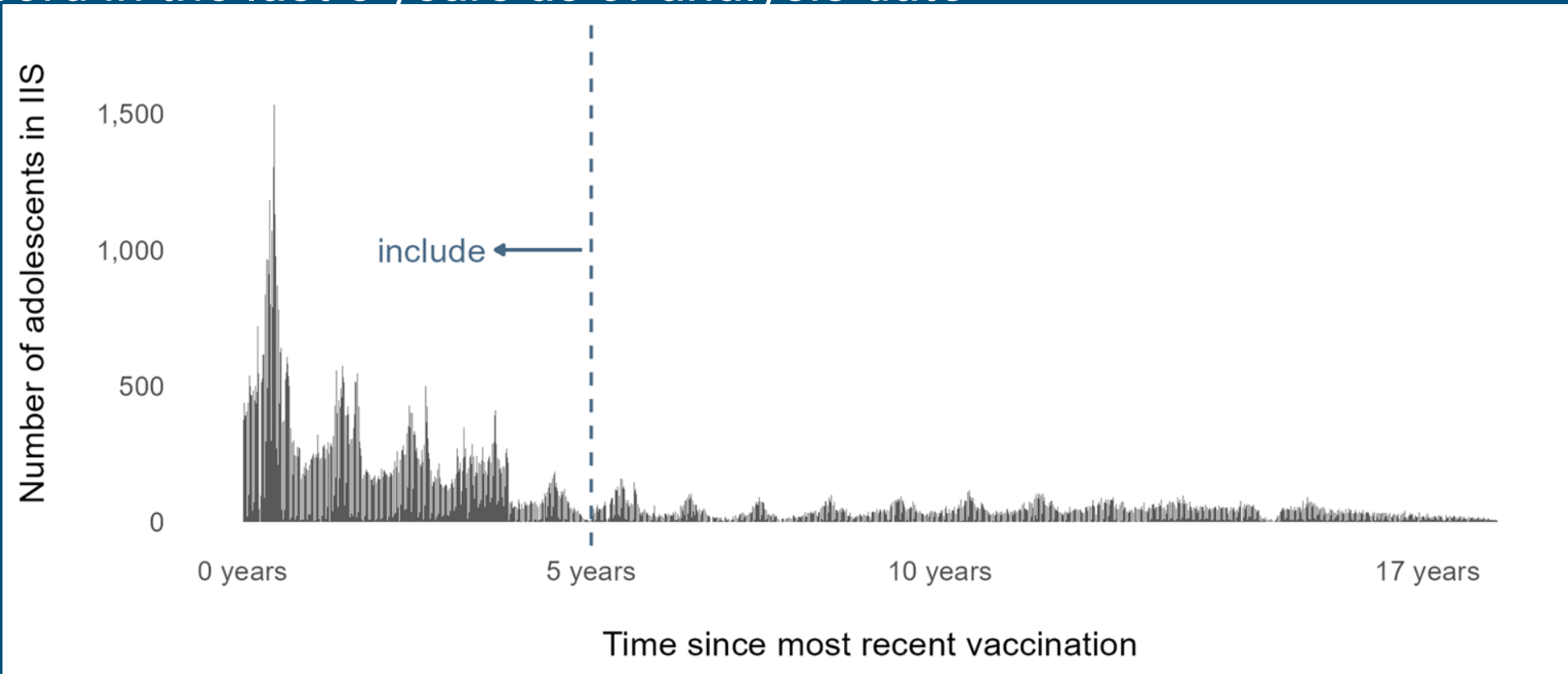
IIS-BASED DENOMINATOR ESTIMATES: SINCE 11 YEARS OLD

●SINCE 11 YEARS OLD: count persons w/ at least 1 vaccine administration record since the age of 11 as of the analysis date
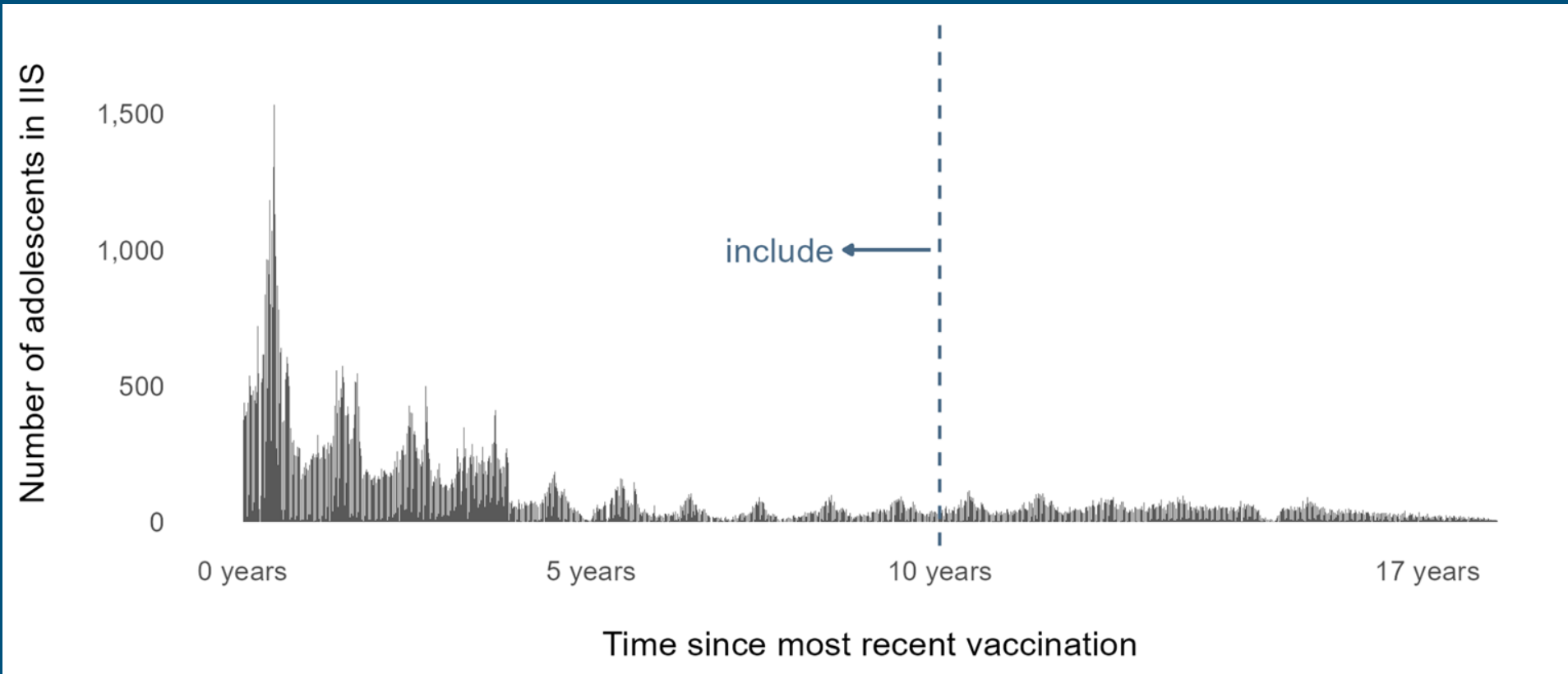
IIS-BASED DENOMINATOR ESTIMATES: 5 YEAR CUTOFF

●5 YEAR CUTOFF: count persons w/ at least 1 vaccine administration record in the last 5 years as of analysis date
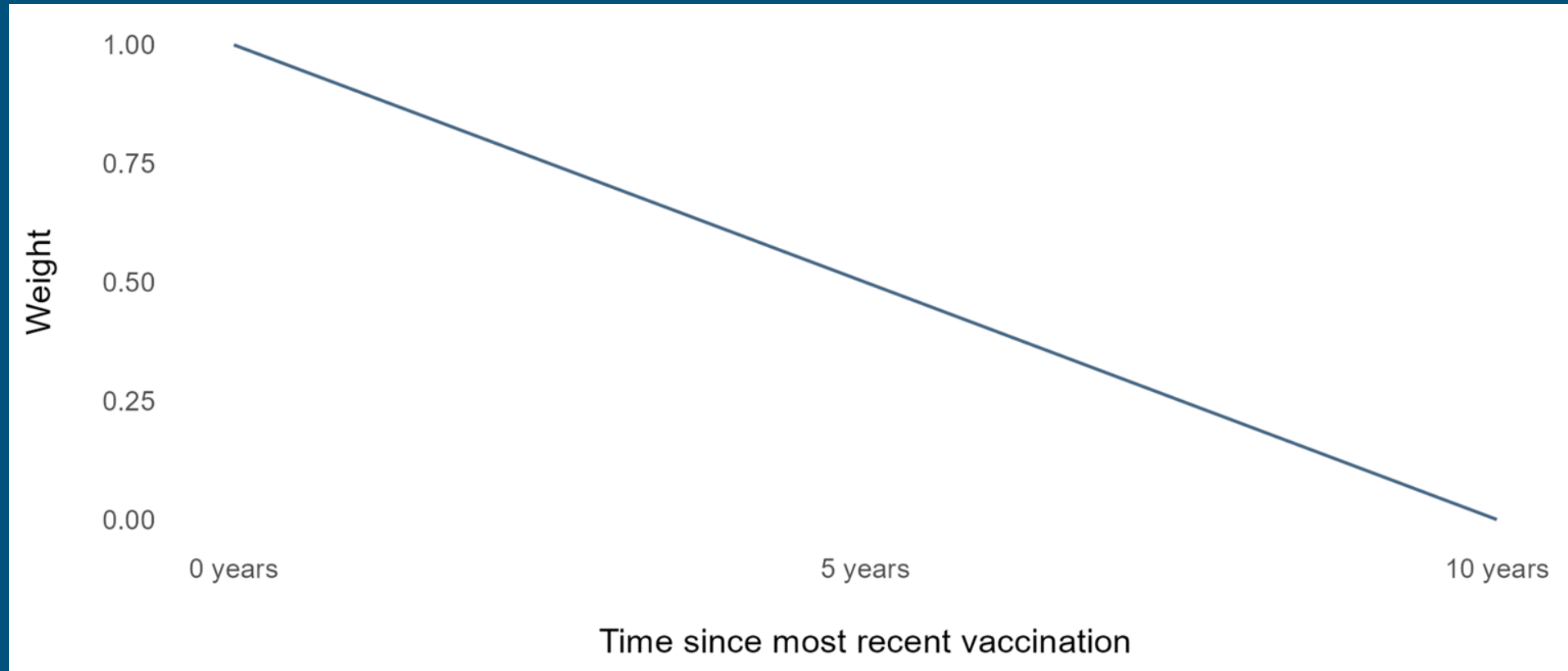
IIS-BASED DENOMINATOR ESTIMATES: 10 YEAR CUTOFF

- 10 YEAR CUTOFF: count persons w/ at least 1 vaccine administration record in the last 10 years as of analysis date
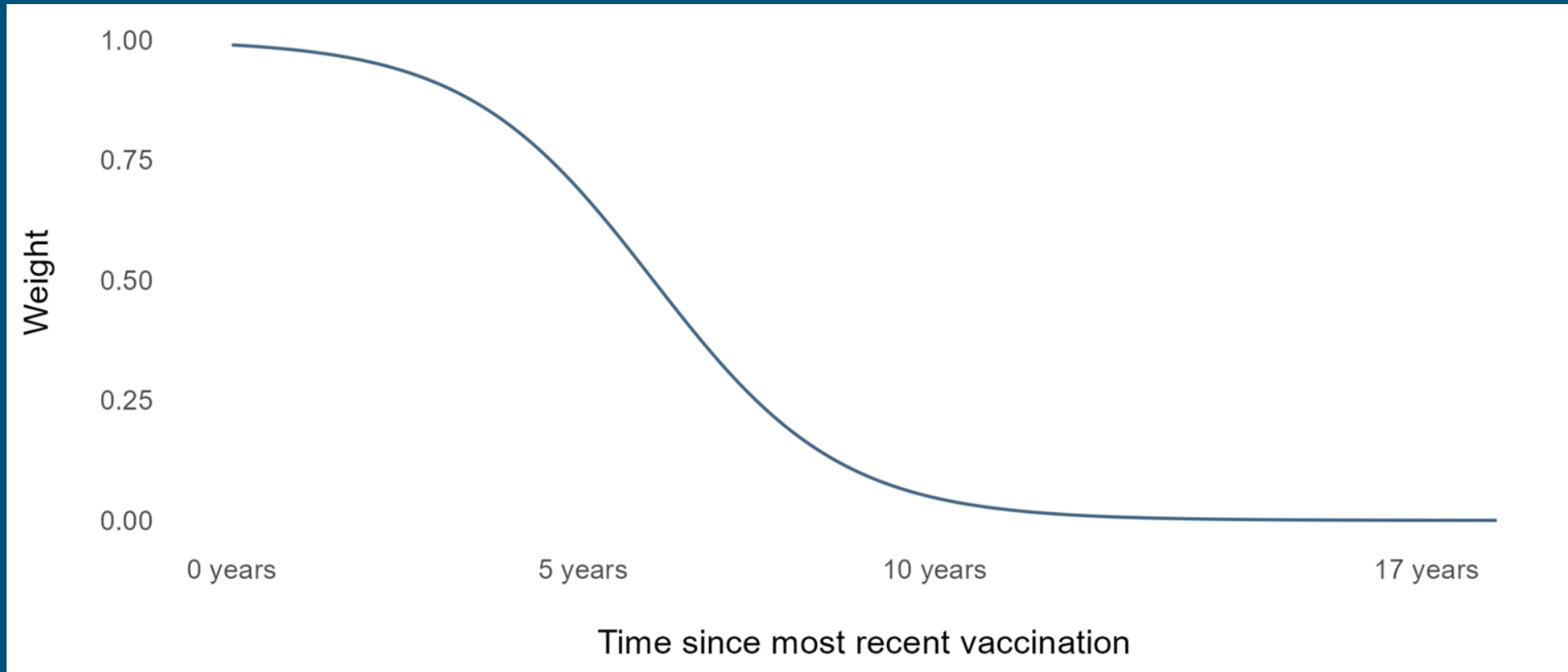
IIS-BASED DENOMINATOR ESTIMATES: LINEAR WEIGHT

- LINEAR WEIGHT: linear weight based on time since last dose: 10 YEARS = 0, 5 YEARS = 0.5

IIS-BASED DENOMINATOR ESTIMATES: OGIVE

- OGIVE: logarithmic weighted denominator, weights person records from 0-1 based on time since last vaccination

IIS-BASED DENOMINATOR ESTIMATES: OGIVE TWEAK

●OGIVE TWEAK: ogive, but MINIMUM 0.1 weight, regardless of time since last vaccination