|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ***Immunity Category*** | **Overall** | **0-17 years** | **18-29 years** | **30-49 years** | **50-64 years** | **65+ years** |
| *Infected* | 3.7% | 8.6 | 4.6 | 2.6 | 2.2 | 1.6 |
| *Reinfected* | 14.3% | 33.2 | 17.7 | 10.1 | 8.5 | 6 |
| *Infected + Vaccinated* | 12% | 12.1 | 10 | 7.4 | 4.8 | 3.5 |
| *Reinfected + Vaccinated* | 29.8% | 30 | 24.6 | 18.5 | 11.8 | 8.6 |
| *Infected + Boosted* | 14.3% | 6.6 | 17.5 | 23.2 | 27.4 | 27.2 |
| *Reinfected + Boosted* | 15.9% | 7.4 | 19.4 | 25.8 | 30.4 | 30.3 |
| *Boosted* | 4.4% | 0.9 | 4.3 | 10 | 13.1 | 20.8 |
| *Vaccinated* | 2.8% | 1.2 | 1.9 | 2.4 | 1.8 | 2 |
| % Prior Infection | 90% | 86.3% | 83% | 77.9% | 70.3% | 46.6% |
| % Booster  (denominator is entire age group) | 34.6% | 15% | 41.7% | 60% | 76.5% | 75.3% |
| % Fully vaccinated only  (denominator is entire age group) | 44.6 | 43.5% | 37% | 28.8% | 19.8% | 13.6% |

**NOTES (from Nathan -- email, 12/17/24):**

A few interesting points as I worked through this:

* It ends up being an overly constrained problem once I set up the system of equations. So I chose to ensure fit to % infected, % any vaccine, % boosted, and assumed that 100% of population fit into either a vaccine, infected, or combination category.
* The Klaussen CID estimates have a quite different population coverage for vaccine coverage (mainly booster coverage), assuming a basic age-weighted average. I favored to fit to the CDC data on booster coverage rather than Klaussmen estimates here, as I had to choose one.
* Klaussmen and CDC both give “prior infection” prevalence. Klaussmen is higher. I ended up using Klaussmen given the nucleocapsid assay has some seroreversion (And probably imperfect seroconversion). This is likely most pronounced in older populations.

What I did:

* I took CDC age-specific seroprevalence estimates and scaled them up to match the 90% population estimate by Klaussmen. I wanted to preserve the age-specific relationship from the seroprevalence data. I did a crude adjustment for seroreversion in the older age group, and did not allow any group to go over 100% for obvious reasons.
* I assembled my age-specific targets: % prior infected (based on the above), % boosted (based on your CDC data), %any vaccine ever (calculated on your CDC data).
* I then set up a system of equations to scale each category by prior infection (X), any vaccine (Y), and booster (Z) for each of their immune categories. Example here:
  + 3.7\*X + 14.3\*X + 12\*X\*Y + 29.8\*X\*Y + 14.3\*X\*Z + 15.9\*X\*Z = prior\_infection;
  + 12\*X\*Y + 29.8\*X\*Y + 2.8\*Y + 14.3\*X\*Z + 15.9\*X\*Z + 4.4\*Z = any\_vaccine\_coverage;
  + 14.3\*X\*Z + 15.9\*X\*Z + 4.4\*Z = booster\_coverage
* Wolfram alpha to solve
* The issue is I couldn’t constrain to the 100%, so I had to slightly adjust the final estimates. This introduces some extra noise.

Notes on interpretation:

* The discrepancies between these estimates (when calculated to a population level) and the Klaussmen estimates are from the following:
  + Different vaccine coverage data targets (mainly more boosters) – hence we estimate higher in the booster categories, and lower in the vaccine only category. This is the majority of the discrepancy, but it’s for good reason given I trust the CDC vaccine data more.
  + Various adjustments / processing which added some variation

**DATA SOURCES**

\_\_\_\_\_ = Estimates pulled from immunity mapping figure, referenced in Klaussen et al. *(Clin. Infectious Diseases)*

Figure link (1st plot): <https://covidestim.org/immunity-blog/blog.html>

Paper link: <https://academic.oup.com/cid/article/77/3/355/7130972?login=false>

\_\_\_\_\_ = Estimates from CDC Seroprevalence surveys (infection-induced seroprevalence only)

Pediatric estimate: <https://covid.cdc.gov/covid-data-tracker/#pediatric-seroprevalence>   
Adult estimates: <https://covid.cdc.gov/covid-data-tracker/#nationwide-blood-donor-seroprevalence-2022>   
  
\_\_\_\_\_ = Estimates from CDC vaccination uptake   
Dataset link: <https://data.cdc.gov/Vaccinations/COVID-19-Vaccination-Age-and-Sex-Trends-in-the-Uni/5i5k-6cmh/about_data>