Epidemiology Basics, Covid-19 Trends & mRNA Clinical Trials

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"And it was so typically brilliant of you to have invited an epidemiologist.


THE WALL STREET JOURNAL.
RICE
"I know more about epidemiology
than I ever wanted to know."

Outline

- Epidemiology defined
- Covid-19 trends
- mRNA vaccines & Covid-19 clinical trial results

Epidemiology

Greek roots:

- epi: upon
- demos: people
- ology: study of

Study of the distribution and determinants (viz., causes) of disease in human populations.

Epidemiology is the fundamental science that supports public health

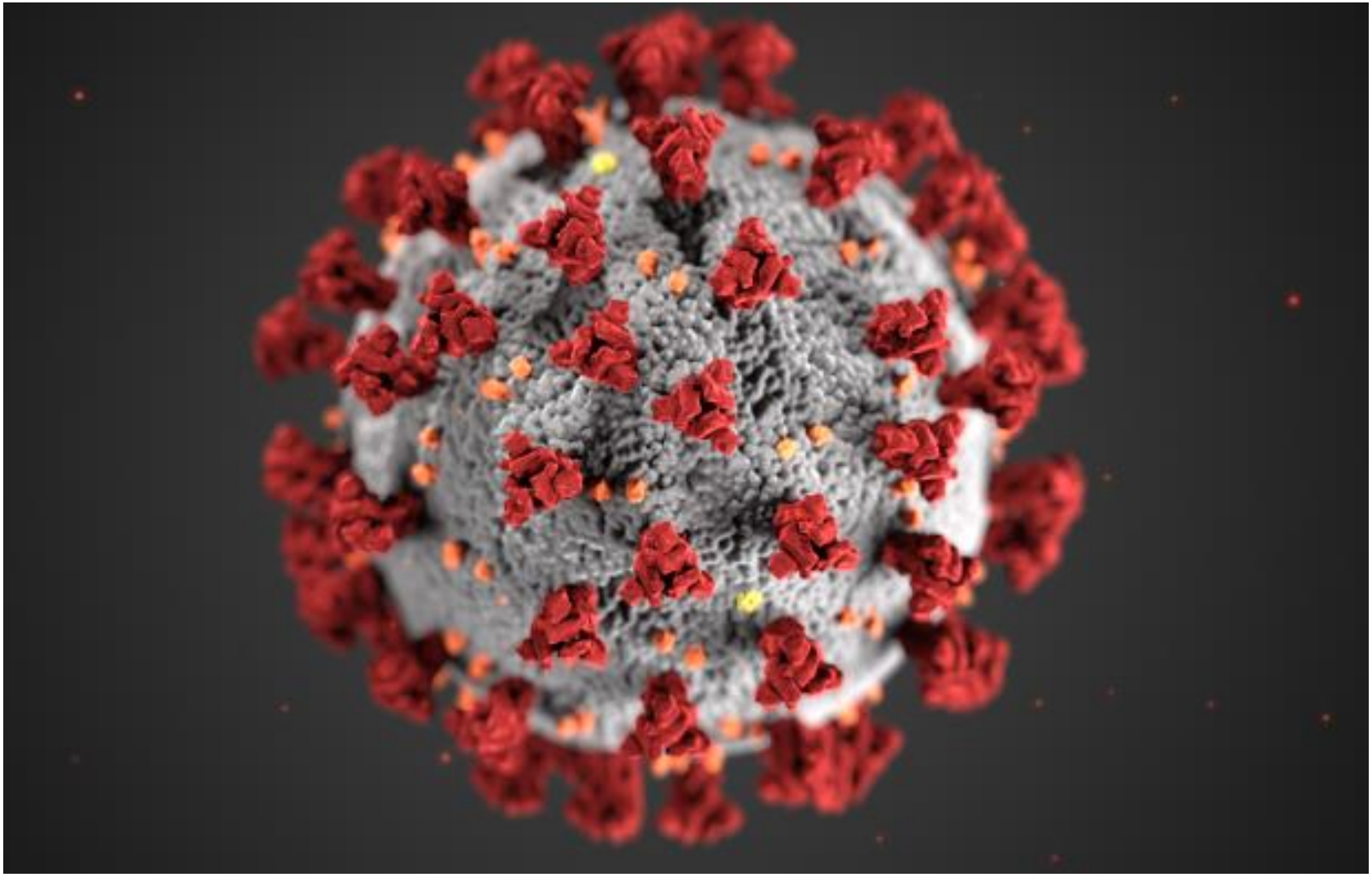
Studying the Distribution of Disease

- Person
- Place
- Time

Identifying Causes of Disease(s)

- Underlying concept for causal research is a "counterfactual" comparison
- Methods to approximate a counterfactual comparison
  - Clinical trials - randomization
  - Observational studies – statistical models to obviate differences between groups being compared that might be predictive of the outcome under study

SARS-CoV2* Image from CDC



* Severe acute respiratory syndrome related coronavirus 2 causes Covid-19

United States COVID-19 Cases and Deaths by State

Maps, charts, and data provided by CDC, updated daily by 8 pm ET†

TOTAL CASES	7-DAY CASE RATE PER 100,000	TOTAL DEATHS
29,113,651	139.8	529,301
+60,678 New Cases		+1,572 New Deaths

CDC | Updated: Mar 12 2021 8:22PM

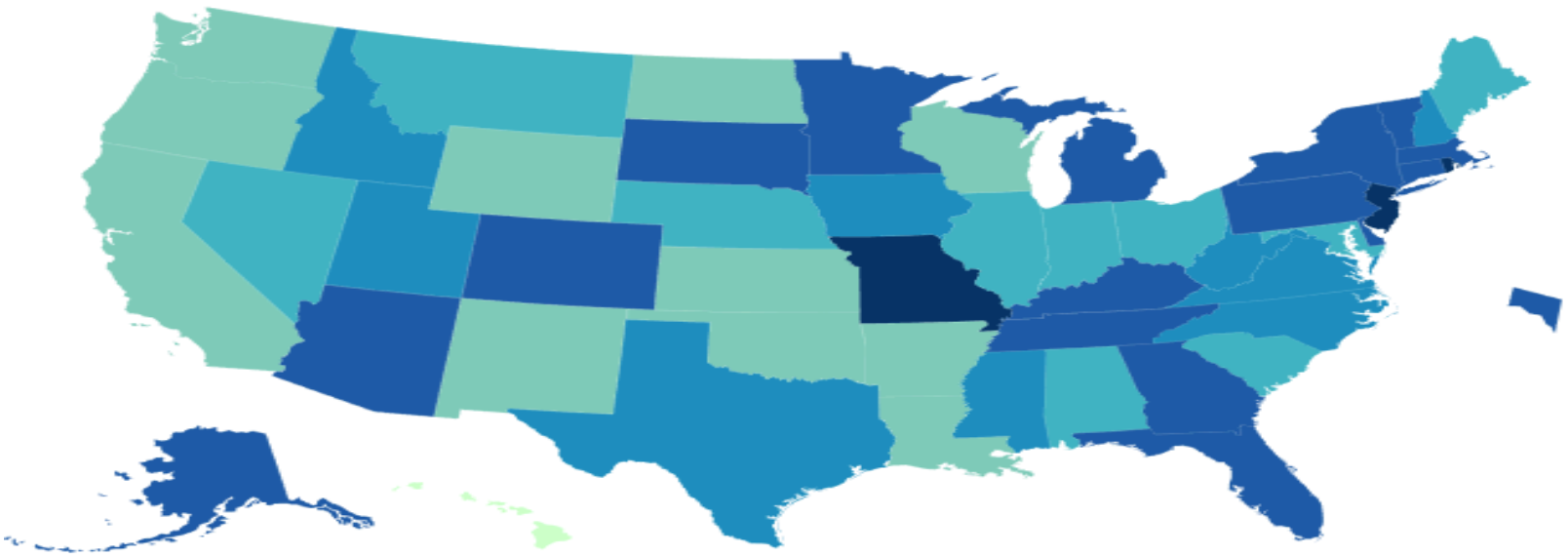
View:
- ● Cases
- ○ Deaths

Time period:
- ● Last 7 Days
- ○ Since Jan 21, 2020

Metric:
- ○ Count
- ● Rate per 100,000

This shows the number of COVID-19 cases for every 100,000 people over the last 7 days, allowing you to compare areas with different population sizes.

US COVID-19 7-Day Case Rate per 100,000, by State/Territory



Territories

AS | FSM | GU | MP | PR | PW | RMI | VI

7-Day Case Rate per 100,000

0 - 42 | 44.9 - 75.7 | 83.6 - 97.3 | 101.5 - 116.6 | 119.4 - 209.2 | 225.9 - 1,387.4

Coding Cause of Death

CAUSE OF DEATH

Part I. Enter the chain of events–diseases, injuries, or complications–that directly caused the death. Do not enter terminal events such as cardiac arrest or respiratory arrest. Do not use abbreviations.

Approximate interval between onset and death:

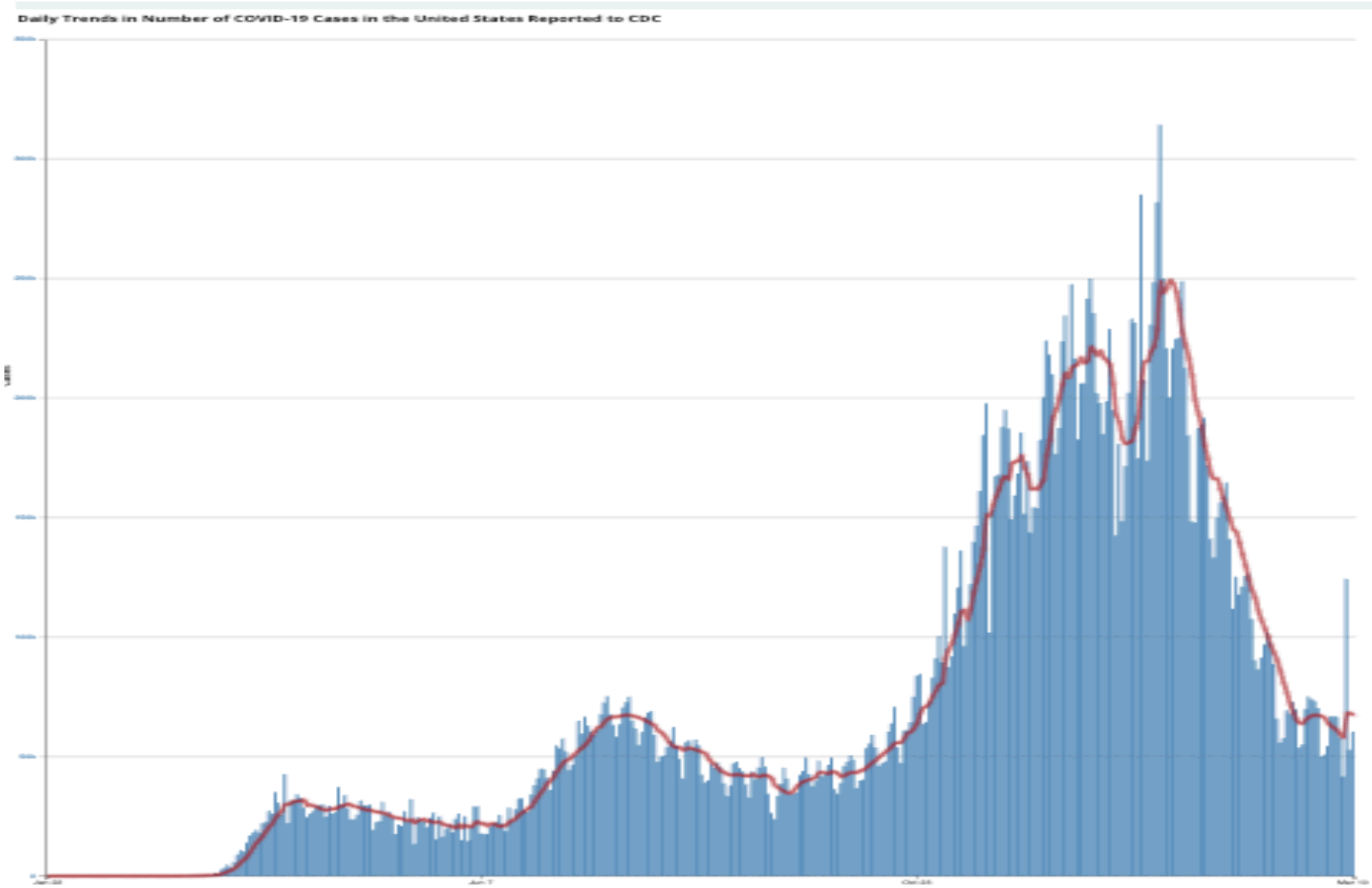
Immediate Cause (Final disease or condition resulting in death)

Sequentially list conditions, if any, leading to the cause listed on line A. Enter the **Underlying Cause** (Disease or injury that initiated the events resulting in death) last.

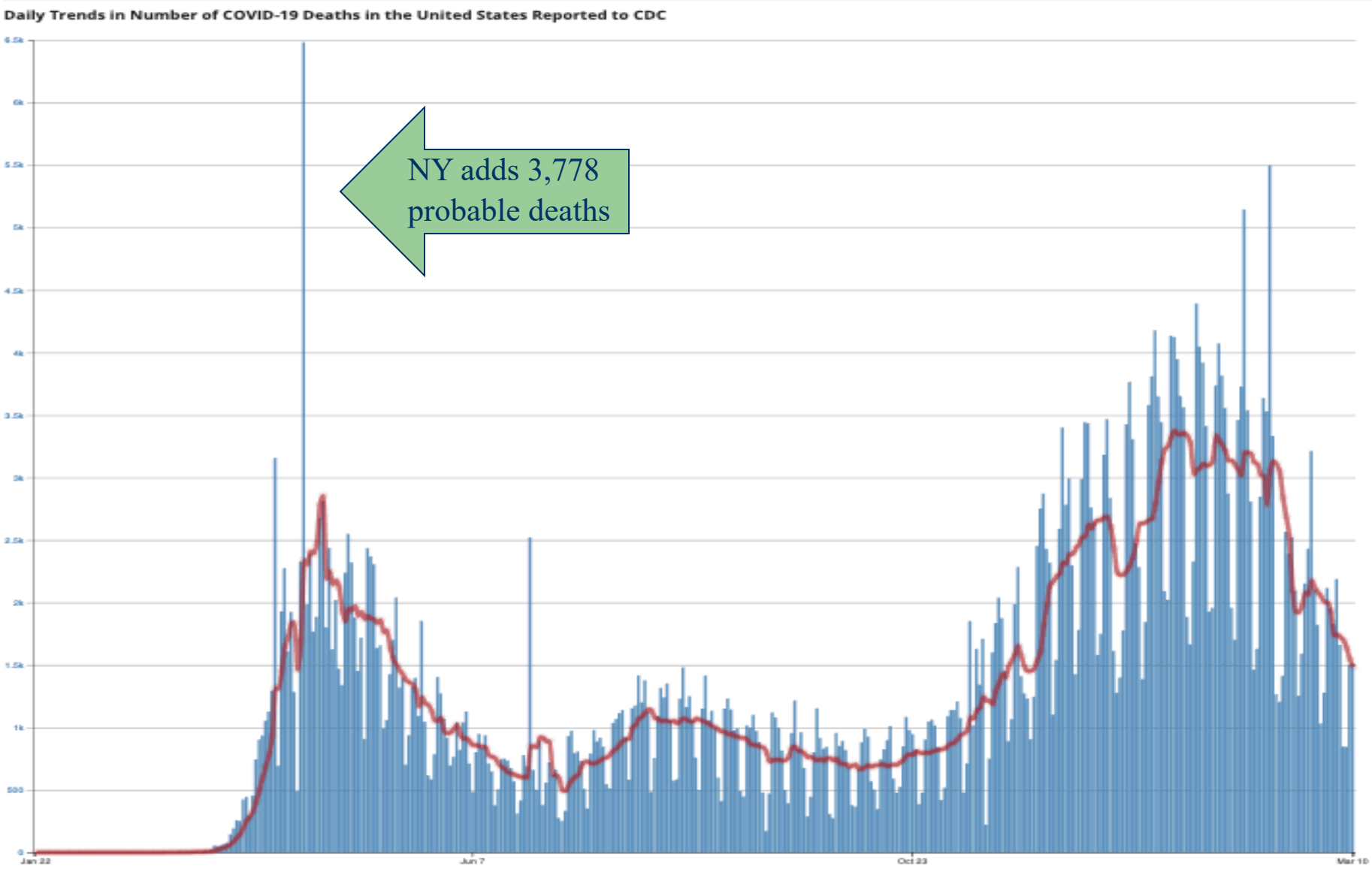
A.	Acute respiratory distress syndrome Due to (or as a consequence of):	
B.	Pneumonia Due to (or as a consequence of):	
C.	COVID-19 Due to (or as a consequence of):	
D.		

Part II. Enter other significant conditions contributing to death, but not resulting in the underlying cause given in Part I.

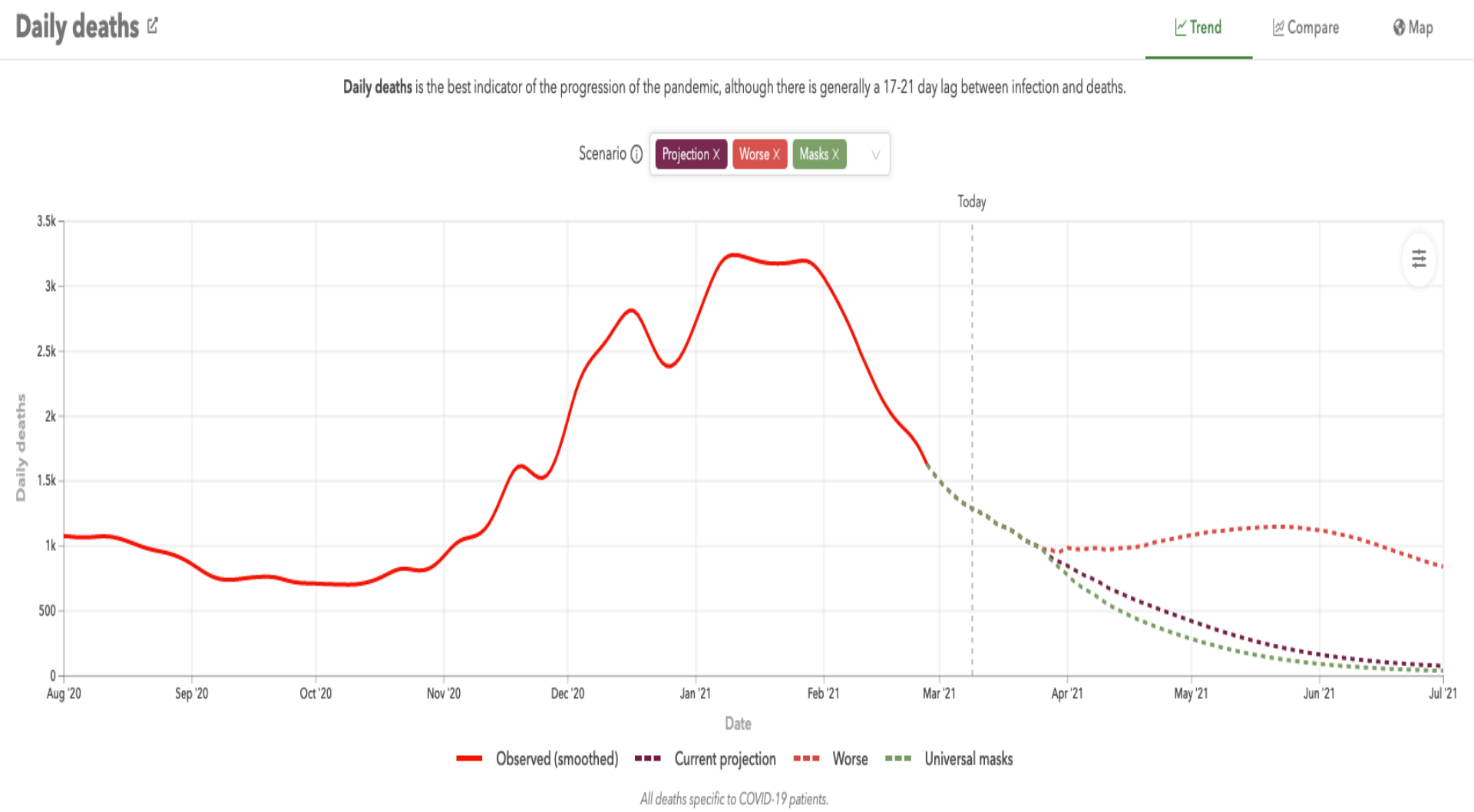
Covid-19 Daily Cases



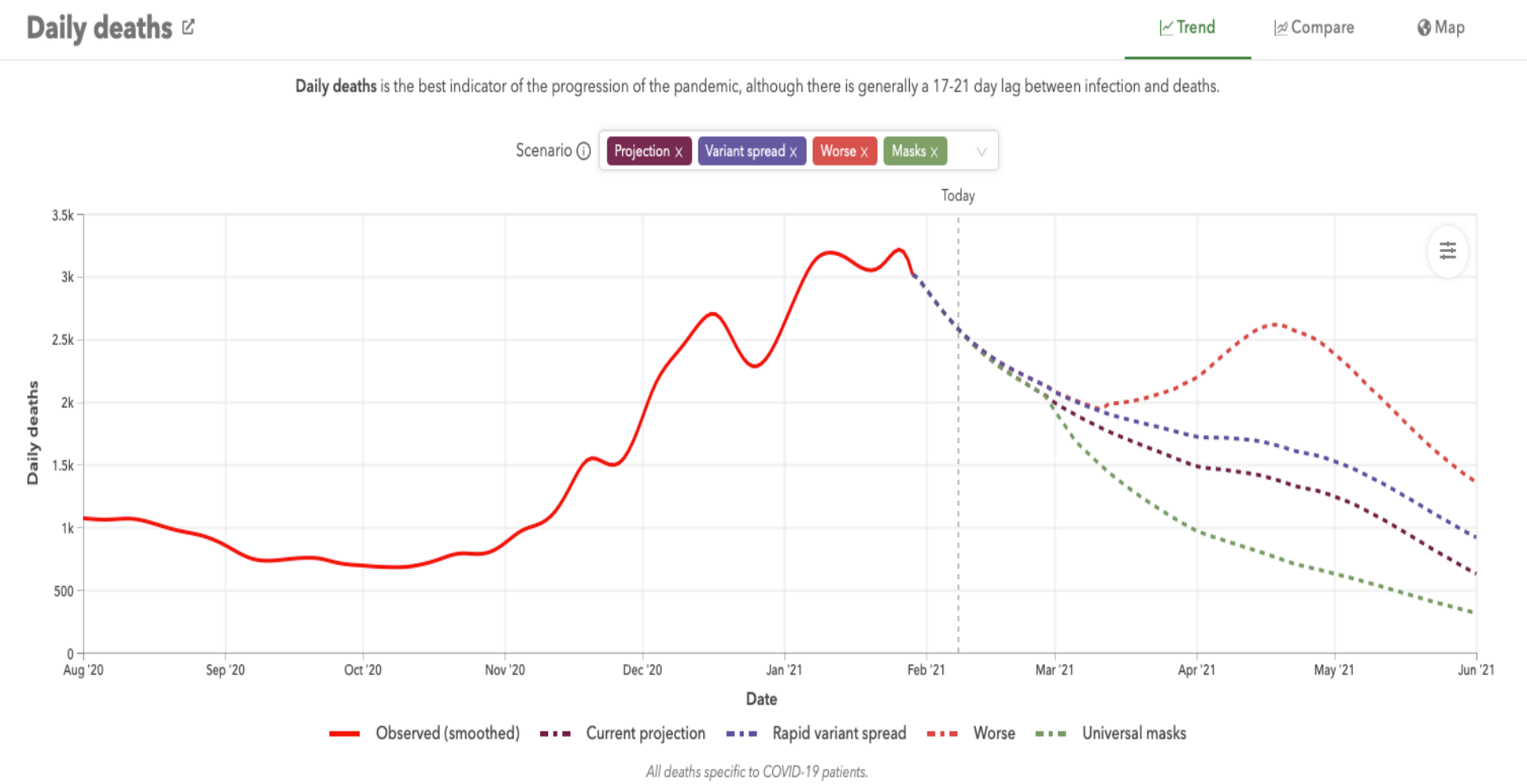
Covid-19 Daily Deaths



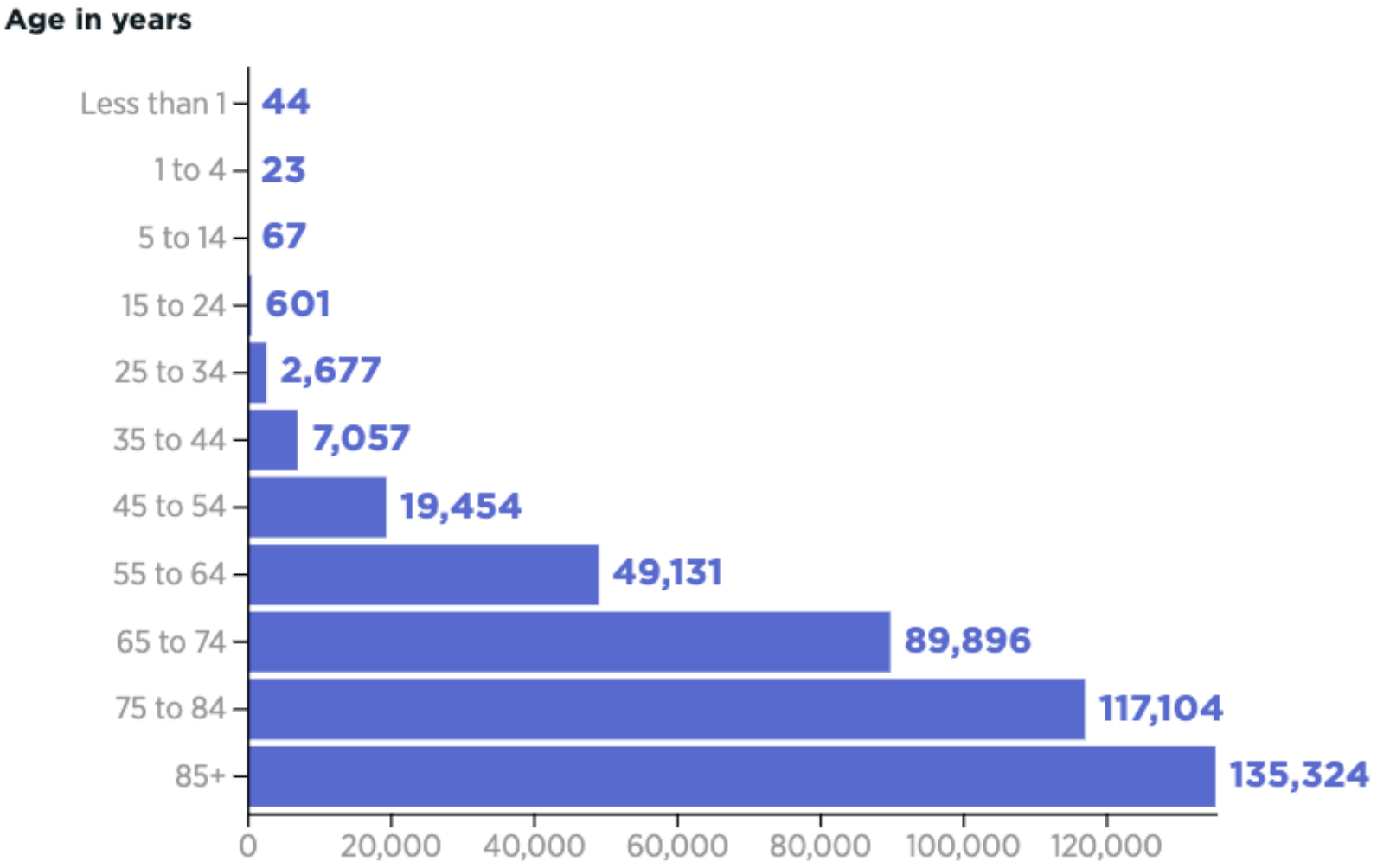
Covid-19 Daily Deaths & Projections – March 9



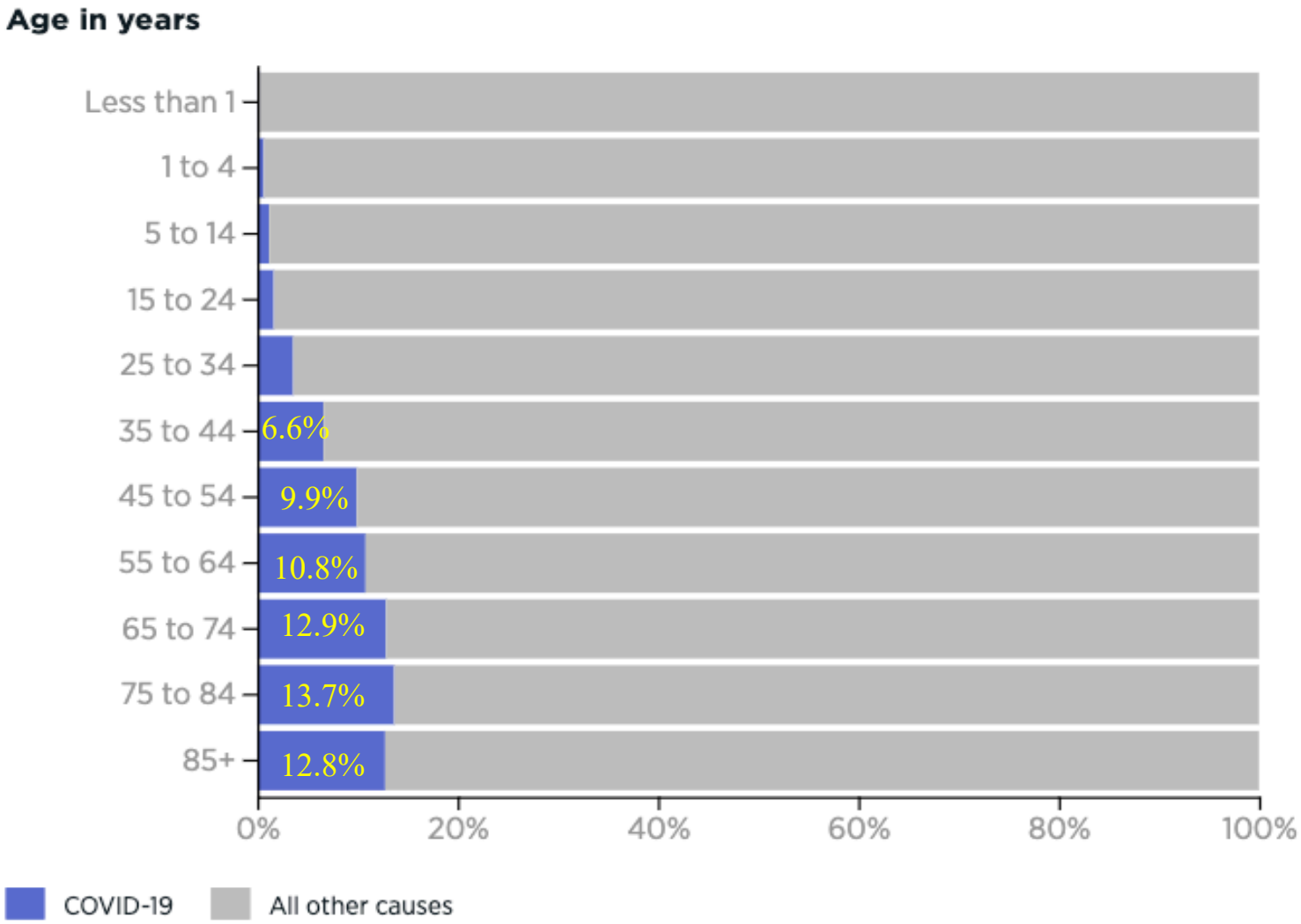
Covid-19 Daily Deaths & Projections – Feb 9



Covid-19 Deaths by Age Group



Covid-19 % of Total Deaths by Age Group



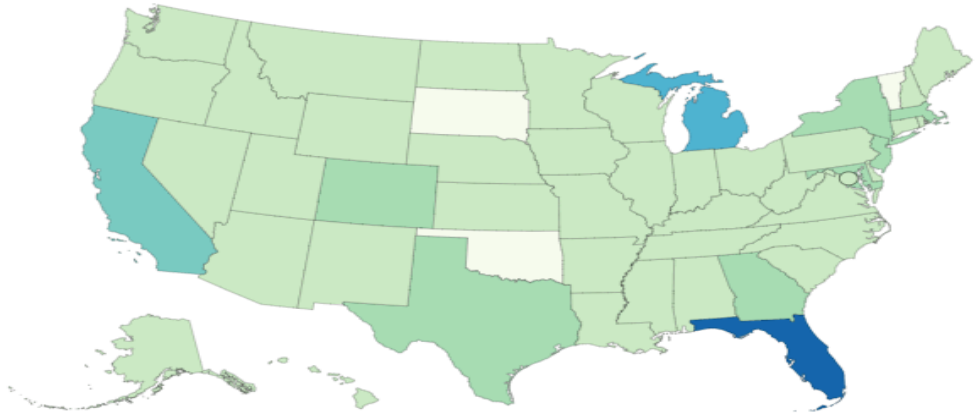
Covid-19 Variants by State

US COVID-19 Cases Caused by Variants

Updated Mar. 9, 2021 Languages Print

Variant	Reported Cases in US	Number of Jurisdictions Reporting
B.1.1.7	3283	49
B.1.351	91	21
P.1	15	9

Emerging Variant Cases in the United States*†



Number of Cases

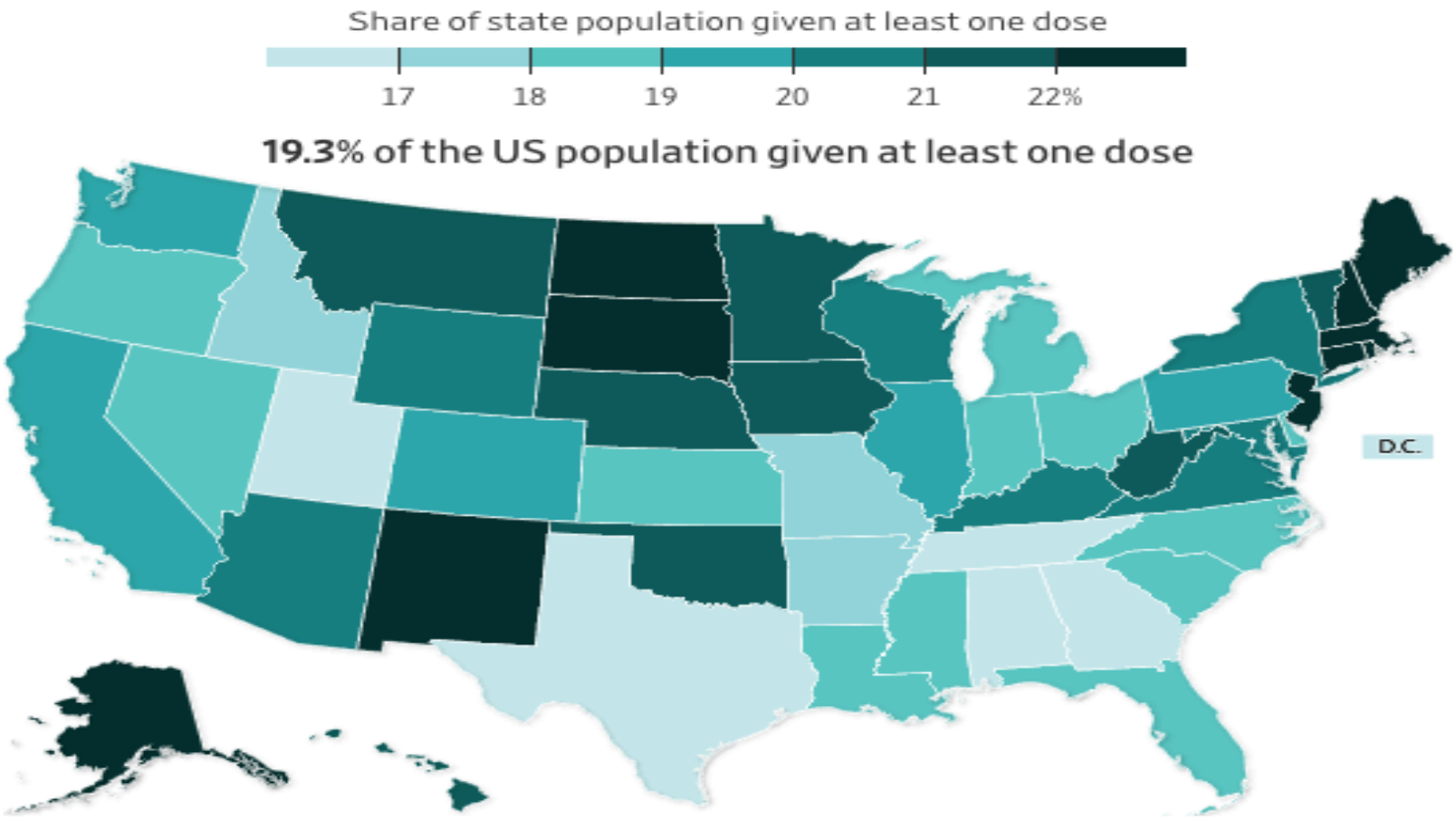
- 0 to 0
- 1 to 100
- 101 to 200
- 201 to 300
- 401 to 500
- 601 to 700

Filters

Variant B.1.1.7

Territories AS GU MH FM MP PW PR VI

Covid-19 Vaccination by State

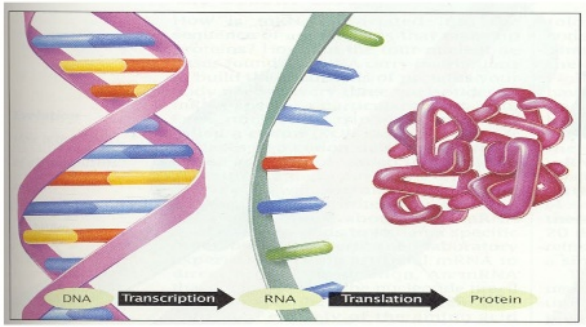


Last updated March 12, at 7:00 a.m.
Source: Centers for Disease Control and Prevention

How Pfizer & Moderna Vaccines Work

Protein Synthesis

DNA → mRNA → Protein



- We make proteins based on a DNA template, copied on to mRNA, using cellular “machinery”
- Cellular machinery will make whatever matches the instructions on mRNA (e.g., insulin, enzymes, etc.)
- mRNA vaccines contain the sequence of nucleic acids that instruct cells to make the SARS-CoV-2 virus’ spike protein

Covid-19 Vaccine Clinical Trials

- Success criterion > 30% efficacy
- Efficacy (%) defined as: 100 x (1 – $\text{incidence}_{\text{vaccine}}$ / $\text{incidence}_{\text{placebo}}$)
- Incidence of "… "confirmed Covid-19" with onset at least 7 days after the second dose in participants who had been without serologic or virologic evidence of SARS-Cov-2 infection up to 7 days after the second dose."
- Confirmed Covid-19 was defined as the presence of at least one symptom (fever, increased cough, shortness of breath, chills, loss of taste or smell …) combined with a respiratory specimen that was positive for SARS-Cov-2 by PCR testing. [viz., symptomatic]

Covid-19 Vaccine Clinical Trials

- Trials were “event driven”
- Independent data & safety monitoring board (DMB) reviewed unblinded data at regular intervals or for cause.
- DMB could have recommend stoppage early for efficacy (early success or futility) or for safety issues (stoppage or evaluation)
- There were differences in the amount of mRNA between trials
  - Pfizer 30 µg of BNT162b2 or saline placebo
  - Moderna 100 µg of mRNA-1273 or saline placebo

Covid-19 Vaccine Clinical Trials

	Moderna	Placebo	Pfizer	Placebo
male	7,923	8,062	9,639	9,436
female	7,258	7,108	9,221	9,410
total	15,181	15,160	18,860	18,846
white	12,029	11,995	15,636	15,630
A. American	1,563	1,527	1,729	1,763
other	1,589	1,648	6,761	6,730
lung disease	710	744		
cardiac disease	752	744		
obesity	1,025	1,021		
diabetes	1,435	1,440		
liver disease	100	96		
HIV	92	87		

Vaccine Efficacy

	14 days after 2nd dose	14 days after 1st dose	Severe Covid-19
Pfizer	95%	93%	90%
Moderna	94%	95%	100%

Efficacy similar for: ≥ 65 years, men and women, white and African American participants

Efficacy against severe Covid-19 was based on 10 cases in the Pfizer Trial and 30 cases in the Moderna

Adverse Events Pfizer & Moderna Trials

- [Pfizer] … short-term mild to moderate pain at the injection site. The incidence of serious adverse events was low and was similar in the vaccine and placebo groups.
- [Moderna] injection site pain after vaccination occurred more frequently in the vaccine group. Serious adverse events were rare, and the incidence was similar in the vaccine and placebo groups.