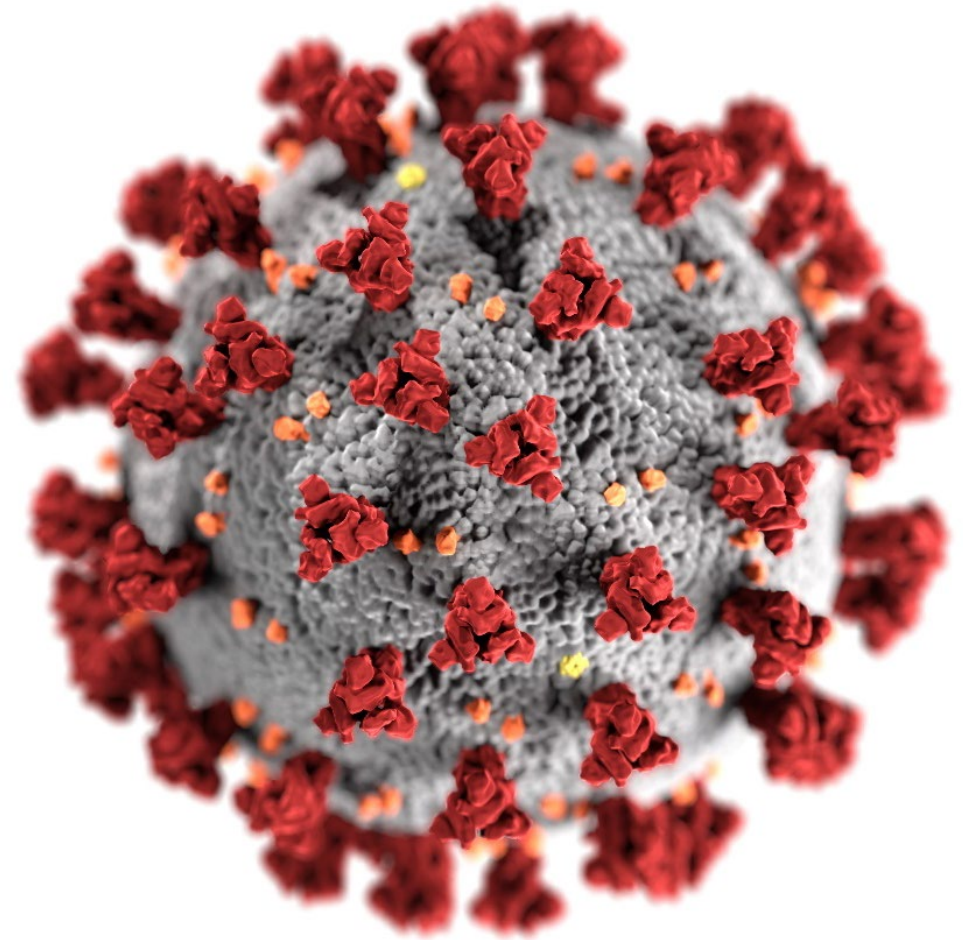


# Update on myocarditis following mRNA COVID-19 vaccination

Vaccines and Related Biological Products Advisory  
Committee (VRBPAC)

June 14, 2022

Tom Shimabukuro, MD, MPH, MBA  
CDC COVID-19 Vaccine Coordination Unit



[cdc.gov/coronavirus](https://cdc.gov/coronavirus)



# Topics

- Background on classic myocarditis and myocarditis associated with mRNA COVID-19 vaccination (included for reference)
- Update on myocarditis following mRNA COVID-19 vaccination with a focus on children ages 5–17 years\*
  - Findings from the Vaccine Adverse Event Reporting System (VAERS)
  - Findings from the Vaccine Safety Datalink (VSD)
- Comparative risk for myocarditis between the two available mRNA COVID-19 vaccines, Moderna and Pfizer-BioNTech



\* Analyses focus on children ages 5–11 years for the 2-dose (10 µg) primary series separated by at least 3 weeks, and children ages 12–17 years for the 2-dose (30 µg) primary series separated by at least 3 weeks followed by a booster dose at least 5 months after completion of the primary series; data outside of these authorizations and recommendations (e.g., off authorization use, vaccination errors, special population authorizations/recommendations) are not included in these analyses

# Epidemiology of classic myocarditis in children (excluding infants)

- Usually an infectious cause, typically viral or presumed to be viral, although infection with a pathogen is frequently not identified (only ~40% of time a pathogen is identified)<sup>1,2,3</sup>
- Can be due to direct microbial infection of myocardial cells and/or ongoing inflammatory response, with or without clearance of pathogen<sup>4,5,6</sup>
  - Can also be toxin-mediated or in setting of systemic infection or infection of non-cardiac tissue
- Rarer causes include autoimmune, hypersensitivity, and giant cell myocarditis
- Incidence in males > females starting after age 5 years<sup>7</sup>
- Previously unrecognized myocarditis was identified as cause of death in 8% of cases of sudden, unexplained death in 1–17- year-olds<sup>8</sup> and 9% of sudden death in athletes<sup>9</sup>
- It is common to not identify a pathogen or possible infectious etiology for myocarditis
  - Based on case series, where autopsy tissues were examined and tissue-based infectious disease testing was performed, a specific infectious cause was only identified in 13%–36% of cases across age groups<sup>6,10,11</sup>
  - For a case series where endomyocardial biopsy tissues were tested, viral nucleic acids were detected in heart tissues in ~38% (adults and children combined)<sup>1</sup>

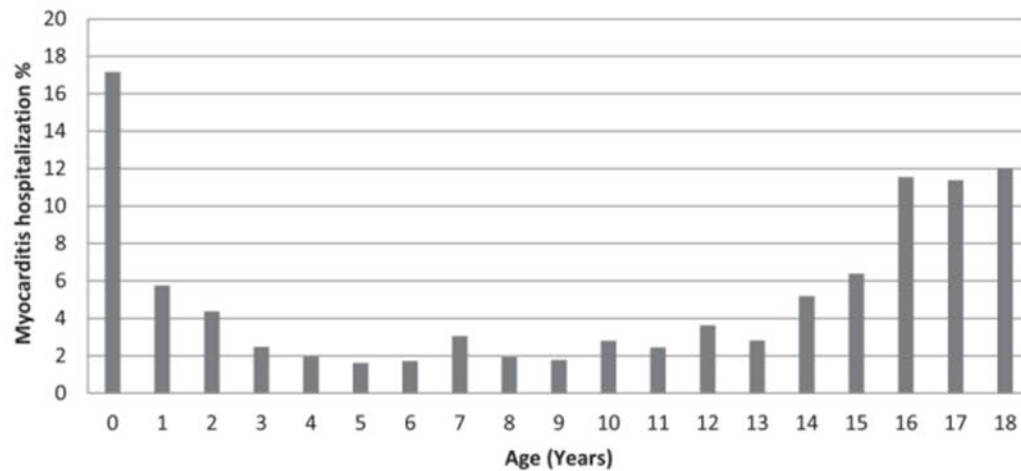


<sup>1</sup>Bowles et al. J Am Coll Cardiol. 2003;42:466-72. <sup>2</sup>Simpson et al. J Am Coll Cardiol. 2013;61:(10\_Supplement) E1264. <sup>3</sup>Park et al. J Korean Med Sci. 2021;36:e232. <sup>4</sup>Caforio et al. Eur Heart J. 2013;34:2636-48, 2648a-2648d. <sup>5</sup>Feldman et al. N Engl J Med. 2000;343:1388-98. <sup>6</sup>Guarner et al. Hum Pathol. 2007;38:1412-9. <sup>7</sup>Arola et al. J Am Heart Assoc. 2017;6:e005306. <sup>8</sup>Burns et al. J Pediatr X. 2020;2:100023. <sup>9</sup>Maron et al. Circulation. 2009;119:1085-92. <sup>10</sup>Weber et al. Arch Dis Child. 2008;93:594-8. <sup>11</sup>Ilina et al. Pediatrics. 2011;128:e513-20.

# Epidemiology of myocarditis

## Children

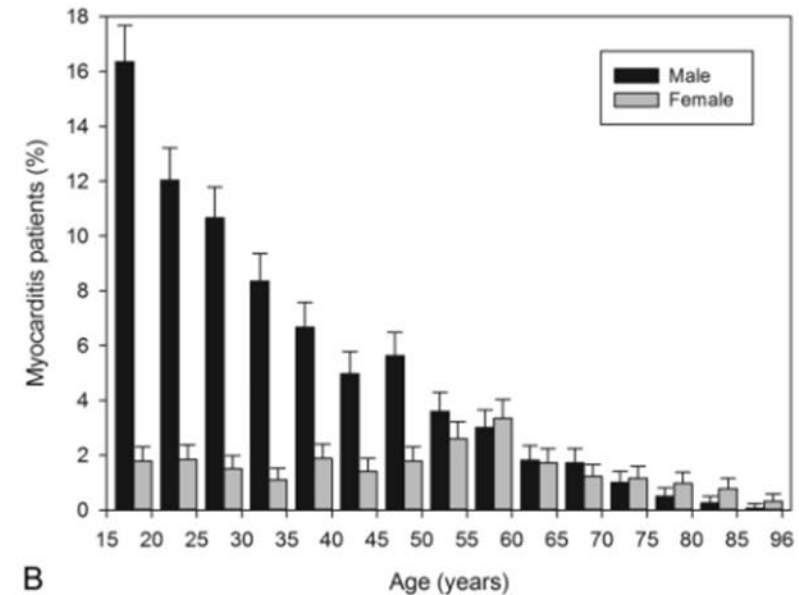
- Annual incidence 0.8 per 100,000
  - In 15-18yo, 1.8 per 100,000 in 2015-2016
- 66% male
- Median LOS 6.1 days



Vasudeva et al. *American J Cardiology*. 2021.

## Adults

- Gradual decrease in incidence with age
- 76% male



B

Kyto et al. *Heart*. 2013.



Previously presented at the June 23, 2021, ACIP meeting: <https://www.cdc.gov/vaccines/acip/meetings/downloads/slides-2021-06/02-COVID-Oster-508.pdf>

LOS = Length of hospital stay

Characteristic	Myocarditis associated with mRNA COVID-19 vaccination <sup>*,†</sup>	Viral myocarditis <sup>‡</sup>
Inciting exposure	mRNA COVID-19 vaccination • Dose 2 > Dose 1	Viral illness • 30–60% with asymptomatic viral course
Demographics	Most cases in adolescents and young adults, males > females	Males > females, male incidence peaks in adolescence and gradually declines
Symptom onset	A few days after vaccination, most within a week	1–4 weeks after viral illness
Fulminant course	Rare <sup>¶</sup>	23%
ICU level support	~2%	~50%
Mortality/transplant	Rare <sup>¶</sup>	11–22%
Cardiac dysfunction	12%	60%
Recovery of cardiac function	Nearly all	~75%
Time to recovery of cardiac function (ejection fraction on cardiac echo), if initially poor	Hours to days	Days to weeks to months

\* <https://www.cdc.gov/vaccines/acip/meetings/index.html>, <https://www.cdc.gov/vaccinesafety/research/publications/index.html>

† Oster et al. JAMA. 2022;327:331-340.

‡ Law et al. Circulation. 2021;144:e123-e135. Ghelani et al. Circ Cardiovasc Qual Outcomes. 2012;5:622-7. Kim et al. Korean Circ J. 2020;50:1013-1022. Messroghli et al. Am Heart J. 2017;187:133-144. Patel et al. J Am Heart Assoc. 2022;11:e024393.

¶ There are rare reports in the literature, especially from other countries, but it is unclear to what extent such cases were investigated



# VAERS is the nation's early warning system for vaccine safety



## VAERS

### Vaccine Adverse Event Reporting System

<http://vaers.hhs.gov>



# VAERS

VAERS accepts reports from everyone (healthcare professionals, patients, parents, caregivers, manufacturers, etc.) regardless of the plausibility of the vaccine causing the event or the clinical seriousness of the event

## Key strengths

- Rapidly detects potential safety problems
- Can detect rare adverse events

## Key limitations

- Passive surveillance system
- Inconsistent quality and completeness of information
- Reporting biases
- Generally, cannot determine cause and effect ←



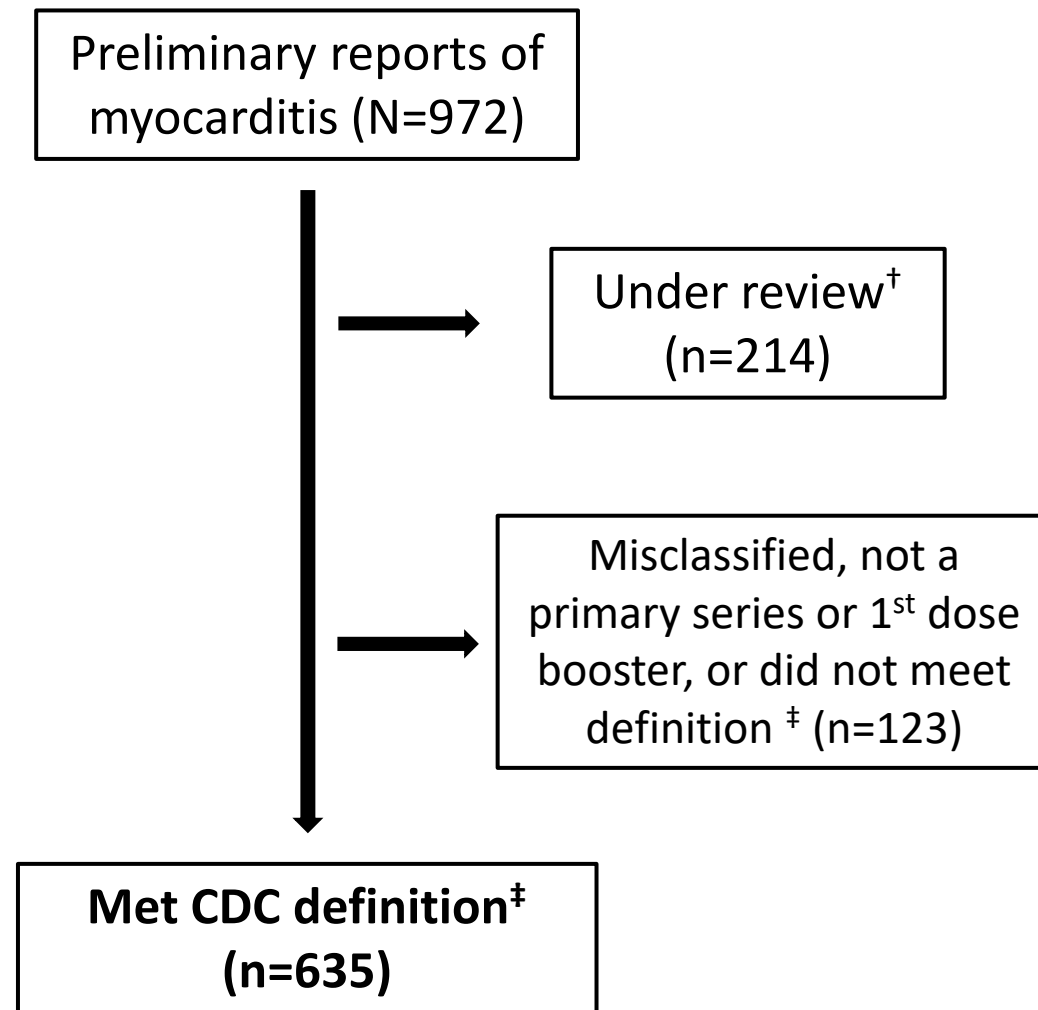
# Reports to VAERS of myocarditis after Pfizer-BioNTech vaccination among children ages 5–17 years (as of May 26, 2022)\*

- 54.8 million total Pfizer-BioNTech doses administered to children ages 5–17 years in the United States
  - 27.7 million dose 1
  - 23.3 million dose 2
  - 3.8 million 1<sup>st</sup> booster dose (ages 12–17 years)

\* As of May 26, 2022, primary series vaccination among children ages 16–17 years since Dec 14, 2020; children ages 12–15 years since May 10, 2021; children ages 5–11 years since Nov 3, 2021; 1<sup>st</sup> dose booster vaccination among children ages 16–17 years since Dec 9, 2021; children ages 12–15 years since Jan 5, 2022.

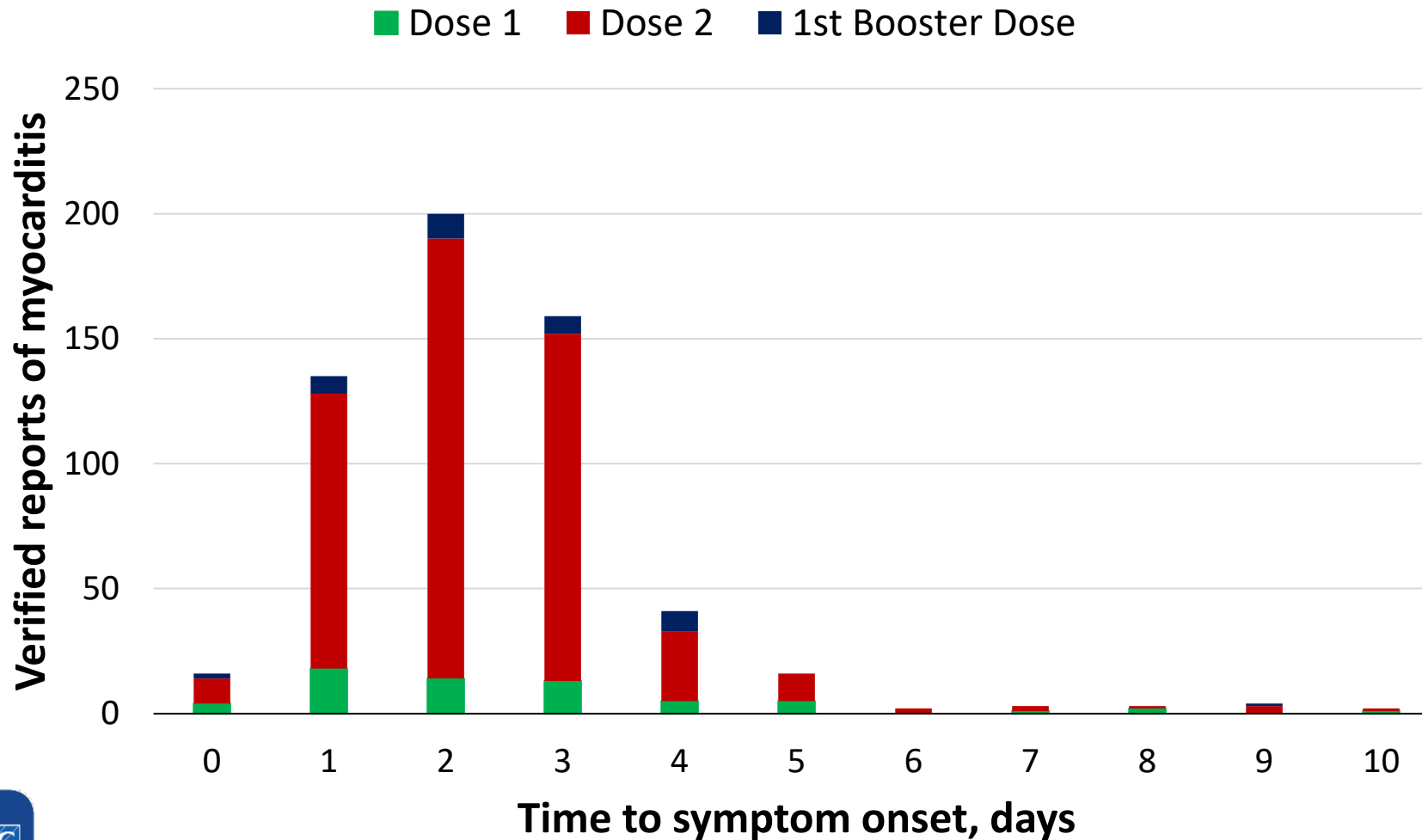
† Awaiting medical records and/or healthcare provider interview; some still processing

‡ Adjudicated after healthcare provider interview and/or medical record review; CDC myocarditis case definition available at: <https://www.cdc.gov/mmwr/volumes/70/wr/mm7027e2.htm>





# Verified\* U.S. reports to VAERS of myocarditis after Pfizer-BioNTech vaccination among children ages 5–17 years, by time to symptom onset† and dose number (N=630, as of May 26, 2022)



† 630 of 635 (99%) with known time to symptom onset; 49 (8%) reports with time to symptom onset >10 days



\*Verified according to CDC myocarditis case definition available at: <https://www.cdc.gov/mmwr/volumes/70/wr/mm7027e2.htm>

# VAERS reporting rates of myocarditis (per 1 million doses administered) after mRNA COVID-19 vaccination, days 0–7 and 8–21 post-vaccination<sup>\*,†</sup>

	0–7 days			8–21 days			0–7 days			8–21 days			
	Males			Males			Females			Females			
	Age (yrs)	Dose 1	Dose 2	Booster	Dose 1	Dose 2	Booster	Dose 1	Dose 2	Booster	Dose 1	Dose 2	Booster
Pfizer-BioNTech	5–11	0.2	2.6	0.0	0.6	0.0	0.0	0.2	0.7	0.0	0.2	0.0	0.0
	12–15	5.3	46.4	15.3	1.2	1.2	0.9	0.7	4.1	0.0	0.4	0.2	0.9
	16–17	7.2	75.9	24.1	1.7	3.2	1.3	0.0	7.5	0.0	0.7	0.4	0.0
Pfizer-BioNTech and Moderna	18–24	4.2	38.9	9.9	1.1	2.2	0.4	0.6	4.0	0.6	0.2	0.7	0.0
	25–29	1.8	15.2	4.8	0.4	1.1	0.5	0.4	3.5	2.0	0.2	0.0	0.8
	30–39	1.9	7.5	1.8	0.4	0.8	0.2	0.6	0.9	0.6	0.3	0.2	0.0
	40–49	0.5	3.3	0.4	0.2	0.5	0.0	0.4	1.6	0.6	0.2	0.2	0.0
	50–64	0.5	0.7	0.4	0.2	0.3	0.1	0.6	0.5	0.1	0.2	0.5	0.1
	65+	0.2	0.3	0.6	0.3	0.2	0.1	0.1	0.5	0.1	0.1	0.2	0.1

\* As of May 26, 2022; reports verified to meet case definition by provider interview or medical record review; primary series and 1<sup>st</sup> booster doses only

† An estimated 1–10 cases of myocarditis per 100,000 person years occurs among people in the United States, regardless of vaccination status; adjusted for days 0–7 and 8–21 risk intervals, this estimated background is **0.2 to 2.2 per 1 million person-day 0–7 risk interval and 0.4 to 3.8 per 1 million person-day 8–21 risk interval** (peach shaded cells indicate that reporting rate exceeded estimated background incidence for the period)



# CDC enhanced surveillance for myocarditis outcomes following mRNA COVID-19 vaccination in VAERS case reports among children ages 5–17 years\*

- **Purpose:** Assess functional status and clinical outcomes among individuals reported to have developed myocarditis after COVID-19 mRNA vaccination
- **Methods:** A two-component survey conducted at least 90 days after the onset of myocarditis symptoms
  - **Patient or parent survey:** Focused on ascertaining functional status, clinical symptoms, quality of life, and need for medication or other medical treatment
  - **Healthcare provider (e.g., cardiologist) survey:** Gather data on cardiac health and functional status



\* <https://www.cdc.gov/coronavirus/2019-ncov/vaccines/safety/myo-outcomes.html>; surveillance project includes two separate cohorts, children ages 5–11 years and people ages 12–29 years

# CDC enhanced surveillance for myocarditis outcomes following mRNA COVID-19 vaccination in VAERS case reports among children ages 5–17 years

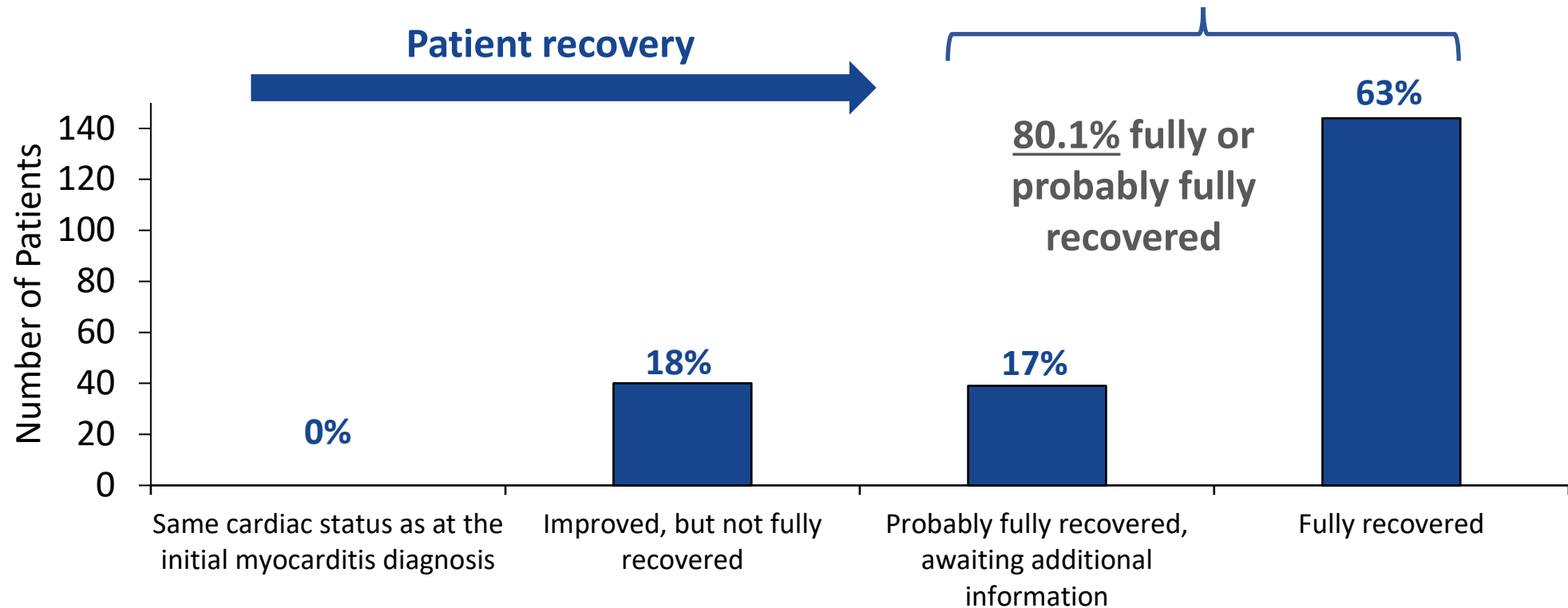
- During the surveillance periods (through November 2021 for 12–17 years and April 2022 for 5–11 years), VAERS received **430 reports** of myocarditis or myopericarditis after mRNA COVID-19 vaccination in children ages 5–17 years that met CDC case definition\* and were at least 90 days post-myocarditis diagnosis
  - **190 completed the patient or parent survey**, 128 were unreachable on multiple attempts, 98 had no telephone contact information in the report, and 7 declined to participate
  - **226 cardiologists or other healthcare providers (HCP) completed a survey**, 120 were unreachable on multiple attempts, and 65 had no telephone contact information in the report



\* <https://www.cdc.gov/mmwr/volumes/70/wr/mm7027e2.htm>

# CDC enhanced surveillance for myocarditis outcomes following mRNA COVID-19 vaccination in VAERS case reports among children ages 5–17 years

- Based on the cardiologists or healthcare provider assessment, most patients appear to have fully or probably fully recovered from their myocarditis
  - 226 patients received a follow-up assessment by a cardiologist or other healthcare provider regarding their myocarditis recovery



Children ages 5–17 years

Note: 5 (2%) providers were unsure



# CDC enhanced surveillance for myocarditis outcomes following mRNA COVID-19 vaccination in VAERS case reports among children ages 5–17 years

## Key findings

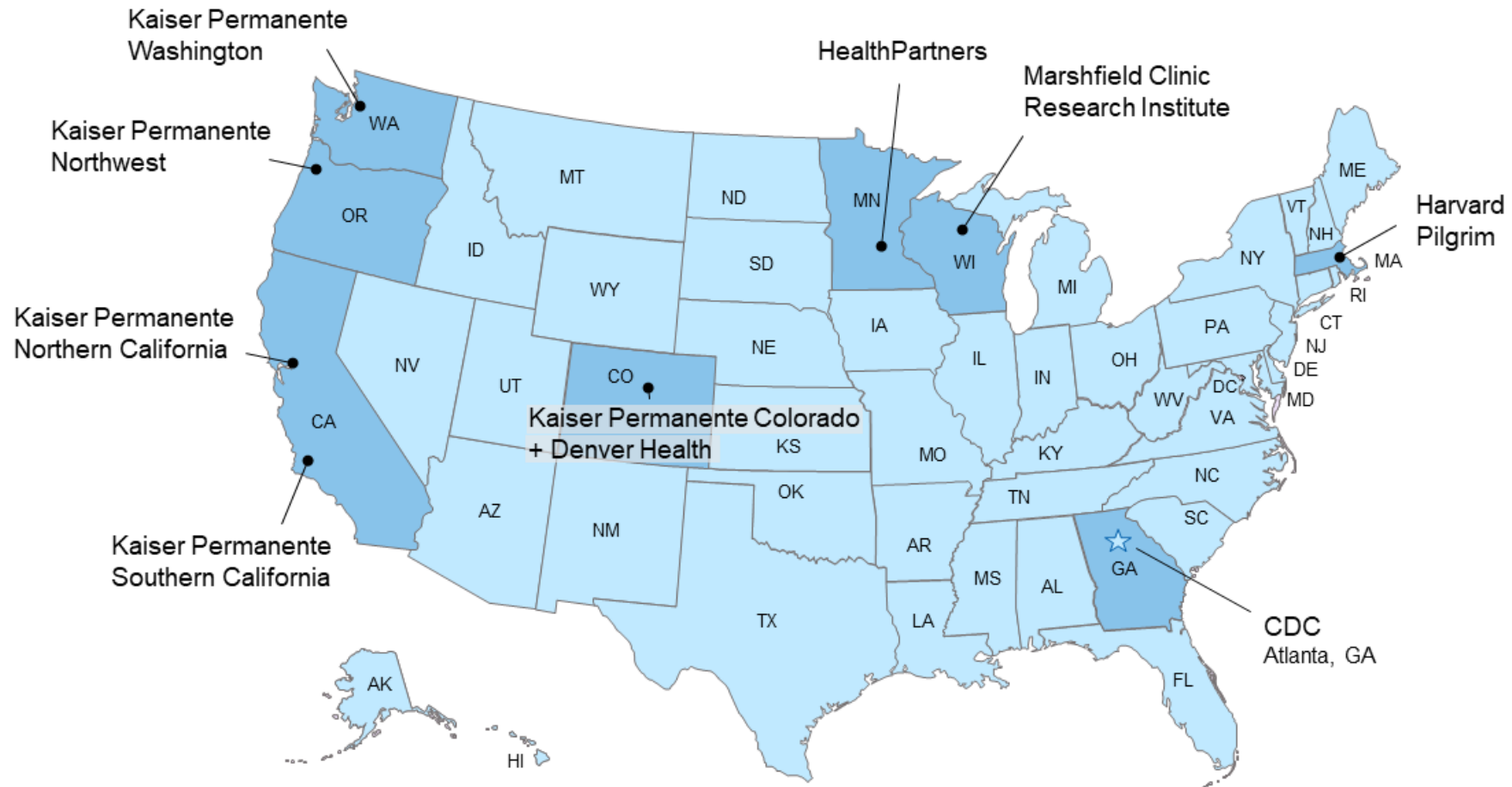
- At least 90 days after myocarditis diagnosis, most patients who were reached reported no impact on their quality of life, and most did not report missing school or work
- Most (80.1%) healthcare providers who completed surveys indicated the patient was fully recovered or probably fully recovered
  - There was substantial heterogeneity in initial and follow-up treatment and testing
  - There did not appear to be a single test that was indicative of recovery

## Next steps

- Additional follow-up with patients who were not yet recovered at time of the 90+ day survey (and their healthcare providers) to further assess recovery status at 12+ months



# Vaccine Safety Datalink (VSD)



- Established in 1990
- Collaborative project between CDC and 9 integrated healthcare organizations



# VSD Rapid Cycle Analysis (RCA)

## Aims:

- To monitor the safety of COVID-19 vaccines weekly using prespecified outcomes of interest among VSD members
- To describe the uptake of COVID-19 vaccines over time among eligible VSD members overall and in strata by age, site, and race/ethnicity





# VSD COVID-19 vaccine RCA prespecified surveillance outcomes

Prespecified outcomes	Settings
Acute disseminated encephalomyelitis	Emergency dept, Inpatient
Acute myocardial infarction – <b>First ever in EHR in ICD-10 era</b>	Emergency dept, Inpatient
Acute respiratory distress syndrome (descriptive monitoring only)	Emergency dept, Inpatient
Anaphylaxis – <b>First in 7 days in EHR in ICD-10 era</b> (descriptive monitoring only)	Emergency dept, Inpatient
Appendicitis	Emergency dept, Inpatient
Bell's palsy – <b>First ever in EHR in ICD-10 era</b>	Emergency dept, Inpatient, Outpatient
Cerebral venous sinus thrombosis	Emergency dept, Inpatient
Disseminated intravascular coagulation	Emergency dept, Inpatient
Encephalitis / myelitis / encephalomyelitis	Emergency dept, Inpatient
Guillain-Barré syndrome	Emergency dept, Inpatient
Immune thrombocytopenia	Emergency dept, Inpatient, Outpatient
Kawasaki disease (descriptive monitoring only)	Emergency dept, Inpatient
Multisystem inflammatory syndrome in children/adults (MIS-C/MIS-A) (descriptive monitoring only)	Emergency dept, Inpatient
Myocarditis / pericarditis – <b>First in 60 days in EHR in ICD-10 era</b>	Emergency dept, Inpatient
Narcolepsy / cataplexy (descriptive monitoring only)	Emergency dept, Inpatient, Outpatient
Pulmonary embolism – <b>First ever in EHR in ICD-10 era</b>	Emergency dept, Inpatient
Seizures	Emergency dept, Inpatient
Stroke, hemorrhagic	Emergency dept, Inpatient
Stroke, ischemic	Emergency dept, Inpatient
Thrombosis with thrombocytopenia syndrome – <b>First ever in EHR in ICD-10 era</b>	Emergency dept, Inpatient
Thrombotic thrombocytopenic purpura	Emergency dept, Inpatient
Transverse myelitis	Emergency dept, Inpatient
Venous thromboembolism – <b>First ever in EHR in ICD-10 era</b>	Emergency dept, Inpatient, Outpatient

EHR = Electronic health record

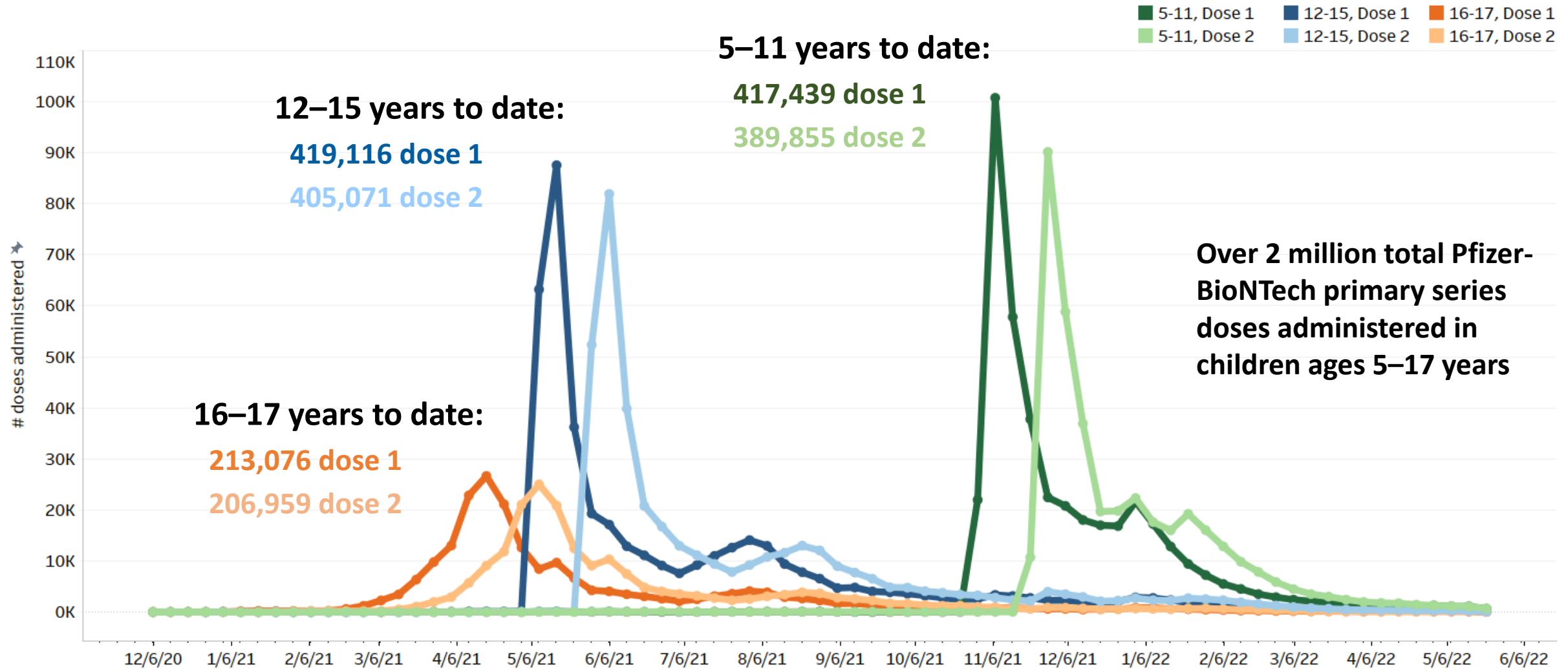


# VSD Rapid Cycle Analysis (RCA) analytic strategy

- For the primary analysis, the number of outcomes observed in the risk interval after COVID-19 vaccination were compared to the number expected
- The expected was derived from “vaccinated concurrent comparators” who were in a comparison interval after COVID-19 vaccination
- On each day that an outcome occurred, vaccinees who were in their risk interval were compared with similar vaccinees who were concurrently in their comparison interval
  - Comparisons were adjusted for age group, sex, race/ethnicity, VSD site, as well as calendar date
- For the prespecified outcome myocarditis/pericarditis, cases were verified using the CDC case definition (<https://www.cdc.gov/mmwr/volumes/70/wr/mm7027e2.htm>)

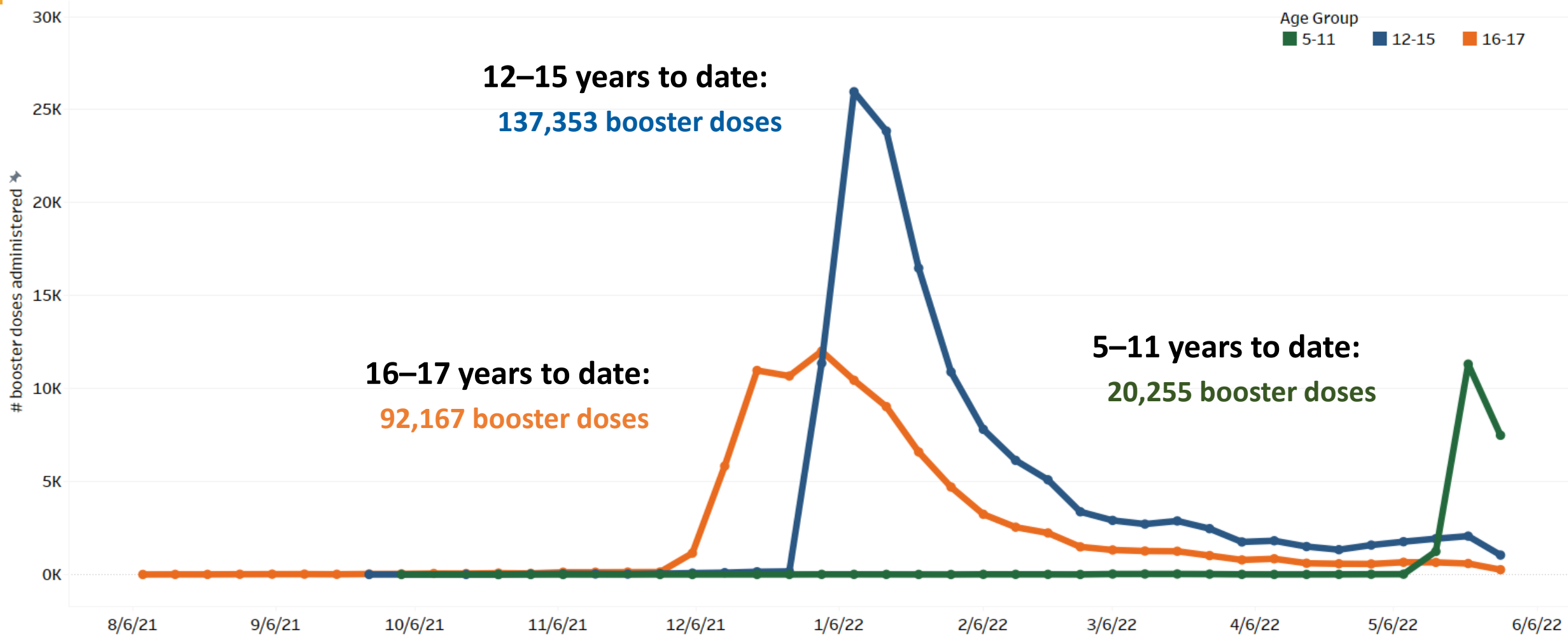


# Pfizer-BioNTech vaccine doses administered\* in VSD in pediatric age groups



\* Pfizer-BioNTech was the only authorized vaccine in these ages during the surveillance period

# Pfizer-BioNTech vaccine booster doses administered\* in VSD in pediatric age groups



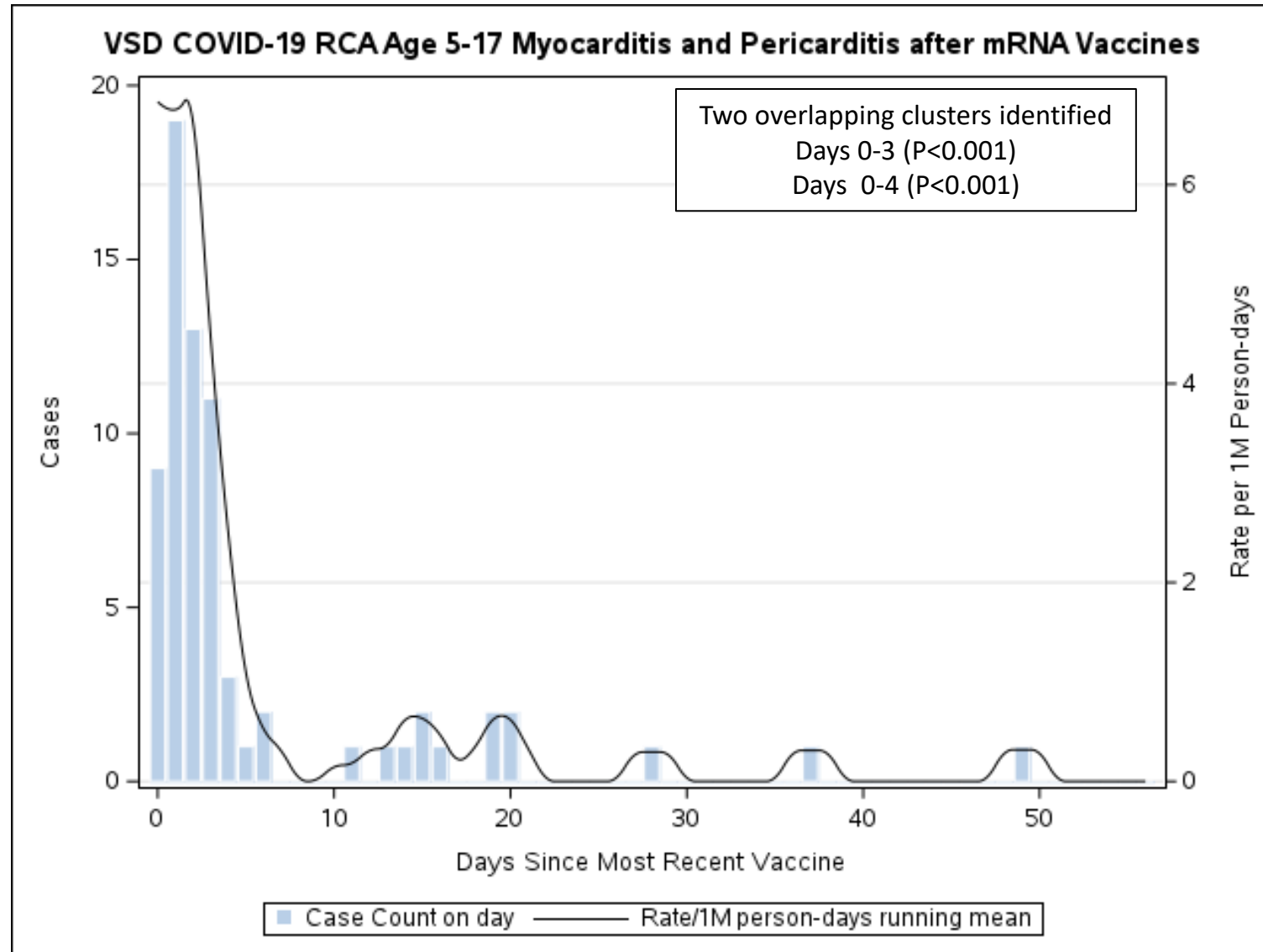
\* Pfizer-BioNTech was the only authorized vaccine in these ages during the surveillance period

# VSD RCA findings for myocarditis and pericarditis following mRNA COVID-19 vaccines

- Children ages 5–11 years (primary series only)
  - No statistical signals to date for myocarditis/pericarditis
- People ages  $\geq 12$  years, including adults
  - Statistical signals detected for myocarditis/pericarditis for Pfizer-BioNTech and for both mRNA COVID-19 vaccines combined for primary series vaccination
  - Statistical signals detected for myocarditis/pericarditis for both mRNA COVID-19 vaccines combined for 1<sup>st</sup> booster dose



# Day of symptom onset of verified myocarditis/pericarditis among children ages 5–17 years after either primary series dose of an mRNA COVID-19 vaccine



Based on data through  
May 28, 2022



# Verified myocarditis and pericarditis in the 0–7-day risk interval among MALE

**children ages 5-17 years by age group and dose** (compared with outcome events in vaccinated comparators on the same calendar days, based on data through May 28, 2022)

Age Group	Pfizer-BioNTech dose	Events in Risk Interval	Events in Comparison Interval*	Adjusted Rate Ratio <sup>†</sup>	95% Conf Interval	2-sided P-value	Excess cases in Risk Period per million doses
5–11 Years	Dose 1	0	0	NE	NE	NE	NE
	Dose 2 <sup>‡</sup>	2	0	NE	0.87 – ∞	0.061	15.2
	1 <sup>st</sup> Booster	0	0	NE	NE	NE	NE
12–17 Years <sup>¶</sup>	Dose 1	3	1	<b>14.00</b>	<b>1.20 – 421.96</b>	<b>0.035</b>	<b>8.9</b>
	Dose 2	44	1	<b>160.52</b>	<b>30.19 – 3343.73</b>	<b>&lt;0.001</b>	<b>147.0</b>
	1 <sup>st</sup> Booster	9	1	<b>14.98</b>	<b>1.39 – 484.33</b>	<b>0.023</b>	<b>85.1</b>
12–15 Years subgroup	Dose 1	2	1	<b>13.63</b>	<b>0.94 – 433.36</b>	<b>0.056</b>	<b>8.8</b>
	Dose 2	28	1	<b>104.88</b>	<b>18.45 – 2267.59</b>	<b>&lt;0.001</b>	<b>151.0</b>
	1 <sup>st</sup> Booster	1	1	3.97	0.05 – 320.79	0.560	12.7
16–17 Years subgroup	Dose 1	1	0	NE	0.13 – ∞	0.285	9.6
	Dose 2	14	0	<b>NE</b>	<b>10.20 – ∞</b>	<b>&lt;0.001</b>	<b>138.7</b>
	1 <sup>st</sup> Booster	7	0	<b>NE</b>	<b>1.16 – ∞</b>	<b>0.038</b>	<b>200.3</b>

NE=not estimable

\* Comparison interval is 22–42 days after either dose.

<sup>†</sup> Adjusted for VSD site, 5-year age group, sex, race/ethnicity, and calendar date. 1<sup>st</sup> booster analyses are also adjusted for time since primary series.

<sup>‡</sup> One case was non-informative for the risk interval analyses but was included in the excess risk calculation estimates.

<sup>¶</sup> Subgroup events may not sum to “12–17” total due to non-informative events.



# Verified myocarditis and pericarditis in the 0–7-day risk interval among FEMALE children ages 5-17 years by age group and dose (compared with outcome events in vaccinated comparators on the same calendar days, based on data through May 28, 2022)

Age Group	Pfizer-BioNTech dose	Events in Risk Interval	Events in Comparison Interval*	Adjusted Rate Ratio†	95% Conf Interval	2-sided P-value	Excess cases in Risk Period per million doses
5-11 Years	Dose 1	0	0	NE	NE	NE	NE
	Dose 2	0	0	NE	NE	NE	NE
	1 <sup>st</sup> Booster	0	0	NE	NE	NE	NE
12 – 17 Years‡	Dose 1	1	1	9.16	0.23 – 364.80	0.200	2.8
	<b>Dose 2</b>	<b>5</b>	<b>1</b>	<b>18.15</b>	<b>1.62 – 558.73</b>	<b>0.018</b>	<b>18.4</b>
	1 <sup>st</sup> Booster	2	3	0.79	0.07 – 7.49	0.835	- 5.0
12 – 15 Years subgroup	Dose 1	0	0	NE	NE	NE	0.0
	<b>Dose 2</b>	<b>4</b>	<b>0</b>	<b>NE</b>	<b>1.01 – ∞</b>	<b>0.049</b>	<b>24.8</b>
	1 <sup>st</sup> Booster	0	0	NE	NE	NE	0.0
16 – 17 Years subgroup	Dose 1	1	1	12.11	0.31 – 477.83	0.154	8.4
	Dose 2	1	1	6.10	0.16 – 239.90	0.283	7.9
	1 <sup>st</sup> Booster	2	3	1.10	0.11 – 9.58	0.924	4.0

NE=not estimable

\* Comparison interval is 22–42 days after either dose.

† Adjusted for VSD site, 5-year age group, sex, race/ethnicity, and calendar date. 1<sup>st</sup> booster analyses are also adjusted for time since primary series.

‡ Subgroup events may not sum to “12–17” total due to non-informative events.





# VSD incidence rates of verified myocarditis/pericarditis in the 0–7 days following Pfizer-BioNTech vaccination, December 14, 2020–May 28, 2022

Children ages 5-17 years	Cases	Doses	Incidence rate per million doses admin.	95% Confidence Intervals
<b>5–11 years</b>				
Males – Dose 1	0	211,644	0.0	0.0 – 14.2
<b>Males – Dose 2</b>	<b>3</b>	<b>197,465</b>	<b>15.2</b>	<b>3.1 – 44.5</b>
Females – Dose 1	0	205,795	0.0	0.0 – 14.6
Females – Dose 2	0	192,380	0.0	0.0 – 15.6
<b>12–15 years</b>				
Males – Dose 1	2	210,622	9.5	1.2 – 34.3
<b>Males – Dose 2</b>	<b>31</b>	<b>203,420</b>	<b>152.5</b>	<b>103.6 – 216.4</b>
Males – 1 <sup>st</sup> Booster	1	59,483	17.0	0.4 – 94.9
Females – Dose 1	0	208,494	0.0	0.0 – 14.4
<b>Females – Dose 2</b>	<b>5</b>	<b>201,638</b>	<b>24.8</b>	<b>8.1 – 57.9</b>
Females - 1 <sup>st</sup> Booster	0	61,876	0.0	0.0 – 48.4
<b>16–17 years</b>				
Males – Dose 1	1	104,142	9.6	0.2 – 53.5
<b>Males – Dose 2</b>	<b>14</b>	<b>100,980</b>	<b>138.7</b>	<b>75.8 – 232.8</b>
<b>Males – 1<sup>st</sup> Booster</b>	<b>8</b>	<b>40,177</b>	<b>200.3</b>	<b>86.5 – 394.7</b>
Females – Dose 1	1	108,934	9.2	0.2 – 51.2
Females – Dose 2	1	105,929	9.4	0.2 – 52.6
<b>Females - 1<sup>st</sup> Booster</b>	<b>2</b>	<b>45,794</b>	<b>44.0</b>	<b>5.3 – 159.0</b>



## Level of care and status of verified myocarditis and pericarditis case ages 5–17 years in the 0-7 days after primary series and 1<sup>st</sup> booster dose of mRNA COVID-19 vaccine, VSD

Level of care and status	Pfizer-BioNTech primary series (n=58)	Pfizer-BioNTech 1 <sup>st</sup> booster (n=12)
Highest level of care		
Emergency department	4 (7%)	0 (0%)
Admitted to hospital	34 (59%)	6 (50%)
Admitted to ICU	20 (34%)	6 (50%)
Length of hospital stay, median (range)	2 days (0–7 days)	1 day (1–4 days)
0 – 1 days	20 (34%)	8 (67%)
2 – 3 days	28 (48%)	3 (25%)
4+ days	10 (17%)	1 (8%)
Discharged to home	58 (100%)	12 (100%)

Based on data through June 4, 2022



# Comparative risk for myocarditis between the two available mRNA COVID-19 vaccines, Moderna and Pfizer-BioNTech



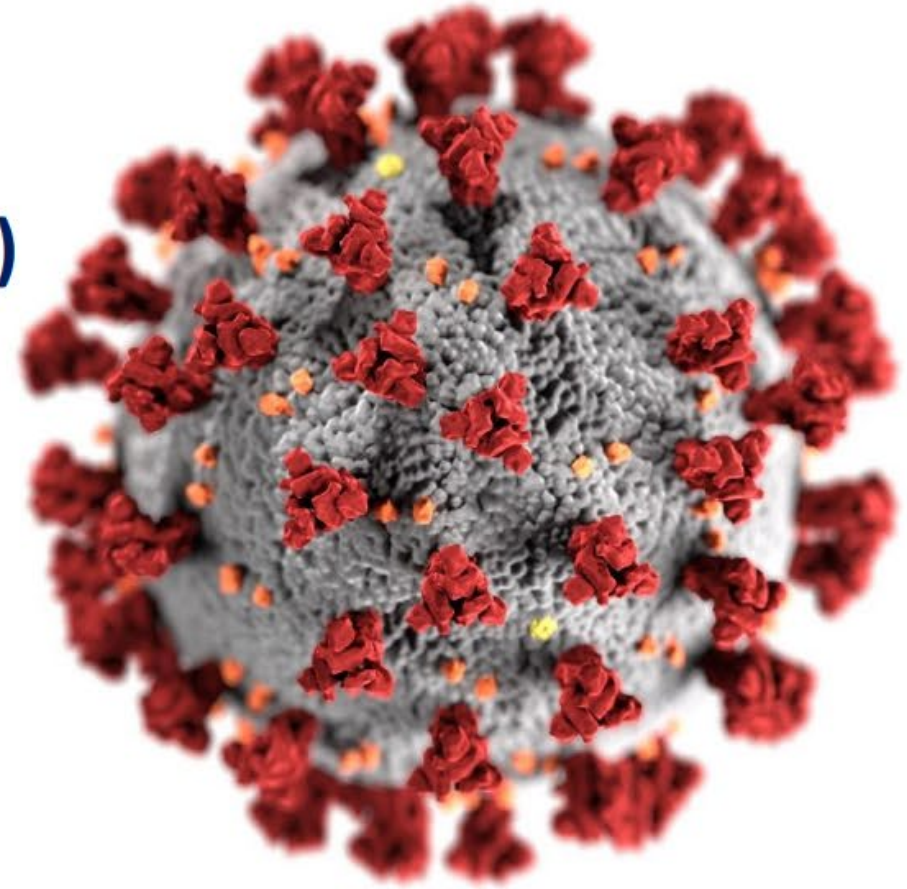
# Myopericarditis following COVID-19 vaccination: Updates from the Vaccine Adverse Event Reporting System (VAERS)

Oct 21, 2021

John R. Su, MD, PhD, MPH

Vaccine Safety Team

CDC COVID-19 Vaccine Task Force



[cdc.gov/coronavirus](https://www.cdc.gov/coronavirus)



## Reporting rates (per 1 million doses administered) of myocarditis among males after mRNA COVID-19 vaccines, 7-day risk period (N=797)\*

- **169,740,953** doses of mRNA vaccine administered to males (dose 1 and dose 2)
- Reporting rates exceed background incidence
  - After dose 1 of Pfizer (12–24 years) and Moderna (18–39 years)
  - After dose 2 of Pfizer (12–39 years) and Moderna (18–49 years)

	Pfizer		Moderna	
	(Males)		(Males)	
Ages	Dose 1	Dose 2	Dose 1	Dose 2
<b>12-15</b>	<b>4.2</b>	<b>39.9</b>	0.0	not calculated
<b>16-17</b>	<b>5.7</b>	<b>69.1</b>	0.0	not calculated
<b>18-24</b>	<b>2.3</b>	<b>36.8</b>	<b>6.1</b>	<b>38.5</b>
<b>25-29</b>	1.3	<b>10.8</b>	<b>3.4</b>	<b>17.2</b>
<b>30-39</b>	0.5	<b>5.2</b>	<b>2.3</b>	<b>6.7</b>
<b>40-49</b>	0.3	2.0	0.2	<b>2.9</b>
<b>50-64</b>	0.2	0.3	0.5	0.6
<b>65+</b>	0.2	0.1	0.1	0.3



## Reporting rates (per 1 million doses administered) of myocarditis among females after mRNA COVID-19 vaccines, 7-day risk period (N=138)\*

- 193,215,313 doses of mRNA vaccine administered to females (dose 1 and dose 2)
- Reporting rates exceed background incidence
  - After dose 2 of Pfizer (12–24 years) and dose 2 Moderna (18–29 years)

Ages	Pfizer (Females)		Moderna (Females)	
	Dose 1	Dose 2	Dose 1	Dose 2
12-15	0.4	3.9	0.0	0.0
16-17	0.0	7.9	0.0	0.0
18-24	0.2	2.5	0.6	5.3
25-29	0.2	1.2	0.4	5.7
30-39	0.6	0.7	0.5	0.4
40-49	0.1	1.1	0.2	1.4
50-64	0.3	0.5	0.5	0.4
65+	0.1	0.3	0.0	0.3



# Myocarditis Analyses in the Vaccine Safety Datalink: Rapid Cycle Analyses and “Head-to-Head” Product Comparisons

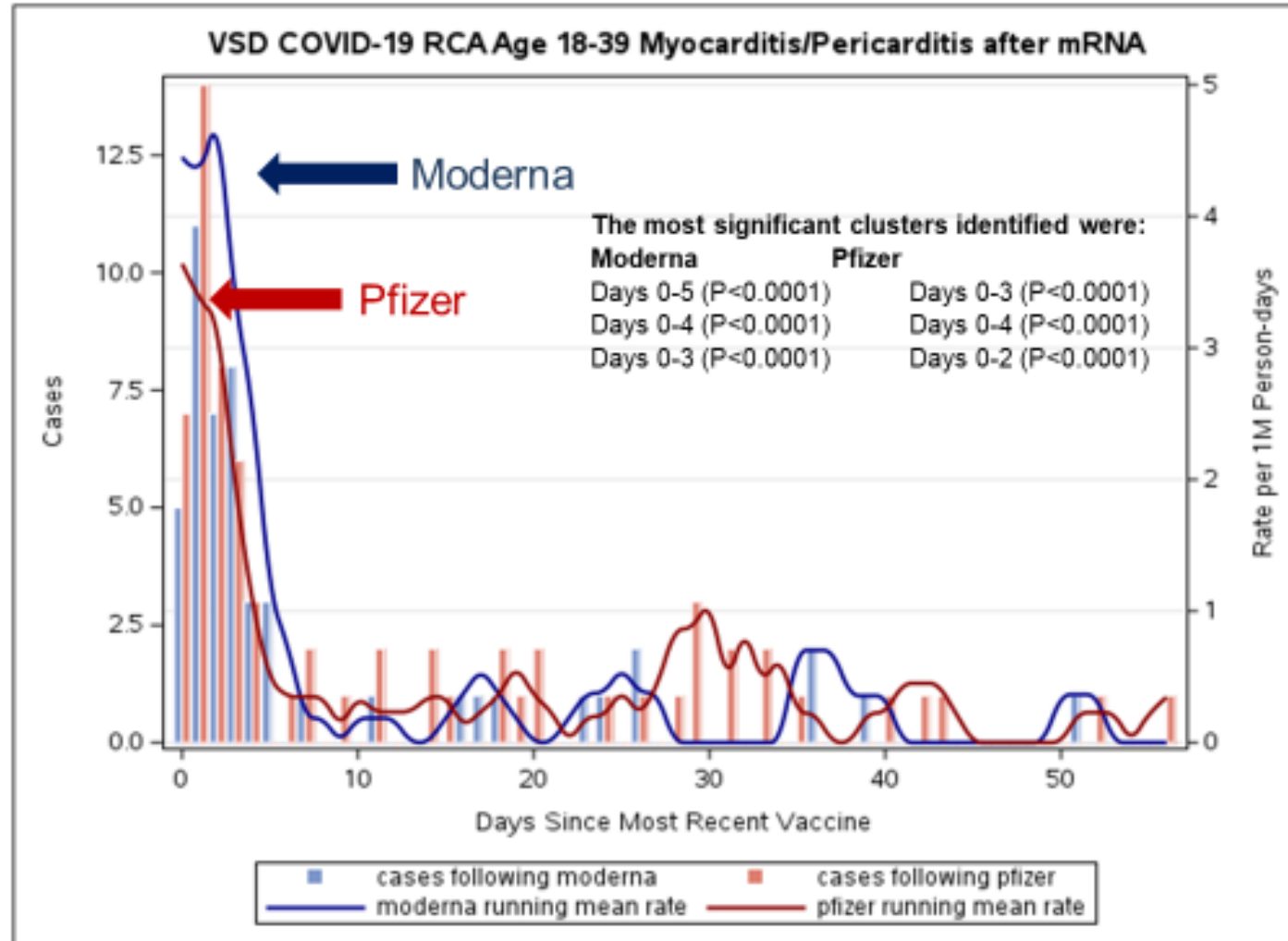
**Nicola Klein, MD, PhD**  
**Kaiser Permanente Vaccine Study Center**  
**Kaiser Permanente Northern California**

 KAISER PERMANENTE  
VACCINE STUDY CENTER



Marshfield Clinic<sup>®</sup>  
Research Institute

# Symptom Onset of Verified Myocarditis and Pericarditis among 18–39-Year-Olds by Vaccine Product





## Myocarditis and Pericarditis in 18–39-Year-Olds in the 0-7 Day Risk Interval: Moderna vs Pfizer

	Sex	Moderna (N)	Pfizer (N)	Adjusted Rate Ratio <sup>1</sup>	95% Confidence Interval	2-Sided P-value	Excess Cases in Risk Period per 1M Doses of Moderna vs Pfizer <sup>2</sup>
Either Dose	All	38	41	<b>1.61</b>	<b>1.02 – 2.54</b>	<b>0.041</b>	<b>8.0</b>
	Male	32	36	1.52	0.93 – 2.48	0.097	13.4
	Female	6	5	2.34	0.65 – 8.71	0.188	3.5
Dose 1	All	9	7	2.27	0.80 – 6.65	0.122	5.5
	Male	6	6	1.65	0.49 – 5.57	0.414	5.6
	Female	3	1	6.79	0.65 – 197.90	0.116	5.1
Dose 2	All	29	34	1.48	0.88 – 2.50	0.141	10.7
	Male	26	30	1.50	0.86 – 2.61	0.152	21.9
	Female	3	4	1.35	0.23 – 7.15	0.714	1.6

<sup>1</sup>Adjusted for VSD site, age, sex, race/ethnicity, and calendar date. Adjusted rate ratio is an estimate of the Moderna rate divided by Pfizer rate.

<sup>2</sup>Excess cases is an estimate of the Moderna rate minus the Pfizer rate. Excess cases per million doses were estimated by dividing the Moderna incidence rate by the rate ratio estimate and subtracting the result from the Moderna rate.

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# VSD incidence rates of verified myocarditis/pericarditis 0–7 days following COVID-19 mRNA vaccination – December 14, 2020–March 31, 2022

(Adults ages 18-39 years)	Pfizer-BioNTech*	Moderna†
	Incidence rate per million doses admin	Incidence rate per million doses admin
<b>18–29 years</b>		
<b>Males – Dose 1</b>	<b>11.5</b>	<b>24.1</b>
<b>Males – Dose 2</b>	<b>81.7</b>	<b>97.3</b>
<b>Males – 1<sup>st</sup> Booster</b>	<b>47.6</b>	<b>70.3</b>
<b>Females – Dose 1</b>	<b>2.4</b>	<b>3.9</b>
<b>Females – Dose 2</b>	<b>5.0</b>	<b>0.0</b>
<b>Females - 1<sup>st</sup> Booster</b>	<b>4.7</b>	<b>13.9</b>
<b>30–39 years</b>		
<b>Males – Dose 1</b>	<b>2.8</b>	<b>4.5</b>
<b>Males – Dose 2</b>	<b>14.7</b>	<b>37.0</b>
<b>Males – 1<sup>st</sup> Booster</b>	<b>16.5</b>	<b>7.1</b>
<b>Females – Dose 1</b>	<b>0.0</b>	<b>3.8</b>
<b>Females – Dose 2</b>	<b>7.3</b>	<b>3.9</b>
<b>Females - 1<sup>st</sup> Booster</b>	<b>4.0</b>	<b>11.1</b>

\* Pfizer dose totals, all ages/sexes: dose 1: 2,583,600, dose 2: 2,464,035, 1<sup>st</sup> booster: 997,217;

† Moderna dose totals, all ages/sexes: dose 1: 950,608, dose 2: 914,745, 1<sup>st</sup> booster: 563,824



# Summary: Myocarditis and pericarditis following mRNA COVID-19 vaccination

- Current evidence supports a causal association between mRNA COVID-19 vaccines and myocarditis and pericarditis with cases clustering within the first week of vaccination
- Myocarditis is a rare event following mRNA COVID-19 vaccination
  - CDC has verified 635 myocarditis case reports in children ages 5–17 years after 54.8 million Pfizer-BioNTech doses administered in this age group in the United States
- Risk appears greatest in adolescents in the age groups 16–17 and 12–15 years and is generally higher after dose 2 compared to dose 1 of the primary series and in males compared to females
  - In VSD analysis, in a minority of age and sex strata, incidence is highest following booster dose
- The reporting rate in VAERS of myocarditis following Pfizer-BioNTech in male children ages 5–11 years after dose 2 of the primary series is slightly elevated when compared to background incidence; otherwise, reporting rates are within background incidence
- To date, myocarditis and pericarditis has not statistically signaled in VSD RCA surveillance in children ages 5–11 years



# Summary: Myocarditis and pericarditis following mRNA COVID-19 vaccination (cont.)

- Available information suggests that most persons with myocarditis after mRNA COVID-19 vaccination recover from their myocarditis by 90+ days after diagnosis
- In age groups where product comparisons can be made (e.g., 18–39 years), some evidence suggests that myocarditis and pericarditis risk may be higher after Moderna than after Pfizer-BioNTech; however, findings are not consistent in all U.S. monitoring systems



# Acknowledgments

- VAERS Team
- V-safe Team
- Clinical Immunization Safety Assessment (CISA) Project
- Vaccine Safety Datalink (VSD) Team
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- CDC Infectious Diseases Pathology Branch
- COVID-19 Vaccine Task Force Data Monitoring and Reporting Group
- FDA/Center for Biologics Evaluation and Research
- Kaiser Permanente Northern California (VSD)
- Marshfield Clinic Research Institute (VSD)
- VSD sites
  - HealthPartners Institute, Minneapolis, MN
  - Kaiser Permanente Colorado, Denver, CO
  - Kaiser Permanente Northwest, Portland, OR
  - Kaiser Permanente Southern California, Los Angeles, CA
  - Kaiser Permanente Washington, Seattle, WA
  - Denver Health, Denver, CO



# Promoting v-safe in practice– we need help!

## How:

- Direct patients to <https://vsafe.cdc.gov/en/>
  - Ideally this should occur before vaccination
- Provide **v-safe** information sheet to patients
- Display posters about **v-safe**

<https://www.cdc.gov/coronavirus/2019ncov/vaccines/safety/vsafe/printresources.html>



**Get vaccinated.  
Get your smartphone.  
Get started with v-safe.**

**What is v-safe?**  
v-safe provides personalized and confidential health check-ins via text messages and web surveys so you can quickly and easily share with CDC how you or your dependent feel after getting a COVID-19 vaccine. It takes just a few minutes to enroll and your participation in v-safe helps us monitor the safety of COVID-19 vaccines for everyone.

**v-safe features:**

- Enroll your dependents and complete check-ins on their behalf
- Enter and report how you feel after first, second, additional, and booster doses

**How can I enroll and how does it work?**  
You can enroll in v-safe after any dose of COVID-19 vaccine by using your smartphone and going to [vsafe.cdc.gov](https://vsafe.cdc.gov).

During the first week after each vaccination, v-safe will send you a text message each day to ask how you are feeling. After that, you will receive occasional check-ins, which you can opt out of at any time. Depending on your answers, someone from CDC may call to get more information. Your personal information in v-safe is protected so it's safe and private\*.

**How can I enroll my child or dependent?**  
You can enroll any family member (or friend) who is eligible to be vaccinated in v-safe. Children under 16 years old must be enrolled using a parent or guardian's v-safe account. You can add a dependent to your existing account or create a new account if you don't have one yet. Creating an account to enroll a dependent does not require that you enter your own vaccination information or complete health check-ins for yourself.

Need step-by-step instructions? Go to: [www.cdc.gov/vsafe](https://www.cdc.gov/vsafe)

**v-safe** uses existing information systems managed by CDC, FDA, and other federal agencies. These systems use strict security measures to keep information confidential. These measures comply, where applicable, with the following federal laws, including the Privacy Act of 1974; standards enacted that are consistent with the Health Insurance Portability and Accountability Act of 1996 (HIPAA); the Federal Information Security Management Act, and the Freedom of Information Act.



Sign up with your smartphone's browser at [vsafe.cdc.gov](https://vsafe.cdc.gov)

OR

Aim your smartphone's camera at this code



Need help with v-safe?  
Call 800-CDC-INFO (800-232-4636)  
TTY 888-232-6348  
Open 24 hours, 7 days a week  
Visit [www.cdc.gov/vsafe](https://www.cdc.gov/vsafe)

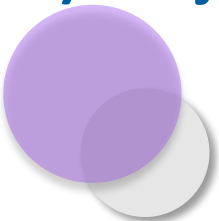


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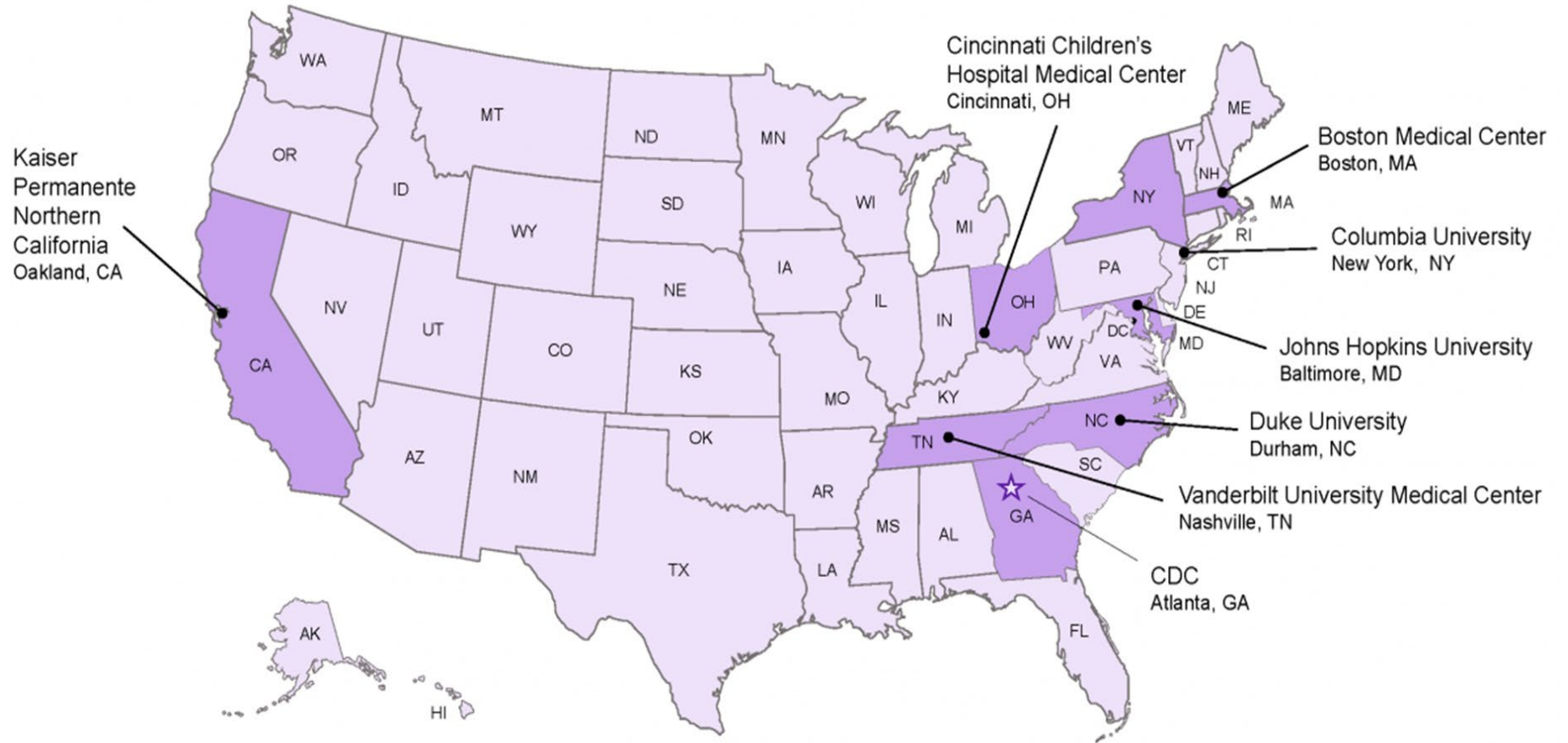


# CISA

## Clinical Immunization Safety Assessment (CISA) Project



7 participating medical research centers with vaccine safety experts



- clinical consult services<sup>†</sup>
- clinical research

<sup>†</sup>More information about clinical consults available at <http://www.cdc.gov/vaccinesafety/Activities/CISA.html>

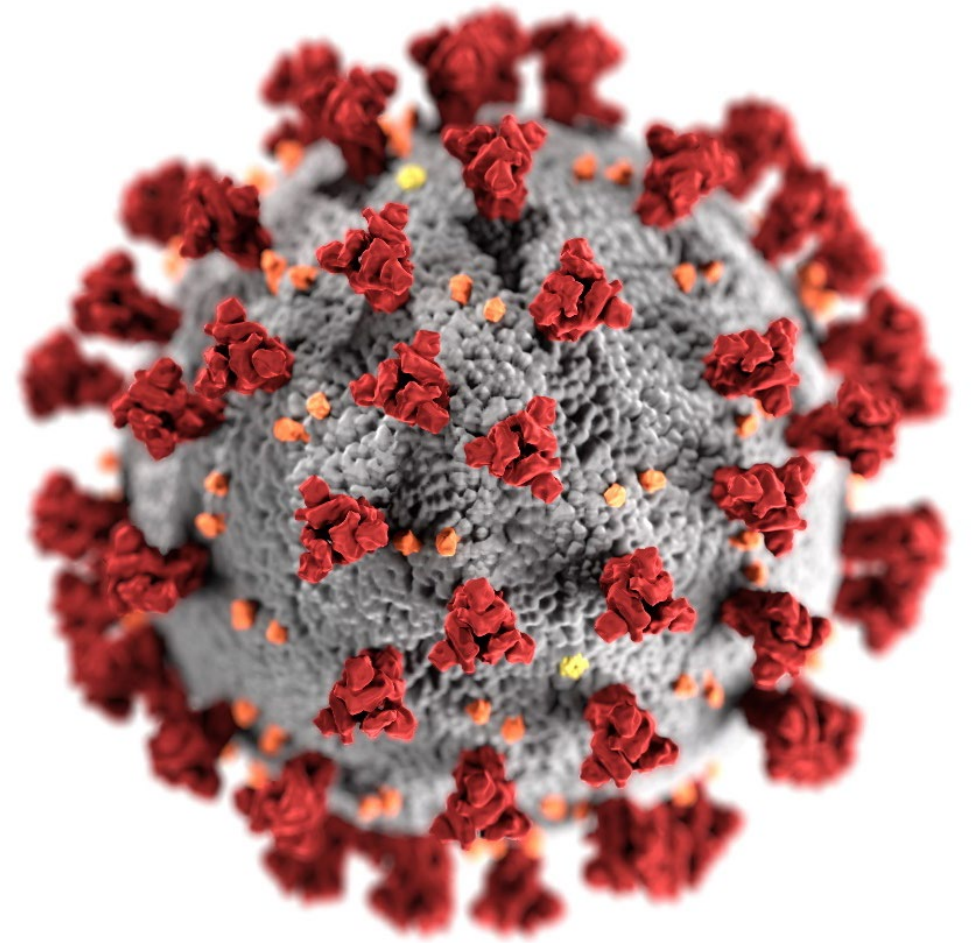
# Disclaimer

- The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention (CDC) or the U.S. Food and Drug Administration (FDA)
- Mention of a product or company name is for identification purposes only and does not constitute endorsement by CDC or FDA





# Thank you!



For more information, contact CDC  
1-800-CDC-INFO (232-4636)  
TTY: 1-888-232-6348 [www.cdc.gov](http://www.cdc.gov)

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.



# Extra slides



# Verified reports to VAERS of myocarditis after Pfizer-BioNTech vaccination among children ages 5–17 years\* (as of May 26, 2022, ~54.8 million doses administered)

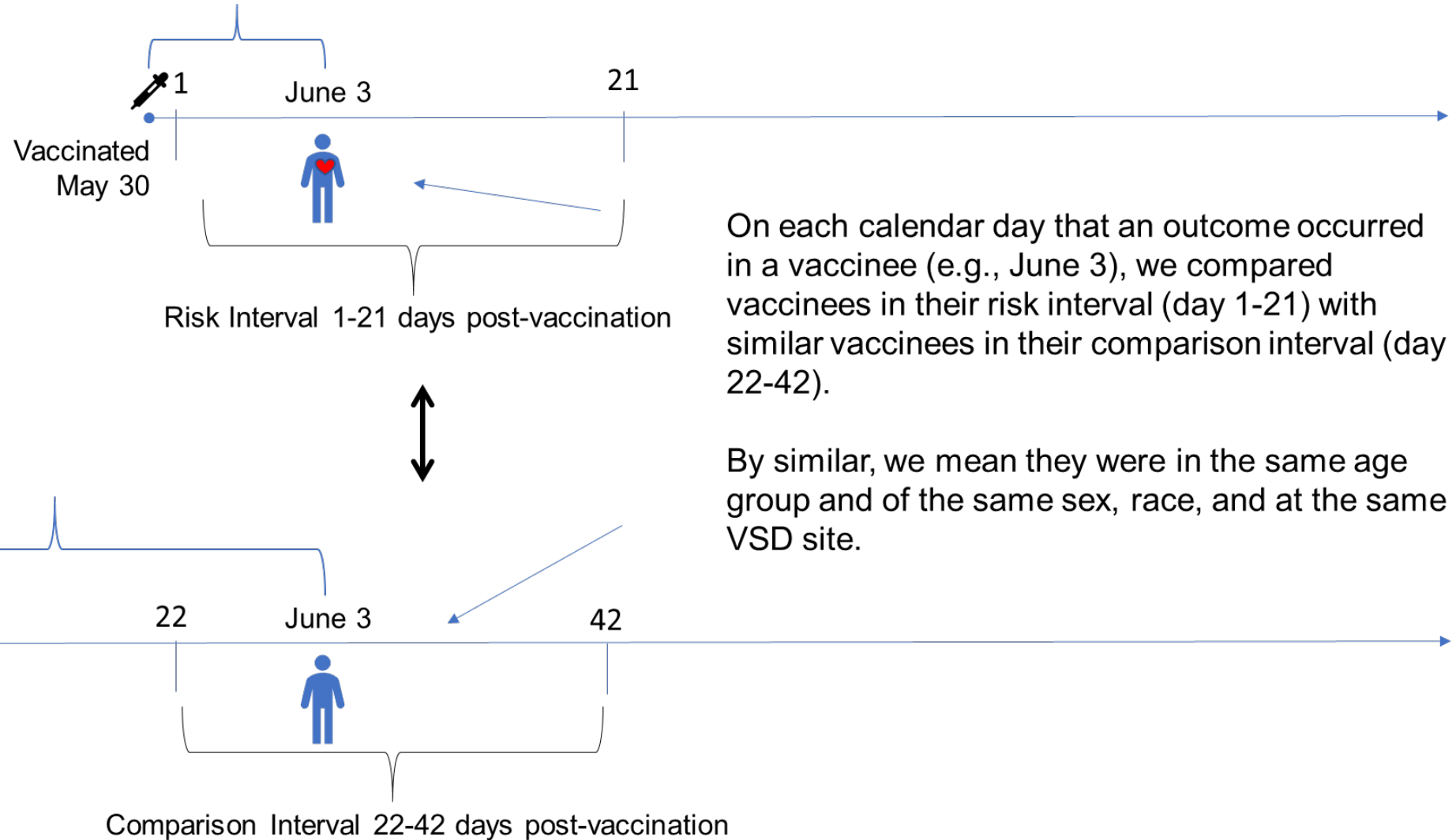
- 635 reports verified using CDC case definition
  - Median age: 15 years (IQR: ages 14–16 years)
  - Median time to symptom onset after vaccination: 2 days (IQR: 2–3 days)
    - 63 reports with symptom onset >7 days after vaccination (maximum known = 93 and 112 days)
  - After dose 2 (n=510), after dose 1 (n=84), after booster dose (n=40)
  - Male cases (n=571), female cases (n=63)
  - 592/631 hospitalized<sup>†</sup>; 36 treated only as outpatients
    - 587/592 (>99%) known to be discharged home
    - 529/587 with known recovery status; 461/529 (87%) recovered from symptoms at time of last follow-up
- 6 deaths
  - Ages 7, 13, 13, 15, 16, 17 years; time to death after vaccination 1, 3, 6, 13, 16, 36 days
  - 4 after dose 2, and 2 after dose 1
  - Myocarditis attributable to cause besides vaccination (n=2); other cause of death besides myocarditis (n=2); unable to fully evaluate (n=2)

\* As of May 26, 2022, primary series vaccination among children ages 16–17 years since Dec 14, 2020; children ages 12–15 years since May 10, 2021; children ages 5–11 years since Nov 3, 2021; 1<sup>st</sup> dose booster vaccination among children ages 16–17 years since Dec 9, 2021; children ages 12–15 years since Jan 5, 2022.

<sup>†</sup> 631 of 635 reports with known hospitalization status



# VSD RCA myocarditis case example



On each calendar day that an outcome occurred in a vaccinee (e.g., June 3), we compared vaccinees in their risk interval (day 1-21) with similar vaccinees in their comparison interval (day 22-42).

By similar, we mean they were in the same age group and of the same sex, race, and at the same VSD site.

# Myocarditis and pericarditis electronic case identification using ICD-10 codes used in VSD monitoring\*

- ICD-10 codes include:
  - B33.22 Viral myocarditis
  - B33.23 Viral pericarditis
  - I30.† Acute pericarditis
  - I40.† Acute myocarditis
  - I51.4 Myocarditis, unspecified
  - I31.9 Disease of the pericardium, unspecified

\* Case definition excludes individuals with COVID-19 infection <30 days before myocarditis/pericarditis diagnosis

† Includes all subcodes



# VSD incidence rates of verified myocarditis/pericarditis 0–7 days following mRNA COVID-19 vaccination – December 14, 2020–March 31, 2022

(Children ages 5-17 years provided for reference)	Pfizer-BioNTech <sup>1</sup>
	Incidence rate per million doses admin
<b>5–11 years</b>	
<b>Males – Dose 1</b>	<b>0.0</b>
<b>Males – Dose 2</b>	<b>15.7</b>
<b>Females – Dose 1</b>	<b>0.0</b>
<b>Females – Dose 2</b>	<b>0.0</b>
<b>12–15 years</b>	
<b>Males – Dose 1</b>	<b>9.5</b>
<b>Males – Dose 2</b>	<b>153.4</b>
<b>Males – 1<sup>st</sup> Booster</b>	<b>16.7</b>
<b>Females – Dose 1</b>	<b>0.0</b>
<b>Females – Dose 2</b>	<b>25.0</b>
<b>Females - 1<sup>st</sup> Booster</b>	<b>0.0</b>
<b>16–17 years</b>	
<b>Males – Dose 1</b>	<b>9.6</b>
<b>Males – Dose 2</b>	<b>139.3</b>
<b>Males – 1<sup>st</sup> Booster</b>	<b>198.1</b>
<b>Females – Dose 1</b>	<b>9.2</b>
<b>Females – Dose 2</b>	<b>9.5</b>
<b>Females - 1<sup>st</sup> Booster</b>	<b>43.4</b>

(Adults ages 18-39 years)	Pfizer-BioNTech <sup>1</sup>	Moderna <sup>2</sup>
	Incidence rate per million doses admin	Incidence rate per million doses admin
<b>18–29 years</b>		
<b>Males – Dose 1</b>	<b>14.4</b>	<b>24.1</b>
<b>Males – Dose 2</b>	<b>81.4</b>	<b>97.3</b>
<b>Males – 1<sup>st</sup> Booster</b>	<b>47.6</b>	<b>70.3</b>
<b>Females – Dose 1</b>	<b>2.4</b>	<b>7.9</b>
<b>Females – Dose 2</b>	<b>5.0</b>	<b>4.1</b>
<b>Females - 1<sup>st</sup> Booster</b>	<b>4.7</b>	<b>7.0</b>
<b>30–39 years</b>		
<b>Males – Dose 1</b>	<b>2.8</b>	<b>4.5</b>
<b>Males – Dose 2</b>	<b>14.7</b>	<b>37.0</b>
<b>Males – 1<sup>st</sup> Booster</b>	<b>16.5</b>	<b>7.1</b>
<b>Females – Dose 1</b>	<b>0.0</b>	<b>3.8</b>
<b>Females – Dose 2</b>	<b>7.3</b>	<b>3.9</b>
<b>Females - 1<sup>st</sup> Booster</b>	<b>4.0</b>	<b>11.1</b>



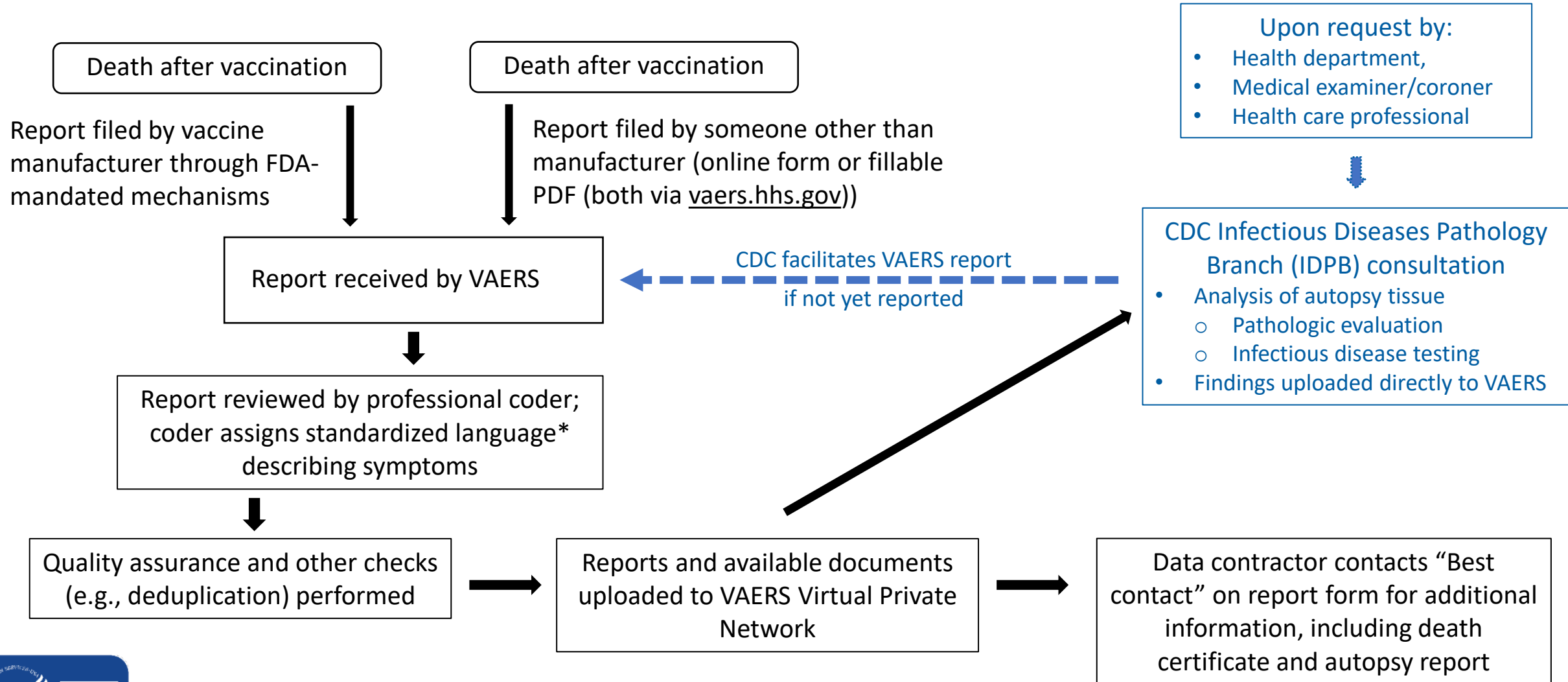
<sup>1</sup> Pfizer dose totals, all ages/sexes: dose 1: 2,583,600, dose 2: 2,464,035, 1<sup>st</sup> booster: 997,217; <sup>2</sup> Moderna dose totals, all ages/sexes: dose 1: 950,608, dose 2: 914,745, 1<sup>st</sup> booster: 563,824

# Characteristics of verified myocarditis and pericarditis cases ages 5-17 years in the 0-7 days after primary series and 1<sup>st</sup> booster dose of mRNA COVID-19 vaccine, VSD

	Pfizer-BioNTech primary series (n=58)	Pfizer-BioNTech 1 <sup>st</sup> booster (n=12)
<b>Descriptive Characteristics</b>	No. (%)	No. (%)
5-11 years of age	3 (5%)	0 (0%)
12-15 years of age	38 (66%)	2 (17%)
16-17 years of age	17 (29%)	10 (83%)
Male sex	51 (88%)	10 (83%)
History of COVID-19 infection	4 (7%)	0 (0%)
Symptom onset post-vaccination, median (range)	2 days (0-6 days)	2 days (0-3 days)
Adjudication diagnosis		
Acute myocarditis	33 (57%)	2 (17%)
Myopericarditis	24 (41%)	10 (83%)
Acute pericarditis	1 (2%)	0 (0%)



# Follow-up procedures on death reports and CDC assistance to partners



\* From the Medical Dictionary for Regulatory Activities (MedDRA) ([www.meddra.org](http://www.meddra.org))



# Role of CDC's Infectious Diseases Pathology Branch in assisting with investigations of death following vaccination

- As part of routine mission, provides pathologic evaluation and infectious disease testing of autopsy tissue specimens
  - Assistance provided at the request of health departments, medical examiners/coroners, other healthcare professionals
- Consulted in the development of National Association of Medical Examiners (NAME) protocol for autopsies in deaths occurring after COVID-19 vaccination

<https://www.cdc.gov/ncezid/dhcpp/idpb/index.html>

<https://www.thename.org/covid-19-resources>

<https://www.thename.org/assets/docs/NAME%20Autopsy%20Protocol%20for%20Deaths%20after%20COVID-19%20vaccination.pdf>

