

## **Supplementary Appendix**

This appendix has been provided by the authors to give readers additional information about their work.

Supplement to: Gabriela Paz-Bailey, Maya Sternberg, Kiersten Kugeler, et al. Covid-19 Rates by Time since Vaccination during Delta Variant Predominance. NEJM Evidence. DOI: 10.1056/EVIDoa2100057.

## Supplement

### COVID-19 rates by time since vaccination during Delta variant predominance

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**Supplemental Table 1. Unadjusted life table estimates of the monthly hazard rate of COVID-19 cases and deaths per 100,000 vaccinated persons per month by time since vaccination during June - August, 15 jurisdictions, January 3<sup>rd</sup>-September 4, 2021, United States\***

Cohort	Hazard rate of SARS-CoV-2 cases per 100,000 vaccinated persons per month			Hazard rate of SARS-CoV-2 deaths per 100,000 vaccinated persons per month		
	JUN	JUL	AUG	JUN	JUL	AUG
<b>JAN-FEB</b>	42.9 (41.5, 44.3)	268.9 (265.0, 272.0)	1633 (1608.0, 1632.0)	1.4 (1.2,1.7)	7.8 (7.2, 8.4)	37.9 (36.0, 39.9)
<b>MAR-APR</b>	31.0 (30.3, 31.7)	190.4 (188.5, 192.0)	1196.0 (1183.0, 1195.0)	0.6 (0.5, 0.7)	3.0 (2.8, 3.2)	15.5 (14.8, 16.2)
<b>MAY-JUN</b>	15.0 (14.4, 15.7)	113.9 (112.0, 115.6)	810.6 (800.6, 814.1)	0.2 (0.1, 0.3)	0.9 (0.7, 1.0)	5.8 (5.2, 6.4)

\*Unadjusted hazard rate is estimated using life table analysis calculated at one-month intervals from June to August for each vaccination cohort.

Note: 95% Confidence intervals in parentheses. The widths of the intervals have not been adjusted for multiplicity and any the inferences drawn may not be reproducible. The hazard rate is the first derivative of the cumulative hazard function at time t, which is the slope of the cumulative hazard at time t. Potential evidence for waning may be detected by comparing the changing slope of the hazard functions for each cohort, which corresponds to assessing the acceleration of the cumulative hazard function. For example, from June to July and July to August the cumulative hazard function for a cohort vaccinated in January-February increases more rapidly (accelerates) relative to a cohort vaccinated later in the year at the same time, this pattern may be suggestive of waning.

**Supplemental Table 2. Adjusted rate ratios for COVID-19 case rates by time since vaccination, 15 jurisdictions, August 1-September 4, 2021, United States**

Category	January-June cohort vs. July cohort	2-month cohorts vs. July cohort		
	Rate ratio for COVID-19 case rate comparing January-June to July cohorts*	Rate ratio for COVID-19 case rate comparing January-February to July cohort	Rate ratio for COVID-19 case rate comparing March-April to July cohort	Rate ratio for COVID-19 case rate comparing May-June to July cohort
<b>Overall cases (15 jurisdictions)</b>	2.04 (1.99 - 2.09)	3.44 (3.36 - 3.53)	2.29 (2.23 - 2.34)	1.44 (1.41 - 1.48)
<b>Age</b>				
12-17	1.73 (1.62 - 1.85)	4.08 (3.07 - 5.42)	2.9 (2.68 - 3.14)	1.55 (1.45 - 1.65)
18-49	2.21 (2.14 - 2.28)	3.94 (3.81 - 4.07)	2.44 (2.36 - 2.52)	1.49 (1.45 - 1.54)
50-64	1.9 (1.8 - 2.0)	3.08 (2.91 - 3.26)	1.93 (1.83 - 2.04)	1.3 (1.23 - 1.37)
65-79	1.8 (1.65 - 1.98)	2.23 (2.03 - 2.45)	1.71 (1.56 - 1.87)	1.22 (1.11 - 1.35)
80+	1.51 (1.28 - 1.78)	1.92 (1.63 - 2.27)	1.24 (1.05 - 1.46)	1.08 (0.91 - 1.29)
<b>Vaccine product</b>				
Pfizer-BioNTech	2.26 (2.19 - 2.33)	3.82 (3.7 - 3.95)	2.52 (2.45 - 2.61)	1.64 (1.59 - 1.69)
Moderna	2.43 (2.29 - 2.58)	3.85 (3.62 - 4.09)	2.62 (2.47 - 2.78)	1.58 (1.49 - 1.68)
Janssen-Johnson & Johnson (J&J)*	1.26 (1.2 - 1.32)	NA	1.49 (1.42 - 1.56)	0.86 (0.81 - 0.9)
<b>Vaccine product and age</b>				
<b>Pfizer-BioNTech</b>				
12-17	1.73 (1.63 - 1.85)	4.09 (3.08 - 5.43)	2.9 (2.68 - 3.14)	1.55 (1.45 - 1.66)
18-49	2.42 (2.32 - 2.53)	4.15 (3.97 - 4.34)	2.58 (2.47 - 2.69)	1.68 (1.61 - 1.76)
50-64	2.44 (2.26 - 2.65)	3.96 (3.65 - 4.3)	2.42 (2.23 - 2.62)	1.67 (1.54 - 1.82)
65-79	2.48 (2.15 - 2.85)	3.0 (2.6 - 3.45)	2.3 (2.0 - 2.65)	1.52 (1.31 - 1.76)
80+	1.99 (1.55 - 2.55)	2.41 (1.88 - 3.09)	1.58 (1.23 - 2.03)	1.32 (1.01 - 1.73)
<b>Moderna</b>				
18-49	2.62 (2.44 - 2.83)	4.59 (4.25 - 4.96)	2.93 (2.71 - 3.16)	1.69 (1.56 - 1.82)
50-64	2.26 (2 - 2.55)	3.66 (3.24 - 4.15)	2.29 (2.02 - 2.58)	1.49 (1.32 - 1.69)

65-79	1.98 (1.64 - 2.39)	2.38 (1.97 - 2.87)	1.87 (1.55 - 2.26)	1.36 (1.12 - 1.65)
80+	1.38 (1.02 - 1.88)	1.75 (1.28 - 2.38)	1.18 (0.87 - 1.61)	1.02 (0.74 - 1.42)
<b>Janssen-J&amp;J*</b>				
18-49	1.45 (1.37 - 1.54)	NA	1.82 (1.71 - 1.94)	0.9 (0.84 - 0.97)
50-64	1.0 (0.91 - 1.1)	NA	1.11 (1.01 - 1.21)	0.73 (0.66 - 0.81)
65-79	0.83 (0.71 - 0.97)	NA	0.86 (0.73 - 1.01)	0.75 (0.63 - 0.89)
80+	0.75 (0.54 - 1.04)	NA	0.74 (0.53 - 1.03)	0.76 (0.53 - 1.08)
<b>Region</b>				
South	1.95 (1.89 - 2.01)	3.24 (3.14 - 3.35)	2.18 (2.12 - 2.25)	1.42 (1.37 - 1.46)
West	2.02 (1.88 - 2.16)	3.5 (3.25 - 3.76)	2.14 (1.99 - 2.3)	1.43 (1.33 - 1.54)
Northeast	2.49 (2.33 - 2.65)	4.29 (4.02 - 4.58)	2.97 (2.78 - 3.16)	1.67 (1.56 - 1.78)
Midwest	1.98 (1.86 - 2.11)	3.34 (3.14 - 3.56)	2.19 (2.06 - 2.33)	1.38 (1.29 - 1.47)

\*Janssen-J&J only includes March-June

Note: The Poisson regression models were stratified by vaccine product and controlled for age, cohort and region, including an interaction for age and cohort and an offset variable using person-time. 95% Confidence intervals are presented in parentheses. The widths of the intervals have not been adjusted for multiplicity and any the inferences drawn may not be reproducible.

**Supplemental Table 3. Adjusted rate ratios for COVID-19 death rates by time since vaccination, 14 jurisdictions, August 1-September 4, 2021, United States**

Category	January-June cohort vs. July cohort	2-month cohorts vs. July cohort		
	Rate ratio for COVID-19 death rate comparing January-June to July cohorts*	Rate ratio for COVID-19 death rate comparing January-February to July cohort	Rate ratio for COVID-19 death rate comparing March-April to July cohort	Rate ratio for COVID-19 death rate comparing May-June to July cohort
<b>Overall deaths (14 jurisdictions)</b>	1.34 (1.03 - 1.76)	1.7 (1.29 - 2.23)	1.24 (0.94 - 1.63)	1.22 (0.92 - 1.62)
<b>Age</b>				
18-49	1.13 (0.46 - 2.8)	1.52 (0.51 - 4.54)	1.47 (0.58 - 3.70)	0.67 (0.25 - 1.81)
50-64	1.65 (0.91 - 3.0)	2.26 (1.19 - 4.32)	1.68 (0.92 - 3.07)	1.37 (0.73 - 2.56)
65-79	0.95 (0.64 - 1.4)	1.03 (0.69 - 1.53)	0.92 (0.62 - 1.36)	1.04 (0.69 - 1.58)
80+	2.0 (1.13 - 3.53)	2.59 (1.46 - 4.58)	1.61 (0.91 - 2.85)	1.69 (0.94 - 3.07)
<b>Vaccine product</b>				
Pfizer-BioNTech	2.49 (1.50 - 4.14)	3.22 (1.93 - 5.38)	2.15 (1.29 - 3.58)	1.91 (1.12 - 3.25)
Moderna	1.68 (0.87 - 3.24)	1.68 (0.87 - 3.27)	1.62 (0.84 - 3.14)	1.86 (0.95 - 3.66)
Janssen-Johnson & Johnson (J&J)*	0.64 (0.44 - 0.93)	NA	0.65 (0.44 - 0.94)	0.62 (0.42 - 0.94)
<b>Vaccine product and age</b>				
<b>Pfizer-BioNTech</b>				
18-49	1.18 (0.28 - 4.92)	1.58 (0.31 - 8.13)	1.58 (0.37 - 6.74)	0.57 (0.12 - 2.83)
50-64	1.34 (0.6 - 3.03)	2.1 (0.89 - 4.97)	1.31 (0.58 - 2.98)	1.02 (0.43 - 2.43)
65-79	2.56 (1.06 - 6.18)	2.89 (1.2 - 7.0)	2.37 (0.98 - 5.74)	2.37 (0.95 - 5.90)
80+	6.98 (1.74 - 27.94)	8.77 (2.19 - 35.12)	5.03 (1.25 - 20.17)	4.84 (1.18 - 19.9)
<b>Moderna**</b>				
18-49	NA	NA	NA	NA
50-64	NA	NA	NA	NA
65-79	0.84 (0.38 - 1.88)	0.83 (0.37 - 1.88)	0.82 (0.36 - 1.83)	1.07 (0.46 - 2.50)
80+	1.62 (0.52 - 5.04)	1.64 (0.52 - 5.11)	1.56 (0.50 - 4.88)	1.97 (0.61 - 6.34)

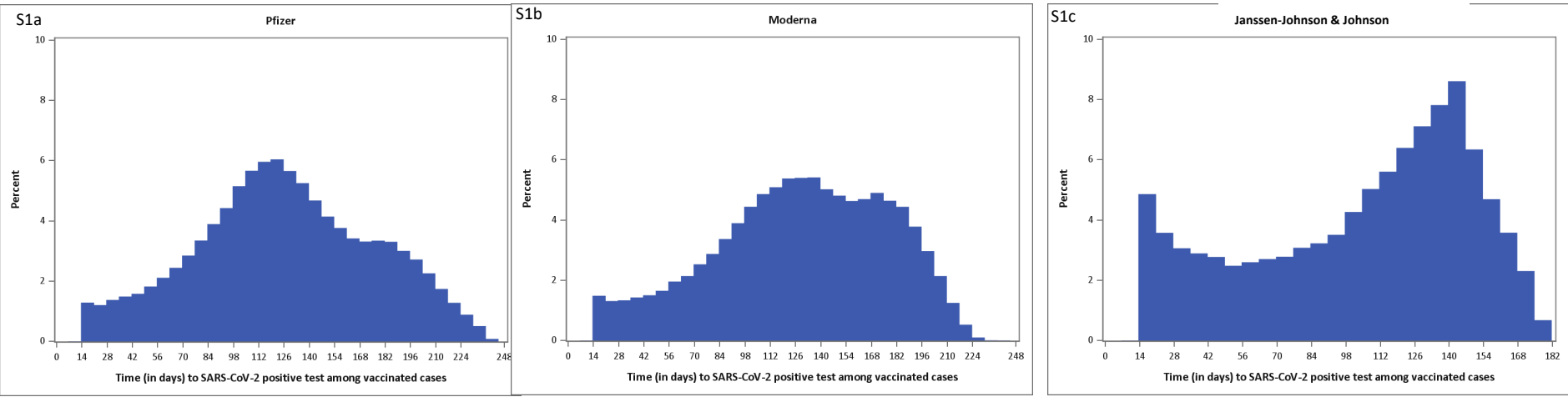
<b>Janssen-J&amp;J*</b>				
18-49	0.56 (0.16 - 1.93)	NA	0.91 (0.26 - 3.16)	0.09 (0.01 - 0.84)
50-64	1.28 (0.52 - 3.13)	NA	1.37 (0.56 - 3.38)	1.05 (0.41 - 2.72)
65-79	0.5 (0.29 - 0.84)	NA	0.48 (0.28 - 0.82)	0.55 (0.31 - 0.99)
80+	0.54 (0.25 - 1.16)	NA	0.51 (0.24 - 1.11)	0.63 (0.27 - 1.44)
<b>Region</b>				
South	1.26 (0.94 - 1.70)	1.55 (1.14 - 2.10)	1.17 (0.87 - 1.58)	1.16 (0.85 - 1.60)
West	1.52 (0.49 - 4.75)	2.03 (0.64 - 6.40)	1.32 (0.42 - 4.15)	1.81 (0.55 - 5.91)
Northeast	1.67 (0.62 - 4.49)	2.45 (0.90 - 6.68)	1.55 (0.57 - 4.18)	1.31 (0.46 - 3.68)
Midwest	1.92 (0.62 - 5.98)	2.54 (0.81 - 7.97)	1.76 (0.56 - 5.49)	1.47 (0.45 - 4.8)

\*Janssen-J&J only includes March-June

\*\* There were no deaths in July among 18-64 year old recipients of Moderna.

Note: The Poisson regression models were stratified by vaccine product and controlled for age, cohort and region, including an interaction for age and cohort and an offset variable using person-time. Due to limited number of deaths in July for some cells, adjusted rate ratio estimates are unstable and should be interpreted with caution. Deaths among 12-17 year old Pfizer recipients were excluded due to small cell size across all cohorts. 95% Confidence intervals are presented in parentheses. The widths of the intervals have not been adjusted for multiplicity and any the inferences drawn may not be reproducible.

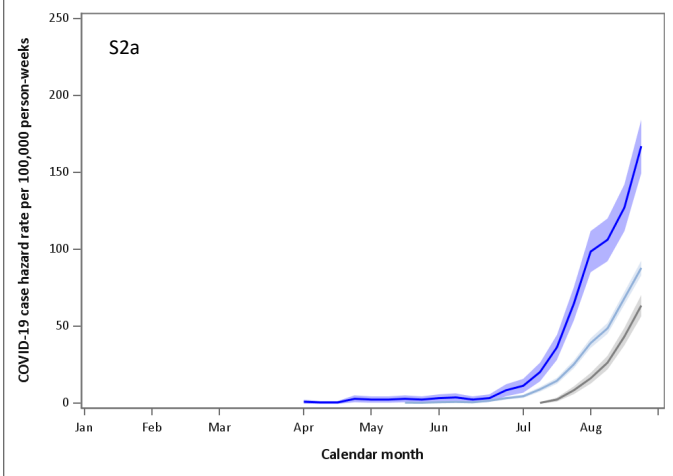




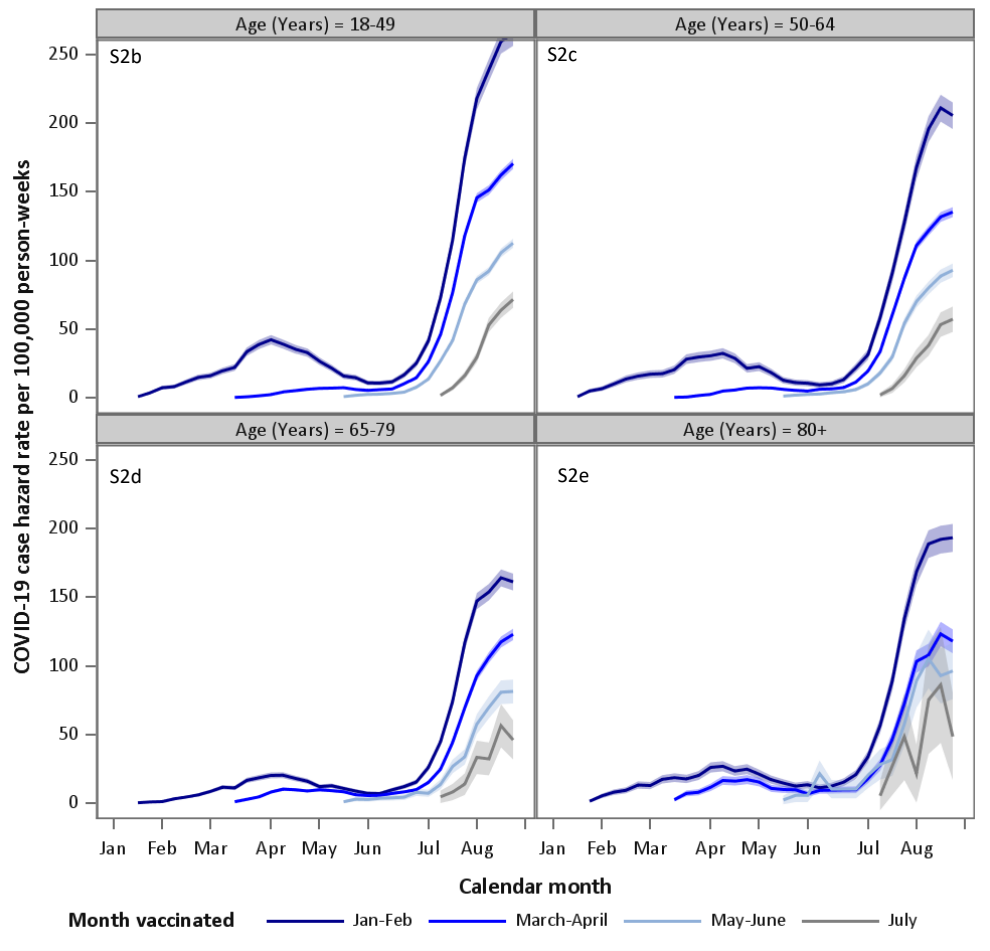
Supplemental Figure 1. Distribution of the numbers of days after receiving vaccine dose to positive SAR-CoV-2 positive test among persons vaccinated with a) Pfizer-BioNTech, b) Moderna and c) Janssen-Johnson & Johnson, 15 jurisdictions, January 3-September 4, 2021, United States

Note: there is a shorter x-axis for Janssen-Johnson & Johnson vaccine since it became available later in the year compared to mRNA vaccines.

Age (Years) = 12-17

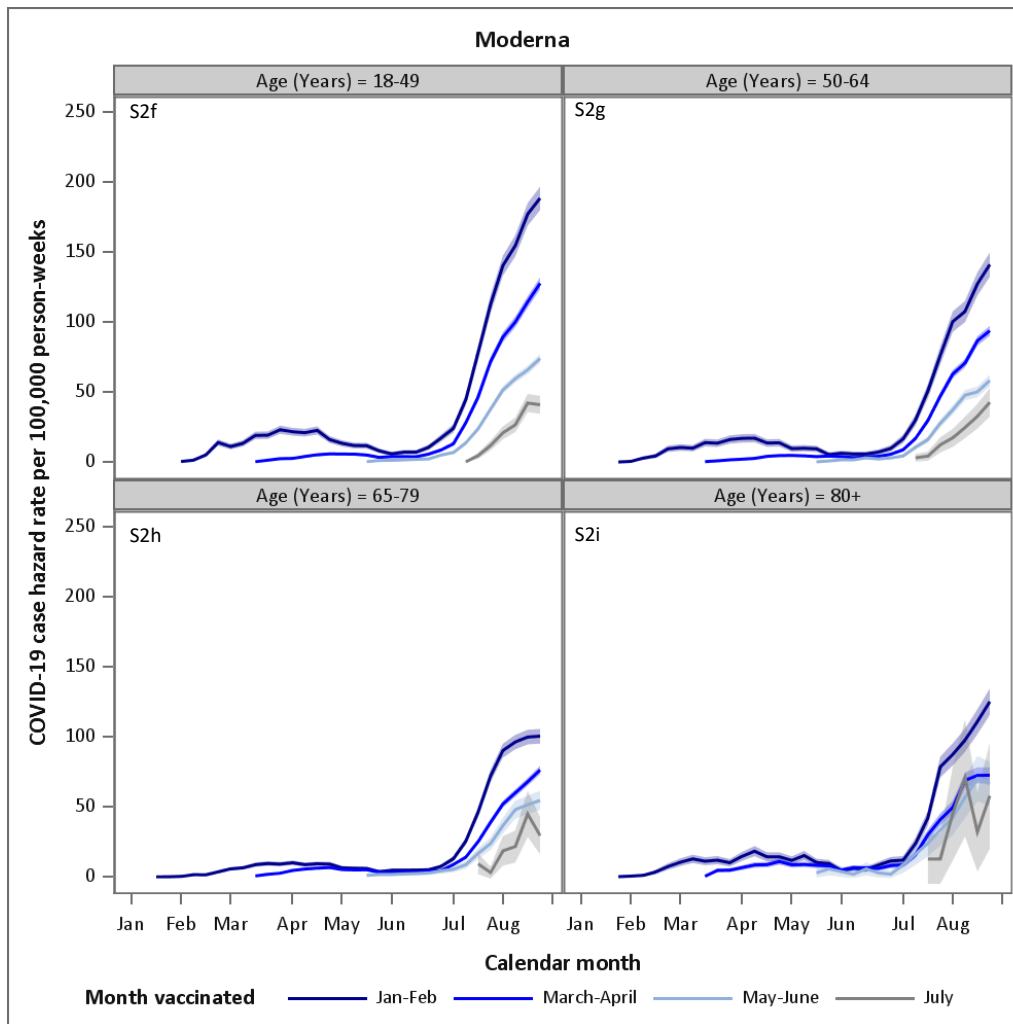


Pfizer



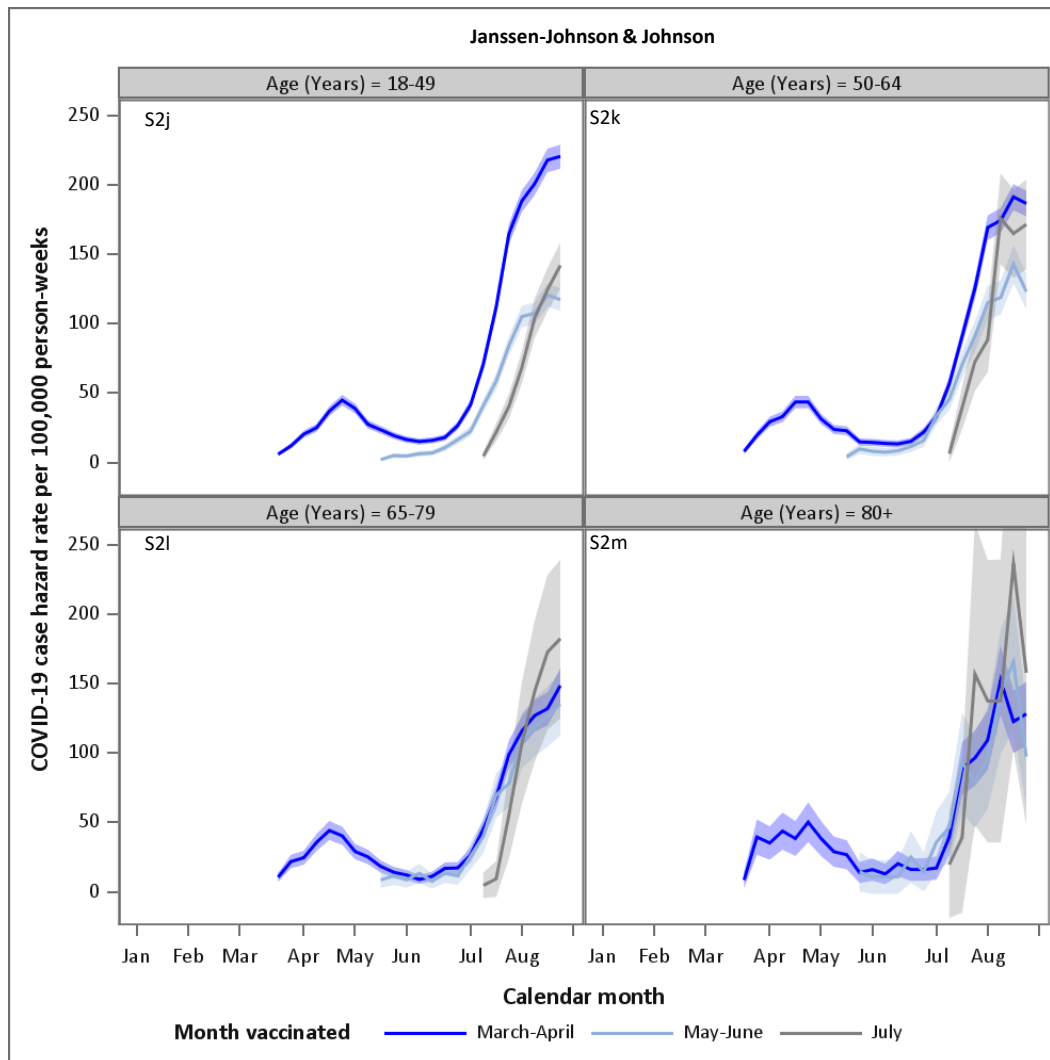
Supplemental Figure 2a-m. COVID-19 case hazard rates by vaccination cohort and age group for Pfizer-BioNTech (a-e), Moderna (f-i) and Janssen-Johnson & Johnson (j-m), 15 Jurisdictions, January 3-September 4, 2021, United States

Note: 95% confidence intervals presented around hazard curves. The widths of the intervals have not been adjusted for multiplicity and any the inferences drawn may not be reproducible. Excluded persons vaccinated with Janssen-Johnson & Johnson in the January-February cohort and all persons aged 12-17 vaccinated either with Moderna or Janssen-Johnson & Johnson.



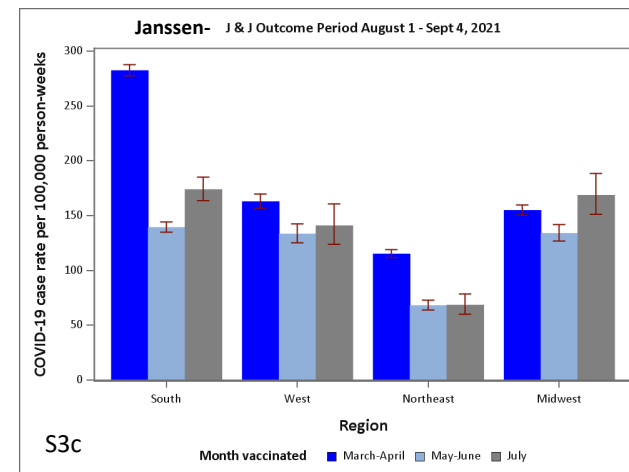
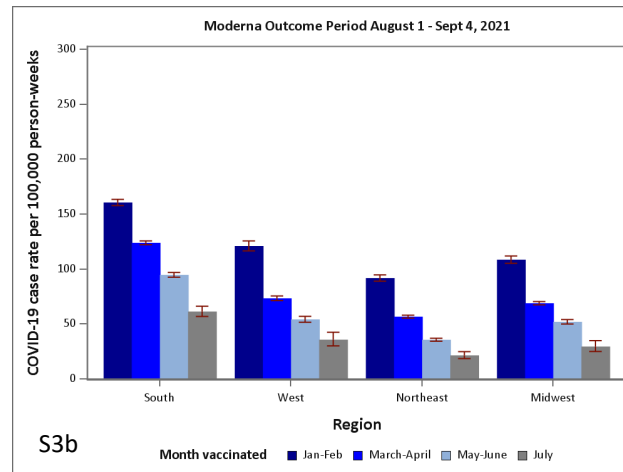
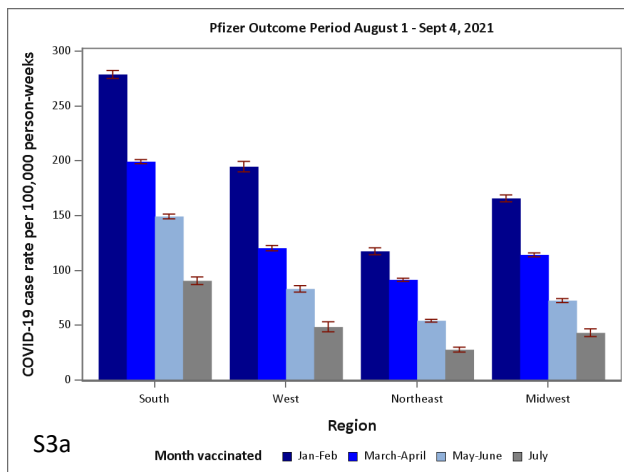
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Note: 95% confidence intervals presented around hazard curves. The widths of the intervals have not been adjusted for multiplicity and any the inferences drawn may not be reproducible. Excluded persons vaccinated with Janssen-Johnson & Johnson in the January-February cohort and all persons aged 12-17 vaccinated either with Moderna or Janssen-Johnson & Johnson.



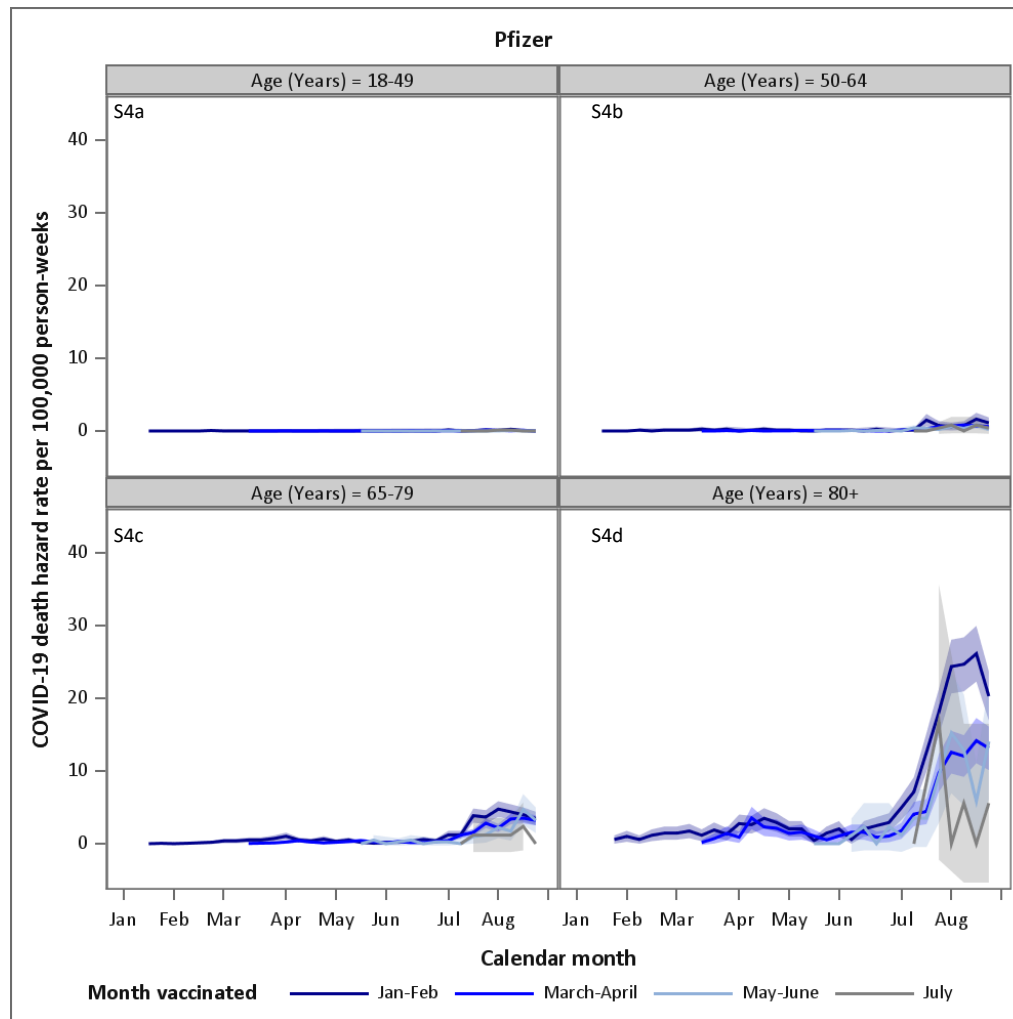
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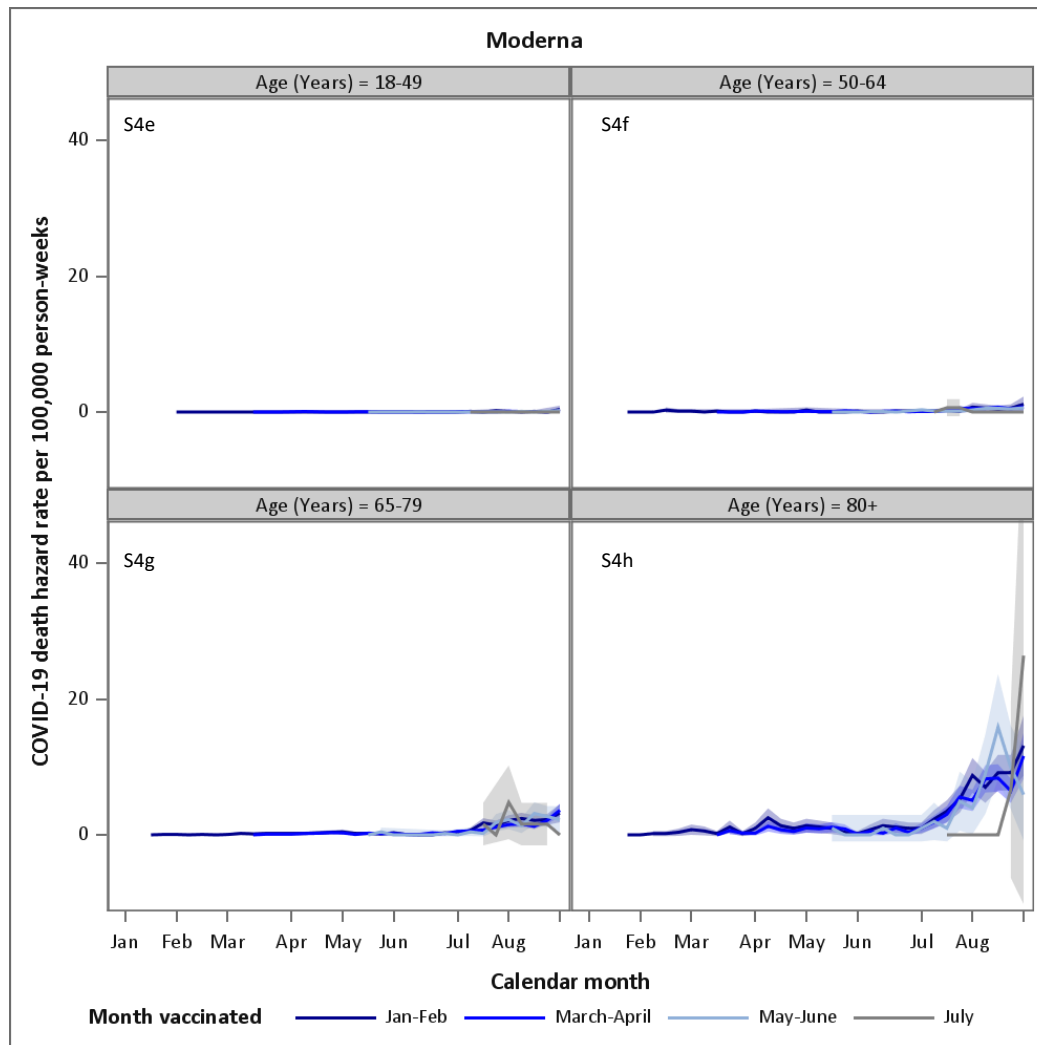
## Supplemental Figure 3a-3c. COVID-19 case rates by vaccination cohort and region for a) Pfizer-BioNTech, b) Moderna and c) Janssen-Johnson & Johnson, 15 Jurisdictions, August 1-September 4, 2021, United States

Note: Excluded persons vaccinated with Janssen-Johnson & Johnson in the January-February cohort and all persons aged 12-17 vaccinated either with Moderna or Janssen-Johnson & Johnson. Error bars represent 95% confidence intervals. The widths of the intervals have not been adjusted for multiplicity and any the inferences drawn may not be reproducible.



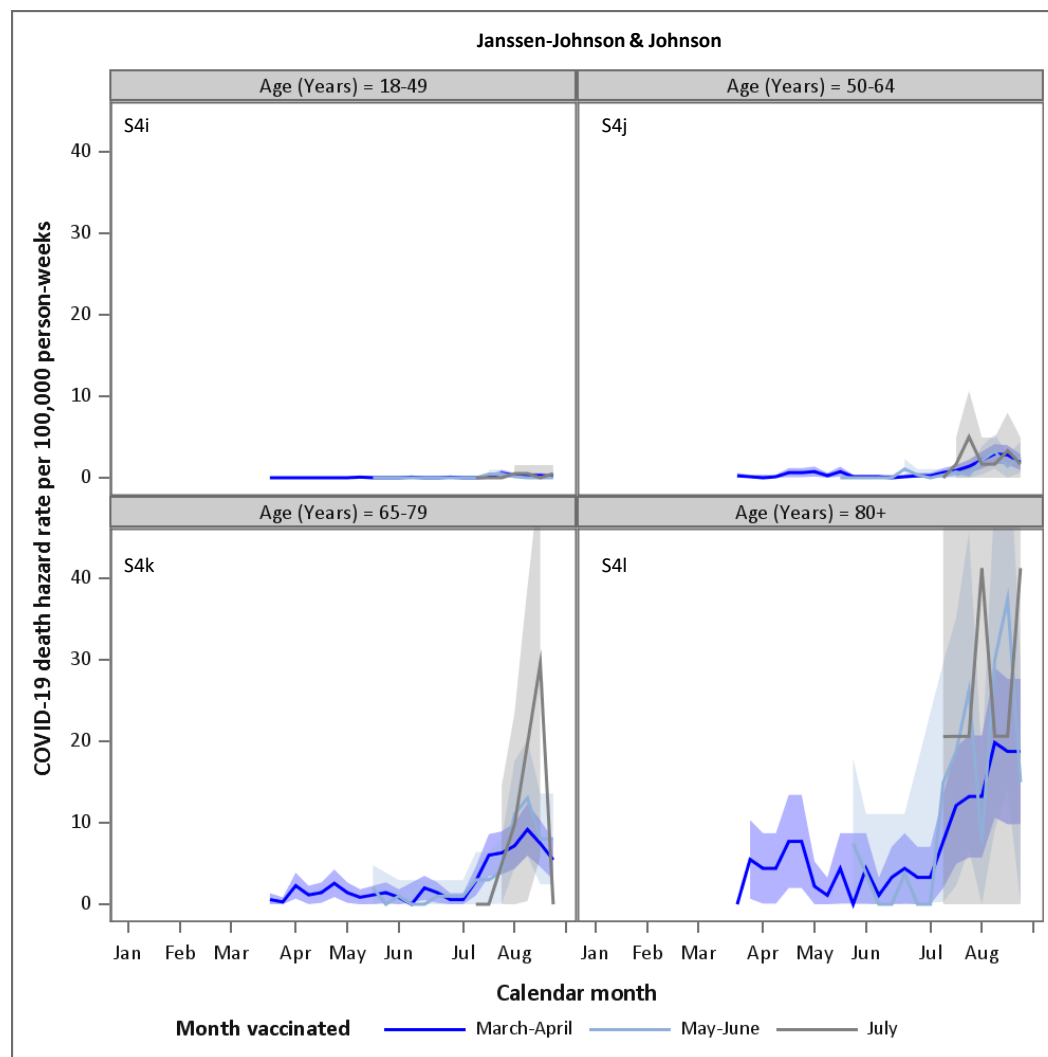
Supplemental Figure 4a-l. COVID-19 death hazard rates by vaccination cohort and age group for Pfizer-BioNTech (a-d), Moderna (e-h) and Janssen-Johnson & Johnson (i-l), 14 Jurisdictions, January 3-September 4, 2021, United States

Note: 95% confidence intervals presented around hazard curves. The widths of the intervals have not been adjusted for multiplicity and any the inferences drawn may not be reproducible. Excluded persons vaccinated with Janssen-Johnson & Johnson in the January-February cohort and all persons aged 12-17 vaccinated either with Moderna or Janssen-Johnson & Johnson. Due to few deaths in July cohort hazard rate may be unstable and should be interpreted with caution. Deaths for 12-17 not shown. Only 1 death noted among 12-17 in March-April cohort.



Supplemental Figure 4a-l. COVID-19 death hazard rates by vaccination cohort and age group for Pfizer-BioNTech (a-d), Moderna (e-h) and Janssen-Johnson & Johnson (i-l), 14 Jurisdictions, January 3-September 4, 2021, United States

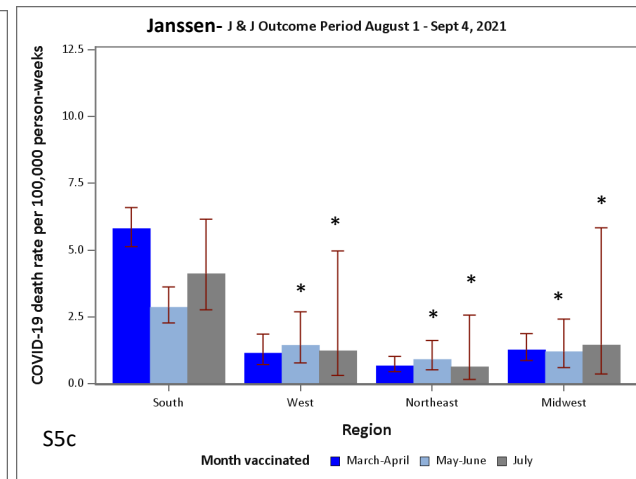
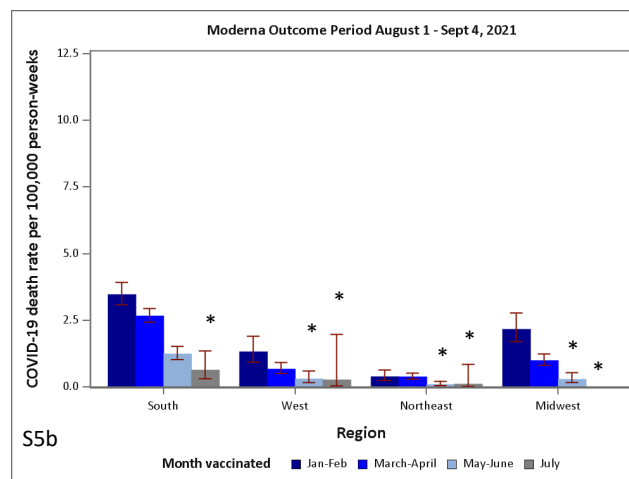
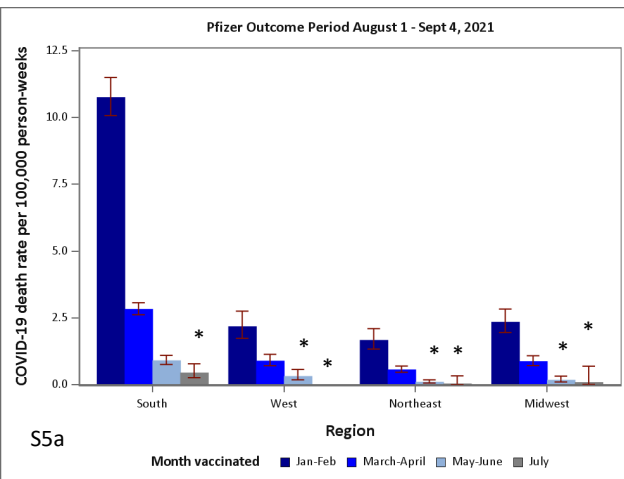
Note: 95% confidence intervals presented around hazard curves. The widths of the intervals have not been adjusted for multiplicity and any the inferences drawn may not be reproducible. Excluded persons vaccinated with Janssen-Johnson & Johnson in the January-February cohort and all persons aged 12-17 vaccinated either with Moderna or Janssen-Johnson & Johnson. Due to few deaths in July cohort hazard rate may be unstable and should be interpreted with caution. Deaths for 12-17 not shown. Only 1 death noted among 12-17 in March-April cohort.



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Note: 95% confidence intervals presented around hazard curves. The widths of the intervals have not been adjusted for multiplicity and any the inferences drawn may not be reproducible. Excluded persons vaccinated with Janssen-Johnson & Johnson in the January-February cohort and all persons aged 12-17 vaccinated either with Moderna or Janssen-Johnson & Johnson. Due to few deaths in July cohort hazard rate may be unstable and should be interpreted with caution. Deaths for 12-17 not shown. Only 1 death noted among 12-17 in March-April cohort.





Supplemental Figure 5a-5c. COVID-19 death rates by vaccination cohort and region for a) Pfizer-BioNTech, b) Moderna and c) Janssen-Johnson & Johnson, 15 Jurisdictions, August 1-September 4, 2021, United States

Note: Excluded persons vaccinated with Janssen- Johnson & Johnson in the January-February cohort and all persons aged 12-17 vaccinated either with Moderna or Janssen-Johnson & Johnson. Error bars represent 95% confidence intervals. The widths of the intervals have not been adjusted for multiplicity and any the inferences drawn may not be reproducible. For death counts  $\leq 15$  marked with (\*), rates may be unstable and should be interpreted with caution.