

1 **Effectiveness of COVID-19 vaccination against SARS-CoV-2 Infection among Residents of US**
2 **Nursing Homes, Before and During the Delta variant Predominance, December 2020 – November**
3 **2021**

4
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14 **Running title:** COVID-19 vaccine effectiveness in nursing home residents

15

1 **Abstract**

2 **Background:** Residents of nursing homes experience disproportionate morbidity and mortality
3 related to COVID-19 and were prioritized for vaccine introduction. We evaluated COVID-19
4 vaccine effectiveness (VE) in preventing SARS-CoV-2 infections among nursing home
5 residents.

6 **Methods:** We used a retrospective cohort of 4,315 nursing home residents during December 14,
7 2020 - November 9, 2021. A Cox proportional hazards model was used to estimate hazard ratios
8 comparing residents with a completed vaccination series to unvaccinated among those with and
9 without prior SARS-CoV-2 infection (identified using positive SARS-CoV-2 tests and/or
10 diagnosis codes), by vaccine product, and by period (before and during Delta variant
11 predominance). VE was estimated as one minus the hazard ratio times 100%.

12 **Results:** Overall adjusted VE for the completed vaccination series was 58% (95% CI: 44%, 69%)
13 among residents without a history of SARS-CoV-2 infection. During the pre-Delta period, the
14 VE within 150 days of receipt of the second dose of Pfizer-BioNTech (67%, 95% CI: 40%, 82%)
15 and Moderna (75%, 95% CI: 32%, 91%) was similar. During the Delta period, VE measured
16 >150 days after the second dose was 33% (95% CI: -2%, 56%) for Pfizer-BioNTech and 77%
17 (95% CI: 48%, 91%) for Moderna. Rates of infection were 78% lower (95% CI: 67%, 85%)
18 among residents with prior SARS-CoV-2 infection and completed vaccination series compared
19 to unvaccinated residents without a history of SARS-CoV-2 infection.

20 **Conclusions:** COVID-19 vaccines were effective in preventing SARS-CoV-2 infections among
21 nursing home residents and history of prior SARS-CoV-2 infection provided additional
22 protection. Maintaining high coverage of recommended doses of COVID-19 vaccines remains a
23 critical tool for preventing infections in nursing homes.

24 **Keywords:** COVID-19, vaccine effectiveness, nursing home residents

1 **Introduction**

2 Residents of skilled nursing facilities experience disproportionate morbidity and
3 mortality after infection with SARS-CoV-2, the virus that causes COVID-19, and were therefore
4 prioritized by the U.S. Centers for Disease Control and Prevention (CDC)'s Advisory Committee
5 on Immunization Practices (ACIP) to be offered COVID-19 vaccination first during early phases
6 of vaccine introduction.[1] In December 2020, the CDC launched the Federal Pharmacy
7 Partnership for Long-Term Care Program to efficiently vaccinate residents and staff of long-term
8 care facilities.[2] Residents were offered two-dose mRNA vaccines: the mRNA-1273 vaccine
9 produced by Moderna or the BNT162b2 vaccine produced by Pfizer-BioNTech. Subsequently, in
10 February 2021 a one-dose viral vector vaccine (Ad26.COV2 from Janssen/Johnson &
11 Johnson[J&J]) became available for vaccination.

12 Nursing home residents were not included in clinical trials evaluating efficacy of
13 COVID-19 vaccines.[3, 4] However, several observational studies evaluated vaccine
14 effectiveness (VE) among nursing home residents using real-world data and demonstrated that
15 COVID-19 vaccines are highly effective in preventing infection, hospitalization, and mortality in
16 these populations. [5-8] While a decline in VE during the time period where the Delta variant
17 (B1.617.2) was circulating has been documented in this population, [9] current studies have not
18 been able to assess the relative contribution of waning vaccine-induced immunity since receipt of
19 a primary vaccination series or the predominance of emerging variants to observed changes in
20 VE over time.

21 There is accruing evidence from studies among community-dwelling adults
22 demonstrating strong protection against COVID-19 re-infections in individuals who have
23 previously survived an infection.[10, 11] There are limited data on the influence of prior

1 infection on VE among nursing home residents, a population with a high prevalence of
2 documented prior infections.[12]

3 The objective of this analysis was to evaluate effectiveness of COVID-19 vaccination in
4 preventing SARS-CoV-2 infections among a cohort of nursing home residents before and during
5 predominance of the Delta variant, to describe potential waning of VE by time since vaccination,
6 and to evaluate the role of prior infection in preventing subsequent infection and on VE.

7 **Methods**

8 The data from 105 nursing homes in ten states operating under the tradename Signature
9 Healthcare, predominantly from the southeast region, were reported to BASE10 Genetics, a
10 Health Management IT firm. Data were collected for any resident who had been present in a
11 participating nursing home on December 14, 2020 and included nursing home characteristics and
12 resident-level information: dates present at a facility, demographic characteristics, COVID-19
13 vaccination dates, vaccine product, and SARS-CoV-2 testing information (test date, type, and
14 result). International Classification of Diseases 10th revision, clinical modification (ICD-10-CM)
15 codes and corresponding onset dates were extracted from nursing home electronic medical
16 records for each resident in the cohort. If two doses of vaccine were given 21 or 28 days apart,
17 missing COVID-19 vaccine product information was imputed based on the time interval between
18 dose one and dose two (i.e., 21 days for Pfizer-BioNTech and 28 days for Moderna).

19 **Cohort Description**

20 We created a retrospective closed cohort for residents who were living continuously in a
21 participating nursing home beginning on December 14, 2020 (i.e., the date the U.S. COVID-19
22 vaccination program launched in nursing homes). For each nursing home, the date facility-level

1 vaccination began was determined as the date three or more residents were vaccinated. Residents
2 who left the facility for one or more days between December 14, 2020, and the date vaccination
3 began in their facility were excluded. Residents with a positive SARS-CoV-2 test (antigen test
4 and/or reverse transcription polymerase chain reaction (RT-PCR)) or a COVID-19 diagnosis
5 code (U07.1) on the day of or within the 90 days preceding the date vaccination began in their
6 facility were excluded. Presence of one or more underlying medical conditions, risk factors for
7 severe COVID-19, were defined based on ICD-10-codes.[13] Presence of prior history of
8 SARS-CoV-2 infection was defined as a positive SARS-CoV-2 antigen or RT-PCR test or a
9 COVID-19 diagnosis code (U07.1) dated 91 or more days prior to the date vaccination began at a
10 resident's nursing home.

11 Resident-time follow up started on the date vaccination began at a facility until a resident
12 experienced their first positive SARS-CoV-2 test during the study follow up period or a
13 censoring event occurred. Residents were censored the first date they were not present in a
14 participating facility, on the date a third dose or a booster dose was administered, or at the end of
15 the evaluation period (November 9, 2021), whichever was earliest. All resident-days were
16 categorized as unvaccinated, pre-vaccine effect, partially vaccinated, or completed initial series
17 as defined in Table 1. Time after a completed initial vaccination series was further stratified into
18 two intervals, based on data from immunogenicity and early effectiveness studies showing
19 waning of vaccine effect: within 150 days and more than 150 days since the completion of
20 primary series and before the receipt of the booster dose.

21 To further study the effect of different variants on VE, the study period (the date of
22 vaccination clinic in a particular facility–November 9, 2021) was stratified into three periods: a
23 pre-Delta period (the date of vaccination clinic in a particular facility–May 9, 2021); an

1 intermediate period, the period when Delta circulation was documented but not predominant
2 (May 10, 2021–June 20, 2021); and the Delta period, when $\geq 50\%$ of SARS-CoV-2 viruses
3 sequenced nationally were the Delta variant (June 21, 2021–November 9, 2021).

4 **Statistical Analyses**

5 We used multivariable mixed-effects Cox proportional hazards models with a time
6 dependent vaccination status to estimate hazard ratios (HRs) comparing rates of SARS-CoV-2
7 infection among residents with a completed vaccination series or partially vaccinated to rates
8 among unvaccinated residents, accounting for clustering within a nursing home using a random
9 effect and adjusting for confounders. VE was calculated as $(1 - HR) * 100\%$. We evaluated the
10 effect of the following factors on VE and included them in the models: resident's age, gender,
11 and number of comorbid conditions. To evaluate the influence of prior infection on VE, we
12 included an interaction term between presence of prior SARS-CoV-2 infection and COVID-19
13 vaccination status in the model.

14 Among individuals without history of prior SARS-CoV-2 infection, we estimated VE for
15 completed vaccination series by vaccine product (Moderna or Pfizer-BioNTech), during the pre-
16 Delta variant (December 14, 2020 – May 9, 2021) and the Delta variant (June 21, 2021 –
17 November 9, 2021) time periods, and time since the receipt of the second dose (i.e., within 150
18 days from or 151 or more days after completion of primary series). The pre-vaccine and partial
19 vaccination time period, as well as residents who had received an unknown or Janssen/J&J
20 vaccine were excluded from the analyses by vaccine product and time since last dose receipt due
21 to limited sample size. During the pre-Delta period, all resident-time was within 150 days from
22 completion of primary series.

23 Analyses were conducted using SAS version 9.4 (SAS Institute).

1 **Project Determination**

2 This activity was reviewed by CDC and was conducted consistent with applicable federal law
3 and CDC policy[§].

4 **Results**

5 Data for 8,301 residents who were present in a participating facility on December 14,
6 2020 for at least one subsequent day were available for analysis. After exclusion criteria were
7 applied (Figure 1), the final analysis cohort included 4,315 residents from 105 nursing homes
8 (Table 2). Facilities were located in Kentucky (39), Tennessee (23), Florida (21), Indiana (8),
9 Georgia (4), North Carolina (3), Ohio (3), Maryland (2), Alabama (1), and Virginia (1). A
10 median age of residents was 78 years (IQR: 68, 86). Most residents in the cohort were female
11 (65%); 81% had one or more underlying medical conditions and 1,427 (33%) residents had a
12 prior COVID-19 diagnosis or a positive SARS-CoV-2 test. Among residents with a history of
13 SARS-CoV-2 infection, the vaccination clinic occurred a median of 170 days since their first
14 diagnosis (IQR: 126 – 219). Residents included in the final cohort contributed a median of 254
15 resident-days (IQR: 94, 343) to the analysis.

16 Overall, 577 (13%) residents had a positive test for SARS-CoV-2 during the study
17 period. Another 1,973 (46%) residents were censored due to leaving the participating nursing
18 home, 230 (5%) were censored at the receipt of a third dose or a booster dose, and the remaining
19 1,535 (36%) were followed through the end of the study period (November 9, 2021). At
20 censoring, 2,938 (68%) of residents had completed their vaccination series; among those, 1,861
21 (63%) had received Pfizer-BioNTech vaccine, 833 (28%) had received Moderna, 52 (2%) had
22 received Janssen/J&J, and 192 (7%) received a single dose of an unknown COVID-19 vaccine
23 product (Table 2). Vaccine type was imputed for 34% of vaccinated residents.

1 During the pre-Delta period, rates of SARS-CoV-2 infections were 1.88 per 1000 resident-days
2 among unvaccinated residents and 0.20 per 1,000 resident-days among those who completed
3 their vaccination series. In the intermediate period rates were 0.09 per 1,000 resident-days for the
4 unvaccinated and 0.03 per 1,000 resident-days for the completely vaccinated. During the Delta
5 period, rates among unvaccinated were 1.40 cases per 1,000 resident-days) and among
6 completely vaccinated were 0.86 per 1,000 resident-days (Figure 2).

7 Among residents with no prior history of SARS-CoV-2 infection, the adjusted VE over
8 the entire study period for the complete vaccination series was 58% (95% CI: 44%, 69%) (Table
9 3). Among residents with a history of SARS-CoV-2 infection, the adjusted rate of SARS-CoV-2
10 infection for residents with a complete vaccination series was similar to unvaccinated residents
11 (VE: 11%, 95% CI: -98%, 60%). When comparing to the rates of infection among unvaccinated
12 residents with no prior history of SARS-CoV-2 infection, residents with prior SARS-CoV-2
13 infection and a completed vaccination series had 78% lower adjusted rates of infection (95% CI:
14 67%, 85%). Adjusted rates of infection among unvaccinated residents with a history of COVID-
15 19 were 58% lower (95% CI: 26%, 76%) compared to those among unvaccinated residents
16 without a history of COVID-19.

17 During the pre-Delta period, the VE within 150 days of the receipt of the second dose
18 was 67% (95% CI: 40%, 82%) for Pfizer-BioNTech and 75% (95% CI: 32%, 91%) for Moderna
19 (Table 4). During Delta variant predominance, we were not able to estimate VE within 150 days
20 of the second dose receipt due to a small number of infections identified (2 among vaccinated
21 with Pfizer-BioNTech and 5 among vaccinated with Moderna), as well as a short resident follow
22 up time during this window (a median of 11 days for Pfizer-BioNTech recipients and 21 days for

1 Moderna recipients). VE 151 days or more after completion of primary series was 33% (95% CI:
2 -2%, 56%) for Pfizer-BioNTech and 77% (95% CI: 48%, 91%) for Moderna (Table 4).

3 Discussion

4 Our study demonstrates that vaccination with primary series of COVID-19 vaccines was
5 effective in preventing SARS-CoV-2 infections among nursing home residents and history of
6 prior infection provided protection among vaccinated and unvaccinated individuals.
7 Effectiveness of primary series of 58% over the entire study period among residents with no
8 prior history of infection in our study is consistent with earlier reports from observational studies
9 among nursing home residents, with effectiveness of primary series for mRNA vaccines ranging
10 from 53% to 83% against SARS-CoV-2 infection.[5, 14-17] Differences in underlying
11 populations studied, SARS-CoV-2 testing practices, prevalence of previous infections, analytic
12 methods, and circulating virus variants contribute to variability in effectiveness estimates across
13 studies.

14 History of prior SARS-CoV-2 infection in our study population modified measured VE,
15 likely through protection afforded by prior infection in preventing SARS-CoV-2 reinfection. Due
16 to a significant protection (58%) from prior infection observed among unvaccinated residents,
17 measured VE for vaccination with primary series was low among residents with prior infection.
18 However, when compared to unvaccinated residents with no prior history of infection,
19 vaccination with 2 doses of mRNA vaccines of residents with history of prior infection was 78%
20 protective. Our results are consistent with earlier reports demonstrating that individuals with
21 prior infection had a reduced risk of re-infection, including with the Delta variant;[6, 11]
22 however, duration of this protection is unknown, and results of these studies show that
23 vaccination provided additional protection to persons with prior infection.

1 Waning over time of vaccine-induced immunity against SARS-CoV-2 infection following
2 receipt of the primary series of mRNA vaccines has been documented in studies among
3 community dwelling adults.[18, 19] A recent analysis of U.S. nursing home data showed
4 effectiveness of two doses of mRNA vaccines declined from 75% in March – May 2021 to 53%
5 in June -August 2021, concomitant with the emergence of the Delta (B.1.617.2) variant, although
6 this study could not differentiate between influence of Delta circulation from waning of vaccine
7 effect.[9] Britton et al. demonstrated that the decline in measured VE in the general population of
8 adults was largely due to waning of VE over time and separate from the Delta variant influence
9 on effectiveness.[18] Our analyses by time since vaccination and by time period showed that
10 effectiveness for both Pfizer-BioNTech and Moderna primary series was high during pre-Delta
11 period within 5 months of the second dose receipt (67% and 75%). During the Delta period,
12 effectiveness within 150 days of vaccination could not be estimated due to a small number of
13 infections identified; effectiveness over 150 days after vaccination was lower for Pfizer-
14 BioNTech than for Moderna. The differences in the effectiveness of the two vaccines during the
15 Delta circulation period have been documented previously.[20]

16 Vaccine effectiveness data from this and other studies among nursing home residents are
17 consistent with surveillance data from the National Healthcare Safety Network (NHSN)
18 suggesting that the national program to vaccinate U.S. nursing home residents played an
19 important role in prevention of SARS-CoV-2 infection in this population. An ecological analysis
20 of NHSN data performed soon after initiation of the program suggested that vaccination
21 contributed to decline in COVID-19 incidence among residents.[21] Subsequent surveillance
22 data showed a precipitous and sustained decrease in the ratio of nursing home resident incidence
23 to overall community incidence.[22] This ratio never returned to levels observed prior to the

1 vaccination program, even during the period of Omicron variant predominance when community
2 incidence peaked at more than three times higher than at any time prior to the national nursing
3 home vaccination program. These observations suggest that vaccination of nursing home
4 residents, in combination with vaccination of staff and other infection control practices,[23] had
5 an important public health impact role in limiting introduction and/or spread of SARS-CoV-2 in
6 nursing homes.

7 This study is subject to several limitations. First, to minimize potential misclassification of
8 exposure for residents who may have received vaccine doses in the community, we followed a
9 closed cohort of residents present at the participating facilities at the time vaccination clinics
10 started. This limited our statistical power to evaluate VE by both time since vaccine receipt and
11 time period because most residents included in the study cohort were vaccinated during the same
12 narrow window of time. Additionally, lack of documentation for vaccine type and imputation
13 based on time between doses may have led to possible exposure misclassification for the
14 analyses stratified by vaccine product. Second, despite efforts to identify prior SARS-CoV-2
15 infection using both positive tests and COVID-19 diagnosis codes, undocumented or unknown
16 previous infection may lead to misclassification on prior infection status. Third, nearly half
17 (46%) of residents in the cohort were censored due to leaving the network of facilities for any
18 reason, limiting resident-time for monitoring outcomes during the Delta period. Fourth, our study
19 was limited to facilities predominantly in the southeastern United States, and therefore, results
20 may not be generalizable outside of that area. Fifth, we could not evaluate effectiveness against
21 hospitalization or death. Studies among nursing home residents, as well as community dwelling
22 adults have demonstrated effectiveness of COVID-19 vaccines against hospitalizations and
23 severe outcomes to be higher and more sustained over time compared to the effectiveness against

1 SARS-CoV-2 infection.[20] Lastly, a closed cohort design limited our ability to evaluate
2 effectiveness of a third dose or booster doses, as well as effectiveness during the period of
3 Omicron variant circulation (14).

4 Following reported declines in vaccine-induced immunity with time [9], ACIP recommended
5 use of a COVID-19 vaccine booster dose among adults, including nursing home residents.[23]
6 To date, only a single study evaluated effectiveness of booster doses among nursing home
7 residents during Delta variant circulation.[25] Studies are needed among nursing home residents
8 to understand how effective the current vaccination strategies are in this population, particularly
9 against the more recently emerged B.1.1.529 Omicron variant.

10 In conclusion, our results from a large cohort of over 4,000 residents of 105 nursing homes
11 demonstrate that COVID-19 vaccines are effective in preventing SARS-CoV-2 infections. Our
12 data support vaccination as an important COVID-19 prevention tool in this population, including
13 in persons with prior infection. Maintaining high coverage of recommended doses of COVID-19
14 vaccines is critical to reduce morbidity and mortality from COVID-19 among people who live in
15 a setting with increased risk for poor outcomes after SARS-CoV-2 infection.

16
17 § See e.g., 45 C.F.R. part 46.102(1)(2), 21 C.F.R. part 56; 42 U.S.C. §241(d); 5 U.S.C. §552a; 44 U.S.C.
18 §3501 et seq.

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1 **NOTES**

2 **Acknowledgements:** Long term care facilities operating under the trade name “Signature Healthcare”
3 and the staff at Base10 Genetics

4 **Supplement Sponsorship:** This article appears as part of the supplement “Vaccines, Variants,
5 and Vigilance: Strengthening the COVID-19 Public Health Response through Partnerships and
6 Collaborations”, supported by the Infectious Diseases Society of America through Cooperative
7 Agreement NU50CK000574 with the U.S. Centers for Disease Control and Prevention.

8 **Disclaimer:** The findings and conclusions in this report are those of the author(s) and do not necessarily
9 represent the views of the Centers for Disease Control and Prevention.

10 **Conflicts of Interest:** AAS, KSM, SJ report funding from their employer Base10 Genetics. They
11 also report holding stocks with their employer Base10 Genetics. HW, JB, JJ, KMH, MYF, and
12 TP have no conflicts to report.

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ACCEPTED MANUSCRIPT

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2 **Table 1.** Definitions for vaccination status of residents by number of doses and time since
3 vaccine dose receipt

Vaccination status	Description
Unvaccinated	No COVID-19 vaccine doses received
Pre-Vaccine Effect	0-13 days after the receipt of the first vaccine dose
Partially Vaccinated	14 or more days after receipt of the first dose of mRNA-1273 (Moderna) or BNT162b2 (Pfizer-BioNTech) COVID-19 vaccine through 6 days after receipt of the 2nd dose of Moderna or Pfizer-BioNTech COVID-19 vaccine
Completed Initial Vaccination Series	7 or more days after receipt of the 2 nd dose of Moderna or Pfizer-BioNTech COVID-19 vaccine <i>or</i> 14 or more days after receipt of a dose of Ad26.COV2.S (Janssen/J&J) vaccine
Completed Initial Vaccination Series within past 5 months	<i>0-150 days after met the definition for “completed initial vaccination series”</i>
Completed Initial Vaccination Series 5 or more months prior	<i>151 or more days after met the definition for “completed initial vaccination series”</i>

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1 **Table 2.** Descriptive characteristics of 4,315 residents included in the study cohort.

Characteristic	No. (column %) of residents		Residents with a positive SARS-CoV-2 test ^a		Residents with No positive SARS-CoV-2 test ^a	
			No. (row %)		No. (row %)	
Total	4315	100%	577	13%	3738	87%
Person - Time, Median (Q1 – Q3), days	254	94-343	63	42 - 251	302.5	123 - 343
Sex						
Female	2826	65%	405	70%	2421	65%
Age group, years						
≤64	785	18%	87	15%	698	19%
65 to 74	1032	24%	126	22%	906	24%
75 to 84	1268	29%	183	32%	1085	29%
≥85	1230	29%	181	31%	1049	28%
Underlying medical conditions^b						
None	835	19%	108	19%	727	19%
1 to 2	2371	55%	337	58%	2034	54%
3 to 5	1011	23%	119	21%	892	24%
≥ 6	98	2%	13	2%	85	2%
History of prior COVID-19 diagnosis^c						
<i>No History</i>	2,888	67%	491	85%	2,397	64%
Days from first diagnosis to first facility vaccination clinic						
91 – 150 days	549	13%	26	5%	523	14%
151 – 210 days	454	11%	37	6%	417	11%
211 – 270 days	334	8%	16	3%	318	9%
> 270 days	90	2%	7	1%	83	2%
Censoring Status						
Positive Test (Case)	577	13%	577	100%	NA	
Discharge/Left Facility	1,973	46%	NA		1,973	53%
Booster or Third Dose	230	5%			230	6%
End of Study	1535	36%			1535	41%
Vaccination status at censoring						
Unvaccinated	795	18%	165	29%	630	17%
Pre-vaccine effect	292	7%	130	23%	162	4%
Partially vaccinated	290	7%	76	13%	214	6%
Completed vaccination series	2938	68%	206	36%	2732	73%
Vaccine type among fully vaccinated^d						
mRNA-1273 (Moderna)	833	28%	26	13%	807	30%
BNT162b2 (Pfizer-BioNTech)	1861	63%	170	83%	1691	62%
Ad26.COVS.2.S (Janssen/J&J)	52	2%	2	1%	50	2%
Unknown vaccine	192	7%	8	4%	184	7%

^a Includes tests for SARS-CoV-2 in the study follow-up period

^b Comorbidities assessed included: cancer, chronic kidney disease, chronic obstructive pulmonary disease, heart conditions, immunocompromised state, chemotherapy, radiation, obesity, sickle cell disease, smoking, and diabetes

^c Positive SARS-CoV-2 test (antigen test or rtPCR) or a ICD-10 diagnosis code U07.1 91 days or more prior to the date of the first vaccination clinic at a resident's facility

^d 684 residents with missing product had an interval of 21 days between doses and were coded as Pfizer. 305 residents with missing product had 28 days between doses and were coded as Moderna.

1 **Table 3.** Effectiveness of COVID-19 vaccines against new SARS-CoV-2 infection among
 2 nursing home residents, December 2020 – November 2021

Vaccination Status ^a	Number of residents	Resident-Days	Median days contributed per resident (IQR)	Number of SARS-CoV-2 infections	Vaccine Effectiveness, % (95% CI)	Protection compared to unvaccinated with no prior SARS-CoV-2 history %, (95% CI)
<i>No History of prior SARS-CoV-2 infection</i>						
Unvaccinated	871	95,060	51 (21, 209)	146	REF	REF
Pre-vaccine	2,333	30,860	14 (14, 14)	115	25% (1%, 44%)	25% (1%, 44%)
Partial vaccination	2,062	40,145	14 (14, 21)	67	34% (10%, 52%)	34% (10%, 52%)
Completed vaccination series	1,874	357,250	226 (108, 277)	163	58% (44%, 69%)	58% (44%, 69%)
<i>History of prior SARS-CoV-2 infection ^b</i>						
Unvaccinated	442	56,549	100 (21, 230)	19	REF	58% (26%, 76%)
Pre-vaccine	1,187	16,233	14 (14, 14)	15	-29% (-158%, 36%)	82% (66%, 90%)
Partial vaccination	1,113	22,041	14 (14, 21)	9	11% (-98%, 60%)	78% (56%, 89%)
Completed vaccination series	1,064	209,939	247 (117.5, 277)	43	11% (-56%, 49%)	78% (67%, 85%)
^a Unvaccinated resident-days defined as no doses of any COVID-19 vaccine received. Pre-vaccine effect is observed within the first 14 days after receipt of the first dose. Partial vaccination resident-days observed 14 or more days after the first dose and through 6 days after receipt of the second dose. Completed vaccination series is 7 or more days after receipt of the second dose of mRNA vaccines or 14 or more days after the receipt of a dose of Janssen/J&J (Table 1).						
^b Positive SARS-CoV-2 test (antigen test or rtPCR) or a ICD-10 diagnosis code U07.1 91 days or more prior to the date of the first vaccination clinic at a resident's facility						

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1 **Table 4.** Effectiveness of mRNA COVID-19 vaccines against SARS-CoV-2 infection among
 2 nursing home residents with no prior history of SARS-CoV-2 infection, before and during
 3 B.1.617.2 (Delta) variant predominance, stratified by mRNA vaccine manufacturer and time
 4 since completing primary vaccination series, December 2020–November 2021.

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Vaccination Status ^a	Number of residents	Resident-Days	Median days contributed per resident (IQR)	Number of SARS-CoV-2 infections	Vaccine Effectiveness
					% (95% CI)
Model 1: Pre-Delta variant predominance (Dec 14, 2020 - May 9, 2021)					
Unvaccinated	871	57,871	51 (21, 122)	109	REF
Completed Pfizer-BioNTech, within past 150 days	1,196	103,668	95 (87, 104)	22	67% (40%, 82%)
Completed Moderna, within past 150 days	466	35,290	86 (73, 89)	6	75% (32%, 91%)
Model 2: Delta variant predominance (Jun 21, 2021 - Nov 9, 2021)					
Unvaccinated	245	25,707	141 (60, 141)	36	REF
Completed Pfizer-BioNTech, within past 150 days	687	8,970	11 (5, 14)	2	Not Estimated ^b
Completed Pfizer-BioNTech, over 150 days ago	858	90,195	126 (84, 135)	108	33% (-2%, 56%)
Completed Moderna, within past 150 days	409	12,845	21 (14, 32)	5	Not Estimated ^b
Completed Moderna, over 150 days ago	357	31,093	109 (30, 122)	9	77% (48%, 91%)

6 ^a Unvaccinated resident-days defined as no doses of any COVID-19 vaccine received. Pre-vaccine effect is observed
 7 within the first days 0-13 after receipt of the first dose. Partial vaccination resident-days observed 14 or more days
 8 after the first dose and through 6 days after receipt of the second dose. Completed vaccination series is 7 or more
 9 days after receipt of the second dose of mRNA vaccines or 14 or more days after the receipt of a dose of
 10 Janssen/J&J (Table 1). Due to insufficient sample size, pre-vaccine and partial vaccination resident-days were
 11 excluded from stratified analyses.

12 ^b Due a small number of infections identified and a short resident follow up time during the Delta period, VE was
 13 not estimated for residents who received their vaccine within the past 150 days in the Delta time period.

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1 **FIGURE LEGENDS**

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3 **Figure 1.** Selection diagram of nursing home residents for inclusion in the study cohort.

4

5 **Figure 2.** Rates of SARS-CoV-2 infection by vaccination status^a and time period among
6 residents without prior history of SARS-CoV-2 infection^b

7 ^a Unvaccinated resident-days defined as no doses of any COVID-19 vaccine received. Pre-vaccine effect is observed
8 within the first days 0-13 after receipt of the first dose. Partial vaccination resident-days observed 14 or more days
9 after the first dose and through 6 days after receipt of the second dose. Completed vaccination series is 7 or more
10 days after receipt of the second dose of mRNA vaccines or 14 or more days after the receipt of a dose of
11 Janssen/J&J (Table 1).

12 ^bPrior history of SARS-CoV-2 infection defined as **a** Positive SARS-CoV-2 test (antigen test or rtPCR) or a ICD-10
13 diagnosis code U07.1 91 days or more prior to the date of the first vaccination clinic at a resident's facility

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ACCEPTED MANUSCRIPT

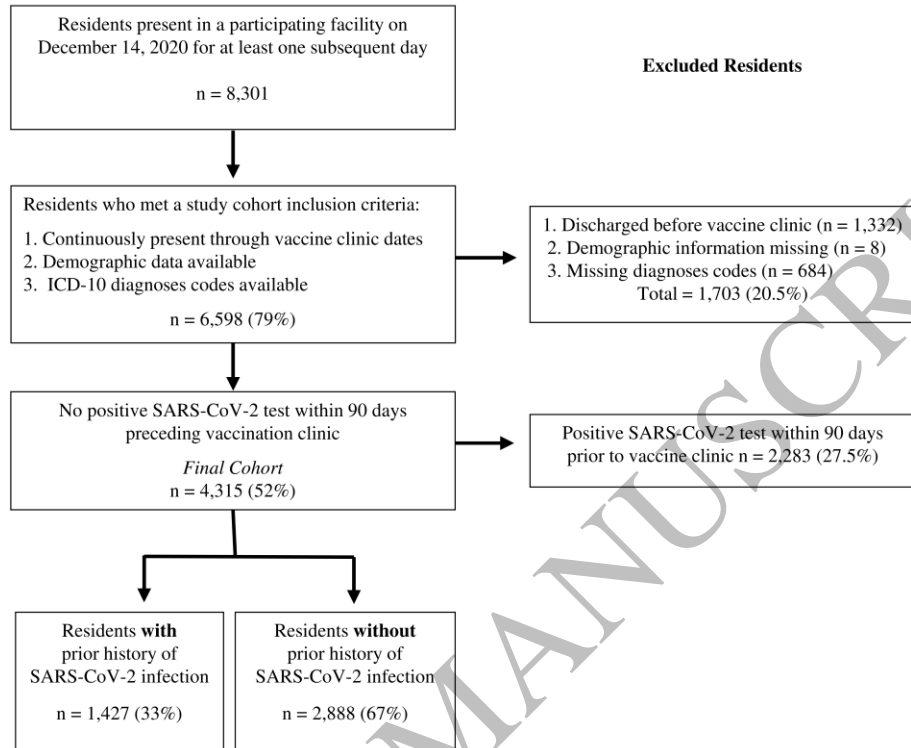
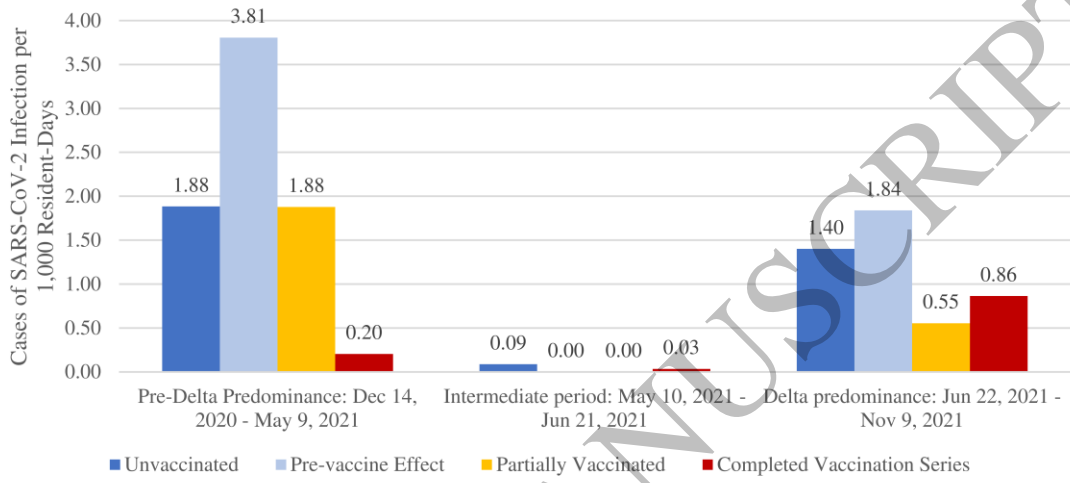


Figure 1
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Figure 2
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