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Original Study

Ecological Analysis of the Decline in Incidence Rates of COVID-19 Among Nursing Home Residents Associated with Vaccination, United States, December 2020–January 2021



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A B S T R A C T

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Objective: To evaluate if facility-level vaccination after an initial vaccination clinic was independently associated with COVID-19 incidence adjusted for other factors in January 2021 among nursing home residents.

Design: Ecological analysis of data from the CDC's National Healthcare Safety Network (NHSN) and from the CDC's Pharmacy Partnership for Long-Term Care Program.

Setting and Participants: CMS-certified nursing homes participating in both NHSN and the Pharmacy Partnership for Long-Term Care Program.

Methods: A multivariable, random intercepts, negative binomial model was applied to contrast COVID-19 incidence rates among residents living in facilities with an initial vaccination clinic during the week ending January 3, 2021 (n = 2843), vs those living in facilities with no vaccination clinic reported up to and including the week ending January 10, 2021 (n = 3216). Model covariates included bed size, resident SARS-CoV-2 testing, staff with COVID-19, cumulative COVID-19 among residents, residents admitted with COVID-19, community county incidence, and county social vulnerability index (SVI).

Results: In December 2020 and January 2021, incidence of COVID-19 among nursing home residents declined to the lowest point since reporting began in May, diverged from the pattern in community cases, and began dropping before vaccination occurred. Comparing week 3 following an initial vaccination clinic vs week 2, the adjusted reduction in COVID-19 rate in vaccinated facilities was 27% greater than the reduction in facilities where vaccination clinics had not yet occurred (95% confidence interval: 14%–38%, $P < .05$).

Conclusions and Implications: Vaccination of residents contributed to the decline in COVID-19 incidence in nursing homes; however, other factors also contributed. The decline in COVID-19 was evident prior to widespread vaccination, highlighting the benefit of a multifaceted approach to prevention including continued use of recommended screening, testing, and infection prevention practices as well as vaccination to keep residents in nursing homes safe.

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

The authors declare no conflicts of interest.

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Nursing home residents were disproportionately affected by the COVID-19 pandemic in the United States.^{1–3} The US Centers for Disease Control and Prevention's (CDC's) National Healthcare Safety Network (NHSN) surveillance data indicated that >630,000 cases and >127,000 deaths had occurred among nursing home residents by mid-February 2021.⁴ Throughout the spring, summer, and fall of 2020, the Centers for Medicare & Medicaid Services (CMS) required enforced testing and visitation restrictions to reduce incidence of COVID-19, mitigate outbreaks, and protect residents and staff.⁵ During that time, incidence of COVID-19 among residents and staff of nursing homes paralleled the incidence in the community.^{6,7}

In fall 2020, on top of existing comprehensive infection prevention and mitigation strategies, distribution of point-of-care testing capacity to nursing homes augmented efforts to screen and test residents and staff for mitigating the spread of COVID-19. By late November, the incidence of COVID-19 among residents and staff of nursing homes no longer followed the pattern observed in the community.⁶ Subsequently, following a peak in COVID-19 case rates in mid-December (31 cases per 1000 resident-weeks), the rate of COVID-19 among nursing home residents declined to 3.7 per 1000 resident-weeks by February 14, 2021.⁶ Also, in late December 2020, national implementation of vaccination against COVID-19 for long-term care residents and personnel began through the CDC's Pharmacy Partnership for Long-term Care Program (PPP), henceforth referred to as the Pharmacy Partnership Program (PPP). This program established a series of three 1-day, on-site clinics at participating facilities during which vaccination was offered to residents and staff by select pharmacy partners. Among facilities that participated in the PPP, coverage with the first dose of a 2-dose vaccination series was 78% for nursing home residents and 38% for staff by January 17, 2021.⁸

The contribution of partial-course vaccination, or of other factors, to the downward change in case rates of COVID-19 among nursing home residents during late 2020 and early 2021 was uncertain. For the period when the decline occurred and during many preceding months, multiple infection prevention and control measures were concurrently implemented at facility, community, and individual levels. We conducted an ecological analysis among residents of CMS-certified nursing homes that reported surveillance data to NHSN and that also participated in the PPP. The aim was to examine the relationship between facility-level vaccination status and the decline in COVID-19 incidence adjusted for other factors during December 28, 2020–January 31, 2021, among nursing home residents.

Methods

Background Description of COVID-19 Temporal Pattern

To describe the pattern of case rates of COVID-19 among residents and staff in nursing homes in the context of community incidence, we plotted the resident and staff case rates superimposed on the incidence rate (new cases of COVID-19 per 100,000 population) in the community for the period of May 24, 2020, through February 14, 2021. The case rate per 1000 resident-weeks among residents and staff in nursing homes was calculated from data on cases (numerator) and resident census by week (denominator) collected by NHSN. The incidence rate in the community was sourced from the Department of

Health and Human Services platform for data sharing ("HHS Protect") which supports the federal response to the pandemic and consolidates data feeds of county-level cases and deaths; this rate did not exclude cases from nursing homes.

Data Sources

National Healthcare Safety Network (NHSN)

The CDC's NHSN began nationwide, facility-level surveillance for COVID-19 in nursing homes on April 26, 2020. A federal mandate issued by CMS required nursing homes to commence routine reporting of COVID-19 cases among residents and staff beginning May 25, 2020.⁹ Surveillance data in NHSN included cases of COVID-19 occurring among residents and staff, testing practices, resident occupancy, and shortages of personal protective equipment and staff. Cases of COVID-19 were defined as residents or staff diagnosed by a positive SARS-CoV-2 viral nucleic acid or antigen test, regardless of symptoms.¹⁰ Approximately 15,400 CMS-certified nursing homes from all states reported aggregate data to NHSN every week. Throughout this article, the term "nursing home" refers to the approximately 15,400 CMS-certified skilled nursing facilities and nursing facilities.

Pharmacy Partnership for Long-Term Care Program (PPP)

The PPP was a federal vaccine administration program launched to enable vaccination of long-term care residents and staff at no cost to facilities. Participating pharmacies provided services to support facility-level coordination, cold-chain management for Pfizer-BioNTech or Moderna COVID-19 vaccines, on-site vaccination, and federal reporting requirements. Following each on-site vaccination clinic, data regarding vaccination of residents and staff were uploaded to a CDC-HHS data portal ("Tiberius"). Most nursing homes enrolled in the program through NHSN, allowing unique NHSN facility identifiers to be linked to the PPP database. By the date of this study, the program provided vaccination services for 13,710 CMS-certified nursing homes. Data for 10,651 of these nursing homes were available in both data sources and used for analysis.

Pharmacies began contacting facilities to schedule on-site vaccination on December 14, 2020. Clinic dates were chosen based on facility preference and to ensure efficient distribution. In some instances, facilities might have deferred clinics to later dates because of ongoing COVID-19 outbreaks or to allow more time to work with staff and residents to increase uptake. State and local jurisdictions chose the start date for clinics; 13 jurisdictions started the week of December 21, and remaining jurisdictions started on or after December 28 through January 31.

Definitions of Time Points

Because the week ending January 3 was the first week a substantial number of facilities held vaccination clinics, data from 5 time points were included: T0 (week ending January 3), T1 (week ending January 10), T2 (week ending January 17), T3 (week ending January 24), and T4 (week ending January 31). Week T0 was the vaccination index week; weeks T3 and T4 were the considered "impact" weeks based on evidence that 12–14 days after vaccination is required for immune response.^{11,12}

Study Population

Analysis included 6051 (of 10,651) nursing homes that had data available from both NHSN and the PPP for the week ending January 3, 2021 (T0), and excluded facilities that had instituted vaccination clinics during the week ending January 10 (T1). The cohort was stratified into vaccinated and nonvaccinated groups based on timing of vaccination clinics to explore the role of facility-level vaccination status (having held 1 or more vaccination clinics vs none). The vaccinated group was defined as nursing homes where any resident received the first dose of vaccination against SARS-CoV-2 during T0. The nonvaccinated comparison group was defined as nursing homes where no resident had been vaccinated at T0 and T1. Although we excluded the 3809 facilities that provided vaccination in week T1 to minimize contamination of the comparison group, vaccination in the comparison group could have occurred in subsequent weeks (T2 onward). We assumed the 2415 facilities most subject to contaminating the comparison group by undergoing vaccination clinics in T2 (the week ending January 17) had provided vaccination too close to the impact week of T3 to cause substantive impact from a single dose of vaccine. About 96% of study facilities reported weekly COVID-19 incidence data for all 5 weeks from T0 to T4. The number of nursing homes in both vaccinated and comparison groups contributing weekly data were identical during the study period.

Statistical Analysis

Since the COVID-19 case rate among residents was declining before vaccination began, and because the baseline COVID-19 rate at T0 differed between the vaccinated and nonvaccinated comparison groups, we used a paired difference-in-difference approach to assess the impact of being in the vaccinated group on case rates of COVID-19 among residents. Relative changes in case rates between 2 consecutive weeks were compared between the 2 groups calculated as:

$$\text{Relative percentage change} = \left(\frac{\text{weekly changes of COVID - 19 incidence rates in any vaccinated group}}{\text{weekly changes of COVID - 19 incidence rates in the comparison group}} - 1 \right) \times 100\%$$

To assess the independent role of facility-level vaccination on the outcome of facility-level incidence, we conducted generalized log-linear mixed effect modeling (negative binomial distribution) using the log of occupied beds as offset and adjusting for multiple factors that we have found to be associated with incidence of COVID-19 through our analyses during the pandemic. These factors were facility-level and county-level covariates that varied with time: resident SARS-CoV-2 testing rate (same week as outcome), number of staff with COVID-19 in the previous 2 weeks, cumulative incidence among residents (May 25, 2020, through prior week), number of residents admitted with COVID-19 in the previous week, and community incidence rate in the previous week. The covariates of bed size and county-level social vulnerability index (SVI; higher score means higher vulnerability) were time-fixed.¹³

Vaccination of staff was not included in the model because it demonstrated collinearity with vaccination of residents. Shortages of staffing, personal protective equipment, and testing supplies were not statistically significant for inclusion in the model. We evaluated the requirement of a random component by conducting covariance tests and incorporated the facility-level variable as a random effect to account for differential baseline characteristics among all nursing homes. Model diagnostics were evaluated by examining fit statistics

and residual graphs to assess for either high leverage or outlier influential data points. The difference-in-difference approach using a mixed model allowed us to estimate the relative percentage change between the weekly rate change (incidence rate ratio in each pair of 2 consecutive weeks) of any vaccinated group and the comparison group. We assessed 4 pairwise comparisons (T1 vs T0, T2 vs T1, T3 vs T2, T4 vs T3) by incorporating interaction terms between vaccination status and time in the model and by computing contrast estimates between the vaccinated and nonvaccinated comparison groups. An alternative version of these pairwise comparisons based on a more saturated mixed model that included additional significant interaction terms was used to evaluate whether association of these covariates with COVID-19 incidence changed over time, and to confirm that the reduction due to vaccination coverage was sustained during the study period. Statistical significance was defined at an alpha of 0.05.

This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy. [See, eg, 45 CFR part 46.102(l)(2), 21 CFR part 56; 42 USC §241(d); 5 USC §552a; 44 USC §3501 et seq.]

Results

Figure 1 shows the temporal patterns of unadjusted rates of COVID-19 among residents and staff in nursing homes and in the community. In late 2020, COVID-19 case rates in nursing homes declined and diverged from the pattern of the rate in community cases. The decline began before vaccination clinics started; although the incidence rate of COVID-19 increased in the community at the end of December, the rate of COVID-19 cases did not increase in nursing homes. Figure 2 shows the unadjusted temporal pattern of case rates of COVID-19 among nursing home residents by vaccination group and nonvaccinated comparison group.

Baseline Characteristics and COVID-19 Rates Between the Vaccinated and Comparison Groups

In the index week, the median facility-level vaccination coverage (partial or complete vaccination) among residents in the vaccinated group was 76% (interquartile range: 59%–90%). Facility-level baseline characteristics between the vaccinated and comparison groups are presented in Table 1. Facilities in the vaccinated group had a median baseline case rate of 19.7 per 1000 occupied beds and facilities in the nonvaccinated, and the comparison group started the study with a median baseline case rate of 20.7 ($P = .7$). The distribution of vaccinated vs unvaccinated facilities was significantly different among geographical regions; 64% of facilities in the Northeast region were categorized into the vaccinated group, whereas 42% to 45% of facilities in the other regions were vaccinated ($P < .001$).

Impact of Initial Vaccination Clinic in Nursing Homes

When factors associated with COVID-19 incidence were included along with vaccination status in multivariable modeling, there were no significant differences in the change of COVID-19 case rates between residents of the vaccinated group and residents of the

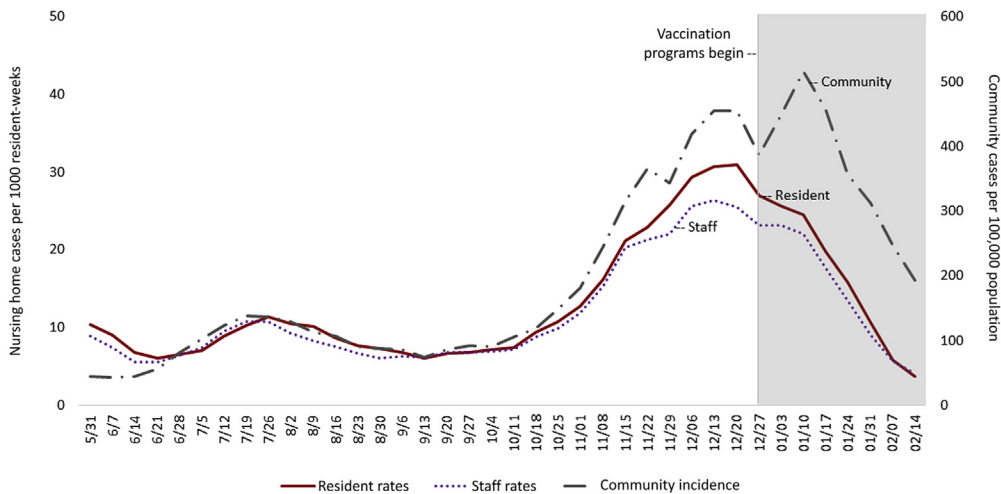


Fig. 1. COVID-19 cases* per 1000 resident-weeks¹ among residents and staff in nursing homes vs community cases per 100,000 population, May 2020–February 2021. The graph shows the temporal pattern of the COVID-19 case rates among residents and staff in nursing homes superimposed on the incidence rate in the community. It highlights the decline in COVID-19 incidence rates among residents and staff of nursing homes that began before the decline in incidence in the community and before vaccination. *Confirmed COVID-19 cases were diagnosed by a positive SARS-CoV-2 viral nucleic acid or antigen test. ¹Resident-weeks were calculated as the total number of occupied beds on the day data were reported.

comparison group during postvaccination weeks T1 and T2 (Figure 3). In postvaccination week T3, however, the reduction in COVID-19 case rates in the vaccinated group was 27% (95% confidence interval 14%–38%) greater than the reduction among the comparison group [Table 2; 27% reduction from T2 to T3 obtained from $(1 - \exp(-0.20 - 0.11)) = 1 - \exp(-0.31) = 27\%$]. In post-vaccination week T4, the reduction in COVID-19 case rates in the vaccinated group was 17% (95% confidence interval 2%–31%) more than the reduction in the comparison group [Figure 3, Table 2; 17% reduction from T3 to T4 obtained from $(1 - \exp(-0.39 - (-0.20))) = 1 - \exp(-0.19) = 17.4\%$].

Effect of Other Covariates on Resident COVID-19 Rates

Other facility-level and county-level covariates, in addition to vaccination status, were independently associated with COVID-19 case rates among the residents in the multivariable modeling (Table 2). The number of staff with COVID-19 infections in the prior 2 weeks was positively associated with resident COVID-19 rates. Higher resident COVID-19 testing rates were associated with higher resident COVID-19 case rates. Facilities in the highest category of resident cumulative case rates were less likely to report resident COVID-19 cases in the following week. Higher numbers of residents newly admitted with COVID-19 in the prior week were associated with lower onset of resident COVID-19 rates in the following week. Nursing homes with greater than 60 and less than 138 beds, and location in a county with higher SVI and higher county-level community COVID-19 incidence rates, were associated with higher COVID-19 rates (Table 2).

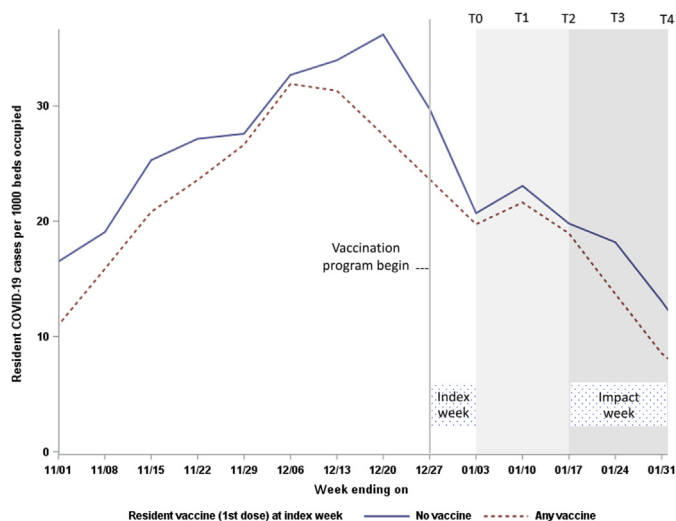


Fig. 2. COVID-19 cases per 1000 resident beds occupied, nursing homes. Case rates of COVID-19 among residents in nursing homes by category of facility. The 2 categories shown are facilities with an initial clinic for vaccination as part of the Pharmacy Partnership Program during the week ending January 3 (Index Week also called T0) (vaccination group) and facilities that did not have vaccination clinics that week (nonvaccinated, comparison group). The Impact Weeks (also called T3 and T4) were defined based on the expectation that development of immunity takes several weeks.

Discussion

In December 2020–January 2021, the temporal case rate of COVID-19 in nursing homes declined and diverged from the pattern in community cases. This study showed that the declining rate in residents was significantly associated with facility-level vaccination status following a single vaccination clinic as well as with multiple facility- and community-level factors. There was a 27% (95% confidence interval 14%–38%) decline in case rates of COVID-19 in residents associated with nursing homes that had held at least 1 vaccination clinic compared with residents of nursing homes that had not held a vaccination clinic during the same time interval.

Cases among nursing home residents continued to decline into March, reaching new lows each week.⁶ Although facility-level vaccination was associated with the observed decline, COVID-19 rates in nursing homes had diverged from the pattern exhibited in the community earlier in December and did not experience the postholiday peaks. Because COVID-19 rates in nursing homes had begun to decrease before widespread administration of vaccine, there remained the possibility of residual confounding from additional factors that could not be adjusted for in the statistical models.

Table 1
Baseline Characteristics (at Index Week T0) of Nursing Homes by Vaccination Status

Characteristics	Vaccinated Group (n = 2843)	Comparison Group (n = 3216)	P Value*
COVID-19 case rates in residents per 1000 beds occupied, median	19.7	20.7	.7
Case rates at index week by vaccination subgroup:			
1%-59% of residents vaccinated	30.4	20.7	<.001
60%-79% of residents vaccinated	18.4	20.7	.39
≥80% of residents vaccinated	11.8	20.7	<.001
Resident vaccine coverage per 100 beds occupied, median Percent (IQR)	76 (59-90)		
Bed size, median (IDR)	105 (50-81)	96 (46-159)	.01
Beds occupied, median (IDR)	68 (31-130)	59 (29-108)	<.001
COVID-19 POC and non-POC test rate in residents per 100 beds occupied (index week), median (IDR)	0.85 (0-1.86)	0.75 (0-1.86)	.03
Residents admitted with COVID-19 in the prior week, median (IDR)	0 (0-2)	0 (0-1)	.02
Residents with COVID-19 cases in the prior 2 wk, median (IDR)	0 (0-12)	0 (0-14)	.01
Cumulative case rates among residents (from May 25 through prior week) per 100 beds, median (IDR)	0.20 (0.01-0.65)	0.26 (0.01-0.68)	.34
Staff with COVID-19 cases in the prior 2 wk, median (IDR)	2 (0-9)	2 (0-9)	.24
County-level community incidence rate per 100,000 population, median (IDR)	350 (178-563)	335 (177-527)	.09
County-level social vulnerability index, median (IDR)	0.47 (0.14-0.82)	0.52 (0.14-0.89)	<.001

IDR, interdecile range; POC, point of care.

Vaccinated group of facilities had held an initial vaccination clinic as of January 3, 2021.

Social vulnerability index: higher score means higher vulnerability.

*Derived from nonparametric test based on Mood scores.

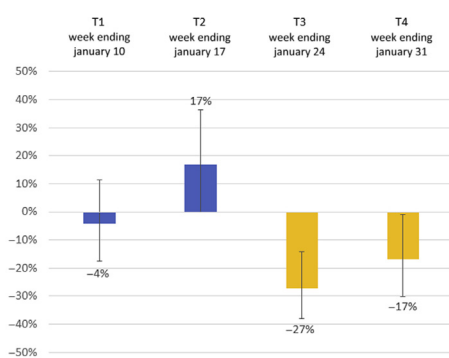
There are several examples of unmeasured confounding factors that may have been associated with facilities categorized as undergoing vaccination. Facilities in the vaccination group had undertaken vaccination in the early weeks of the PPP, and 2 of the coverage subgroups had significantly lower rates of COVID-19 cases in the index week than did the comparison group. The reasons for this difference are unclear, but it is plausible that earlier scheduling of vaccination clinics might have been associated with stronger infection prevention and testing programs, which in turn could have contributed to declines in this group. Effective infection prevention and control strategies in nursing homes guided by nonoutbreak testing of staff and by outbreak-triggered rapid serial testing of both residents and staff has been modeled as being able to successfully prevent up to 92% of SARS-CoV-2 infections.^{5,14,15} We did not directly assess the impact of infection control guidance and regulations recommended by CDC and CMS that were under way, such as new case management, focused

surveys and audits, and direct support from CDC-CMS strike teams. Further complicating interpretation of differences in the rate of decline between the comparison groups, facilities having active outbreaks may have postponed their initial vaccination clinics pending resolution of the outbreak and were therefore over-represented in the unvaccinated facility group.

Assessing the real-world impact of COVID-19 vaccination and other infection control and prevention measures in nursing homes is complicated but critical. Given the disproportionate impact of COVID-19 on nursing homes¹⁻³ combined with evolving information about the effectiveness of vaccines in older persons, these analyses have important implications for ongoing planning and guidance. Understanding the best options to protect nursing home residents was increasingly critical as the Pharmacy Partnership Program ended, and jurisdictions were faced with complicated decisions for continued vaccination and policies for visitation and testing. Because approximately 25% of facilities have new resident admissions and discharges every 30 days,¹⁶ facility-level vaccination coverage could decline, presenting uncertain levels of increased risk. Real-world studies monitoring vaccination coverage, duration of protection, and vaccine effectiveness in this vulnerable population will need to be conducted based on the full 2-dose regimen.

CDC's NHSN is the nation's surveillance program for health care-associated conditions.^{17,18} For the purposes of monitoring the pandemic, in collaboration with CMS, NHSN was able to rapidly expand from approximately 3000 nursing homes performing monthly reporting to receiving weekly reporting from the approximately 15,400 CMS-certified nursing homes and more than 1000 additional facilities for assisted living and intermediate care for individuals with intellectual disabilities.^{9,19,20} The results of this study and others^{7,8,21} demonstrate the importance of NHSN as a national surveillance infrastructure for nursing homes and other health care delivery populations. NHSN has the infrastructure to continue capturing vaccination coverage data after the PPP concludes to provide ongoing insight into the safety of this health care population.

This study is subject to several limitations. First, the analysis was an ecological, observational study that could neither isolate nor account for all factors that might have contributed to differences in rate reductions. Because participation in the PPP was voluntary, there was some risk of selection bias that the difference-in-difference approach may not address. However, we sought to mitigate this risk through the mixed effects model and facility and community covariates. Second, it



Relative percent change = $\frac{\text{Weekly rate change in COVID-19 rates (incidence rate ratio between 2 consecutive weeks) in the vaccinated group (any vaccination)} - 1}{\text{Weekly rate changes in COVID-19 rates (incidence rate ratio between 2 consecutive weeks) in the comparison group}} \times 100\%$

Fig. 3. Relative percentage change in case rates of COVID-19 among residents of nursing homes for the vaccinated group of nursing homes vs the unvaccinated comparison group of nursing homes. Loglinear model—adjusted comparison shows the impact of facility-level vaccination coverage after adjustment for other covariates. The estimate of percentage relative change for each week relative to the previous week is shown by the height of the bars. Yellow bars indicate a percentage change that is statistically different from zero; blue bars indicate a percentage change that is not significantly different from zero. Vertical lines represent the 95% confidence interval around the relative percentage change. Confidence bounds were derived from the regression model and equal to parameter estimate \pm (1.96 \times standard error of parameter estimate).

Table 2
Generalized Log-Linear Mixed Model Showing Factors Associated With COVID-19 Incidence Rates Among Residents of Nursing Homes—National Healthcare Safety Network

Factors	Parameter Estimate	Standard Error	95% Lower Limit	95% Upper Limit	P Value
Resident vaccination coverage (first dose) at vaccination index week					
Yes	−0.03	0.07	−0.16	0.10	.64
No	Ref	—	—	—	—
Time					
Postvaccination week 1 (T1)	−0.27	0.05	−0.38	−0.17	<.001
Postvaccination week 2 (T2)	−0.64	0.06	−0.75	−0.52	<.001
Postvaccination week 3 (T3)	−0.62	0.06	−0.73	−0.50	<.001
Postvaccination week 4 (T4)	−0.62	0.06	−0.74	−0.50	<.001
Vaccination index week (T0)	Ref	—	—	—	—
Interaction between resident vaccinated group × Time					
Vaccinated group × T1	−0.04	0.08	−0.19	0.11	.58
Vaccinated group × T2	0.11	0.08	−0.04	0.27	.16
Vaccinated group × T3	−0.20	0.08	−0.37	−0.04	.01
Vaccinated group × T4	−0.39	0.09	−0.56	−0.22	<.001
Vaccinated group × T0	Ref	—	—	—	—
Nursing Home bed size					
61–88	0.14	0.07	0.01	0.27	.04
89–137	0.19	0.05	0.09	0.29	.00
≤60 or ≥138	Ref	—	—	—	—
Resident COVID-19 point-of-care (POC) and non-POC testing rate per 100 beds occupied (same week)					
6–<54	1.31	0.07	1.17	1.45	<.001
54–<94	1.70	0.07	1.56	1.84	<.001
94–<123	1.80	0.07	1.66	1.94	<.001
≥123	2.55	0.07	2.41	2.69	<.001
<6	Ref	—	—	—	—
Cumulative incidence rates among residents (cumulative from May 25 through prior week) per 100 beds					
5–<18	0.35	0.06	0.24	0.46	<.001
18–<36	0.45	0.06	0.33	0.57	<.001
36–<56	0.31	0.06	0.18	0.44	<.001
≥56	−0.15	0.07	−0.30	−0.01	.03
<5	Ref	—	—	—	—
Number of residents newly admitted with COVID-19 in the prior week					
≥5	−0.24	0.08	−0.40	−0.09	.00
0–4	Ref	—	—	—	—
Number of staff with COVID-19 confirmed cases during prior 2 wk					
1	0.23	0.05	0.13	0.33	<.001
2	0.51	0.05	0.40	0.61	<.001
3–4	0.85	0.05	0.75	0.95	<.001
≥5	1.57	0.05	1.47	1.67	<.001
0	Ref	—	—	—	—
County-level community incidence rate per 100,000 population					
253–345	0.14	0.05	0.04	0.25	.01
345–<432	0.33	0.06	0.23	0.44	<.001
432–<556	0.47	0.06	0.35	0.58	<.001
≥556	0.60	0.06	0.48	0.73	<.001
<253	Ref	—	—	—	—
County-level social vulnerability index					
0.25–<0.43	0.20	0.07	0.06	0.34	.01
0.43–<0.61	0.27	0.07	0.12	0.41	.00
0.61–<0.77	0.19	0.07	0.05	0.34	.01
≥0.77	0.22	0.08	0.08	0.37	.00
<0.25	Ref	—	—	—	—
Covariance parameter estimates					
Dispersion factor = 1.59; variance of the random effect = 31.73.					
Cov Parm	Subject	Estimate	Standard Error	Variance	
Intercept	orgid	1.8618	0.07238	31.72656	
Scale		1.5864	0.04128		

is likely that the vaccination status of each comparison group did not remain constant, which may have attenuated estimated differences. Specifically, residents of the unvaccinated comparison group may have begun to receive vaccine during each succeeding week. Because we took an intent-to-treat approach, the risk of this misclassification would be toward minimizing a true effect. Third, it is possible that

facilities with no vaccination clinics recorded by the PPP during the relevant weeks had vaccinated residents. To avoid this potential contamination of the nonvaccinated group, we only included facilities that eventually conducted vaccination clinics through the program, and the risk of this misclassification would be toward minimizing a true effect. Fourth, the unit of analysis was at the facility level as

patient-level case and vaccination data were not available, thus potentially masking important direct impacts. Finally, because facility-level vaccination coverage of staff was collinear with coverage of residents, it could not be assessed in the same model. However, vaccination of staff was low at 38% overall.⁸

Conclusions and Implications

In February 2021, the COVID-19 case rate among nursing home residents declined to the lowest since reporting began in May 2020. The divergence of the pattern of the case rates of COVID-19 in nursing homes from the general community prior to implementation of vaccination campaigns suggested that other factors, such as existing infection prevention strategies, played a role in the decline during December 2020 and January 2021. Our analysis also provides evidence that implementation of vaccination programs contributed to the decline even after a single vaccination clinic. Vaccination should be a central part of a multifaceted strategy that includes other infection prevention practices to keep residents in nursing homes safe.

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