

## **Associations of incomplete SARS-CoV-2 vaccination among patients with unstable housing in Houston**

J. Thomas Gebert  
Evan Shegog  
Emily Xiao  
James Fan  
Mary McEvoy, RN, MSN/MPH  
Audrey Lopez  
Dana Clark, MD

**J. Thomas Gebert** is affiliated with the Medical Scientist (MD/PhD) Training Program at Baylor College of Medicine and the Graduate Program in Development, Disease Models, and Therapeutics at Baylor College of Medicine. **Evan Shegog** and **James Fan** are affiliated with the McGovern Medical School at The University of Texas Health Science Center at Houston. **Emily Xiao** is affiliated with the School of Medicine at Baylor College of Medicine. **Mary McEvoy** and **Audrey Lopez** are affiliated with Healthcare for the Homeless – Houston. **Dana Clark** is affiliated with the Department of Family Medicine at Baylor College of Medicine. Please address all correspondence to J. Thomas Gebert, Medical Scientist (MD/PhD) Training Program, Baylor College of Medicine, 1 Baylor Plaza, Houston, TX, 77030; email: gebert@bcm.edu.

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Abstract: Vaccination is a safe and effective way to protect against SARS-CoV-2. Two of the three authorized SARS-CoV-2 vaccines require two doses, presenting logistical challenges. Those with unstable housing face barriers that amplify these challenges. In this study we utilized a database maintained by Healthcare for the Homeless – Houston to determine the rates of partial vaccination among those with unstable housing in Houston (n=294). We then performed post-hoc analyses to identify predictors of partial vaccination. Our key finding was that 30% of those with unstable housing missed their second dose, a proportion far higher than the national average. Those with permanent supportive housing and those who had a Harris County Gold Card (financial assistance for health care costs) were more likely to return for dose two, while those who were younger, living on the streets, or staying in a temporary homeless shelter were more likely to miss the second dose.

Key words: SARS-CoV-2, COVID-19, vaccination, homeless, partial, incomplete.

Individuals with unstable housing are at an elevated risk for both SARS-CoV-2 infection and severe disease.<sup>1,2</sup> However, vaccination offers an effective approach to decreasing SARS-CoV-2 incidence and severity.<sup>3,4</sup>

The U.S. Food and Drug Administration (FDA) has granted approval to the SARS-CoV-2 vaccines from Pfizer-BioNTech and emergency use authorization to those from Moderna and Johnson & Johnson. Data from the initial clinical studies suggest that complete vaccination with any of the three vaccines offers similar protection against SARS-CoV-2.<sup>3,4</sup> While the vaccine from Johnson & Johnson requires just one dose, those from both Pfizer-BioNTech and Moderna require two doses spaced three or four weeks apart, respectively. Receiving just one dose of a two-dose vaccine offers partial protection against SARS-CoV-2, but this protection is inferior to a complete series or a single dose of the Johnson & Johnson vaccine.<sup>5</sup> Considering factors that may limit an individual's likelihood of returning for a second dose may help patients and their physicians decide which vaccine is appropriate for them. This is a particularly important consideration for individuals with unstable housing, who face an abundance of barriers that make it difficult to access the health care system.

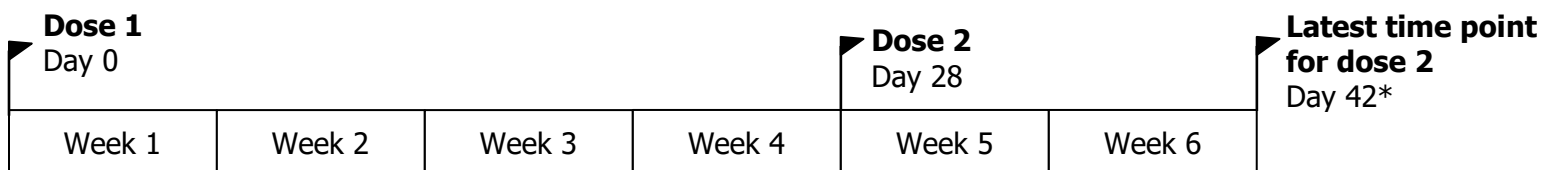
In this study we aimed to determine the proportion of patients who did not receive a second dose after receiving the first dose of the Moderna vaccine at Healthcare for the Homeless – Houston (HHH), an organization that exclusively provides care for individuals who are homeless or at high risk for becoming homeless in downtown Houston, Texas. Additionally, we aimed to identify medical and sociodemographic factors associated with missed second doses.

## **Methods**

We queried a database maintained by Healthcare for the Homeless – Houston (HHH) that documents all individuals who received the SARS-CoV-2 vaccine at one of its facilities. At the time of our study, HHH was administering both the one-dose JNJ-78436735 vaccine from Johnson & Johnson and the two-dose mRNA-1273 vaccine from Moderna, which we will refer to as the "J&J vaccine" and the "Moderna vaccine" respectively. The HHH vaccination database includes patient name, medical record number, date of birth, preferred language, race, ethnicity, and date of vaccine administration. Both the first dose and second dose of the Moderna vaccine are documented as separate encounters within the database. Thus, we were able to

identify individuals who had received the first dose but not the second dose of the Moderna vaccine and those who received a complete Moderna vaccination series. We defined a “missed second dose” or “partial/incomplete vaccination,” as any individual who had received their first dose more than six weeks prior to the time of our analysis and had not yet received a second dose. We chose the six-week timepoint based upon the recommended vaccination schedule from both Moderna and the Center for Disease Control and Prevention (CDC) (Figure 1). According to this timeline, patients should receive the second dose of mRNA-1273 four weeks after the first dose but may receive the second dose up to six weeks (42 days) following the first dose if necessary.

### Moderna mRNA-1273 Vaccine Schedule



\*No data on vaccine efficacy for 2<sup>nd</sup> doses administered beyond this point

Figure 1. Timeline of recommended vaccine schedule. For the purposes of this study, we classified individuals as having missed their 2<sup>nd</sup> dose if they were beyond 6 weeks from their first dose and had not yet received their second. This is in accordance with CDC guidelines which state that dose 2 should be administered 28 days after dose 1 but may be administered up to 42 days following dose 1 when necessary. Timeline adapted from Fowlkes A, Gaglani M, Groover K, et al. Effectiveness of COVID-19 vaccines in preventing SARS-CoV-2 infection among frontline workers before and during B.1.617.2 (Delta) variant predominance — eight U.S. locations, December 2020–August 2021. *MMWR Morb Mortal Wkly Rep.* 2021 Aug 27;70(34):1167-9.<sup>6</sup>

Using the HHH database, we first determined the mean age of those who received the J&J vaccine and those who received the Moderna vaccine. We calculated odds ratios with 95% confidence intervals to compare the populations based on race, ethnicity, or preferred language. Following this initial comparison, we focused our analyses on those who received the Moderna vaccine with incomplete vaccination series being our primary outcome of interest.

We next performed a retrospective review of electronic medical records to identify medical and socioeconomic characteristics of the individuals who received the Moderna vaccine at HHH. We documented the date of the most recent medical encounter prior to vaccination, dichotomized as one year or less, or more than one year. We classified each encounter as an outpatient visit with primary care, outpatient visit with psychiatry, outpatient visit with therapist/case manager/other, emergency room visit, or other. We also documented whether each subject had been previously tested for or diagnosed with SARS-CoV-2. We documented the year of the subject's most recent influenza vaccination, dichotomized as two years or less, or more than two years. We documented any chronic medical condition(s) for each patient along with smoking status, drug use, and alcohol use. For patients who were currently homeless or had a history of homelessness, we classified their housing situation as shelter, street, transitional housing, doubled up (i.e., living with friend/family), or permanent supportive housing. We documented each patient's primary mode of transportation to the clinic, classified as walk, drive, ride from friend/family, or public transit. Finally, we classified the insurance status of each subject as uninsured/self-pay, Medicare/Medicaid, private insurance, or Gold Card (Harris County financial assistance for public health benefits). We collected the indicated data from electronic medical records held by HHH. The data were deidentified, collated into a spreadsheet, and stored on an encrypted server maintained by the Baylor College of Medicine.

We then stratified our study population into two outcome groups: those who received just one dose of the Moderna vaccine (partial vaccination) vs. those who received both doses (complete vaccination). We calculated odds ratios with 95% confidence intervals to determine whether any of the investigated factors were associated with an increase in the likelihood of partial vaccinated. We used the Baptista-Pike method to calculate 95% confidence intervals for each odds ratio. We performed all analysis using GraphPad Prism version 9.2.0. for Windows, GraphPad Software, San Diego, California USA, [www.graphpad.com](http://www.graphpad.com).

Prior to its initiation, our study was approved by the institutional review boards at the Baylor College of Medicine, Healthcare for the Homeless – Houston, and the University of Texas McGovern Medical School.

## Results

As of July 2021, a total of 294 individuals had received at least one dose of a SARS-CoV-2 vaccine at Healthcare for the Homeless – Houston. Comparing the demographics of those who received the J&J vaccine vs. the Moderna vaccine, we found that the populations were similar in race, ethnicity, and age (Table 1).

**TABLE 1.**  
**COMPARISON OF AGE, PREFERRED LANGUAGE, RACE AND ETHNICITY OF HEALTHCARE FOR THE HOMELESS – HOUSTON PATIENTS RECEIVING THE JANSSEN VACCINE MANUFACTURED BY JOHNSON & JOHNSON (J&J) VS. THE MRNA-1273 VACCINE FROM MODERNA.**

	<b><u>J&amp;J</u></b>	<b><u>Moderna</u></b>	<b><u>Overall</u></b>
<b>Average age, years (SD)</b>	49.4 (10.6)	55.1 (12.4)	53.3 (12.1)
<b>English-speaking, count (%)</b>	90 (96%)	186 (93%)	276 (94%)
<b>Race, count (%)</b>			
White	36 (38%)	57 (29%)	93 (32%)
Black/African American	47 (50%)	120 (60%)	167 (57%)
Asian	8 (9%)	1 (1%)	9 (3%)
Unreported	14 (15%)	17 (9%)	31 (11%)
<b>Ethnicity, count (%)</b>			
Hispanic/Latino	8 (9%)	30 (15%)	38 (13%)
Not Hispanic/Latino	79 (84%)	166 (83%)	245 (83%)
Unreported	1 (1%)	4 (2%)	5 (2%)
<b>Total</b>	<b>94</b>	<b>200</b>	<b>294</b>

After filtering out individuals who received the one-dose Johnson & Johnson vaccine and individuals who were still within a six-week window from receiving their first dose of the Moderna vaccine, we were left with 200 patients who had received a minimum of one dose of the Moderna vaccine.

Of the 200 patients who received the first dose, 140 (70%) received the second dose within a six-week window. The remaining 60 patients (30%) were beyond six weeks from their first dose and had not yet received dose 2 (Figure 2).

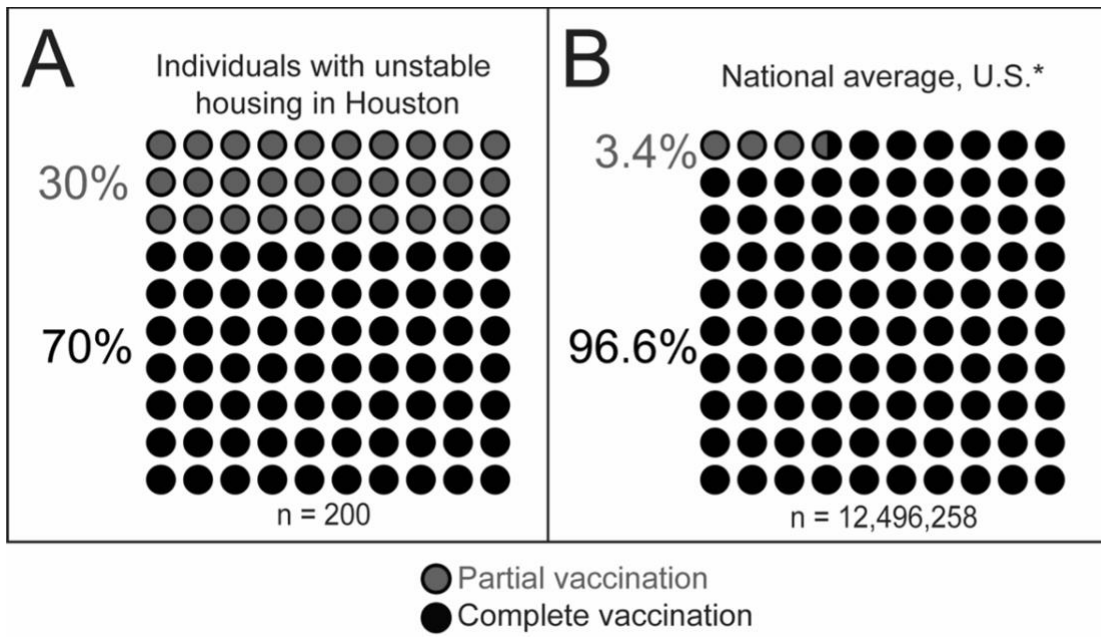


Figure 2. Proportion of patients in the HHH cohort (A) who missed the second SARS-CoV-2 vaccination dose (red) vs. the CDC-published national average (B).

Note:

\*Data adapted from Fowlkes A, Gaglani M, Groover K, et al. Effectiveness of COVID-19 vaccines in preventing SARS-CoV-2 infection among frontline workers before and during B.1.617.2 (Delta) variant predominance — eight U.S. locations, December 2020–August 2021. *MMWR Morb Mortal Wkly Rep.* 2021 Aug 27;70(34):1167-9.<sup>6</sup>

The factor that was most strongly associated with complete vaccination was housing type, with those living in “permanent supportive housing” being nearly 10 times more likely to receive the second dose compared with all other classes of homelessness (OR=9.8, Table 2). Those living on the street (OR=0.2118, Table 2) or in a temporary shelter (OR=0.10, Table 2) were least likely to receive complete vaccination. We also found that the average age of those who completed the vaccination series was 6.3 years higher than that of those who were only partially vaccinated (57.0 years, SD =11.26 vs. 50.73 years, SD=13.7). The time since the most recent medical encounter prior to vaccination, dichotomized as one year or less year vs. more than one year, showed little difference between partially vs. fully vaccinated groups (OR=1.5). However, regardless of recency, those whose most recent medical encounter was in the emergency room were less likely to complete the vaccination series compared with those whose most recent medical encounter was in any other setting (OR=0.15, Table 2).

**TABLE 2.**  
**DEMOGRAPHIC FACTORS AND ASSOCIATION WITH INCOMPLETE VACCINATION. FOR EACH DEMOGRAPHIC FACTOR, INDIVIDUALS WITH UNREPORTED VALUES WERE DROPPED FROM ANALYSES. OR = ODDS RATIO, CI = CONFIDENCE INTERVAL**

Factor	Total count	Complete vaccination		Partial vaccination		OR	95% CI
		Count	%	Count	%		
<b>Biological Sex</b>							
Female	56	98	68%	46	32%	1.408	.695 to 2.887
Male	144	42	75%	14	25%		
<b>Race</b>							
White	57	42	74%	15	26%	1.311	.6538 to 2.597
Black/African American	120	82	68%	38	32%	.8392	.4561 to 1.543
Asian	1	0	0%	1	100%	0	.000 to 3.904
Unreported	17	12	71%	5	29%		
<b>Ethnicity</b>							
Hispanic/Latino Not	30	20	67%	10	33%	.8333	.3619 to 1.882
Hispanic/Latino	166	116	70%	50	30%	.9667	.4405 to 2.112
Unreported	4	4	100%	0	0%	∞	.4223 to ∞
<b>Preferred language:</b>							
<b>English</b>		130	70%	56	30%	.9286	.3099 to 2.923
Prefers language other than English		10	71%	4	29%		
<b>Time since most recent encounter</b>							
≤1yr	77	56	73%	21	27%	1.481	.7794 to 2.787
>1yr	98	63	64%	35	36%		
Unreported	10	10	100%	0	0%		
<b>Context of most recent encounter</b>							
Vaccination	1	1	100%	0	0%	NA	NA
Outpatient visit, primary care	110	83	75%	27	25%	.5639	.3185 to 1.000



Outpatient visit, psychiatry	17	8	47%	9	53%	.3778	.1370 to .9856
Outpatient visit, therapist/other	3	0	0%	3	100%	0	.000 to .5301
Emergency Dept.	18	5	28%	13	72%	.147	.05601 to .4306
Other (add to notes)	39	31	79%	8	21%	2.077	.9245 to 4.574
Unreported	12	12	100%	0	0%		

**Previous COVID Test**

Yes	72	49	68%	23	32%	.9384	.5124 to 1.786
No	121	84	69%	37	31%		

**Previous COVID dx**

Yes	4	3	75%	1	25%	1.362	.1993 to 17.96
No	189	130	69%	59	31%		

**Year of most recent flu vaccine**

≤2	85	64	75%	21	25%	1.801	.9381 to 3.289
>2	42	27	64%	15	36%		
Unreported	73	49	67%	24	33%		

**Currently homeless**

Yes	74	49	66%	25	34%	.7691	.4096 to 1.468
No	110	79	72%	31	28%		
Unreported	16	12	75%	4	25%		

**Housing type**

Shelter	22	9	41%	13	59%	.1001	.03369 to .2969
Transitional Housing	12	11	92%	1	8%	3.259	.5100 to 36.52
Doubled up	3	3	100%	0	0%	∞	.2341 to ∞
Street	14	7	50%	7	50%	.2118	.06959 to .6500
Permanent Supportive Housing	64	60	94%	4	6%	9.844	3.289 to 27.84
Other	2	2	100%	0	0%		
Unreported	83	48	58%	35	42%		

**Current smoker**

Yes	103	71	69%	32	31%	.8953	.4614 to 1.680
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No	80	57	71%	23	29%		
Unreported	17	12	71%	5	29%		
<b>Alcohol use</b>							
Yes	75	54	72%	21	28%	1.198	.6316 to 2.243
No	107	73	68%	34	32%		
Unreported	18	13	72%	5	28%		
<b>Drug use</b>							
Yes	48	31	65%	17	35%	.7059	.3530 to 1.401
No	129	93	72%	36	28%		
Unreported	22	16	73%	6	27%		
<b>Unemployed</b>							
Yes	90	62	69%	28	31%	.9118	.3575 to 2.308
No	24	17	71%	7	29%		
Unreported	86	61	71%	25	29%		
<b>Insurance Status</b>							
Gold card	14	14	100%	0	0%	∞	1.737 to ∞
Uninsured (self-pay)	111	72	65%	39	35%	1.679	.9018 to 3.108
Private Insurance	6	5	83%	1	17%	2.248	.2964 to 26.91
Medicare/Medicaid	62	43	69%	19	31%	.9948	.5207 to 1.916
Unreported	7	6	86%	1	14%		
<b>Transportation</b>							
Drive	15	9	60%	6	40%	.3667	.1152 to 1.317
Ride from friend/family	3	1	33%	2	67%	.1415	.009633 to 1.326
Public Transit	41	34	83%	7	17%	2.429	.8011 to 6.956
Walk	12	10	83%	2	17%	1.705	.3649 to 8.435
Unreported	129	86	67%	43	33%		

Finally, we investigated insurance status as a predictor of complete vs. partial vaccination. We classified each subject as having no insurance (uninsured/self-pay), Gold Card (Harris County financial assistance for public health benefits), private insurance, or Medicare/Medicaid. Those with a Gold Card were significantly

more likely to receive the second dose (OR=inf, Table 2), while there was no association with any other type of insurance or lack thereof.

Biological sex, race, ethnicity, influenza vaccination within the last two years, smoking status, alcohol use, drug use, unemployment, mode of transportation to clinic, and insurance status all showed no association with partial vs. complete vaccination (Table 2). We also found little difference in the average number of years since the patient's most recent influenza vaccination between groups ( $u_{\text{parital}} = 2.61$  years,  $SD=2.51$ ;  $u_{\text{complete}} = 2.45$  years,  $SD=2.32$ ).

## Discussion

Vaccination is both safe and effective for the prevention of SARS-CoV-2.<sup>6</sup> However, two out of the three FDA-authorized vaccines require multiple doses. This presents logistical challenges for the implementation of vaccination efforts, particularly for individuals with unstable housing. Based on data published by the CDC,<sup>7</sup> around 3.4% of individuals in the U.S. received just one dose of either the Pfizer or Moderna vaccine and are therefore considered partially vaccinated against SARS-CoV-2. Our study suggests that 30% of individuals with unstable housing in Houston missed their second dose, suggesting they are 8.8 times more likely to miss their second dose compared with the general U.S. population as published by the CDC.<sup>7</sup>

An important finding from this study was that those with a history of homelessness who were currently in a permanent supportive housing facility were 9.8 times more likely to receive both doses of the vaccine relative to those in all other settings of homelessness. Stable housing likely facilitates follow-up as it allows for easier and more consistent communication with patients by phone or mail.

Our study also suggests that those with unstable housing who are younger in age are less likely to receive the second dose, as the average age of those partially vaccinated was 6.3 years lower than those who were fully vaccinated. We also observed that the average age of those who received the Moderna vaccine was 5.7 years older than those who received the J&J vaccine. This is likely attributable to the CDC prioritization of vaccination for those >65 years old in combination with the earlier FDA approval of the Moderna vaccine.

As a retrospective study, our analyses were limited to information previously documented in each patient's medical record. For some predictors, such as mode of transportation to clinic, poor documentation likely impeded detection of an effect. Rates of documentation were similar between groups for each predictor, suggesting that reporter bias was not a major concern. It is also possible that some of the patients who did not return to HHH for a second dose of the Moderna vaccine received the second dose elsewhere. However, the majority of patients in our study population who did not receive a second dose received their first dose between March-April 2021 (57 out of 60 patients), when vaccinations were not yet widely available on a walk-in basis. Finally, given that HHH serves only those who are homeless, have a history of homelessness, or are at high risk for becoming homeless, we did not have a stably housed control group.

Altogether, the results from this study suggest that those with unstable housing in Houston are much more likely to miss the second dose of a two-dose SARS-CoV-2 vaccine than the general U.S. population. Further work is needed to confirm these findings on a national scale before they can be extrapolated to those with unstable housing at large. A one-dose vaccine may be more appropriate for those with unstable housing, particularly for those who are younger in age, living in a shelter or on the streets, or have recently been in the emergency room. However, physicians should work with their patients to determine their best option and providers should not hesitate to initiate a two-dose vaccine for individuals with unstable housing if it is available. Our results show that the majority (70%) of patients with unstable housing will still return for the second dose, and partial vaccination still yields partial protection.<sup>8</sup>

## References

1. Baggett TP, Keyes H, Sporn N, et al. Prevalence of SARS-CoV-2 infection in residents of a large homeless shelter in Boston. *JAMA*. 2020 Jun 2;323(21):2191-2.  
<https://doi.org/10.1001/jama.2020.6887>  
PMid:32338732

2. Leifheit KM, Chaisson LH, Medina JA, et al. Elevated mortality among people experiencing homelessness with COVID-19. *Open Forum Infect Dis*. 2021 Jun 4;8(7):ofab301.  
<https://doi.org/10.1093/ofid/ofab301>  
PMid:34291120
3. Tenforde MW, Olson SM, Self WH, et al. Effectiveness of Pfizer-BioNTech and Moderna vaccines against COVID-19 among hospitalized adults aged  $\geq 65$  years — United States, January–March 2021. *MMWR Morb Mortal Wkly Rep*. 2021 May 7;70(18):674-9.
4. Sadoff J, Gray G, Vandebosch A, et al. Safety and efficacy of single-dose Ad26.COV2.S vaccine against Covid-19. *N Engl J Med*. 2021 Jun 10;384(23):2187-201. Epub 2021 Apr 21.  
<https://doi.org/10.1056/NEJMoa2101544>  
PMid:33882225
5. European Centre for Disease Prevention and Control (ECDC). Partial COVID-19 vaccination, vaccination following SARS-CoV-2 infection and heterologous vaccination schedule: summary of evidence. Stockholm, Sweden: ECDC, 2021. Available at <https://www.ecdc.europa.eu/en/publications-data/partial-covid-19-vaccination-summary>.
6. Fowlkes A, Gaglani M, Groover K, et al. Effectiveness of COVID-19 vaccines in preventing SARS-CoV-2 infection among frontline workers before and during B.1.617.2 (Delta) variant predominance — eight U.S. locations, December 2020–August 2021. *MMWR Morb Mortal Wkly Rep*. 2021 Aug 27;70(34):1167-9.  
<https://doi.org/10.15585/mmwr.mm7034e4>  
PMid:34437521
7. Kriss JL, Reynolds LE, Wang A, et al. COVID-19 vaccine second-dose completion and interval between first and second doses among vaccinated persons — United States, December 14, 2020–February 14, 2021. *MMWR Morb Mortal Wkly Rep*. 2021 Mar 19;70(11):389-95.  
<https://doi.org/10.15585/mmwr.mm7011e2>  
PMid:33735162

8. Moline HL, Whitaker M, Deng Li, et al. Effectiveness of COVID-19 vaccines in preventing hospitalization among adults aged  $\geq 65$  years — COVID-NET, 13 states, February–April 2021. *MMWR Morb Mortal Wkly Rep.* 2021 Aug 13;70(32):1088-93.

<https://doi.org/10.15585/mmwr.mm7032e3>

PMid:34383730