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APPENDIX

Exhibit A-1. Geographic distribution of mRNA vaccine administration among Medicare beneficiaries measured at the county level, overall and by U.S. regions

Exhibit A-2. Predicted probability of Pfizer-BioNTech for first dose of mRNA vaccine among Medicare beneficiaries (January 1, 2021 and July 31, 2021) and booster dose of mRNA vaccine among Medicare beneficiaries (August 1, 2021 and April 31, 2022)

Exhibit A-3. Odds-ratio of Pfizer-BioNTech for first dose of mRNA vaccine among Medicare beneficiaries (January 1, 2021 and July 31, 2021) and booster dose of mRNA vaccine among Medicare beneficiaries (August 1, 2021 and April 31, 2022)

Exhibit A-4. Description of COVID-19 vaccine coverage in the study sample relative to CDC vaccine administration data for individuals 65 years and older

Exhibit A-5. Association between receiving the Pfizer-BioNTech vs Moderna mRNA vaccine as the first COVID-10 vaccine dose and urbanicity by percent vaccine capture

Data

This project was funded as two administrative supplements to a large cooperative agreement (U54AG063546) to examine how COVID has affected the older adult population, particularly those living with dementia. We established a public-private partnership between CVS Health, Walgreens, and academic institutions funded by the National Institute on Aging (NIA) to link customer data from CVS Health and Walgreens to Medicare enrollment and claims information, which resulted in a cohort of over 38 million individuals. A comprehensive overview of the data source and linkage, as well as how to access the linked data, is described in Hayes et al (1).

Our data is at the patient level, and it is possible that a patient may have received Pfizer vaccines for their primary series and Moderna for their booster dose(s), or vice versa. However, 94.65% of beneficiaries received a Pfizer vaccine for both their first dose and booster dose. Given the small percentage of beneficiaries who switched vaccine products between their first dose and booster dose, we did not require that individuals received the same vaccine product for both the first dose and booster dose.

A public GitHub repository for this study was created and contains all statistical code and 3 county-level datasets (t.ly/NvbCD). Due to data privacy and use requirements, small cell sizes and other information (e.g., file paths) have been redacted. As such, there are small differences in the data source used for the study and public use files. Any inquiries about these files should be directed to the corresponding author.

Results

Exhibit A-1. Geographic distribution of mRNA vaccine administration among Medicare beneficiaries measured at the county level, overall and by U.S. regions

	Overall	Northeast	Midwest	South	West
Dose 1					
Number of counties	3,139	217	1,055	1,420	447
Number of Medicare beneficiaries vaccinated across counties	14,448,485	3,075,797	3,620,658	4,938,507	2,813,523
Number of Medicare beneficiaries vaccinated across counties, median (IQR)	800 (2,706)	5,161 (14,843)	576 (1,936)	876 (2,278)	346 (2,555)
% Pfizer, median (IQR)	48.38% (30.96%)	53.56% (20.39%)	49.46% (34.02%)	45.45% (29.78%)	51.73% (33.39%)
Booster Dose					
Number of counties	3,140	217	1,055	1,422	446
Number of Medicare beneficiaries vaccinated across counties	19,151,132	4,167,652	4,178,690	7,105,985	3,698,805
Number of Medicare beneficiaries vaccinated across counties, median (IQR)	978 (3,353)	6,505 (21,495)	636 (2,155	1,044 (2,926)	405 (3,138)
% Pfizer, median (IQR)	42.61% (28.17%)	52.45% (17.23%)	44.19% (24.92%)	39.16% (31.04%)	39.99% (27.50%)

Exhibit A-2. Predicted probability of Pfizer-BioNTech for first dose of mRNA vaccine among Medicare beneficiaries (January 1, 2021 and July 31, 2021) and booster dose of mRNA vaccine among Medicare beneficiaries (August 1, 2021 and April 31, 2022)

Month Year	Large Central Metro		Large Fringe Metro		Medium Metro		Small Metro		Micropolitan		Non-Core	
	Pred. Prob	95% CI	Pred. Prob	95% CI	Pred. Prob	95% CI	Pred. Prob	95% CI	Pred. Prob	95% CI	Pred. Prob	95% CI
A. First Dose												
January 2021	62.3%	62.2-62.3	58.3%	58.2-58.4	54.1%	54.0-54.2	51.3%	51.1-51.4	48.8%	48.6-49.0	43.9%	43.7-44.1
February 2021	54.0%	53.9-54.1	50.4%	50.3-50.4	46.5%	46.4-46.6	44.0%	43.8-44.1	38.3%	38.1-38.5	35.1%	34.9-35.3
March 2021	62.7%	62.6-62.8	59.1%	59.0-59.2	60.1%	60.0-60.2	54.1%	63.9-54.3	45.4%	45.1-45.6	39.8%	39.5-40.1
April 2021	62.7%	62.6-62.9	59.0%	58.8-59.1	60.0%	59.8-60.2	54.9%	54.5-55.2	46.1%	45.7-46.5	43.3%	42.8-43.8
May 2021	63.0%	62.8-63.3	57.1%	56.8-57.3	58.5%	58.3-58.8	55.7%	55.2-56.1	46.7%	46.2-47.2	42.4%	41.8-43.1
June 2021	70.8%	70.4-71.1	65.8%	65.4-66.2	65.1%	64.7-65.5	63.3%	62.6-63.9	53.9%	53.1-54.6	49.6%	48.6-50.5
July 2021	71.3%	71.0-71.6	66.1%	65.7-66.4	64.8%	64.4-65.1	62.3%	61.8-62.9	52.6%	52.0-53.2	49.1%	48.3-49.9
B. Booster Dose												
August 2021	56.9%	56.6-57.1	58.3%	58.1-58.5	52.5%	52.2-52.7	53.0%	52.6-53.5	47.8%	47.3-48.4	38.9%	38.2-39.7
September 2021	88.6%	88.5-88.6	88.9%	88.8-89.0	89.2%	89.1-89.3	89.0%	88.9-89.1	87.5%	87.3-87.7	89.2%	82.6-83.2
October 2021	61.9%	61.9-62.0	59.0%	58.9-59.1	56.6%	56.5-56.7	55.3%	55.2-55.4	46.5%	46.7-47.0	41.1%	40.9-41.3
November 2021	43.9%	43.8-44.0	40.3%	40.2-40.4	38.3%	38.2-38.4	36.5%	36.3-36.6	30.3%	30.2-30.5	26.7%	26.5-26.9
December 2021	53.2%	53.1-53.4	48.8%	48.7-48.9	46.9%	46.8-47.1	44.0%	43.8-44.2	36.4%	36.2-36.6	32.6%	32.3-32.9
January 2022	56.5%	56.3-56.7	52.3%	52.2-52.5	51.3%	51.1-51.5	49.3%	49.0-49.6	40.2%	39.9-40.6	36.8%	36.3-37.3
February 2022	59.4%	59.1-59.8	54.9%	54.5-55.3	54.0%	53.6-54.5	50.6%	49.9-51.3	40.4%	39.6-41.2	37.9%	36.9-38.9
March 2022	55.0%	54.6-55.4	52.3%	51.9-52.7	50.4%	49.9-51.0	50.2%	49.4-51.1	40.9%	40.0-41.8	37.9%	36.6-39.1
April 2022	51.4%	51.2-51.7	49.7%	49.5-50.0	48.5%	48.2-48.8	47.9%	47.4-48.4	37.1%	36.5-37.7	30.7%	30.0-31.5

Exhibit A-3. Odds-ratio of Pfizer-BioNTech for first dose of mRNA vaccine among Medicare beneficiaries (January 1, 2021 and July 31, 2021) and booster dose of mRNA vaccine among Medicare beneficiaries (August 1, 2021 and April 31, 2022)

	Odds-ratio	95% Confidence Interval
First Dose		
Large Central Metro	reference	reference
Large Fringe Metro	0.843	0.841-0.846
Medium Metro	0.767	0.765-0.770
Small Metro	0.669	0.666-0.671
Micropolitan	0.540	0.537-0.542
Non-Core	0.455	0.452-0.457
Booster Dose		
Large Central Metro	reference	reference
Large Fringe Metro	0.880	0.878-0.882
Medium Metro	0.807	0.805-0.810
Small Metro	0.746	0.743-0.748
Micropolitan	0.530	0.528-0.533
Non-Core	0.424	0.421-0.426

Sensitivity analyses

A limitation of our study was our inability to capture COVID-19 vaccinations that were not billed to Medicare or administered at a CVS Health or Walgreens pharmacy. Thus, data were missing vaccines administered for free or not recorded in administrative data sources (e.g., those administered at mass vaccination clinics) (2). We assessed the extent of missing vaccines in our data source and the impact of missing vaccines on our inferences. We cannot, however, distinguish whether missing data differs by vaccine product (Pfizer-BioNTech versus Moderna).

We obtained county-level data on all first doses administered to individuals 65 years and older published by the U.S. Centers for Disease Control and Prevention (CDC) (3). The CDC's data includes vaccination counts among all individuals ages 65 years and older covered by Medicare as well as those not enrolled in Medicare.

For every U.S. county, we calculated the percentage of vaccines we captured relative to the CDC data, and categorized counties according to the extent of missingness: low capture (< 20.0% of CDC vaccinations), medium capture (20% to < 50% of CDC vaccinations), and high capture (> 50% of CDC vaccinations). While our data captures mRNA vaccinations among Medicare beneficiaries only, the CDC county-level data includes both mRNA and Johnson & Johnson vaccinations as well as vaccinations among non-Medicare beneficiaries 65 years and older. Therefore, the degree of missingness in our study's data will be overestimated.

We stratified the primary analysis by individuals living in counties with low, medium, and high vaccine capture to assess the robustness of the primary analysis by degree of data completeness. We also described differences in the extent of missingness by urbanicity.

Across all U.S. counties, our data's measure of mRNA vaccine administrations captured median 36% (Interquartile range=27%-46%) of dose 1 vaccinations reported by the CDC (Exhibit A-1). The extent of missingness varied slightly by urbanicity, with generally greater vaccine capture in urban areas than rural areas. When stratified by low, medium, and high vaccine capture, we replicated the primary analysis – individuals living in more urban counties were more likely to receive Pfizer while those living in more rural counties were more likely to receive Moderna (Exhibit A-2). As the CDC denominator includes Janssen vaccinations and non-Medicare beneficiaries, we underestimate vaccine coverage for our data source (1).

Exhibit A-4. Description of COVID-19 vaccine coverage in the study sample relative to CDC vaccine administration data for individuals 65 years and older

	Overall[3]	Low vaccine capture (< 20% of CDC vaccinations[1])	Medium vaccine capture (20%-50% of CDC vaccinations[1])	High vaccine capture (> 50% of CDC vaccinations[1])
N individuals	12,464,850	1,250,565	9,152,114	2,062,171
N counties	2,648	1,226	1,202	220
Proportion of vaccine capture at county level[1]				
Median (IQR)	0.36 (0.27-0.46)	0.16 (0.13-0.17)	0.35(0.28-0.41)	0.54(0.53-0.57)
Urbanicity[2], number of individuals (%)				
Large central metro	3,387,150 (27.17%)	305,772 (24.45%)	2,702,620 (29.53%)	378,758 (18.37%)
Large fringe metro	3,725,508 (29.89%)	212,355 (16.98%)	2,558,742 (27.96%)	954,411 (46.28%)
Medium metro	2,851,564 (22.88%)	243,756 (19.49%)	2,153,225 (23.53%)	454,583 (22.04%)
Small metro	1,094,573 (8.78%)	157,456 (12.59%)	828,240 (9.05%)	108,877 (5.28%)
Micropolitan	894,005 (7.17%)	179,571 (14.36%)	610,085 (6.67%)	104,349 (5.06%)
Non-core	512,050 (4.11%)	151,655 (12.13%)	299,202 (3.27%)	61,193 (2.97%)

Notes: IQR=interquartile range; CDC=Centers for Disease Control and Prevention; Column percentages are reported.

[1] To estimate percent vaccine coverage, and approximately determine the extent of missing data in our data source, we divided the number of mRNA vaccines captured in our data source by the total number of first doses administered to individuals 65 years and older data published by the Centers for Disease Control and Prevention (CDC) (3) . As the CDC denominator is not restricted to Medicare beneficiaries and includes all first doses (i.e., the Janssen vaccine), these likely reflect underestimates of vaccine capture.

[2] Urbanicity was defined using the National Center for Health Statistics (NCHS) Urban-Rural Classification Scheme for Counties (4). Non-core counties are defined as nonmetropolitan counties that are not in a micropolitan area statistical area.

[3] Overall column includes individuals 65+ years of age who belong to the county that did not have missing CDC county vaccination numbers for Dose 1.

Exhibit A-5. Association between receiving the Pfizer-BioNTech vs Moderna mRNA vaccine as the first COVID-10 vaccine dose and urbanicity by percent vaccine capture

	Low vaccine capture (< 20% of CDC vaccinations[1])		Medium vaccine capture (20%-50% of CDC vaccinations[1])		High vaccine capture (> 50% of CDC vaccinations[1])	
	Predicted Probability of Pfizer	OR (95%CI)	Predicted Probability of Pfizer	OR (95%CI)	Predicted Probability Of Pfizer	OR (95%CI)
Urbanicity[2], n (%)						
Large central metro	0.647	ref	0.576	ref	0.639	ref
Large fringe metro	0.570	0.725 (0.717-0.733)	0.539	0.862 (0.859-0.865)	0.597	0.837 (0.831-0.844)
Medium metro	0.550	0.667 (0.660-0.674)	0.528	0.822 (0.820-0.825)	0.594	0.828(0.821-0.836)
Small metro	0.493	0.531 (0.524-0.537)	0.485	0.693 (0.690-0.696)	0.600	0.847 (0.835-0.859)
Micropolitan	0.479	0.502 (0.493-0.508)	0.439	0.577 (0.574-0.580)	0.452	0.466 (0.459-0.472)
Non-core	0.436	0.423 (0.418-0.429)	0.398	0.483 (0.483-0.491)	0.284	0.224 (0.220-0.228)

Notes: IQR=interquartile range; CDC=Centers for Disease Control and Prevention; OR=Odds Ratio; CI=confidence interval

[1] To estimate percent vaccine coverage, and approximately determine the extent of missing data in our data source, we divided the number of mRNA vaccines captured in our data source by the total number of first doses administered to individuals 65 years and older data published by the Centers for Disease Control and Prevention (CDC) (3). As the CDC denominator is not restricted to Medicare beneficiaries and includes all first doses (i.e., the Janssen vaccine), these likely reflect underestimates of vaccine capture.

[2] Urbanicity was defined using the National Center for Health Statistics (NCHS) Urban-Rural Classification Scheme for Counties (4). Non-core counties are defined as nonmetropolitan counties that are not in a micropolitan area statistical area.

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