

Supplementary Appendix

Methods Supplementary

Data sources and Medicare claims files

The following files from the Center for Medicare and Medicaid Services (CMS) were the primary data used after the CVS and Walgreens customer data were matched to a Medicare beneficiary (January 2016 to August 2022): Common Medicare Environment/Medicare Beneficiary Summary File (MBSF; demographics, enrollment, cost/utilization, history of chronic conditions); Medicare Parts A and B claims (e.g., inpatient, outpatient, carrier, long-term care claims, which include vaccination billings that would occur outside of the pharmacy setting), Medicare Advantage Encounter Data (outpatient/carrier encounters for Medicare Advantage enrollees; available through December 2020), and Part D

event data (prescription drug claims). Medicare claims data are administrative billing data generated through healthcare encounters (e.g., physician visits, hospitalizations) that can be used to derive longitudinal information about vaccine receipt, diagnoses, medication use, facilities use, healthcare utilization, and other clinical variables. Diagnoses are provided via International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) codes [33]. Procedures (including vaccination events, diagnostic testing, etc.) are captured via Common Procedural Terminology (CPT) codes. Medical devices and supply use are captured using Healthcare Common Procedure Coding System (HCPCS) codes. Other CMS files available for linkage include the Outcome and Assessment Information Set (OASIS; 2016-2020), the Inpatient Rehab Facility-Patient Assessment Instrument (IRF-PAI; 2016-2020), and the Long-term Care Minimum Data Set (MDS (2016-2022)).

Supplementary Table 1: Common Procedural Terminology (CPT) Codes used to Identify COVID-19 vaccinations in Medicare claims data

Vaccine type, Dose	Manufacturer	Dose	CPT Code
BNT162b2	Pfizer, BioNTech	Dose 1	0001A
mRNA-1273	Moderna	Dose 1	0011A
JNJ-78436735	Johnson & Johnson	Dose 1	0034A
BNT162b2	Pfizer, BioNTech	Dose 2	0002A
mRNA-1273	Moderna	Dose 2	0012A
BNT162b2	Pfizer, BioNTech	Dose 3	0003A
BNT162b2	Pfizer, BioNTech	Booster Dose	0004A
BNT162b2	Pfizer, BioNTech	Booster Dose	0124A
JNJ-78436735	Johnson & Johnson	Booster Dose	0031A
mRNA-1273	Moderna	Booster Dose	0134A
mRNA-1273	Moderna	Dose 3	0013A
mRNA-1273	Moderna	Booster Dose	0064A

Supplementary Table 2.1: Number of CVS Health IDs by match/no-match across all records (vaccine and drug history)

Type of record	Match type	All CVS Health IDs		CVS Health IDs 65+	
		#	%	#	%
<i>Total</i>		27,086,723	100.0%	22,165,224	100.0%
All Records	Match	24,016,176	88.7%	20,906,184	94.3%
	One CVS Health ID to One BID	20,138,112	74.3%	17,574,851	79.3%
	Many CVS Health IDs to One BID	1,541,987	5.7%	1,340,133	6.0%
	Many BIDs to One CVS Health ID, Resolved	2,336,077	8.6%	1,991,200	9.0%
	No Match	3,070,547	11.3%	1,259,040	5.7%
	Potential Candidates not found	2,761,956	10.2%	1,105,319	5.0%
	Many BIDs to One CVS Health ID, Unresolved	308,591	1.1%	153,721	0.7%

Supplementary Table 2.2: Number of Walgreens IDs by match/no-match across all records (vaccine and drug history)

Type of record	Match type	All Walgreens IDs		Walgreens IDs 65+	
		#	%	#	%
<i>Total</i>		23,510,025	100.0%	19,069,353	100.0%
All Records	Match	22,519,900	95.8%	18,311,833	96.0%
	One WAG ID to One BID	20,216,716	86.0%	16,412,633	86.1%
	Many WAG IDs to One BID	1,424,560	6.1%	1,164,851	6.1%
	Many BIDs to One WAG ID, Resolved	878,624	3.7%	734,349	3.9%
	No Match	990,125	4.2%	757,520	4.0%
	Potential Candidates not found	818,512	3.5%	618,630	3.2%
	Many BIDs to One WAG ID, Unresolved	171,613	0.7%	138,890	0.7%

BID – Medicare beneficiary identifier. WAG – Walgreens.

Supplementary Table 2.3: Summary of matched Medicare beneficiary IDs (BIDs) in the COVID VAXines Effects on the Aged (COVVAXAGE) database alive and with a valid address at first observable week of Medicare enrollment*

Data source	BIDs			
	Total		Age 65+	
	n	%	n	%
Total	38,116,281	100.00%	28,251,114	100.00%
CVS Health customer only	16,472,713	43.22%	12,573,226	44.51%
Walgreens customer only	15,398,313	40.40%	10,600,585	37.52%
Both CVS Health and Walgreens	6,245,255	16.38%	5,077,303	17.97%

BID – Medicare beneficiary identifier.

*N = 134,592 beneficiaries died or had an invalid address before their first observable week of Medicare enrollment.

Supplementary Table 3: Characteristics of Matched versus Unmatched IDs (age 65+ only) from CVS Health and Walgreens Databases

	Matched to medicare Beneficiary	Not matched	aSMD
CVS Health			
Average Age in years, mean (SD)	73.8 (7.2)	73.0 (8.1)	0.09
% Female	57%	39%	0.37
Walgreens			
Average Age in years, mean (SD)	74.0 (7.1)	74.0 (7.6)	0.12
% Female	59%	39%	0.41

aSMD-absolute standardized mean difference. An aSMD > 0.10 (10%) is considered to be a large enough difference to be potentially important [24].

Supplementary Table 4: Counts and percentages of beneficiaries with a first dose of a COVID-19 vaccination identified via a medicare claim only, a pharmacy record only, or both, over time in the COVid VAXines effects on the aged (COVVAXAGE) database

year	Month	Medicare only, n	Pharmacy only, n	Both medicare & pharmacy, n	Total N	% Medicare*	% Pharmacy*	% Both*
2020	Dec	47,026	39,832	183,081	269,939	17.42%	14.76%	67.82%
2021	Jan	3,427,518	275,920	1,431,237	5,134,675	66.75%	5.37%	27.87%
	Feb	3,349,877	234,168	1,273,435	4,857,480	68.96%	4.82%	26.22%
	Mar	2,006,305	158,765	644,657	2,809,727	71.41%	5.65%	22.94%
	Apr	768,656	89,367	303,228	1,161,251	66.19%	7.70%	26.11%
	May	363,536	78,693	237,167	679,396	53.51%	11.58%	34.91%
	Jun	127,969	41,096	105,090	274,155	46.68%	14.99%	38.33%
	Jul	139,006	55,760	138,600	333,366	41.70%	16.73%	41.58%
	Aug	218,393	89,011	193,662	501,066	43.59%	17.76%	38.65%

*percentage of total vaccines administered in that month.

