

Supplemental Material

Section 1, Tables 1-4.

Table 1. Percentages of values missing among public use NHIS variables used in the multiple imputation and percentages and means of these variables by linkage, FFS/MA status, and mammography status in year 2004: 2004-2005 NHIS (all women in study cohort, ages 65 or older in 2004)

Public-use Variable Name	Variable label	% missing	Categories	Linkage			FFS or MA in 2004			Mammography claims in 2004		
				Not linked (N=6939)	Linked (N=5198)	P-value ¹	FFS participants (N=4325)	MA participants (N=826)	P-value ¹	No (N=3460)	Yes (N=1703)	P-value ¹
				%	%		%	%		%	%	
ORIGIN_I	Hispanic ethnicity	0	Yes	11.76	9.87	0.001	8.28	15.82	<0.001	11.10	6.22	<0.001
			No	88.24	90.13		91.72	84.18		88.90	93.78	
RACRECI2	Race	0	White	84.84	85.82	<0.001	85.91	85.27	0.87	84.36	88.73	<0.001
			Black	11.47	11.77		11.67	12.32		12.92	9.45	
			Other	3.69	2.40		2.42	2.42		2.72	1.82	
			Married or Living with partner	41.59	44.37		44.15	45.77		40.56	52.27	
R_MARITL	Marriage status	0.96	Widowed/Divorced/ Separated	54.63	51.96	0.001	52.01	51.45	0.28	55.48	44.67	<0.001
			Never married	3.78	3.68		3.84	2.78		3.96	3.06	
			Yes	96.18	97.49		97.76	97.94		97.21	98.94	
CITIZENP	Citizenship	1.17	No	3.82	2.51	<0.001	2.24	2.06	0.74	2.79	1.06	<0.001
			1	42.53	37.56		38.26	34.72		38.47	36.12	
FM_SIZE	Family size	1.33	2	44.21	46.24	<0.001	46.15	47.07	0.18	42.57	53.86	<0.001
			3	7.62	9.37		9.01	10.88		10.74	6.41	
			4	2.97	3.66		3.69	3.42		4.39	2.14	
			5	1.94	2.36		2.17	2.81		2.81	1.19	
			>=6	0.73	0.82		0.72	1.10		1.02	0.30	
			Owned or being bought	79.58	79.38		78.97	82.32		77.61	83.37	
			Rented	17.61	18.07		18.25	16.22		19.72	14.26	
HOUSEOWN	Housing	2.05	Other	2.81	2.55	0.58	2.79	1.45	0.03	2.67	2.37	<0.001
			Less than high school	21.50	22.02		21.92	22.03		25.13	15.45	
			High school/some college/associate	56.80	54.51		54.24	56.54		53.89	56.07	
FM_EDUC1	Family highest education	3.01	College or above	21.70	23.47	0.03	23.84	21.43	0.30	20.98	28.48	<0.001
			Yes	7.35	8.77		9.02	7.61		11.16	3.99	
			No	92.65	91.23		90.98	92.39		88.84	96.01	
PLAADL	Need help with personal care	0	Yes	13.46	18.09	0.004	19.16	12.56	0.19	20.50	13.22	<0.001
			No	86.54	81.91		80.84	87.44		79.50	86.78	
PLAWKNOW	Unable to work due to health problem	0.14	Yes	13.47	18.10	<0.001	19.16	12.58	<0.001	20.51	13.23	<0.01
PLAWKLIM	Limited kind/amount of work	0.22	Limited in work	10.32	11.28		11.78	8.71		11.54	10.76	
			Not limited in work	76.20	70.61		69.06	78.72		67.95	76.01	

Public-use Variable Name	Variable label	% missing	Categories	Linkage			FFS or MA in 2004			Mammography claims in 2004		
				Not linked (N=6939)	Linked (N=5198)	P-value ¹	FFS participants (N=4325)	MA participants (N=826)	P-value ¹	No (N=3460)	Yes (N=1703)	P-value ¹
				%	%		%	%		%	%	
PLAWALK	Have difficulty walk w/o equip?	0.08	Yes	18.30	22.76	<0.001	23.40	20.05	0.04	26.16	16.15	<0.001
			No	81.70	77.24		76.60	79.95		73.84	83.85	
PLAREMEM	Limited by difficulty remembering?	0.18	Yes	7.35	10.03	<0.001	10.46	7.85	0.02	11.95	6.17	<0.001
			No	92.65	89.97		89.54	92.15		88.05	93.83	
LA1AR	Any limitation - all persons, all conditions	0.27	Yes	35.59	41.39	<0.001	42.56	35.43	<0.001	45.25	33.63	<0.001
			No	64.41	58.61		57.44	64.57		54.75	66.37	
PHSTAT	Reported health status	0.41	Excellent	11.55	11.67	0.04	11.59	11.96	0.02	11.10	12.76	<0.001
			Very good	24.63	23.97		23.51	26.81		22.64	26.88	
			Good	36.16	34.28		34.09	35.51		33.63	35.71	
			Fair	20.18	21.66		21.89	19.69		22.38	19.82	
			Poor	7.48	8.42		8.91	6.04		10.24	4.82	
PNMED12M	Need and NOT get medical care 12m	0.21	Yes	3.06	2.71	0.26	2.84	2.17	0.28	3.21	1.76	0.003
			No	96.94	97.29		97.16	97.83		96.79	98.24	
PHOSPYR	In a hospital OVERNIGHT, 12m	0.80	Yes	16.18	18.86	<0.001	19.52	15.96	0.02	20.23	16.35	<0.001
			No	83.82	81.14		80.48	84.04		79.77	83.65	
LACHRONR	Limitation of activity recode by chronic condition status	0	Not limited	64.55	58.66	<0.001	57.49	64.61	<0.001	54.80	66.41	<0.001
			Limited	35.45	41.34		42.51	35.39		45.20	33.59	
PHCDV2W	See health professional in office, etc, 2wk	0.87	Yes	4.32	4.84	0.17	5.09	3.75	0.10	6.00	2.59	<0.001
			No	95.68	95.16		94.91	96.25		94.00	97.41	
P10DVYR	Receive care 10+ times, 12m	1.05	Yes	20.55	24.17	<0.001	25.47	17.43	<0.001	23.67	25.13	0.25
			No	79.45	75.83		74.53	82.57		76.33	74.87	
NOTCOV	Cov stat as used in Health United States	0.54	Not covered	1.60	0.31	<0.001	0.25	0.12	0.47	0.29	0.12	0.23
			Covered	98.40	99.69		99.75	99.88		99.71	99.88	
SINGLE	Single service plan recode	0.49	Yes	12.76	15.68	<0.001	15.93	15.01	0.51	14.19	18.91	<0.001
			No	87.24	84.32		84.07	84.99		85.81	81.09	
PRIVATE	Private health insurance recode	0.62	Yes	53.58	57.59	<0.001	60.07	46.37	<0.001	53.19	67.35	<0.001
			No	46.42	42.41		39.93	53.63		46.81	32.65	
HCSPFYR	Amount family spent for medical care	7.59	Zero	9.03	8.00	<0.001	7.98	7.49	0.20	9.02	5.69	<0.001
			Less than \$500	40.80	35.85		35.25	38.95		36.79	33.94	
			\$500 - \$1,999	31.59	33.10		33.38	32.58		32.55	34.60	
			\$2,000 - \$2,999	8.85	10.41		10.33	10.74		9.74	11.68	
			\$3,000 - \$4,999	5.00	6.30		6.52	4.99		6.01	6.78	
			\$5,000 or more	4.73	6.34		6.54	5.24		5.89	7.32	
PSSRR	Receive income from SS or RR	2.69	Yes	88.24	91.93	<0.001	92.21	93.43	0.23	91.92	93.33	0.07
			No	11.76	8.07		7.79	6.57		8.08	6.67	
POPENS	Receive income from any other pension	4.34	Yes	26.84	29.10	0.007	29.85	25.95	0.02	26.39	35.01	<0.001
			No	73.16	70.90		70.15	74.05		73.61	64.99	
PSSI	Received income from SSI	3.40	Yes	5.23	6.89	<0.001	7.51	2.56	<0.001	7.59	4.91	<0.001
			No	94.77	93.11		92.49	97.44		92.41	95.09	

Public-use Variable Name	Variable label	% missing	Categories	Linkage			FFS or MA in 2004			Mammography claims in 2004		
				Not linked (N=6939)	Linked (N=5198)	P-value ¹	FFS participants (N=4325)	MA participants (N=826)	P-value ¹	No (N=3460)	Yes (N=1703)	P-value ¹
				%	%		%	%		%		
PINRSTR	Receive interest income	7.65	Yes	34.23	42.39	<.0001	42.54	42.95	0.83	37.92	52.15	<.0001
			No	65.77	57.61		57.46	57.05		62.08	47.85	
PDIVD	Receive dividends from stocks, funds, etc.	7.89	Yes	18.27	23.76	<.0001	24.38	21.29	0.06	19.61	32.49	<.0001
			No	81.73	76.24		75.62	78.71		80.39	67.51	
PINCOT	Received income from any other source	3.92	Yes	1.60	1.86	0.27	1.82	2.08	0.62	2.01	1.60	0.31
			No	98.40	98.14		98.18	97.92		97.99	98.40	
PSSAPL	Ever applied for SSI	3.00	Yes	5.05	7.85	<.0001	8.60	3.28	<.0001	8.86	5.50	<.0001
			No	94.95	92.15		91.40	96.72		91.14	94.50	
PSDAPL	Ever applied for SSDI	3.19	Yes	4.65	6.50	<.0001	6.79	4.99	0.05	7.18	5.09	0.005
			No	95.35	93.50		93.21	95.01		92.82	94.91	
PFSTP	Person authorized to receive food stamps	2.36	Yes	3.68	5.94	<.0001	6.32	2.79	<.0001	6.42	4.43	0.004
			No	96.32	94.06		93.68	97.21		93.58	95.57	
MEDICARE	MEDICARE	0.67	Yes	92.43	96.16	<.0001	96.76	95.39	0.05	95.56	98.53	<.0001
			No	7.57	3.84		3.24	4.61		4.44	1.47	
MEDICAID	MEDICAID	0.62	Yes	9.44	12.10	<.0001	12.92	6.30	<.0001	13.53	8.40	<.0001
			No	90.56	87.90		87.08	93.70		86.47	91.60	
INCGRP_I	Total combined family income	0	0 - \$4999	3.63	2.19	<.0001	2.17	1.94	0.20	2.63	1.17	<.0001
			\$5000-\$9999	10.43	10.47		10.71	9.08		11.97	7.40	
			\$10000-\$14999	13.85	14.22		13.76	17.19		15.87	11.04	
			\$15000-\$19999	12.25	11.10		11.01	11.99		11.10	11.22	
			\$20000-\$24999	12.45	11.04		10.82	11.99		10.81	11.45	
			\$25000-\$34999	16.60	15.04		15.28	13.80		13.93	17.20	
			\$35000-\$44999	9.83	10.39		10.43	10.05		9.71	11.74	
			\$45000-\$54999	6.05	7.37		7.35	7.51		6.73	8.63	
			\$55000-\$64999	3.67	4.08		4.05	4.12		3.93	4.35	
			\$65000-\$74999	2.61	3.37		3.35	3.51		3.15	3.82	
			\$75000 and over	8.62	10.73		11.08	8.84		10.17	11.98	
			Mean (SE)	Mean (SE)	P-value	Mean (SE)	Mean (SE)	P-value	Mean (SE)	Mean (SE)	P-value	
AGE_P	Age	0		74.51 (0.08)	74.63 (0.09)	0.51	74.64 (0.10)	74.83 (0.21)	0.42	75.21 (0.11)	73.56 (0.14)	<.0001

Note: FFS=Fee for Service, MA=Medicare Advantage. P-value¹ is to test independence of the NHIS variables among groups (linked vs. unlinked, FFS vs. MA, mammography vs. no mammography).

Table 2 Averages across years of simulated biases, standard deviations, and root mean square errors of estimated percentages of FFS Medicare participants with mammography screening for simulation 1 (simulate screening status and then simulate plan type given screening status), by association of FFS/MA plan type across years.

FFS/MA Plan type association across years	Year	Before-deletion analysis (gold standard)		Available-case analysis			MI: Screening-first			MI: Plan-first			MI: One-step		
		Percent	SD	Bias	SD	RMSE	Bias	SD	RMSE	Bias	SD	RMSE	Bias	SD	RMSE
Low ($\beta = 0.5$)	1	36.29	0.49	5.67	0.85	5.70	-0.03	0.73	0.49	0.14	0.63	0.46	0.01	0.65	0.44
	2	37.38	0.57	4.85	0.81	4.88	-0.11	0.96	0.63	0.14	0.85	0.59	-0.10	0.87	0.58
	3	40.27	0.58	5.04	0.84	5.07	0.01	0.87	0.61	0.28	0.89	0.67	-0.05	0.83	0.56
	4	40.57	0.56	4.97	0.71	5.00	-0.05	0.72	0.54	0.22	0.75	0.56	-0.09	0.81	0.57
	5	40.82	0.51	5.07	0.74	5.10	0.00	0.75	0.60	0.20	0.71	0.63	-0.08	0.67	0.56
Medium ($\beta = 4$)	1	36.29	0.49	5.67	0.85	5.70	-0.11	0.70	0.48	-0.01	0.68	0.44	-0.08	0.66	0.46
	2	36.12	0.58	4.59	0.84	4.62	-0.11	0.89	0.63	-0.07	0.88	0.58	-0.12	0.88	0.59
	3	38.74	0.55	4.77	0.82	4.80	-0.04	0.77	0.54	0.00	0.79	0.54	-0.11	0.76	0.53
	4	38.87	0.51	4.62	0.66	4.65	-0.11	0.70	0.49	-0.06	0.72	0.55	-0.21	0.72	0.55
	5	39.00	0.46	4.70	0.65	4.73	-0.09	0.60	0.49	-0.02	0.59	0.49	-0.16	0.61	0.53
High ($\beta = 7$)	1	36.29	0.49	5.67	0.85	5.70	-0.23	0.73	0.54	0.01	0.70	0.48	-0.10	0.63	0.45
	2	34.58	0.58	4.18	0.80	4.21	-0.26	0.96	0.68	0.02	0.95	0.62	-0.14	0.86	0.56
	3	37.22	0.53	4.39	0.81	4.42	-0.13	0.80	0.62	-0.02	0.82	0.61	-0.16	0.76	0.56
	4	37.11	0.53	4.22	0.66	4.25	-0.13	0.67	0.49	-0.02	0.69	0.50	-0.21	0.67	0.52
	5	37.16	0.47	4.25	0.65	4.27	-0.06	0.66	0.55	-0.06	0.60	0.51	-0.17	0.61	0.50

Note: FFS=Fee for Service, MA=Medicare Advantage

Table 3. Averages across years of simulated biases, standard deviations, and root mean square errors of estimated percentages of FFS participants with mammography screening for simulation 2 (simulate plan type and then simulate screening status given plan type), by association of FFS/MA plan type across years.

FFS/MA Plan type association across years	Year	Before-deletion analysis (gold standard)		Available-case analysis			MI: Screening-first			MI: Plan-first			MI: One-step		
		Percent	SD	Bias	SD	RMSE	Bias	SD	RMSE	Bias	SD	RMSE	Bias	SD	RMSE
Low ($\beta = 0.5$)	1	40.59	0.56	2.94	0.84	2.98	0.28	0.97	0.75	0.00	0.97	0.69	0.07	0.92	0.63
	2	40.57	0.56	2.81	0.79	2.87	-0.05	0.84	0.57	-0.20	0.84	0.62	-0.22	0.84	0.60
	3	43.40	0.49	3.06	0.71	3.10	0.40	0.83	0.70	0.07	0.68	0.46	0.08	0.72	0.44
	4	43.78	0.37	2.98	0.70	3.02	0.07	0.75	0.59	-0.11	0.79	0.60	-0.15	0.72	0.56
	5	44.04	0.46	3.09	0.71	3.14	0.16	0.64	0.56	0.07	0.70	0.58	0.08	0.69	0.56
Medium ($\beta = 4$)	1	40.59	0.56	2.94	0.84	2.98	0.30	1.00	0.79	0.12	0.96	0.65	0.10	0.91	0.61
	2	40.93	0.55	2.87	0.80	2.92	0.05	0.85	0.59	-0.19	0.81	0.58	-0.14	0.85	0.58
	3	43.94	0.47	3.09	0.67	3.14	0.33	0.71	0.58	0.09	0.74	0.55	0.12	0.66	0.49
	4	44.41	0.44	3.02	0.78	3.06	0.07	0.78	0.59	-0.10	0.78	0.57	-0.11	0.77	0.57
	5	44.77	0.45	3.15	0.69	3.19	0.21	0.62	0.50	0.06	0.60	0.49	0.13	0.62	0.50
High ($\beta = 7$)	1	40.59	0.56	2.94	0.84	2.98	0.41	0.95	0.79	0.07	0.93	0.64	-0.01	0.90	0.62
	2	40.98	0.54	2.89	0.78	2.94	0.14	0.84	0.63	-0.23	0.79	0.60	-0.30	0.80	0.64
	3	44.03	0.47	3.17	0.67	3.22	0.54	0.70	0.78	0.07	0.62	0.51	-0.05	0.68	0.48
	4	44.41	0.45	3.11	0.82	3.17	0.30	0.78	0.65	-0.19	0.89	0.69	-0.30	0.84	0.69
	5	44.68	0.46	3.26	0.72	3.31	0.55	0.58	0.72	-0.01	0.68	0.56	-0.04	0.66	0.50

Note: FFS=Fee for Service, MA=Medicare Advantage

Table 4. Ranges of ϕ coefficients for lag 1 to lag 3 and above of FFS/MA coverage and mammography screening among FFS participants by different MI methods. Results of the two simulation studies ($\beta = 7$) and the linked NHIS-Medicare data.

Setup	Methods	ϕ coefficients of FFS/MA coverage			ϕ coefficients of Mammography screening among FFS		
		Lag 1	Lag 2	Lag 3 and above	Lag 1	Lag 2	Lag 3 and above
Simulation 1 $\beta = 7$	Before-deletion analysis	0.89-0.92	0.81-0.85	0.70-0.77	0.43-0.51	0.43-0.54	0.39-0.50
	Available-case analysis	0.88-0.92	0.79-0.85	0.69-0.77	0.43-0.50	0.44-0.53	0.40-0.49
	Screening-first	0.88-0.92	0.79-0.85	0.69-0.77	0.43-0.51	0.44-0.53	0.41-0.49
	Plan-first	0.88-0.92	0.79-0.85	0.69-0.77	0.43-0.51	0.44-0.53	0.41-0.49
	One-step	0.88-0.92	0.79-0.85	0.69-0.78	0.43-0.50	0.43-0.53	0.40-0.49
Simulation 2 $\beta = 7$	Before-deletion analysis	0.92-0.94	0.86-0.88	0.76-0.82	0.41-0.47	0.41-0.46	0.37-0.40
	Available-case analysis	0.92-0.94	0.85-0.88	0.76-0.82	0.41-0.47	0.40-0.45	0.36-0.40
	Screening-first	0.91-0.94	0.84-0.88	0.74-0.81	0.44-0.50	0.43-0.47	0.39-0.43
	Plan-first	0.92-0.94	0.85-0.88	0.75-0.82	0.40-0.48	0.40-0.45	0.36-0.41
	One-step	0.92-0.94	0.85-0.88	0.75-0.82	0.41-0.48	0.40-0.45	0.37-0.41
NHIS-Medicare data	Available-case analysis	0.89-0.95	0.81-0.87	0.70-0.78	0.41-0.45	0.40-0.45	0.34-0.42
	Screening-first	0.85-0.93	0.76-0.83	0.66-0.75	0.40-0.48	0.40-0.47	0.32-0.42
	Plan-first	0.87-0.93	0.77-0.85	0.69-0.76	0.40-0.45	0.40-0.45	0.34-0.40
	One-step	0.88-0.95	0.79-0.87	0.70-0.77	0.40-0.45	0.39-0.46	0.32-0.42

Note: FFS=Fee for Service, MA=Medicare Advantage

Section 2. Simulation 2 setup

For simulation 2, we generated FFS/MA plan type first and then generated screening based on the plan type. We used similar parameters as in simulation 1, where participants with MA coverage at the previous time point are more likely to have MA coverage at the current time, as follows,

$$\text{Logit}(\text{prob}(P_1 = 1)) = -3 + 2X_1 + 2X_8 - 3X_9,$$

$$\text{Logit}(\text{prob}(P_j = 1)) = \text{intercept} + 2X_1 + 2X_8 - 3X_9 + \beta P_{j-1}, j = 2, \dots, 5.$$

Again, we set values for β , the coefficient of P_{j-1} , to be 0.5, 4, and 7 to represent low, medium, and high association of the current plan type with the previous plan type. The screening status is positively related to the two previous screening statuses, and, as above, participants with MA are less likely to file a mammography screening claim through Medicare, as follows,

$$\text{Logit}(\text{prob}(S_1=1)) = -2 + X_1 + X_2 - 2X_3 + 2X_4 - 4P_1,$$

$$\text{Logit}(\text{prob}(S_2=1)) = -2.2 + X_1 + X_2 - 2X_3 + 2X_4 + 0.5S_1 - 4P_2,$$

$$\text{Logit}(\text{prob}(S_j=1)) = -2.2 + X_1 + X_2 - 2X_3 + 2X_4 + 0.5S_{j-1} + 0.5S_{j-2} - 4P_j, \quad j = 3, \dots, 5.$$