

Financial Incentives Tied to Medicare Star Ratings: Impact on Influenza Vaccination Uptake in Medicare Beneficiaries

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A recent review of cost-effectiveness studies of adult vaccines concluded that most report favorable profiles.¹ Nonetheless, uptake of recommended vaccines remains low.^{2,3} This is of particular concern in older patients, given the greater incidence and severity of infection among older adults. Approximately 90% of influenza-related deaths and 50% to 70% of influenza-related hospitalizations occur among patients 65 years and older.⁴ Although older patients typically have higher rates of vaccination than younger age groups, a substantial proportion of older adults still fail to receive recommended vaccines.^{2,3}

CMS has promoted the uptake of preventive vaccines in Medicare. Some vaccines (eg, pneumococcal vaccine, hepatitis B vaccine, influenza vaccine) are covered for free under the Part B Supplemental Medical Insurance Benefit. Most other commercially available vaccines are covered under the Part D Prescription Drug Benefit. However, vaccines covered by Part D are generally subject to cost sharing, which in 2017 averaged \$39 to \$47 per dose in Medicare Advantage prescription drug (MAPD) plans and \$27 to \$75 per dose in stand-alone prescription drug plans (PDPs).⁵ CMS guidance encourages plans to create zero-dollar cost-share vaccine tiers under Part D, but the agency has offered little incentive for plans to comply. As of 2017, no PDPs offered zero-co-pay vaccine tiers and fewer than 5% of MAPD plans did so.⁵

One potential way to increase vaccination rates is through pay-for-performance programs wherein health plans are eligible for bonus payments if they meet specified quality targets.⁶ One such policy involves the MA Star Ratings Program initiated by CMS in 2007. Under the program, CMS publishes a 1- to 5-star rating measure designed to aid consumers choosing MAPD plans. The star rating metrics include various measures of health services quality and member experience with drug availability. Influenza vaccination is the only vaccine currently included in the star rating metrics. Starting in 2012, MAPD plans with 4 or more stars became eligible to receive quality bonus payments. MAPD plans received an estimated \$3.1 billion in bonuses in 2012, with about one-third of bonus money given to 74 contracts with ratings of 4 stars or higher.⁷ By 2019, 77% of MA enrollees were in plans receiving bonus payments at a total estimated cost of \$6 billion.⁸

ABSTRACT

OBJECTIVES: To evaluate the impact of the star rating bonus payment policy on annual influenza vaccination rates before and after the policy was adopted for Medicare Advantage (MA) plans in 2012.

STUDY DESIGN: Observational study using data from the Medicare Current Beneficiary Survey from 2007 to 2015 to test whether the bonus payment policy led to higher flu vaccination rates in MA prescription drug (MAPD) plans vs fee-for-service prescription drug plans (PDPs), which were ineligible for bonus payments.

METHODS: Mean preperiod (2007-2011) and postperiod (2012-2015) influenza vaccination rates were compared for enrollees in both types of plans using descriptive and multivariate difference-in-difference (DID) equations. The experimental effect of the MA bonus payment policy was estimated as the interaction between plan type (MAPD plan vs PDP) and period (pre- vs post period) controlling for the main effects of plan type (MAPD vs PDP), timing of the observation (pre- vs post period), and other potential confounders.

RESULTS: The study sample included 40,369 person-years of data in the preperiod and 27,703 person-years of data in the post period. Vaccination rates increased by 3.8% in MAPD plans compared with 2.7% in PDPs, leading to a relative MAPD-favored difference that was nonsignificant ($P = .31$). However, the effect was statistically significant (odds ratio [OR], 1.12; $P = .03$) in the main multivariate DID model. A larger relative difference was observed among beneficiaries 75 years and older (OR, 1.18; $P = .03$).

CONCLUSIONS: The Medicare bonus payment policy led to a small increase in beneficiaries' flu vaccination rates, suggesting that expanding the star measure set could be an effective way to increase uptake for other recommended adult vaccines.

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TAKEAWAY POINTS

This study evaluated the impact of the Medicare Advantage (MA) star rating bonus payment policy on annual influenza vaccination rates before and after the policy was adopted in 2012.

- ▶ Recommended adult vaccinations are generally cost-effective, yet uptake tends to be low.
- ▶ One option to encourage uptake is leveraging the pay-for-performance policy under which MA plans with high star ratings earn bonus payments.
- ▶ A small but statistically significant increase in flu vaccination rates in MA plans suggests that expanding the star measure set to include other recommended adult vaccines could be an effective way to increase vaccine uptake.

Evidence suggests that MAPD plans consider their star ratings and associated bonus payments to be important. Li and Doshi⁹ found that the availability of bonus payments led to a significant boost in both star ratings and enrollment among MAPD plans compared with PDPs. Other studies have shown a positive association between high star ratings and MAPD enrollment growth¹⁰⁻¹³ and retention.^{14,15} Furthermore, it appears that highly rated MAPD plans are able to charge higher premiums compared with plans with lower star ratings.^{10,16} Higher premium income is desirable in its own right and also provides revenue to support additional service offerings to enrollees, which in turn can drive higher enrollment.

Few studies have evaluated the impact of star ratings on patient experiences and clinical outcomes, but what has been published generally supports the idea that quality ratings matter. Elliott et al¹⁷ reported that MAPD enrollees express more positive experiences with their care compared with PDP enrollees and that, among MAPD enrollees, the quality of their experiences is positively correlated to star ratings. Timbie et al¹⁸ confirmed higher satisfaction with high star-rated plans and also showed that MAPD plans outperform PDPs on 16 clinical measures included in the star ratings. Likewise, a study by Sussell et al¹⁹ analyzed the impact of value-based MAPD bonus payments on quality of care for type 2 diabetes and found small but statistically significantly better glycated hemoglobin A_{1c} control among patients in high star-rated plans. No study has yet examined the impact of the bonus payment policy on vaccination uptake.

The objective of this study was to evaluate the impact of the MA star rating bonus payment policy on annual influenza vaccination rates before and after the policy was adopted in 2012. We hypothesized that potential bonus payments increased influenza vaccine uptake in MAPD plans relative to PDPs, which were ineligible for such payments.

METHODS

Data Source and Sample Construction

This observational study used data from the Medicare Current Beneficiary Survey (MCBS) from 2007 to 2015, excluding 2014, for which MCBS files were not released. Three characteristics of the MCBS make it an appropriate data set for the current study: (1) it is nationally representative of all Medicare beneficiaries, (2) it contains

annual survey questions regarding various adult vaccinations, and (3) it collects information on a large number of sociodemographic and health characteristics that can serve as control variables in the statistical analysis. A recent study validated the accuracy of self-reported influenza vaccination.²⁰

The study sample was a pooled cross-section of 8 years of MCBS data representing community-dwelling residents enrolled in Part D plans. Long-term care residents were

excluded because facility protocols usually dictate vaccination status.²¹ Also excluded were individuals who had Part D coverage for only part of the year or who switched coverage during the year. Finally, persons with missing/unknown responses to the influenza vaccination question were excluded.

Study Outcome and Subgroups of Interest

The primary outcome of interest was the change in annual influenza vaccination rates for noninstitutionalized Medicare beneficiaries between 2007 and 2011 (the preperiod) and 2012-2015 (the post period) in MAPD plans vs PDPs, based on the survey question, "Did you have a flu shot for last winter?" We also evaluated 3 enrollee subpopulations who are at high risk of serious influenza complications and are therefore expected to be targets for plan vaccination efforts: those 75 years and older, those with diabetes, and those with heart disease/stroke.

Statistical Analysis

The MA bonus payment policy introduced in 2012 was treated as a natural experiment, the effects of which were analyzed using a pre-post comparison group design also known as difference-in-difference (DID) analysis. This approach represents a much stronger analytic method than simple pre-post comparisons in that it controls for contemporaneous changes in a control group (PDP enrollees) when computing pre-post changes in the experimental group (MAPD enrollees).

The study entailed both descriptive and multivariate analyses. We first examined characteristics of the PDP and MAPD samples in the pre- and post periods. Next, we calculated mean pre- and postperiod influenza vaccination rates for enrollees in both plan types. Finally, we subtracted preperiod from postperiod values for MAPD and PDP enrollees (this represents the first difference) and then subtracted the first difference for PDP enrollees from the first difference for MAPD enrollees to obtain the final DID estimates.

Of course, many factors aside from the availability of bonus payments could influence the observed DID values. We estimated multivariate models to control for confounding. The effect of the MA bonus payment policy was estimated as the interaction between being in an MAPD plan with an observation in the post period while controlling for the main effects of plan type, observation period, and other potential confounders.

The unit of observation was the person-year weighted to be nationally representative of the community-dwelling Medicare population. All multivariate analyses were estimated using logistic regression with full sample weights and replicate weights using the balanced repeated replication (BRR) method for variance estimation. The BRR method accounts for clustering of individuals within the MCBS primary and secondary sampling units as well as repeated observations among the same individuals over time.

Sensitivity Analyses

We conducted sensitivity tests to assess the impact of alternative assumptions regarding preperiod/postperiod assignments. These tests used the same analytic framework as in the main study. We examined 2 alternative pre-/post assignments, one including 2011 in the post period rather than the preperiod and one in which 2011 data were excluded from the study altogether. The reason for considering 2011 in the post period is that 2012 star-related bonus payments were based on 2011 data. The analyses excluding 2011 data were based on the assumption that MAPD plans may not have had time to adjust to the new policy until 2012. Only descriptive DID analyses were conducted for the 2 alternative pre-/post periods.

As a final sensitivity test, we replicated the analysis for pneumococcal vaccination status (“Have you ever had a pneumonia shot?”) to test whether there were differentially higher rates of vaccination among MAPD enrollees for a vaccine *not* included in the MA star rating metrics. This test used the same descriptive and multivariate analytic approach as the main study except that a dummy variable for influenza vaccination was included as a covariate in the regression model to account for the possibility of spillover effects whereby a visit to receive an annual influenza vaccination could itself lead to increased pneumococcal vaccination. We hypothesized that the DID values for pneumococcal vaccination would be close to zero and not statistically significant.

RESULTS

Results From the Main Analysis

The main study sample included 40,369 person-years of data in the preperiod (2007-2011) and 27,703 person-years of data in the post period (2012-2015). Once weighted to be nationally representative

TABLE 1. Sample Characteristics for Medicare Beneficiaries Enrolled in MAPD Plans vs PDPs in the Pre- and Post Periods*

Characteristic	MAPD		PDP	
	Preperiod	Post period	Preperiod	Post period
Age in years				
< 65 (SSDI)	12.0	13.8*	23.4	21.3*
65-69	22.5	22.4	18.7	20.8*
70-74	23.2	24.0	19.5	21.0*
≥ 75	42.3	39.8*	38.4	36.9*
Sex				
Female	57.5	56.7	60.4	58.9*
Male	42.5	43.3	39.6	41.1*
Self-reported race/ethnicity				
Non-Hispanic White	69.5	69.3	75.3	75.2
Non-Hispanic Black	10.7	10.3	10.8	9.9
Hispanic	15.4	14.2	7.7	8.2
Other race	4.4	6.2*	6.3	6.7
Marital status				
Married	53.3	52.8	41.6	46.3*
Divorced/separated	16.2	17.7*	17.8	18.1
Widowed	25.4	22.3*	28.9	24.0*
Never married	5.1	7.2*	11.7	11.7
Census region				
South	29.4	33.0*	41.7	39.7*
Northeast	24.2	21.9*	18.3	19.4
Midwest	17.5	21.1*	23.6	23.5
West	28.9	24.0*	16.4	17.4
Metro area residence				
Metro	90.0	86.7*	68.6	72.1*
Nonmetro	10.0	13.3*	31.4	27.9*
Highest education level				
No high school graduation	26.3	22.5*	31.1	22.4*
High school graduation	30.3	28.8	29.9	28.2*
Some post-high school education	43.5	48.6*	39.0	49.4*
Annual income				
≤ \$25,000	51.4	46.6*	60.8	50.3*
> \$25,000	48.6	53.4*	39.2	49.7*

(continued)

of the entire Medicare population, this sample represented 20.2 million beneficiaries in 2007 and 35.6 million beneficiaries in 2015. The increase over time is attributable both to growth in overall Medicare enrollment and to a higher proportion of beneficiaries enrolling in Part D. Notably, MAPD enrollment increased from 31.1% of total Part D coverage in 2007 to 41.5% in 2015. Further details on sample construction are shown in **eAppendix Table 1** (available at ajmc.com).

Table 1 presents sample characteristics by plan type and study period. The samples differ in important respects in both periods. MAPD enrollees were older, on average, with fewer disabled beneficiaries compared with PDP enrollees. The MAPD sample also

TABLE 1. (Continued) Sample Characteristics for Medicare Beneficiaries Enrolled in MAPD Plans vs PDPs in the Pre- and Post Periods*

Characteristic	MAPD		PDP	
	Preperiod	Post period	Preperiod	Post period
Medicare supplemental insurance				
None	63.7	60.6*	14.4	13.1*
Any	36.3	39.4*	85.6	86.9*
Chronic condition count				
0	4.6	3.4*	4.3	3.5*
1-3	55.4	51.2*	52.1	49.3*
≥4	40.0	45.4*	43.6	47.2*
ADL limitations				
0	69.9	64.8*	63.8	61.0*
1-2	20.8	23.8*	23.6	25.2*
≥3	9.3	11.5*	12.6	13.8*
Diabetes	28.2	32.7*	26.0	30.7*
Heart disease/stroke	42.7	45.3*	47.2	48.8

ADL, activities of daily living; MAPD, Medicare Advantage Prescription Drug; PDP, stand-alone prescription drug plan; SSDI, Social Security Disability Insurance.

*Indicates that the difference between post period and preperiod is statistically significant at $P < .05$.

*N = 40,369 person-years of data in the preperiod (2007-2011) and 27,703 in the post period (2012-2015).

Source: Authors' analysis of Medicare Current Beneficiary Survey data from 2007 to 2015, excluding 2014.

TABLE 2. Mean Rates of Annual Influenza Vaccination for Medicare Beneficiaries Enrolled in MAPD Plans vs PDPs in the Pre- and Post Periods by Selected Beneficiary Characteristics

Characteristic	MAPD		PDP	
	Preperiod	Post period	Preperiod	Post period
Total sample	69.3	73.1*	69.1	71.8*
Age in years				
<65 (SSDI)	54.0	60.9*	53.6	56.4
65-69	65.1	68.7	65.4	70.2*
70-74	68.6	74.5*	71.6	75.9*
≥75	76.2	79.0*	78.9	79.3
Sex				
Female	69.6	73.6*	70.4	73.1*
Male	68.9	72.4*	67.1	70.0*
Self-reported race/ethnicity				
Non-Hispanic White	73.4	76.6*	72.0	74.6*
Non-Hispanic Black	60.8	61.7	54.2	54.9
Hispanic	55.8	62.3*	61.1	69.6*
Other race	71.1	77.5	68.6	67.9
Marital status				
Married	72.1	76.0*	73.0	76.1*
Divorced/separated	60.1	66.6*	61.6	63.1
Widowed	72.0	74.6	73.5	76.0*
Never married	55.1	62.8*	55.6	59.9*

(continued)

had higher proportions of beneficiaries who were Hispanic, married, higher income, metro residents, and residing in the West. The biggest relative changes over time were in education and income. Between the pre- and post periods, the share of enrollees with some post-high school education increased by 5.1 percentage points in MAPD plans but double that (10.4 points) in PDPs. Likewise, the increase in share of enrollees with incomes greater than \$25,000 grew more in PDPs (11.8 points) compared with MAPD plans (7.2 points).

Table 2 shows vaccination rates across the 2 plan types in the pre- and post periods. Overall, vaccination rates were highest among those 75 years and older, non-Hispanic White individuals, individuals with incomes greater than \$25,000, and those with diabetes, heart disease/stroke, or 3 or more chronic conditions (other than diabetes and heart disease/stroke). The lowest rates were observed among beneficiaries receiving Social Security Disability Insurance, Black beneficiaries, and beneficiaries who had never married. There were also marked regional differences, with vaccination rates highest in the Midwest and West.

Figure 1 presents descriptive DID results showing changes in annual influenza vaccination rates for MAPD and PDP enrollees for the full sample and 3 subgroups. For the full sample (panel A), vaccination uptake was similar across the 2 settings during the preperiod (69.3% in MAPD plans and 69.1% in PDPs). However, in the post period, vaccination rates in MAPD plans had increased by 3.8 percentage points compared with 2.7 percentage points in PDPs, leading to a relative MAPD-favored difference (DID, 1.1 points), which was not statistically significant ($P = .31$).

For persons 75 years and older (panel B), preperiod influenza vaccination rates were higher in PDPs compared with MAPD plans (78.9% vs 76.2%), but as in the full sample, the postperiod increase in vaccination rates in MAPD plans (2.8 percentage points) exceeded that in PDPs (0.4 percentage points), leading to a DID of 2.4 percentage points in favor of MAPD plans ($P = .06$). Preperiod vaccination rates among plan enrollees with diabetes (panel C) and heart disease/stroke (panel D) were similar in both PDPs and MAPD plans (73.1% to 73.9%), with higher increases observed among MAPD

plans in the post period. The DID estimates for individuals with diabetes and heart disease/stroke were numerically higher among those enrolled in MAPD plans by 2.0 points ($P = .21$) and 1.6 points ($P = .31$), respectively.

Figure 2 presents adjusted DID results for the full sample and 3 subgroups. Detailed regression results are available in the online supplementary materials (eAppendix Tables 2, 2a, 2b, and 2c). As in the descriptive findings, the direction and magnitude of the DID estimates favored MAPD plans, but the conditional estimates were more precise. Estimates for both the full sample (odds ratio [OR], 1.12; $P = .03$) and the sample 75 years or older (OR, 1.18; $P = .03$) were statistically significant. The DID estimates for the diabetes and heart disease/stroke subsamples were identical (ORs, 1.15), and although they were not statistically significant ($P = .10$ in both cases), they too showed reduced variance from the descriptive results.

Results From the Sensitivity Analyses

Sensitivity analysis tests to determine whether alternative pre-/postperiod assignment affected the study results were uniformly negative (eAppendix Table 3). Reassigning 2011 data to the post period and eliminating 2011 data altogether each changed the DID estimates by just ± 0.1 percentage points. The pneumococcal vaccination analysis yielded nonsignificant DID values in both descriptive and multivariate models (eAppendix Tables 4 and 5).

DISCUSSION

Between 2012 and 2015, annual rates of influenza vaccination among Medicare beneficiaries enrolled in both MAPD plans and PDPs exceeded the Healthy People 2020 target of 70%. The rates were marginally higher in MAPD plans, which in and of itself is surprising given that MAPD plans had higher minority enrollment and much slower growth in income and educational levels over the study period compared with PDPs. Our results showed that mean vaccination rates among minorities varied between 6% and 19% below that of White beneficiaries, and higher income and education were both consistently associated with higher vaccination levels.

We attribute the relative improvement in influenza vaccination rates among beneficiaries enrolled in MAPD plans compared with PDPs to the MA bonus payment policy. The fact that we observed no significant difference in uptake of pneumococcal vaccination,

TABLE 2. (Continued) Mean Rates of Annual Influenza Vaccination for Medicare Beneficiaries Enrolled in MAPD Plans vs PDPs in the Pre- and Post Periods by Selected Beneficiary Characteristics

Characteristic	MAPD		PDP	
	Preperiod	Post period	Preperiod	Post period
Census region				
South	66.2	71.7*	66.8	69.5*
Northeast	65.6	66.3	69.5	71.7
Midwest	72.8	76.3*	72.0	73.5
West	73.3	78.3*	70.2	75.1*
Metro area residence				
Metro	69.5	73.4*	69.6	72.4*
Nonmetro	67.5	71.0	67.9	70.4
Highest education level				
No high school graduation	64.6	68.2*	63.7	67.6*
High school graduation	71.0	72.6	69.9	71.0
Some post-high school education	70.9	75.6*	72.7	74.2
Annual income				
$\leq \$25,000$	64.2	67.9*	64.0	65.6
$> \$25,000$	75.0	77.9*	77.6	78.4
Medicare supplemental insurance				
None	69.8	74.1*	61.9	63.1
Any	68.4	71.6*	70.3	73.2*
Chronic condition count				
0	49.3	57.6	46.2	47.9
1-3	67.0	70.5*	65.6	68.1*
≥ 4	74.8	77.2*	75.4	77.5
ADL limitations				
0	69.2	73.9*	68.8	71.8*
1-2	71.5	72.8	69.2	72.6*
≥ 3	65.1	69.3	70.4	70.6
Diabetes				
Yes	73.1	77.0*	73.9	75.8
No	67.8	71.2*	67.4	70.1*
Heart disease/stroke				
Yes	73.3	76.8*	73.3	75.2
No	66.3	70.0*	65.3	68.6*

ADL, activities of daily living; MAPD, Medicare Advantage Prescription Drug; PDP, stand-alone prescription drug plan; SSDI, Social Security Disability Insurance.

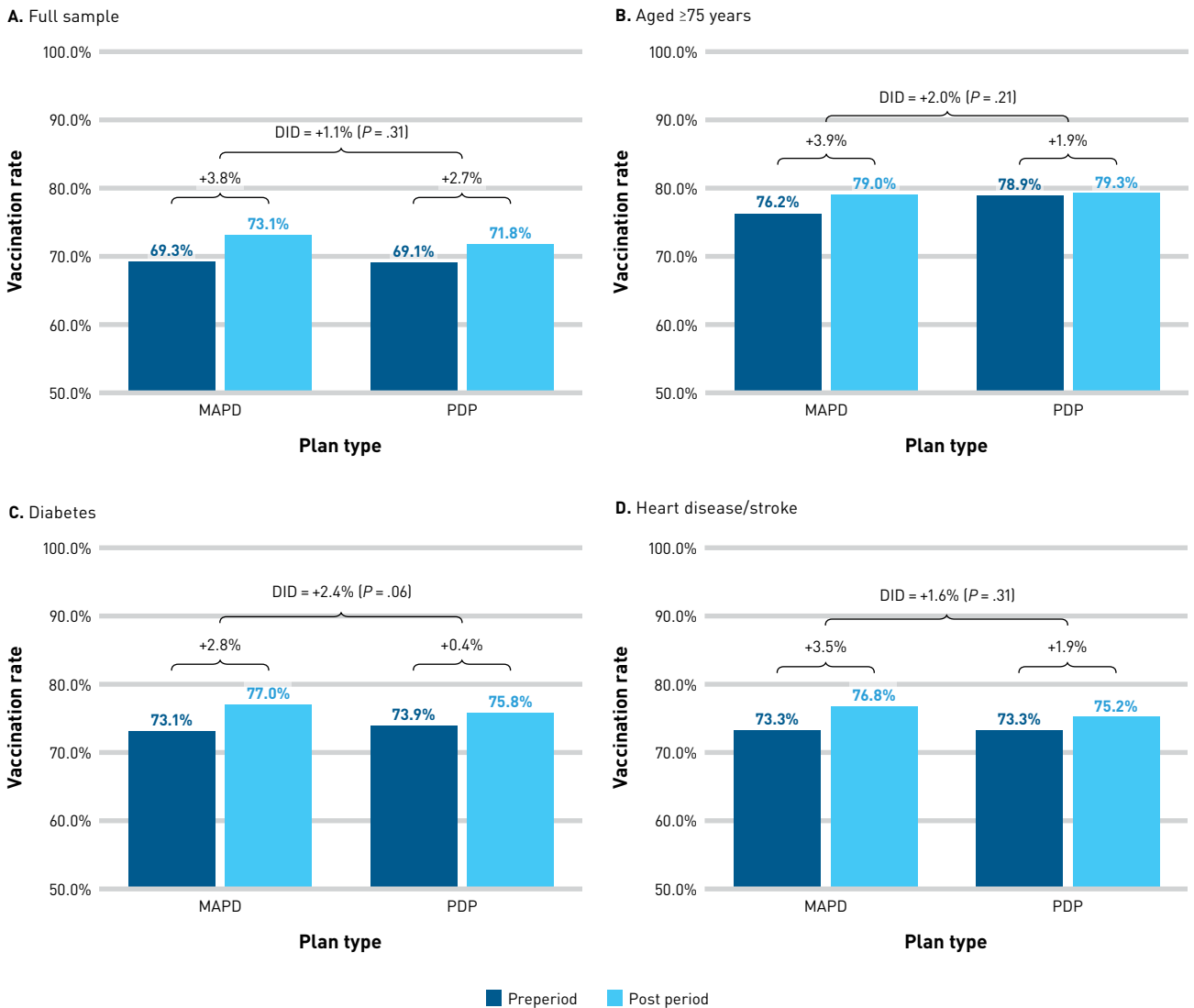
*Indicates that the difference between post period and preperiod is statistically significant at $P < .05$.

Source: Authors' analysis of Medicare Current Beneficiary Survey data from 2007 to 2015, excluding 2014.

which is not included in the star rating measures, between MAPD and PDP enrollees further supports this conclusion. The net gain in influenza vaccination uptake was small but statistically significant, with an adjusted OR of just 1.12 ($P = .03$) for the MAPD population as a whole, and somewhat higher for beneficiaries 75 years and older (OR, 1.18; $P = .03$).

A particular strength of our study is the fact that weights in the MCBS data set permit us to generalize these results to the entire Medicare population over the study period. Another strength is

FIGURE 1. Descriptive DID Estimates of the Impact on Influenza Vaccination Rates of the Star Rating Bonus Policy for Enrollees in MAPD Plans vs PDPs for the Full Sample and 3 Subsamples

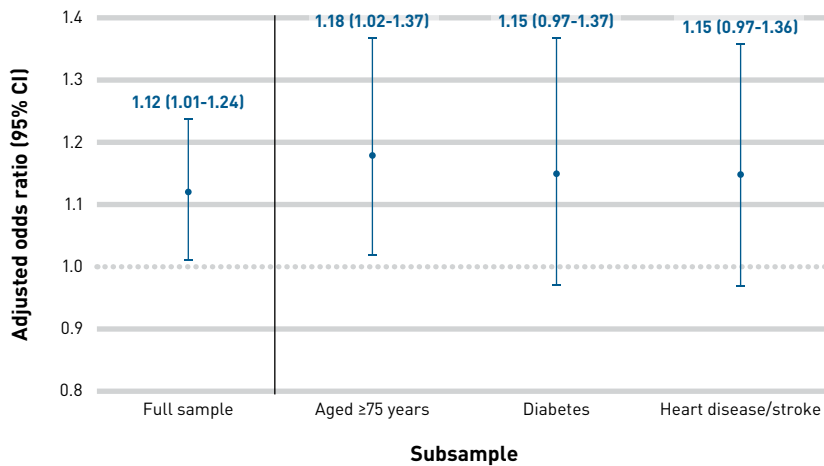


DID, difference-in-difference; MAPD, Medicare Advantage Prescription Drug; PDP, stand-alone prescription drug plan.
 Source: Authors' analysis of Medicare Current Beneficiary Survey data from 2007 to 2015, excluding 2014.

that our multivariate DID model adjusted for covariates including those that changed over time, which proved to be a key factor in the higher precision of the multivariate coefficients relative to unadjusted estimates. Finally, the modest size of the impact was not unexpected given that the study population represented Medicare beneficiaries enrolled in all MAPD plans, including some plans that could reasonably expect to gain bonus payments by increasing vaccination rates whereas others could not. Another possible reason for the small gain is that influenza vaccination rates were very close to the Healthy People 2020 target prior to the advent of the bonus payment policy.

Extrapolating from these findings, one might expect to see much larger impacts should the MA bonus payment policy be applied to other recommended vaccines—those with lower uptake rates and/or newly developed vaccines with no prior history. CMS has made COVID-19 vaccines available free of any cost sharing, but there are already signs that free shots may not be enough to ensure widespread uptake.²² Incentivizing payers through bonus payments tied to vaccine uptake could have an important public health impact under these circumstances. Such a policy could align the incentives for private plans to increase vaccination uptake, which otherwise represents a short-term expense (vaccination and administration

FIGURE 2. Adjusted DID Results for the Impact on Influenza Vaccination Rates of the Star Rating Bonus Policy for Enrollees in MAPD Plans vs PDPs for the Full Sample and 3 Subsamples^a



DID, difference-in-difference; MAPD, Medicare Advantage Prescription Drug; PDP, stand-alone prescription drug plan.

^aThe full set of regression coefficient estimates and 95% CIs are available in the eAppendix.

Source: Authors' analysis of Medicare Current Beneficiary Survey data from 2007 to 2015, excluding 2014.

costs) with a delayed benefit (prevention of disease) that may not generate future savings should enrollees switch plans. It is also important to look beyond COVID-19 to other adult vaccines currently under development for which pay-for-performance policies could prove an effective way of increasing vaccine uptake and maximizing public health impacts. This is especially important for Part D covered vaccines, for which plans currently have no incentives to reduce cost sharing despite CMS guidance to create zero-dollar cost-share vaccine tiers.

Future research is needed to better understand how to maximize the impact of Medicare star ratings. Given the large number of quality measures included in the Star Ratings Program, policy makers need to understand how weighting of individual measures affects potential outcomes and whether higher weighting for vaccines might spur uptake as well as possibly reduce future health care utilization and costs among Medicare beneficiaries. Research should also investigate whether bonus payments could serve as a possible policy lever to address health disparities, especially because the vaccination rate for ethnic minorities is far below that of White beneficiaries as seen in our study. Finally, given that our study was conducted before the COVID-19 pandemic, research is needed to tell whether polarization of opinion around COVID-19 vaccines may affect vaccination efforts for other diseases.

Limitations

As with all observational studies, the methods used in this analysis cannot prove causality. Other study limitations warrant mention. The analysis was designed to measure the average effect of potential

bonus payments across a diverse group of MAPD sponsors, some of which may have attempted to maximize enrollee vaccination rates before the availability of bonuses whereas others may have had such low star ratings that receipt of any bonus payment was out of reach. In neither case would we expect to observe higher vaccination rates in the post period relative to the preperiod attributable to the bonus payment policy. Put another way, had it been possible to isolate only those MAPD plans most likely to benefit from the bonus payment policy, we would have expected to see a greater relative increase in vaccination rates than observed in the present study. Unfortunately, we had no way to assess which plans could reasonably be assured of earning bonuses because identification of plan attributes including star ratings is not possible with MCBS data. Future studies linking data on vaccination rates with plan characteristics and vaccination promotional efforts would provide policy makers with more granular details regarding which interventions are most successful and cost efficient.

It would be of particular interest to determine whether and how plans implemented the well-known CDC immunization strategy known as the AFIX (Assessment, Feedback, Incentives, eXchange) Program (replaced in 2019 with the IQIP [Immunization Quality Improvement for Providers] Program).²³

CONCLUSIONS

The Medicare policy of awarding bonus payments to highly rated MAPD plans had a small but statistically significant positive impact on uptake of influenza vaccines among MAPD enrollees following implementation of the policy in 2012. ■

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Online Supplementary Materials

eAppendix Table 1 presents sample attrition rates due to the study exclusion criteria. In 2007, the final study sample was 7,919 representing 50% of the entire MCBS sample that year, which is reflective of the Part D enrollment in that year (15,806). By 2015, the study sample of 8,837 persons represented 63% of all MCBS respondents (14,068). The increasing proportion of respondents included in the study over time was due primarily to rising Part D enrollment. Not only did Part D enrollments grow over time, but the entire Medicare population also grew, such that the study sample represented 20,201,195 beneficiaries in 2007, rising to 35,557,306 in 2015. Note that these tables also include data for the 2 excluded years (2016 and 2017) which clearly show the large numbers of persons with missing vaccination status.

eAppendix Table 2 reports the full multivariate regression results for the main sample. The adjusted odds ratio (OR) for the interaction term of MAPD and post-period represents the DID estimate which is 1.12 ($p=0.03$). **eAppendix Tables 2a, 2b, and 2c** report multivariate results from the subgroup analysis for persons aged 75+, with diabetes, and with heart disease/stroke, respectively. The model restricted to beneficiaries aged 75 or older generated a DID OR of 1.18 ($p=0.03$). The diabetes and heart/stroke condition models produced identical DID ORs (1.15) neither of which were statistically significant ($p=0.1$ in each case).

eAppendix Table 3 summarizes the descriptive DID findings from sensitivity tests that alter the definition of the post-period. The first row in each panel summarizes results from the main study. In the second row 2011 observations are shifted from the pre- to the post-period, while in the third row, 2011 observations are dropped from the analysis. As can be seen, the effects are very small. For the influenza vaccination analysis, the DID estimate changes from 1.1 (ns) to 1.0 (ns) and then to 1.2 (ns).

eAppendix Tables 4 and 5 present results for pneumococcal vaccinations. As in the descriptive influenza analysis, the pneumococcal vaccination DID value for the entire sample was small and nonsignificant (0.8%, $p=0.32$) as shown in eAppendix Table 4. eAppendix Table 5 reports multivariate regression results from the sensitivity test for pneumococcal vaccinations. As hypothesized, the DID estimate yielded a non-significant OR of 1.07 ($P=0.22$). Of interest is the highly significant impact of having an annual influenza vaccination on ever reporting a pneumococcal vaccination (OR=6.89, $p<0.0001$). This result is consistent with the spillover hypothesis.

eAppendix Table 1. Sample Attrition Table (Part 1: 2007-2011)

Sample selection criteria	2007		2008		2009		2010		2011	
	N	% of previous row	N	% of previous row	N	% of previous row	N	% of previous row	N	% of previous row
Total number of beneficiaries in survey year	15806		14547		14695		14762		15027	
Community dwellers	14804	93.7%	13651	93.8%	13751	93.6%	13879	94.0%	14120	94.0%
No missing for community/ facility status	14804	100.0%	13651	100.0%	13751	100.0%	13879	100.0%	14120	100.0%
Part D enrollment ^a	8673	58.6%	8238	60.3%	8522	62.0%	8706	62.7%	9128	64.6%
MAPD or PDP only (exclude switchers)	8013	92.4%	7777	94.4%	8051	94.5%	8245	94.7%	8748	95.8%
No missing/unknown/refused for flu vaccination survey question	7919	98.8%	7673	98.7%	7954	98.8%	8157	98.9%	8666	99.1%
Has always-enrolled weight (FINAL UNWEIGHTED SAMPLE)	7919	100.0%	7673	100.0%	7954	100.0%	8157	100.0%	8666	100.0%
Has always-enrolled weight (FINAL WEIGHTED SAMPLE)	20201195		21611551		22679576		23727236		25517737	

^a Part D enrollment criterion required enrollment from January until the end of the year for survivors and the month of death for deceased

eAppendix Table 1. Sample Attrition table (Part 2: 2012-2017)

Sample selection criteria	2012		2013		2015		2016		2017	
	N	% of previous row	N	% of previous row	N	% of previous row	N	% of previous row	N	% of previous row
Total number of beneficiaries in survey year	15117		14874		14068		14778		15207	
Community dwellers	14189	93.9%	13924	93.6%	13050	92.8%	13659	92.4%	14077	92.6%
No missing for community/ facility status	14189	100.0%	13924	100.0%	13008	99.7%	13638	99.8%	14055	99.8%
Part D enrollment ^a	9576	67.5%	10241	73.5%	9987	76.8%	10571	77.4%	10981	78.0%
MAPD or PDP only (exclude switchers)	9215	96.2%	9818	95.9%	9428	94.4%	10013	94.7%	10451	95.2%
No missing/unknown/refused for flu vaccination survey question	9122	99.0%	9744	99.2%	8850	93.9%	8525	85.1%	8839	84.6%
Has always-enrolled survey weight (FINAL UNWEIGHTED SAMPLE)	9122	100.0%	9744	100.0%	8837	99.9%	8207	96.3%	8587	97.1%
Has always-enrolled survey weight (FINAL WEIGHTED SAMPLE)	27682904		31421451		35557306		32912393		32801895	

^a Part D enrollment criterion required enrollment from January until the end of the year for survivors and the month of death for deceased

eAppendix Table 2. Results from the Regression Model for Influenza Vaccination in the Total Sample

Variable	Estimate	Standard Error	Odds Ratio	Lower 95% CI	Upper 95% CI	p-value
Plan enrollment						
MAPD	-0.04	0.04	0.96	0.88	1.04	0.27
PDP (reference)						
Time period						
Pre-period (2007-2011) (reference)						
Post-period (2012-2015)	0.04	0.03	1.04	0.97	1.11	0.28
Interaction of MAPD x post-period	0.11	0.05	1.12	1.01	1.24	0.03
Age						
<65	-0.32	0.05	0.73	0.67	0.80	<.0001
65-69 (reference)						
70-74	0.22	0.04	1.24	1.14	1.35	<.0001
75+	0.56	0.04	1.76	1.62	1.91	<.0001
Sex						
Female	0.08	0.03	1.09	1.02	1.16	0.01
Male (reference)						
Race/ethnicity						
White non-Hispanic (reference)						
Black non-Hispanic	-0.44	0.04	0.64	0.59	0.70	<.0001
Hispanic	-0.46	0.05	0.63	0.57	0.70	<.0001
Other race	-0.07	0.06	0.93	0.82	1.06	0.26
Marital status						
Married (reference)						
Divorced/separated	-0.25	0.04	0.78	0.71	0.85	<.0001
Widowed	-0.09	0.03	0.92	0.86	0.98	0.01
Never married	-0.13	0.05	0.88	0.80	0.97	0.01

Census region						
South	0.02	0.04	1.02	0.94	1.10	0.70
Northeast (reference)						
Midwest	0.14	0.05	1.15	1.05	1.27	0.00
West	0.24	0.05	1.28	1.15	1.41	<.0001
Metro area residence						
Metro (reference)						
Non-metro	-0.15	0.03	0.86	0.82	0.91	<.0001
Highest education level						
No high school grad (reference)						
High school grad	0.16	0.04	1.17	1.09	1.26	<.0001
Some post-grad	0.15	0.03	1.16	1.09	1.24	<.0001
Annual income						
≤\$25,000 (reference)						
>\$25,000	0.38	0.03	1.46	1.37	1.57	<.0001
missing	0.20	0.06	1.23	1.08	1.39	0.00
Medicare supplementation						
None (reference)						
Any	0.16	0.03	1.18	1.10	1.25	<.0001
Chronic condition count (excluding diabetes and heart disease)						
0 (reference)						
1-3	0.70	0.06	2.01	1.78	2.28	<.0001
>3	1.14	0.07	3.12	2.72	3.58	<.0001
ADL limitations						
0 (reference)						
1-2	-0.01	0.03	0.99	0.93	1.05	0.71
3+	-0.09	0.04	0.91	0.85	0.98	0.01
Diabetes						
Yes	0.33	0.03	1.39	1.31	1.49	<.0001

No (reference)						
Heart disease/stroke						
Yes	0.15	0.03	1.17	1.10	1.23	<.0001
No (reference)						

eAppendix Table 2a. Results from the Regression Model for Influenza Vaccination in Beneficiaries Aged 75 Years or Older

Variable	Estimate	Standard Error	Odds Ratio	Lower 95% CI	Upper 95% CI	p-value
Plan enrollment						
MAPD	-0.14	0.06	0.87	0.77	0.99	0.02
PDP (reference)						
Time period						
Pre-period (2007-2011) (reference)						
Post-period (2012-2015)	-0.08	0.05	0.93	0.85	1.01	0.10
Interaction of MAPD x post-period	0.17	0.08	1.18	1.02	1.37	0.03
Age						
<65	NA	NA	NA	NA	NA	NA
65-69 (reference)						
70-74	NA	NA	NA	NA	NA	NA
75+	NA	NA	NA	NA	NA	NA
Sex						
Female	0.03	0.05	1.03	0.94	1.12	0.57
Male (reference)						
Race/ethnicity						
White non-Hispanic (reference)						
Black non-Hispanic	-0.57	0.07	0.57	0.49	0.65	<.0001
Hispanic	-0.57	0.06	0.57	0.50	0.65	<.0001
Other race	-0.06	0.09	0.94	0.79	1.13	0.52
Marital status						
Married (reference)						
Divorced/separated	-0.34	0.07	0.71	0.62	0.81	<.0001
Widowed	-0.12	0.04	0.88	0.81	0.96	0.00
Never married	-0.23	0.12	0.80	0.63	1.01	0.06
Census region						
South	-0.03	0.06	0.97	0.87	1.09	0.62
Northeast (reference)						
Midwest	0.11	0.07	1.12	0.97	1.28	0.11
West	0.20	0.07	1.22	1.06	1.41	0.01
Metro area residence						
Metro (reference)						
Non-metro	-0.20	0.06	0.82	0.73	0.91	0.00
Highest education level						
No high school grad (reference)						
High school grad	0.18	0.05	1.20	1.08	1.33	0.00
Some post-grad	0.19	0.06	1.21	1.08	1.36	0.00
Annual income						
≤\$25,000 (reference)						

>\$25,000	0.40	0.05	1.50	1.36	1.65	<.0001
Missing	0.18	0.08	1.19	1.01	1.41	0.04
Medicare supplementation						
None (reference)						
Any	0.08	0.05	1.08	0.98	1.19	0.10
Chronic condition count (excluding diabetes and heart disease)						
0 (reference)						
1-3	0.64	0.10	1.90	1.57	2.31	<.0001
>3	1.10	0.10	3.00	2.46	3.67	<.0001
ADL limitations						
0 (reference)						
1-2	-0.01	0.04	0.99	0.92	1.06	0.71
3+	-0.11	0.06	0.90	0.80	1.01	0.07
Diabetes						
Yes	0.16	0.04	1.18	1.08	1.28	<.0001
No (reference)						
Heart disease/stroke						
Yes	0.18	0.04	1.20	1.11	1.29	<.0001
No (reference)						

eAppendix Table 2b. Results from the Regression Model for Influenza Vaccination in Beneficiaries with Diabetes

Variable	Estimate	Standard Error	Odds Ratio	Lower 95% CI	Upper 95% CI	p-value
Plan enrollment						
MAPD	-0.08	0.07	0.92	0.80	1.07	0.28
PDP (reference)						
Time period						
Pre-period (2007-2011) (reference)						
Post-period (2012-2015)	0.03	0.06	1.03	0.92	1.16	0.61
Interaction of MAPD x post-period	0.14	0.09	1.15	0.97	1.37	0.10
Age						
<65	-0.11	0.09	0.89	0.76	1.06	0.20
65-69 (reference)						
70-74	0.26	0.07	1.30	1.12	1.51	0.00
75+	0.44	0.08	1.55	1.34	1.80	<.0001
Sex						
Female	0.09	0.06	1.09	0.97	1.23	0.12
Male (reference)						
Race/ethnicity						
White non-Hispanic (reference)						
Black non-Hispanic	-0.47	0.08	0.62	0.53	0.73	<.0001
Hispanic	-0.47	0.08	0.62	0.53	0.73	<.0001
Other race	-0.01	0.11	0.99	0.80	1.22	0.90
Marital status						
Married (reference)						
Divorced/separated	-0.14	0.08	0.87	0.74	1.03	0.10
Widowed	-0.06	0.07	0.94	0.81	1.09	0.39
Never married	-0.04	0.11	0.96	0.77	1.21	0.74
Census region						
South	-0.10	0.07	0.91	0.79	1.04	0.15
Northeast (reference)						
Midwest	0.26	0.09	1.30	1.09	1.54	0.00
West	0.28	0.08	1.33	1.13	1.56	0.00
Metro area residence						
Metro (reference)						
Non-metro	-0.14	0.06	0.87	0.76	0.98	0.03
Highest education level						
No high school grad (reference)						
High school grad	-0.02	0.07	0.98	0.85	1.12	0.72
Some post-grad	-0.07	0.07	0.94	0.82	1.07	0.31
Annual income						
≤\$25,000 (reference)						

>\$25,000	0.43	0.05	1.53	1.38	1.70	<.0001
Missing	0.05	0.13	1.05	0.81	1.35	0.71
Medicare supplementation						
None (reference)						
Any	0.05	0.06	1.06	0.94	1.19	0.37
Chronic condition count (excluding diabetes and heart disease)						
0 (reference)						
1-3	0.57	0.18	1.78	1.26	2.51	0.00
>3	0.89	0.18	2.44	1.71	3.48	<.0001
ADL limitations						
0 (reference)						
1-2	-0.01	0.06	0.99	0.88	1.11	0.86
3+	-0.04	0.07	0.97	0.84	1.10	0.60
Diabetes						
Yes	NA	NA	NA	NA	NA	NA
No (reference)						
Heart disease/stroke						
Yes	0.07	0.06	1.08	0.96	1.20	0.19
No (reference)						

eAppendix Table 2c. Results from the Regression Model for Influenza Vaccination in Beneficiaries with Heart Diseases

Variable	Estimate	Standard Error	Odds Ratio	Lower 95% CI	Upper 95% CI	p-value
Plan enrollment						
MAPD	-0.08	0.06	0.93	0.82	1.04	0.20
PDP (reference)						
Time period						
Pre-period (2007-2011) (reference)						
Post-period (2012-2015)	0.03	0.06	1.03	0.92	1.15	0.64
Interaction of MAPD x post-period	0.14	0.09	1.15	0.97	1.36	0.10
Age						
<65	-0.24	0.07	0.79	0.68	0.91	0.00
65-69 (reference)						
70-74	0.23	0.06	1.25	1.10	1.42	0.00
75+	0.63	0.06	1.87	1.67	2.10	<.0001
Sex						
Female	0.05	0.05	1.05	0.96	1.15	0.29
Male (reference)						
Race/ethnicity						
White non-Hispanic (reference)						
Black non-Hispanic	-0.36	0.07	0.70	0.61	0.79	<.0001
Hispanic	-0.57	0.07	0.56	0.49	0.65	<.0001
Other race	-0.07	0.08	0.93	0.78	1.10	0.38
Marital status						
Married (reference)						
Divorced/separated	-0.26	0.06	0.77	0.69	0.87	<.0001
Widowed	-0.17	0.05	0.84	0.76	0.93	0.00
Never married	-0.10	0.07	0.90	0.78	1.04	0.16
Census region						
South	-0.06	0.06	0.94	0.84	1.05	0.28
Northeast (reference)						
Midwest	0.18	0.06	1.20	1.06	1.36	0.00
West	0.24	0.07	1.27	1.12	1.45	0.00
Metro area residence						
Metro (reference)						
Non-metro	-0.18	0.04	0.84	0.78	0.90	<.0001
Highest education level						
No high school grad (reference)						
High school grad	0.14	0.05	1.15	1.04	1.27	0.01
Some post-grad	0.11	0.06	1.12	0.99	1.25	0.06
Annual income						

≤\$25,000 (reference)						
>\$25,000	0.37	0.05	1.45	1.31	1.61	<.0001
Missing	0.24	0.11	1.27	1.01	1.59	0.04
Medicare supplementation						
None (reference)						
Any	0.06	0.05	1.06	0.96	1.17	0.24
Chronic condition count (excluding diabetes and heart disease)						
0 (reference)						
1-3	0.49	0.14	1.64	1.25	2.14	0.00
>3	0.92	0.14	2.51	1.91	3.28	<.0001
ADL limitations						
0 (reference)						
1-2	-0.01	0.05	0.99	0.90	1.09	0.81
3+	-0.08	0.06	0.92	0.83	1.03	0.16
Diabetes						
Yes	0.26	0.05	1.30	1.19	1.42	<.0001
No (reference)						
Heart disease/stroke						
Yes	NA	NA	NA	NA	NA	NA
No (reference)						

eAppendix Table 3. Sensitivity Analysis for Influenza Vaccination Rates Using Different Pre- and Post-Periods

Pre-Period: 2007-2011, Post-Period: 2012-2015										
	MAPD (Pre-period)	MAPD (Post-period)	Difference (Post-Pre)	P-value	PDP (Pre-period)	PDP (Post-period)	Difference (Post-Pre)	P-value	DID	P-value
Total sample	69.3	73.1	3.8	<.0001	69.1	71.8	2.7	0.00	1.1	0.31
Pre-Period: 2007-2010, Post-Period: 2011-2015										
	MAPD (Pre-period)	MAPD (Post-period)	Difference (Post-Pre)	P-value	PDP (Pre-period)	PDP (Post-period)	Difference (Post-Pre)	P-value	DID	P-value
Total sample	68.9	72.5	3.6	<.0001	68.8	71.4	2.6	0.00	1.0	0.35
Pre-Period: 2007-2010, Post-Period: 2012-2015										
	MAPD (Pre-period)	MAPD (Post-period)	Difference (Post-Pre)	P-value	PDP (Pre-period)	PDP (Post-period)	Difference (Post-Pre)	P-value	DID	P-value
Total sample	68.9	73.1	4.2	<.0001	68.8	71.8	3	0.00	1.2	0.31

Note: Differences may not be exact due to rounding

Metro	69.9	73.3	3.4	<.0001	68.0	70.3	2.3	0.02	1.1	0.28
Non-metro	66.4	71.9	5.6	0.01	67.2	70.9	3.7	0.01	1.9	0.31
Highest education level										
No high school grad	65.1	69.6	4.5	0.00	62.0	66.5	4.5	0.00	0.0	0.93
High school grad	71.2	72.7	1.5	0.29	67.8	69.4	1.6	0.22	-0.1	1.00
Some post-high school grad	71.1	75.0	3.9	0.00	72.3	72.9	0.6	0.58	3.4	0.03
Annual income										
<\$25000	65.5	69.0	3.4	0.00	63.1	64.9	1.8	0.08	1.6	0.22
>\$25000	74.6	77.0	2.4	0.02	75.9	76.3	0.5	0.68	2.0	0.20
Missing income	65.7	69.8	4.1	0.36	67.5	72.2	4.7	0.14	-0.6	0.88
Medicare supplemental insurance										
None	70.5	74.0	3.5	0.00	61.6	63.5	2.0	0.36	1.5	0.38
Any	67.8	71.8	4.0	0.00	68.9	71.6	2.7	0.00	1.2	0.41
Chronic condition count										
0	45.2	56.4	11.2	0.01	42.9	36.9	-6.0	0.1	17.2	0.01
1-3	66.0	68.6	2.5	0.02	62.2	64.5	2.3	0.02	0.3	0.77
>3	77.2	79.5	2.3	0.03	76.7	79.1	2.5	0.01	-0.2	0.93
ADL limitations										
0	68.5	73.0	4.5	<.0001	66.6	68.7	2.1	0.02	2.4	0.04
1-2	73.5	74.4	0.9	0.53	69.5	73.2	3.7	0.00	-2.8	0.13
3+	68.7	71.2	2.5	0.28	70.3	73.6	3.2	0.07	-0.7	0.75
Diabetes										
Yes	73.0	76.8	3.8	0.01	73.3	78.3	5.0	<.0001	-1.2	0.39
No	68.2	71.4	3.1	0.00	65.8	67.1	1.2	0.19	1.9	0.11
Heart Disease/Stroke										
Yes	76.2	78.0	1.9	0.09	75.1	77.7	2.6	0.01	-0.7	0.64
No	64.6	69.1	4.5	<.0001	61.2	63.6	2.5	0.03	2.0	0.11

Note: Differences may not be exact due to rounding

eAppendix Table 5. Results from the Regression Model for Pneumococcal Vaccination

Variable	Estimate	Standard Error	Odds Ratio	Lower 95% CI	Upper 95% CI	p-value
Plan enrollment						
MAPD	0.04	0.04	1.04	0.95	1.13	0.40
PDP (reference)						
Time period						
Pre-period (2007-2011) (reference)						
Post-period (2012-2017)	0.02	0.04	1.02	0.94	1.10	0.63
Interaction of MAPD x post-period	0.07	0.06	1.07	0.96	1.20	0.22
Age						
<65	-0.39	0.06	0.68	0.60	0.76	<.0001
65-69 (reference)						
70-74	0.50	0.05	1.64	1.50	1.80	<.0001
75+	0.68	0.05	1.97	1.79	2.16	<.0001
Sex						
Female	0.14	0.03	1.15	1.08	1.22	<.0001
Male (reference)						
Race/ethnicity						
White non-Hispanic (reference)						
Black non-Hispanic	-0.41	0.05	0.67	0.61	0.73	<.0001
Hispanic	-0.62	0.05	0.54	0.48	0.60	<.0001
Other race	-0.39	0.08	0.68	0.58	0.79	<.0001
Marital status						
Married (reference)						
Divorced/separated	0.03	0.05	1.03	0.93	1.15	0.57
Widowed	0.04	0.04	1.04	0.95	1.13	0.37
Never married	-0.10	0.06	0.90	0.80	1.02	0.10
Census region						
South	0.17	0.04	1.19	1.09	1.29	<.0001
Northeast (reference)						
Midwest	0.10	0.05	1.11	1.00	1.24	0.05
West	0.32	0.05	1.38	1.25	1.52	<.0001
Metro area residence						
Metro (reference)						
Non-metro	-0.10	0.04	0.91	0.84	0.97	0.01
Highest education level						
No high school grad (reference)						
High school grad	0.11	0.04	1.12	1.02	1.22	0.01
Some post-grad	0.15	0.04	1.16	1.06	1.26	0.00
Annual income						
≤\$25,000 (reference)						

>\$25,000	0.17	0.04	1.19	1.10	1.28	<.0001
Missing	-0.09	0.07	0.92	0.79	1.06	0.25
Medicare supplementation						
None (reference)						
Any	0.04	0.04	1.04	0.97	1.12	0.29
Chronic condition count (excluding diabetes and heart disease)						
0 (reference)						
1-3	0.51	0.07	1.67	1.44	1.93	<.0001
>3	1.02	0.08	2.77	2.38	3.22	<.0001
ADL limitations						
0 (reference)						
1-2	0.10	0.03	1.10	1.03	1.18	0.00
3+	0.10	0.05	1.10	1.00	1.21	0.04
Diabetes						
Yes	0.28	0.04	1.33	1.23	1.43	<.0001
No (reference)						
Heart disease/stroke						
Yes	0.34	0.03	1.41	1.32	1.51	<.0001
No (reference)						
Influenza vaccine status						
Yes	1.93	0.03	6.89	6.43	7.39	<.0001
No (reference)						