Risk Adjustment for ADRD in Medicare Advantage and Health Care Experiences

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Abstract

Importance: Failure to account for the full complexity and costs of high-need populations in the risk-adjusted capitated payment model for Medicare Advantage (MA) plans may create financial disincentives for plans to invest in comprehensive care for affected beneficiaries, potentially exacerbating health disparities.

Objective: To evaluate whether the reinstatement of Alzheimer's Disease and Related Dementias (ADRD) hierarchical condition category (HCC) into the MA risk-adjusted payment model in 2020 is associated with improved access, affordability, and quality of care for beneficiaries with ADRD.

Design, Setting, and Participants: We analyzed data from 5,353 MA beneficiaries in the Medicare Current Beneficiary Survey (2015–2022). Beneficiaries were stratified into treatment and control groups based on their diagnosis of ADRD.

Exposures: Reinstatement of the ADRD HCC into the MA risk adjustment formula in 2020.

Main Outcomes and Measures: We examined accessibility of needed care, medical financial burden, satisfaction with availability of specialists, and satisfaction with quality of care.

Results: The revised risk-adjusted payment model was associated with a 6.6 percentage-point decrease in reporting any troubles accessing needed care (95% CI, -0.112 to -0.02; P = 0.005) and a 9.2 percentage-point decrease in reporting any medical financial burden (95% CI, -0.161 to -0.023; P = 0.009) among MA beneficiaries with ADRD. The association with satisfaction regarding access to specialists was marginally significant (coefficient, 0.04; 95% CI, -0.005 to 0.084; P = 0.083) and no significant association was observed for satisfaction with overall quality of care (coefficient, -0.014; 95% CI, -0.056 to 0.029; P = 0.530) among MA beneficiaries with ADRD.

Conclusions and Relevance: Reintroducing ADRD HCCs into the MA risk adjustment model is associated with improved access to care and reduced financial burden among beneficiaries with ADRD. These findings suggest that refining risk adjustment to better capture the costs of chronic and complex conditions can help align MA plan incentives with the needs of vulnerable populations. Beyond ADRD, this work highlights the potential value of more nuanced risk adjustment approaches for improving care equity and outcomes for individuals with high-cost, high-need conditions.

Introduction

Alzheimer's Disease and Related Dementias (ADRD) are among the leading causes of disability and dependence among older adults, affecting approximately 6.9 million individuals in the United States, placing a substantial burden on patients, caregivers, and healthcare system, with annual costs exceeding $300 billion in 2024.[1] Medicare Advantage (MA) plans, which now enroll over half of all Medicare beneficiaries,[2] offer a unique approach to addressing the needs of this vulnerable population through enhanced care management programs. About one-third of Medicare-eligible beneficiaries with ADRD in 2018 enrolled in a MA plan, increasing from 22% in 2013.[2] However, MA plans historically faced challenges in providing equitable and high-quality care for beneficiaries with ADRD.[2–7]

Different from traditional Medicare (TM), the risk adjustment model used by the Centers for Medicare & Medicaid Services (CMS) plays a critical role in incentivizing MA plans to deliver care tailored to beneficiaries' health needs. MA plans are privately operated and receive prospective, capitated payments from CMS to finance and deliver healthcare services. The capitated payment is predicted through a risk adjustment model that accounts for a beneficiary's demographics and a selected set of Hierarchical Condition Categories (HCCs). From 2014 to 2020, ADRD diagnoses were excluded from the risk adjustment model due to concerns about coding and auditing claims accuracy.[8] As insurers bear increasing financial risks, for beneficiaries with HCCs not incorporated in the risk-adjusted payment model, the capitated payments may incentivize insurers to manage these beneficiaries' medical costs by providing insufficient coverage, restricting physician networks, or requiring prior authorization for care.[9]

In 2020, CMS reinstated ADRD in the risk-adjusted payment model, marking a significant policy shift. This decision offers a unique opportunity to examine the association between the new risk-adjusted payment model and care experiences among beneficiaries with ADRD. Recent studies have found a significant increase in the ADRD diagnosis rate among MA beneficiaries after this payment model change.[2,8,10] However, there remains limited empirical evidence on the broader implications of this payment model change for care access, affordability, and quality among beneficiaries with ADRD.

Data and Methods

We used data from the CMS Medicare Current Beneficiary Survey (MCBS) Public Use Files spanning 2015 to 2022. The MCBS includes both TM and MA beneficiaries aged 65 and older, as well as beneficiaries under 65 with certain disabling conditions residing in the continental United States. It provides rich information on beneficiaries' care experiences related to access to services and the obstacles encountered.

Sample Inclusion

Our main sample focused on beneficiaries enrolled in any MA plan. To implement the empirical strategy outlined below, our sample included MA enrollees with ADRD as the treatment group, and MA enrollees without ADRD but with stroke/brain hemorrhage, complete/partial paralysis, or Parkinson's disease as the control group. These control group conditions were selected because, similar to ADRD, they often require specialized neurological care and are therefore more comparable to the treatment group with respect to patterns of health care utilization. Unlike ADRD, these conditions were already included in the risk-adjustment model before 2020.

To address potential confounding due to plan-switching behavior following the inclusion of ADRD in the risk adjustment model in 2020, we excluded beneficiaries with only partial MA enrollment in the year preceding the survey. We also excluded veterans. Our final sample comprised 5,353 MA beneficiaries with complete data on all covariates (See **Figure 1** for the data processing flow).

Variables

We used information regarding MA plan enrollment to define MA status. ADRD and conditions for the control group were identified via self-reports of whether a doctor or health professional ever diagnosed the individual with the condition. Due to data limitations, we cannot ascertain the timing of diagnosis or the initial MA enrollment; we discussed potential implications of this limitation in the Discussion section.

We used information on whether a respondent reported any trouble obtaining needed care to measure accessibility of needed care. We defined a respondent as experiencing a medical financial burden if they reported problems paying medical bills (available since 2017) or expressed dissatisfaction with their out-of-pocket costs. Additionally, we examined two binary measures of satisfaction with care: satisfaction with access to specialists and satisfaction with the quality of care received.

Covariates included demographic variables (age, gender, marital status, race/ethnicity, education, and household size) and health-related measures (BMI, number of chronic conditions, and indicators for functional limitations). These are summarized in **Table 1**.

Statistical Analysis

We employed a Difference-in-Differences (DID) model to compare changes in care experiences between the treatment and the control group before and after the inclusion of ADRD HCCs in the MA risk adjustment model in 2020 (**Appendix B.1**). The treatment group consisted of MA enrollees with ADRD, while the control group comprised MA enrollees without ADRD but with stroke/brain hemorrhage, complete/partial paralysis, or Parkinson's diseases. We adjusted the model by interacting the covariates listed in Table 1 with year indicators to mitigate biases arising from contemporaneous shocks (e.g., the onset of COVID-19). To address potential measurement errors due to self-reported care experiences among

beneficiaries with ADRD, we interacted year indicators with an indicator for surveys completed by proxy (e.g., family members). All analyses used heteroskedasticity-robust standard errors, and robustness checks were conducted using balanced repeated replications for standard error estimation.

We conducted an event study analysis within the same framework, using 2019 as the reference year - the final year before the new payment model implemented (**Appendix B.3**). This analysis served two purposes: first, to provide suggestive evidence for the parallel-trends assumption of the DID model; and second, to examine temporal association dynamics following the new payment model.

We conducted a series of placebo tests within the DID framework (**Appendix B.2**). In one illustrative placebo test, we designated MA enrollees with diabetes (but without ADRD) as a placebo treatment group and MA enrollees without either condition as the control group, hypothesizing no association between the 2020 risk adjustment change and their care experiences. We extended this strategy to additional placebo conditions, including hypertension, myocardial infarction, and stroke, among others.

Finally, we replicated the baseline DID design in a TM sample, using TM beneficiaries with ADRD as the placebo treatment group and TM beneficiaries with other neurological conditions (stroke, paralysis, Parkinson's) but not ADRD as the placebo control group.

Study Results

Sample Characteristics

In Table 1, among the 5,353 MA beneficiaries in our sample, 1,629 (30.4%) had been diagnosed with ADRD, while the remaining 3,724 had a stroke, paralysis, or Parkinson's disease. Approximately 18.4% of the sample was under 65, and a significant proportion (58.4%) is 75 or older. The racial composition was predominantly non-Hispanic white (61.7%), followed by Hispanic beneficiaries (16.6%) and black beneficiaries (15.7%). About one-third were male or married with a spouse present. Over half have attained no more than a high school education. Approximately 73% lived with functional limitations (at least one IADL or ADL) and about 88% have more than two chronic conditions.

The sample size varies across care experience outcomes due to missing values in the corresponding measures. About 10% of the sample reported having any troubles accessing needed care, while about 23% reported any medical financial burdens. A significant majority (over 90%) expressed satisfaction with access to specialists or the quality of care.

Figure 2 exhibits trends in each care experience outcome in our treatment and control groups, from 2015 to 2022. Since 2020, a notable decline has been observed in the proportion of MA beneficiaries with ADRD reporting any barriers to accessing needed healthcare (top left) and any medical financial burdens (top right) compared to the control group. However, the differences in satisfaction with access to specialists

(bottom left) or the quality of care (bottom right) between the two groups remained relatively small until 2022.

Association Between MA Risk Adjustment Model Change and Care Experiences

Figure 3 shows improved care experiences following the inclusion of ADRD in the risk-adjusted payment model. The revised risk-adjusted payment model was associated with a 6.6 percentage-point decrease in reporting any troubles accessing needed care (95% CI, -0.112 to -0.02; P = 0.005), and a 9.2 percentage-point decrease in reporting any medical financial burdens (95% CI, -0.161 to -0.023; P = 0.009) among MA beneficiaries with ADRD. The association between the revised payment model and the satisfaction with improved access to specialists was marginally significant, with a coefficient of 4.0 percentage points (95% CI, -0.005 to 0.084; P = 0.083). No significant association was observed for satisfaction with the overall quality of care (coefficient, -0.014; 95% CI, -0.056 to 0.029; P = 0.53).

Figure 4 displays the dynamic association from 2015 to 2022 from the event study analysis. The negative coefficients and the steady downturn pattern in the period after 2019 reassured that the new risk adjustment model in 2020 was associated with a discernible reduction in troubles in getting needed care (top left: coefficient, -0.048; 95% CI, -0.129 to 0.033 in 2020; coefficient, -0.099; 95% CI, -0.181 to -0.016 in 2021, coefficient, -0.091; 95% CI, -0.183 to 0.001 in 2022 in **Table A1**) and alleviated financial stress in paying medical bills (top right: coefficient, -0.097; 95% CI, -0.212 to 0.017 in 2020; coefficient, -0.103; 95% CI, -0.214 to 0.007 in 2021, coefficient, -0.117; 95% CI, -0.237 to 0.002 in 2022 in **Table A1**) among MA beneficiaries with ADRD. Moreover, the stability and insignificance of the coefficients preceding the revised payment model in the top panels, being negative or hovering near zero, lend credibility to the underlying parallel-trends assumption for our DID model. The positive association between the 2020 revised payment model and beneficiaries' satisfaction with access to specialists was relatively weak in 2020 and the subsequent years, although the magnitude of the association showed an increasing trend over time (bottom left). Conversely, the revised payment model demonstrated no significant correlation with beneficiaries' satisfaction regarding the overall quality of care in any single year from 2015 to 2022, further reassuring the null association depicted in **Figure 3**.

We performed multiple robustness tests. To address self-reporting bias among MA beneficiaries with ADRD, we excluded self-respondents with ADRD; the estimates were unchanged (**Figure A1**). To mitigate bias from plan-switching behavior potentially driven by risk adjustment,[2,8,10] we restricted the sample to beneficiaries continuously enrolled in MA plans for at least 3 years, again yielding consistent results **(Figure A2**). Our conclusion is also robust to several model specification tests: using balanced repeated replications for standard error calculations (**Figure A3**), excluding beneficiaries under age 65 (**Figure A4**),

and redefining the control group to include MA beneficiaries with a broader set of conditions but without ADRD (**Figure A5**).

In **Figure A6**, we re-estimated associations using alternative "placebo" treatment groups—beneficiaries without ADRD but with stroke/brain hemorrhage, hypertension, myocardial infarction, cancer, or osteoarthritis, respectively. Most coefficients were near zero and statistically insignificant, indicating no spurious associations between the revised payment model and care experience measures. In **Figure A7**, we compared TM beneficiaries with ADRD to TM beneficiaries without ADRD but with stroke, paralysis, or Parkinson's disease, again finding no significant associations. These placebo results suggest that our main findings are unlikely to be driven by unobserved confounding differences across diseases.

Stratification analyses by beneficiaries' characteristics are presented in **Figure A8**. Among beneficiaries with incomes above 200% of the federal poverty level (FPL), the revised payment model was significantly associated with reduced trouble getting needed care (coefficient, -0.096; 95% CI, -0.19 to -0.001), while those below 200% FPL experienced reductions in both trouble getting needed care (coefficient, -0.084; 95% CI, -0.148 to -0.021) and financial burdens (coefficient, -0.131; 95% CI, -0.219 to -0.044). Non-White beneficiaries had a greater reduction in financial burden (coefficient, -0.142; 95% CI, -0.259 to -0.024), whereas White beneficiaries showed a modest reduction in trouble getting needed care (coefficient, -0.056; 95% CI, -0.114 to 0.002).

By educational attainment, beneficiaries with at least a high school degree experienced significant reductions in trouble accessing care (coefficient, -0.103; 95% CI, -0.195 to -0.011) and financial burdens (coefficient, -0.138; 95% CI, -0.279 to 0.003), whereas no significant associations were detected among those with lower educational attainment. Lastly, beneficiaries residing in metropolitan areas experienced a notable reduction in trouble getting needed care (coefficient, -0.065; 95% CI, -0.114 to -0.016) and greater satisfaction with access to specialists (coefficient, 0.06; 95% CI, 0.012 to 0.109), while no significant associations were observed for non-metropolitan residents, though the direction of estimates suggest potential benefits.

Discussion

Since its introduction in 2004, the HCC-based risk adjustment model has undergone periodic revisions by CMS to enhance payment fairness and sustainability. Although previous studies have mainly demonstrated that the risk-adjusted payments can manage overall medical costs[11–13] there is still a gap in understanding how a condition-specific change, especially for care-intensive conditions, in an HCC-based risk adjustment model incentivizes appropriate care delivery.

Failing to account for the full complexity and costs of high-need populations in the risk-adjusted payment model may under-reimburse the high costs associated with managing these conditions[3,5,9,11],

therefore rendering financial disincentives for plans to invest in comprehensive care for affected beneficiaries, for instance, dropping high-cost beneficiaries,[3,11] providing a narrow provider network,[14,15] and requiring prior-authorization[16,17]. Consequently, existing studies using data prior to 2020 have found large health gaps between beneficiaries with ADRD in MA and TM before the reintroduction of ADRD into the risk-adjustment model.[6,7,18] Compared to TM, the diagnosed dementia rates in MA are notably lower,[19] suggesting a potential under-diagnosis of ADRD in MA. This underdiagnosis further delays in access to appropriate interventions, exacerbating gaps in care quality and outcomes. Moreover, beneficiaries with ADRD enrolled in MA have a substantially high rate of leaving MA and joining TM, especially for those experiencing a great demand for post-acute hospitalization, home care, and long-term nursing home care in the previous year.[2–5,7] High-cost MA beneficiaries, including ADRD patients, also have a larger chance of entering into low-quality nursing homes compared to their TM counterparts.[18]

Our study uses the 2020 reintroduction of ADRD HCC into the payment model as a pertinent case study to provide insights into the underlying recalibration of the risk-adjustment formula. We find that the 2020 reintroduction of ADRD HCCs is associated with improved care access and reduced financial strain among MA beneficiaries with ADRD. These improvements suggest that updating the risk adjustment model to better reflect the costs of chronic and complex conditions can help realign MA plan incentives with the needs of vulnerable populations. These findings provide a timely assessment of this condition-specific risk adjustment change, inform CMS's ongoing refinement of risk-adjusted payment models, and offer insights not only for ADRD but also for other chronic and complex conditions that could benefit from more nuanced risk adjustment.

Despite these promising results, our study also identifies several areas of concern. For instance, the improvements in access to specialists and overall care quality are limited after the reintroduction of ADRD into risk adjustment, and benefits are more pronounced among urban and highly educated populations than among rural or less-educated groups. These gaps indicate that while the policy change represents progress, it does not fully overcome systemic barriers to high-quality and comprehensive care for all beneficiaries with ADRD. Policymakers should consider complementary strategies - such as enhanced care coordination, expanded provider networks, and ADRD-specific quality metrics (e.g., caregiver support and dementia care training) - to further incentivize high-quality and comprehensive care, specifically for beneficiaries in under-served contexts.

We also acknowledge the need to monitor the unintended consequences of risk adjustment reforms. While the inclusion of ADRD HCCs addresses under-compensation for this population, it is essential to ensure that this adjustment does not inadvertently lead to cost-shifting or restricted benefits in other areas. Policymakers should consider periodic reviews of risk adjustment models to avoid up-coding and over-diagnosis,[8,10,13] ensuring a balance of financial sustainability and equity in care delivery.

Limitations

Our analysis has some limitations. First, we cannot directly observe enrollment and diagnosis timing, which limits our ability to address the potential compositional changes in the treatment group - specifically, an increasing rate of dementia diagnoses in MA beneficiaries who are Hispanic or Black, dual-eligible, or received low-income subsidies following the 2020 payment model change.[8,10] Because these groups are more likely to face access and payment challenges, their increased representation in the post-2020 treatment group may lead to an underestimation of our estimates. Second, our estimates represent average associations across beneficiaries with varying levels of disease severity. Future research using individual longitudinal data to track within-person changes over time would provide more robust evidence, overcoming the lack of unique individual identifiers in the MCBS public use files.

Moreover, caution should be warranted when interpreting care experience measures. The satisfaction metrics, such as access to specialists and quality of care, are self-reported and may be subject to response bias. Furthermore, our satisfaction metrics are general rather than specifically tailored to ADRD care, so they may introduce noises that mask the true associations.

Lastly, we do not account for the cost of overdiagnosis, a potential consequence of the risk-adjusted payment model change.[8] Thus, our study may not fully capture the broader impact of risk adjustment on both access to care and quality of care.

Conclusions

Amid the growing aging population and the rising burden of ADRD, the findings of this study provide insights into the importance of refining risk adjustment models to better capture both clinical and social complexities. Expanding the scope of risk adjustment to include social determinants of health, such as caregiver burden, socioeconomic status, or access to community resources, may provide a more holistic approach to mitigating gaps and ensuring equitable care for ADRD patients and their families.

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Table 1. Summary Statistics for Analytical Sample

	All	ADRD	Stroke/Paralysis/ Parkinson's Disease
	N (%)	N (%)	N (%)
Observations	5,353 (100%)	1,629 (100.0%)	3,724 (100.0%)
Dependent Vars:			
Any Troubles Getting Needed Care			
Yes	536 (10.0%)	142 (8.7%)	394 (10.6%)
No	4,803 (90.0%)	1,482 (91.3%)	3,321 (89.4%)
Any Medical Financial Burden			
Yes	975 (23.4%)	235 (19.3%)	740 (25.1%)
No	3,197 (76.6%)	985 (80.7%)	2,212 (74.9%)
Satisfaction about Accessibility to Specialist			
No	398 (7.9%)	140 (9.2%)	258 (7.3%)
Yes	4,651 (92.1%)	1,384 (90.8%)	3,267 (92.7%)
Satisfaction about Quality of Care			
No	371 (7.0%)	116 (7.2%)	255 (7.0%)
Yes	4,909 (93.0%)	1,495 (92.8%)	3,414 (93.0%)
Demographics:			
Age Group <65	987 (18.4%)	113 (6.9%)	874 (23.5%)
Age Group 65 to 75	1,239 (23.1%)	224 (13.8%)	1,015 (27.3%)
Age Group 75+	3,127 (58.4%)	1,292 (79.3%)	1,835 (49.3%)
Non-Hispanic white	3,304 (61.7%)	920 (56.5%)	2,384 (64.0%)
Non-Hispanic black	840 (15.7%)	217 (13.3%)	623 (16.7%)
Hispanic	887 (16.6%)	394 (24.2%)	493 (13.2%)
Other	322 (6.0%)	98 (6.0%)	224 (6.0%)
Male	1,785 (33.3%)	443 (27.2%)	1,342 (36.0%)
Not Married	2,793 (52.2%)	892 (54.8%)	1,901 (51.0%)
Married	1,776 (33.2%)	521 (32.0%)	1,255 (33.7%)
Married: missing	784 (14.6%)	216 (13.3%)	568 (15.3%)
High school or less	2,898 (54.1%)	991 (60.8%)	1,907 (51.2%)
High School above	1,629 (30.4%)	401 (24.6%)	1,228 (33.0%)
Education missing	826 (15.4%)	237 (14.5%)	589 (15.8%)
Self-respondent	3,923 (73.3%)	635 (39.0%)	3,288 (88.3%)
Proxy respondent	1,430 (26.7%)	994 (61.0%)	436 (11.7%)
Household Size: 1	1,669 (31.2%)	373 (22.9%)	1,296 (34.8%)
Household Size: 2	2,318 (43.3%)	749 (46.0%)	1,569 (42.1%)
Household Size: 3+	1,366 (25.5%)	507 (31.1%)	859 (23.1%)
Health Conditions			
Underweight/healthy (<25)	1,806 (33.7%)	702 (43.1%)	1,104 (29.6%)
Overweight (25-30)	1,768 (33.0%)	475 (29.2%)	1,293 (34.7%)
Obese/high-risk obese (>=30)	1,615 (30.2%)	379 (23.3%)	1,236 (33.2%)

BMI missing	164 (3.1%)	73 (4.5%)	91 (2.4%)
IADLs or ADLs: 0	1,462 (27.3%)	212 (13.0%)	1,250 (33.6%)
IADLs: 1	926 (17.3%)	348 (21.4%)	578 (15.5%)
ADLs: 1-2	1,516 (28.3%)	410 (25.2%)	1,106 (29.7%)
ADLs: 3-4	774 (14.5%)	296 (18.2%)	478 (12.8%)
ADLs: 5-6	675 (12.6%)	363 (22.3%)	312 (8.4%)
Chronic Conditions (except ADRD): 0	39 (0.7%)	39 (2.4%)	0 (0%)
Chronic Conditions (except ADRD): 1	208 (3.9%)	124 (7.6%)	84 (2.3%)
Chronic Conditions (except ADRD): 2	416 (7.8%)	182 (11.2%)	234 (6.3%)
Chronic Conditions (except ADRD): 3-4	1,621 (30.3%)	520 (31.9%)	1,101 (29.6%)
Chronic Conditions (except ADRD): 5-6	1,722 (32.2%)	452 (27.7%)	1,270 (34.1%)
Chronic Conditions (except ADRD): 7-10	1,226 (22.9%)	281 (17.2%)	945 (25.4%)
Chronic Conditions (except ADRD): 11+	121 (2.3%)	31 (1.9%)	90 (2.4%)

Notes: The working sample consists of MA beneficiaries from 2015-2022 MCBS. Beneficiaries with only partial enrollment in an MA plan during the past year at the time of the survey and veterans are excluded.

Figure 1. Data Process Flow

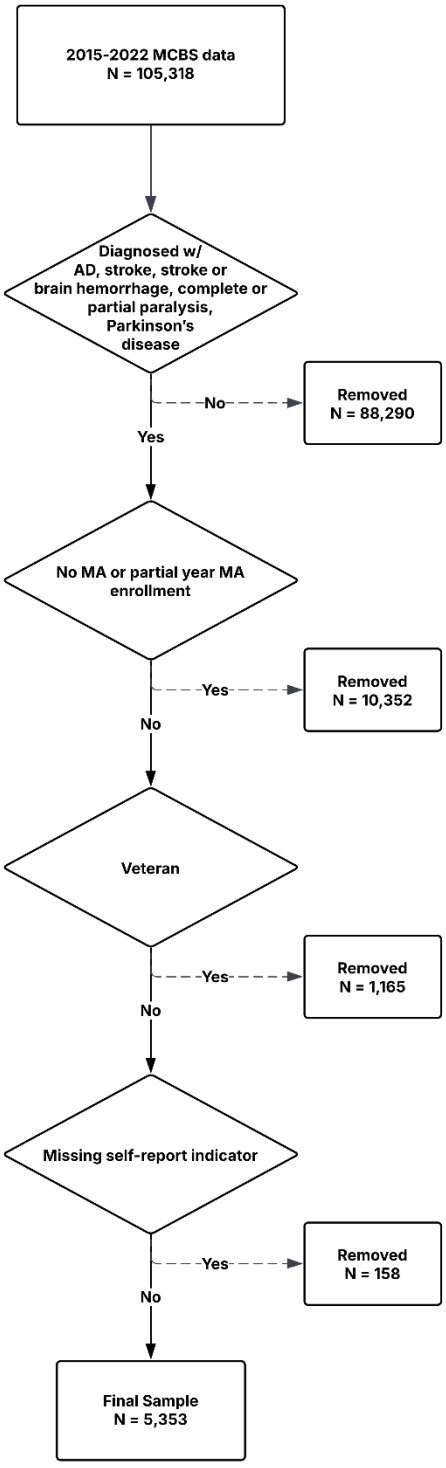
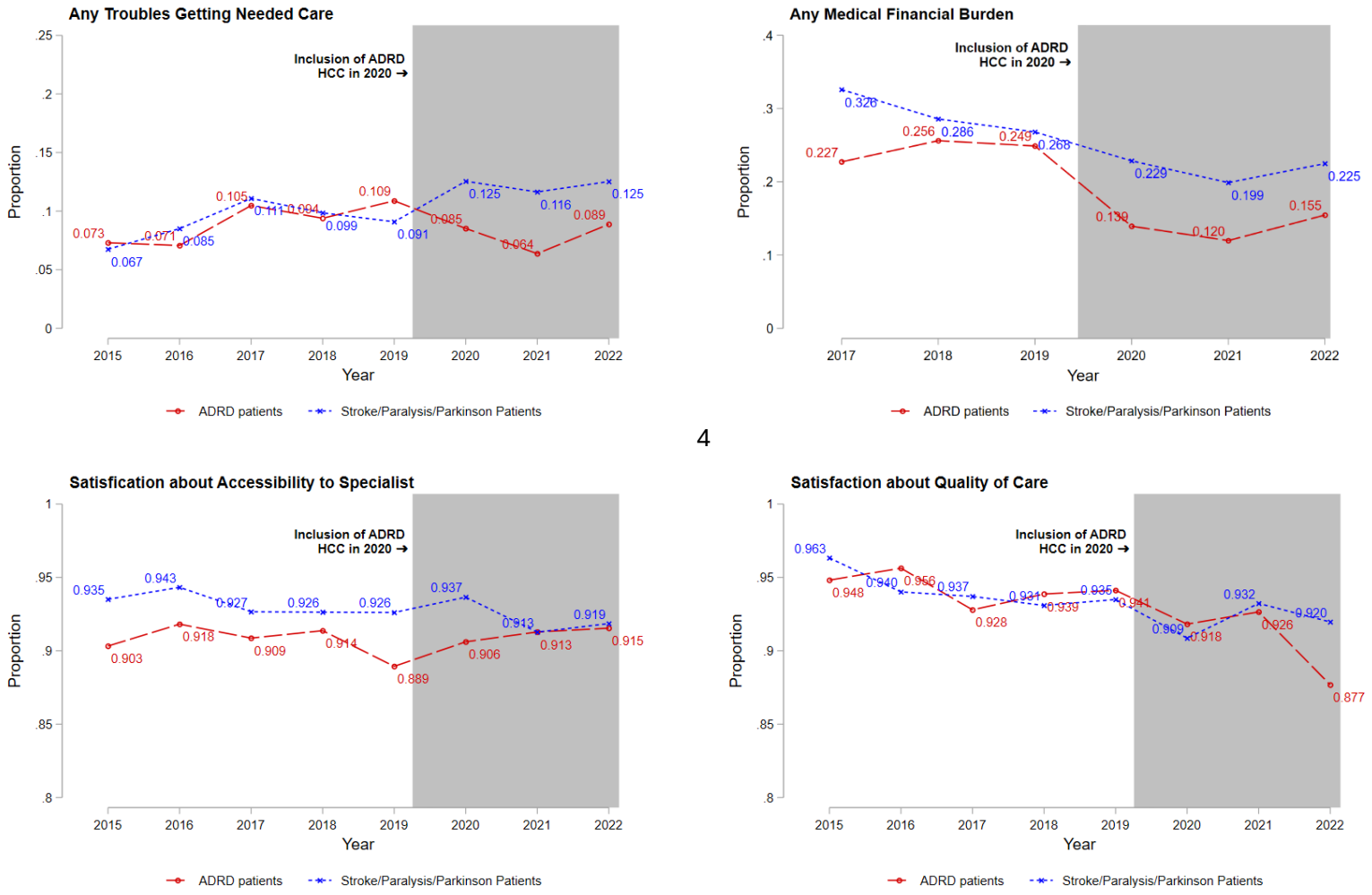
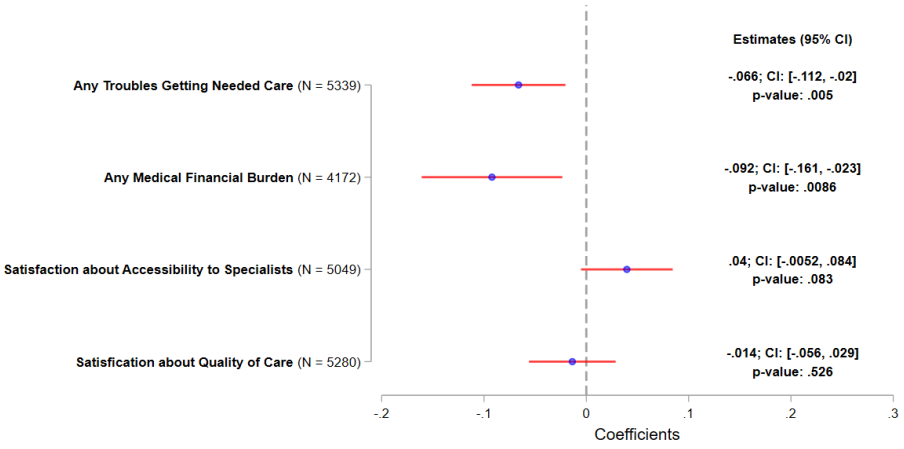


Figure 2. Pattern of Care Experiences Over Time



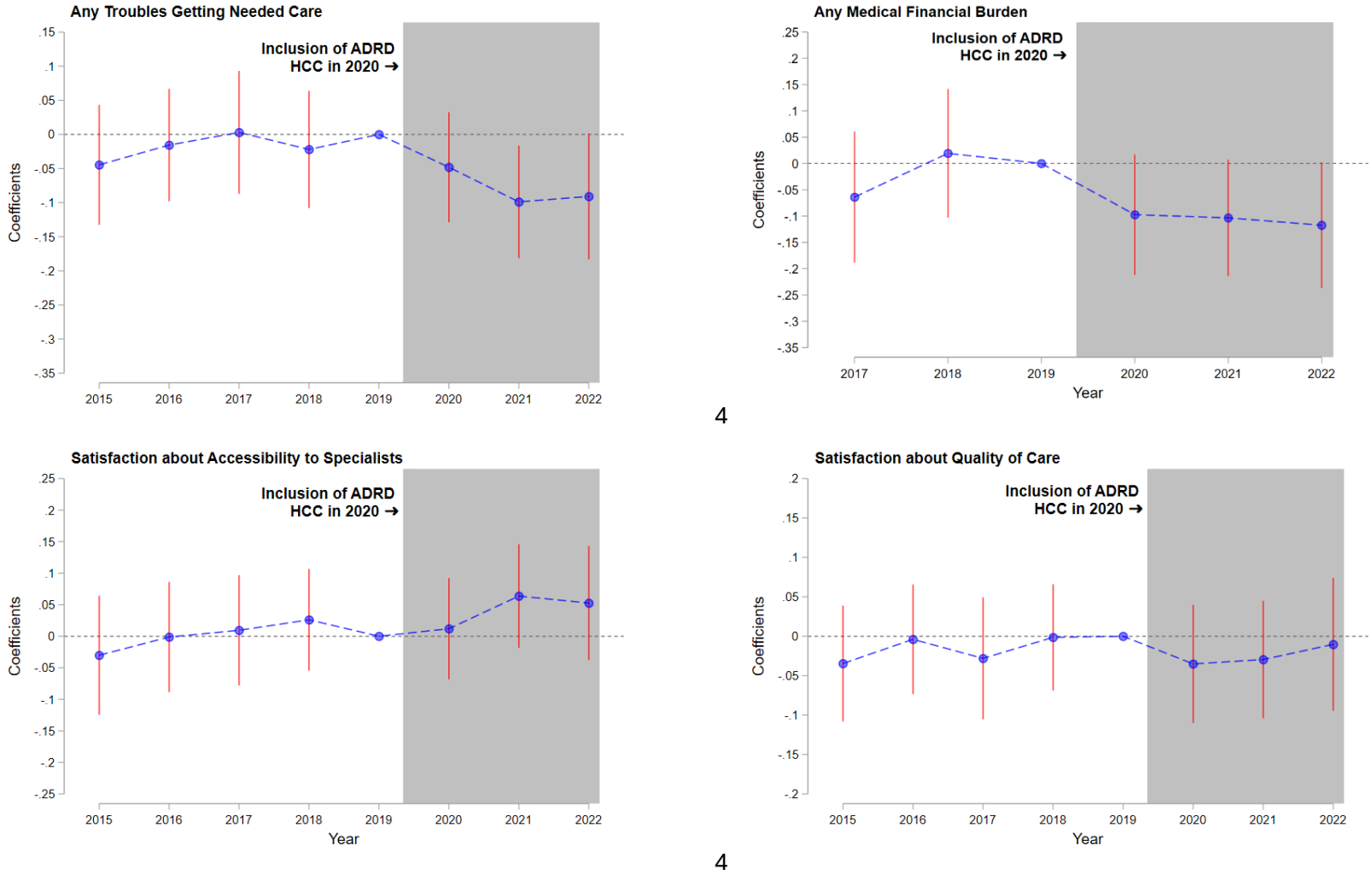
Notes: The working sample consists of MA beneficiaries from 2015-2022 MCBS. Beneficiaries with only partial enrollment in an MA plan during the past year at the time of the survey and veteran are excluded.

Figure 3. Association between the Inclusion of ADRD HCCs in Payment Model and Care Experiences



Notes: The working sample consists of MA beneficiaries from 2015-2022 MCBS. Beneficiaries with only partial enrollment in an MA plan during the past year at the time of the survey and veteran are excluded. The plotted estimates represent the coefficients for the interaction term between the treatment indicator and the post indicator from a DID estimation, with the dependent variable indicated on the y-axis. In each DID estimation, the treatment group consists of MA beneficiaries with ADRD, and the control group consists of MA beneficiaries without ADRD but with stroke/brain hemorrhage, complete/partial paralysis, or Parkinson's diseases. The post indicator takes the value of one if 2020 or afterwards, and zero otherwise. The associated 95% CIs are plotted. Robust standard errors are applied.

Figure 4. Dynamic Association between the Inclusion of ADRD HCCs in Payment Model and Care Experiences



Notes: The working sample consists of MA beneficiaries from 2015-2022 MCBS. Beneficiaries with only partial enrollment in an MA plan during the past year at the time of the survey and veteran are excluded. Each figure presents results from an event study model, with the dependent variable specified above. The plotted estimates represent the coefficients for the interaction term between treated indicator and year indicators. In each

estimation, the treatment group consists of MA beneficiaries with ADRD, and the control group consists of MA beneficiaries without ADRD but with stroke/brain hemorrhage, complete/partial paralysis, or Parkinson's diseases. The associated 95% CIs are also plotted. Robust standard errors are applied.

Online Appendix for "Risk Adjustment for ADRD in Medicare Advantage and Health Care Experiences"

Appendix A: Additional Tables and Figures

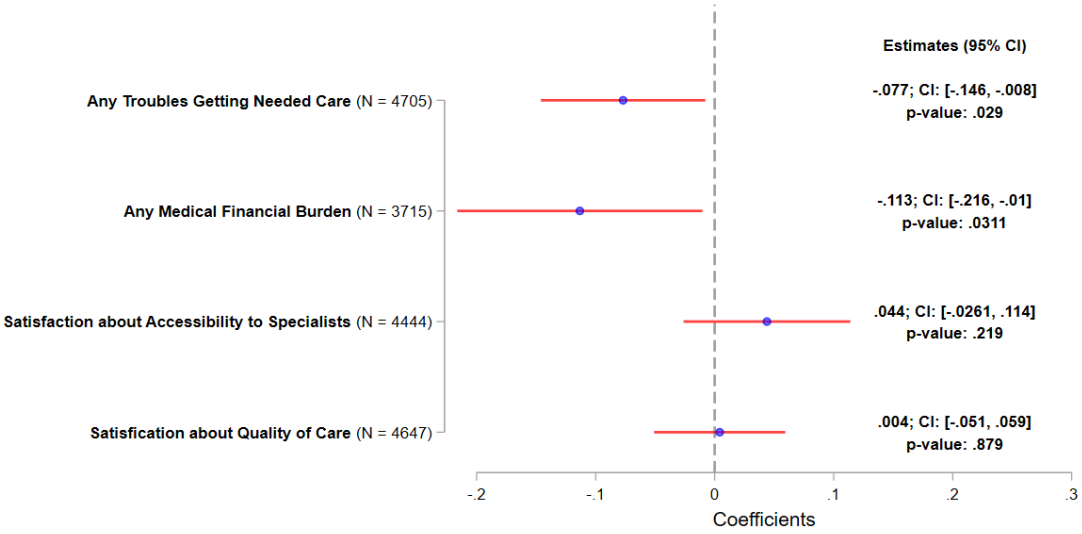
- Figure A1. Drop MA ADRD Beneficiaries with Self-Response
- Figure A2. Exclude Beneficiaries in Current MA Plan for Less than 3 Years
- Figure A3. Using Balanced Repeated Replications Method
- Figure A4. Exclude MA Beneficiaries Under 65
- Figure A5. Using All Conditions as Control
- Figure A6. Placebo Tests Using Other Conditions as Placebo Treatment Group
- Figure A7. Placebo Tests Using Traditional Medicare Beneficiaries
- Figure A8. Stratification Analysis

Appendix B: Econometric Models

- B.1: Difference-in-Differences Model
- B.2: Placebo Tests
- B.3: Event Study Model

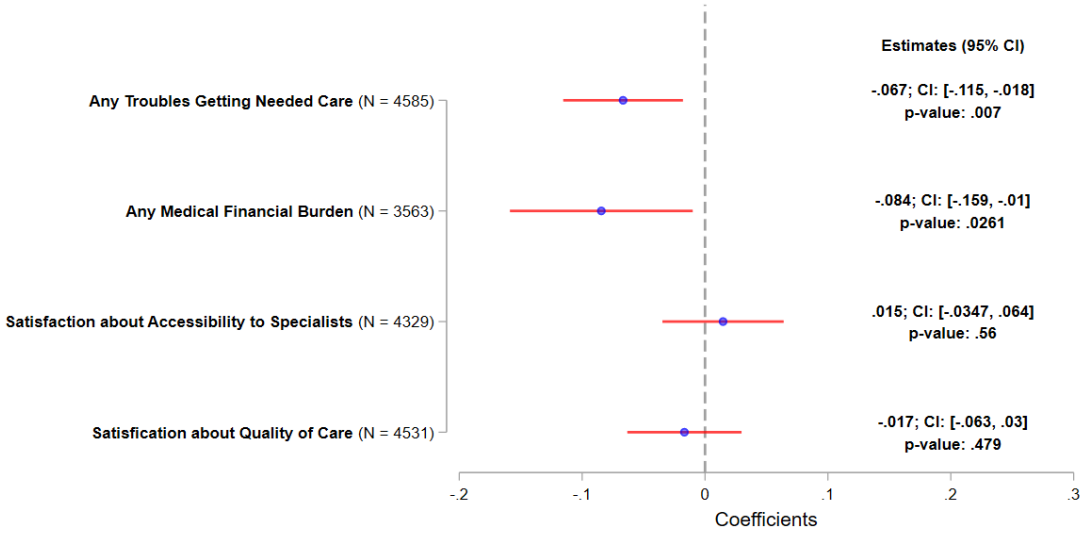
Appendix A: Additional Tables and Figures

Figure A1. Association between the Inclusion of ADRD HCCs in Payment Model and Care Experiences – Drop MA ADRD Beneficiaries with Self-Response



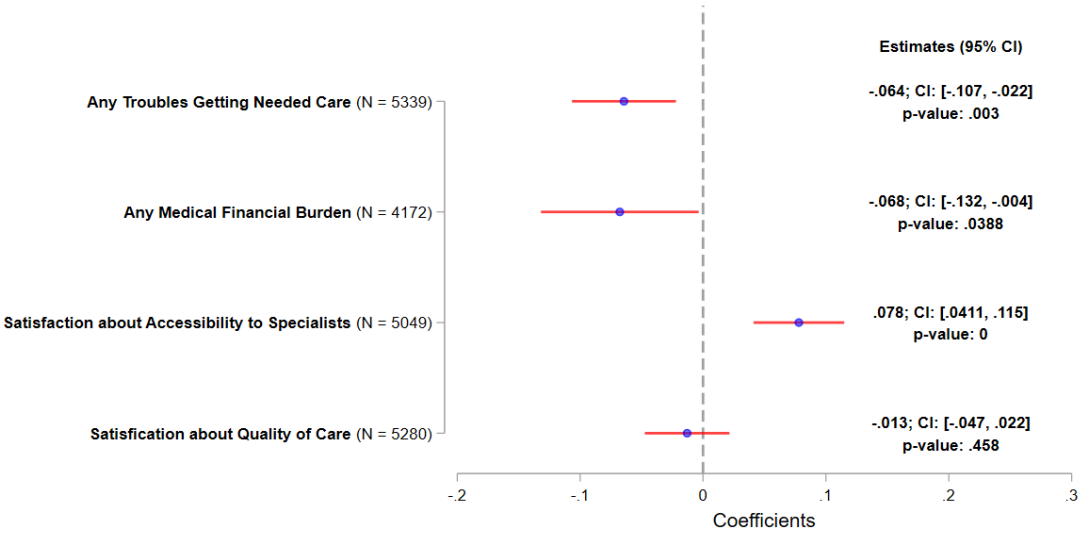
Notes: The working sample consists of MA beneficiaries from 2015-2022 MCBS. Beneficiaries with only partial enrollment in an MA plan during the past year at the time of the survey and veteran are excluded. MA ADRD beneficiaries with self-response in the survey are also removed. The plotted estimates represent the coefficients for interaction term between the treatment indicator and the post indicator from a DID estimation, with the dependent variable indicated on the y-axis. In each DID estimation, the treatment group consists of MA beneficiaries with ADRD, and the control group consists of MA beneficiaries without ADRD but with stroke/brain hemorrhage, complete/partial paralysis, or Parkinson's diseases. The post indicator takes the value of one if 2020 or afterwards, and zero otherwise. The associated 95% CIs are plotted. Robust standard errors are applied.

Figure A2. Association between the Inclusion of ADRD HCCs in Payment Model and Care Experiences – Exclude Beneficiaries in Current MA Plan for Less than 3 Years



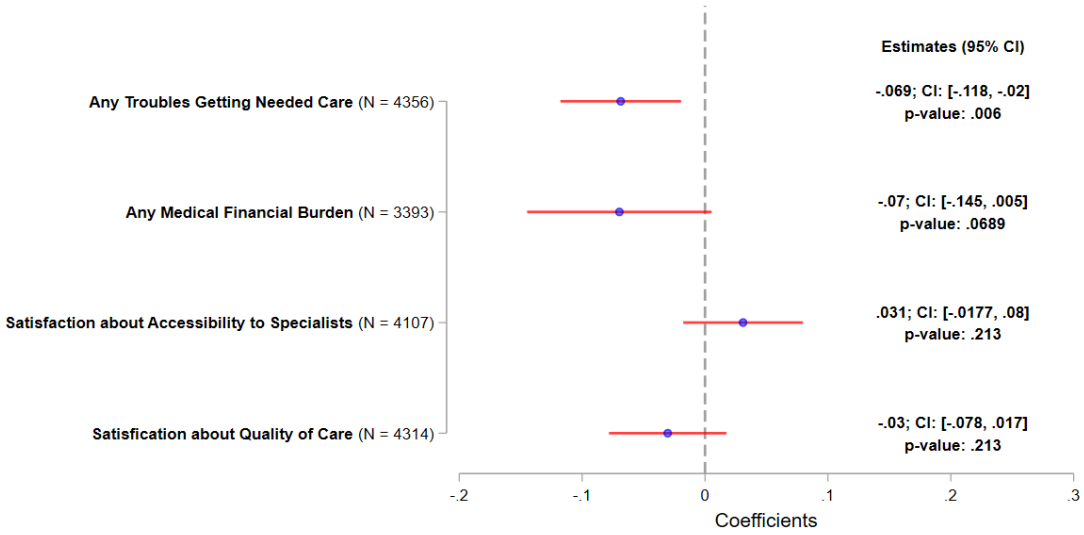
Notes: The working sample consists of MA beneficiaries from 2015-2022 MCBS. Beneficiaries with only partial enrollment in an MA plan during the past year at the time of the survey and veteran are excluded. MA beneficiaries who have been in current MA plans for less than 3 years at the time of the survey are also removed. The plotted estimates represent the coefficients for the interaction term between the treatment indicator and the post indicator from a DID estimation, with the dependent variable indicated on the y-axis. In each DID estimation, the treatment group consists of MA beneficiaries with ADRD, and the control group consists of MA beneficiaries without ADRD but with stroke/brain hemorrhage, complete/partial paralysis, or Parkinson's diseases. The post indicator takes the value of one if 2020 or afterwards, and zero otherwise. The associated 95% CIs are plotted. Robust standard errors are applied.

Figure A3. Association between the Inclusion of ADRD HCCs in Payment Model and Care Experiences using Balanced Repeated Replications Method



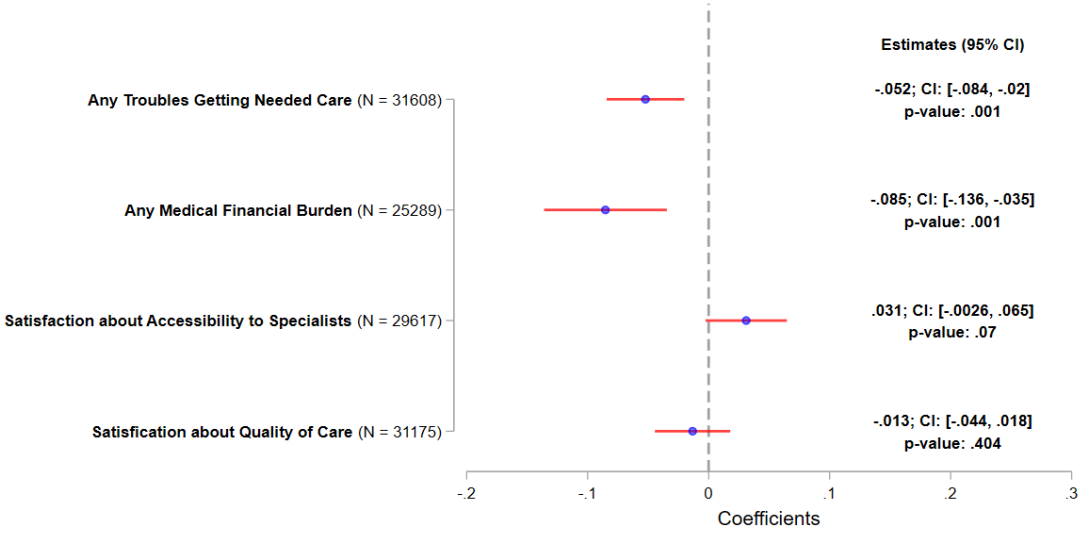
Notes: The working sample consists of MA beneficiaries from 2015-2022 MCBS. Beneficiaries with only partial enrollment in an MA plan during the past year at the time of the survey and veteran are excluded. The plotted estimates represent the coefficients for the interaction term between the treatment indicator and the post indicator from a DID estimation, with the dependent variable indicated on the y-axis. In each DID estimation, the treatment group consists of MA beneficiaries with ADRD, and the control group consists of MA beneficiaries without ADRD but with stroke/brain hemorrhage, complete/partial paralysis, or Parkinson's diseases. The post indicator takes the value of one if 2020 or afterwards, and zero otherwise. The associated 95% CIs are plotted. Balanced repeated replications (BRR) for standard errors are applied.

Figure A4. Association between the Inclusion of ADRD HCCs in Payment Model and Care Experiences – Exclude MA Beneficiaries Under 65



Notes: The working sample consists of MA beneficiaries from 2015-2022 MCBS. Beneficiaries with only partial enrollment in an MA plan during the past year at the time of the survey and veteran are excluded. MA beneficiaries less than 65 years old at the time of the survey are also removed. The plotted estimates represent the coefficients for the interaction term between the treatment indicator and the post indicator from a DID estimation, with the dependent variable indicated on the y-axis. In each DID estimation, the treated group consists of MA beneficiaries with ADRD, and the control group consists of MA beneficiaries without ADRD but with stroke/brain hemorrhage, complete/partial paralysis, or Parkinson's diseases. The post indicator takes the value of one if 2020 or afterwards, and zero otherwise. The associated 95% CIs are plotted. Robust standard errors are applied.

Figure A5. Association between the Inclusion of ADRD HCCs in Payment Model and Care Experiences – Using All Conditions as Control



Notes: The working sample consists of MA beneficiaries from 2015-2022 MCBS. Beneficiaries with only partial enrollment in an MA plan during the past year at the time of the survey and veteran are excluded. MA ADRD beneficiaries with self-response in the survey are also removed. The plotted estimates represent the coefficients for the interaction term between the treatment indicator and the post indicator from a DID estimation, with the dependent variable indicated on the y-axis. In each DID estimation, the treatment group consists of MA beneficiaries with ADRD, and the control group consists of MA beneficiaries without ADRD but with other conditions, including but not limited to stroke/brain hemorrhage, complete/partial paralysis, or Parkinson's diseases. The post indicator takes the value of one if 2020 or afterwards, and zero otherwise. The associated 95% CIs are plotted. Robust standard errors are applied.

Figure A6. Placebo Tests Using Other Conditions as Placebo Treatment Group

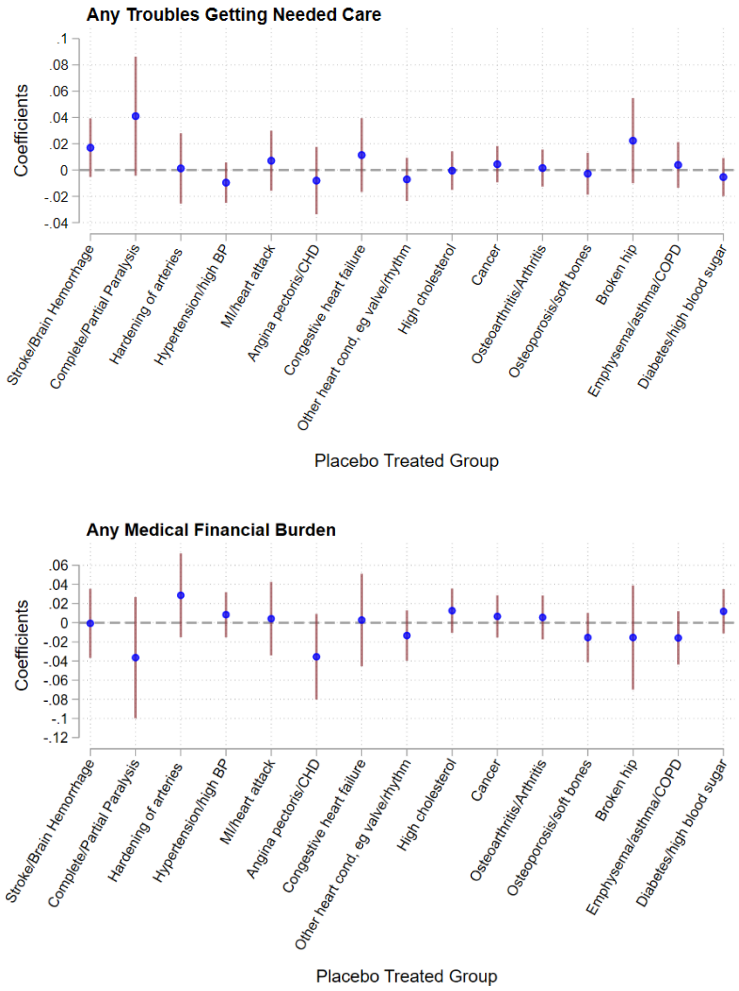
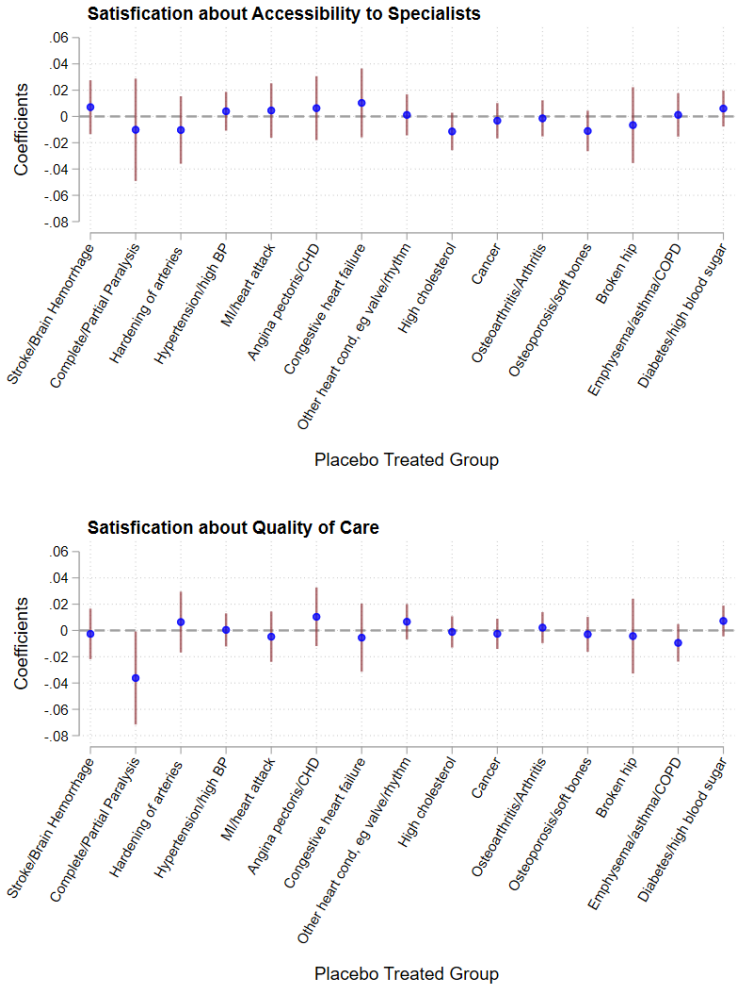
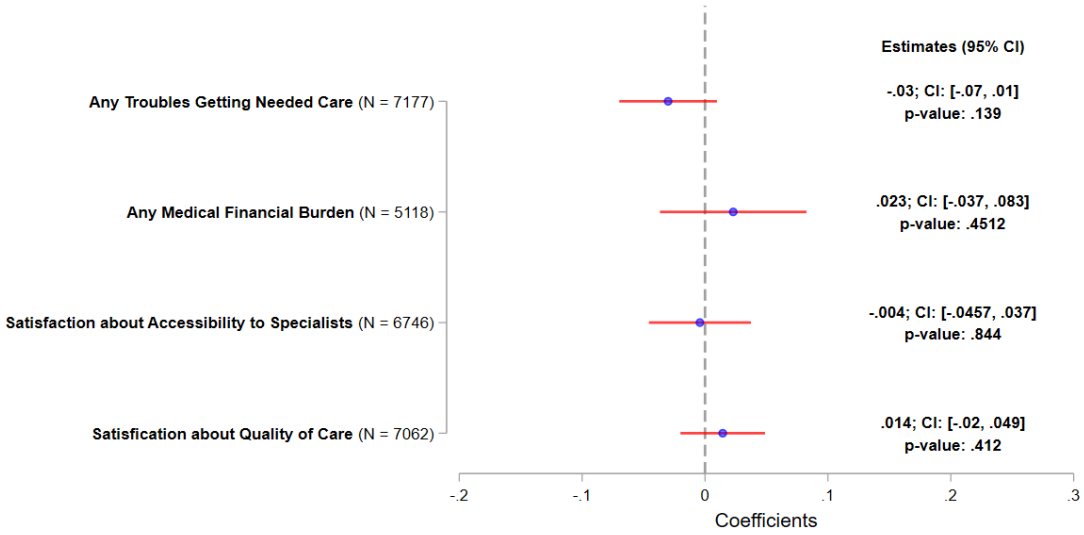


Figure A6 (Cont.). Placebo Tests Using Other Conditions as Placebo Treatment Group



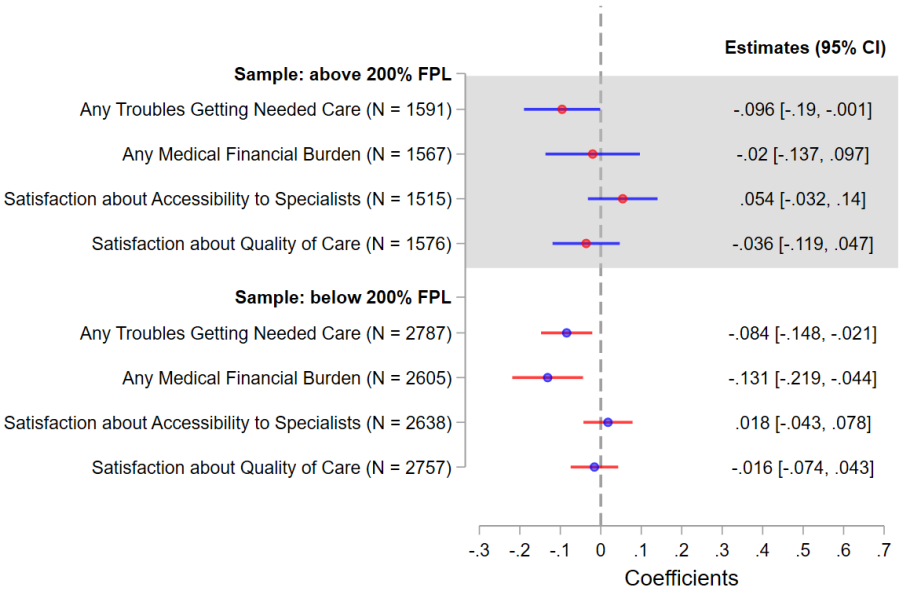
Notes: The working sample consists of MA beneficiaries from 2015-2022 MCBS. Beneficiaries with only partial enrollment in an MA plan during the past year at the time of the survey and veteran are excluded. The plotted estimates represent the coefficients for the interaction term between the treatment indicator and the post indicator from a DID estimation, with the dependent variable indicated in each panel. In each DID estimation, the treatment group consists of non-ADRD MA beneficiaries with the disease specified in the x-axis, and the control group consists of non-ADRD MA beneficiaries without the disease specified in the x-axis. The post indicator takes the value of one if 2020 or afterwards, and zero otherwise. The associated 95% CIs are plotted. Robust standard errors are applied.

Figure A7. Association between the Inclusion of ADRD HCCs in Payment Model and Care Experiences – Using Traditional Medicare Beneficiaries

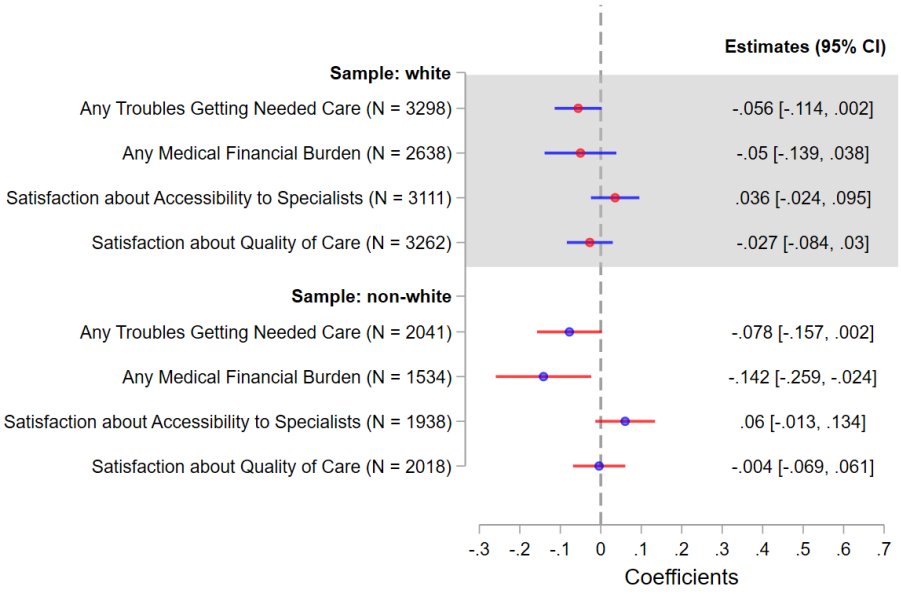


Notes: The working sample consists of TM beneficiaries from 2015-2022 MCBS. Veteran beneficiaries are excluded. The plotted estimates represent the coefficients for the interaction term between the treatment indicator and the post indicator from a DID estimation, with the dependent variable indicated on the y-axis. In each DID estimation, the treatment group consists of TM beneficiaries with ADRD, and the control group consists of TM beneficiaries without ADRD but with stroke/brain hemorrhage, complete/partial paralysis, or Parkinson's diseases. The post indicator takes the value of one if 2020 or afterwards, and zero otherwise. The associated 95% CIs are plotted. Robust standard errors are applied.

Figure A8. Association between the Inclusion of ADRD HCCs in Payment Model and Care Experiences – Stratification Analysis

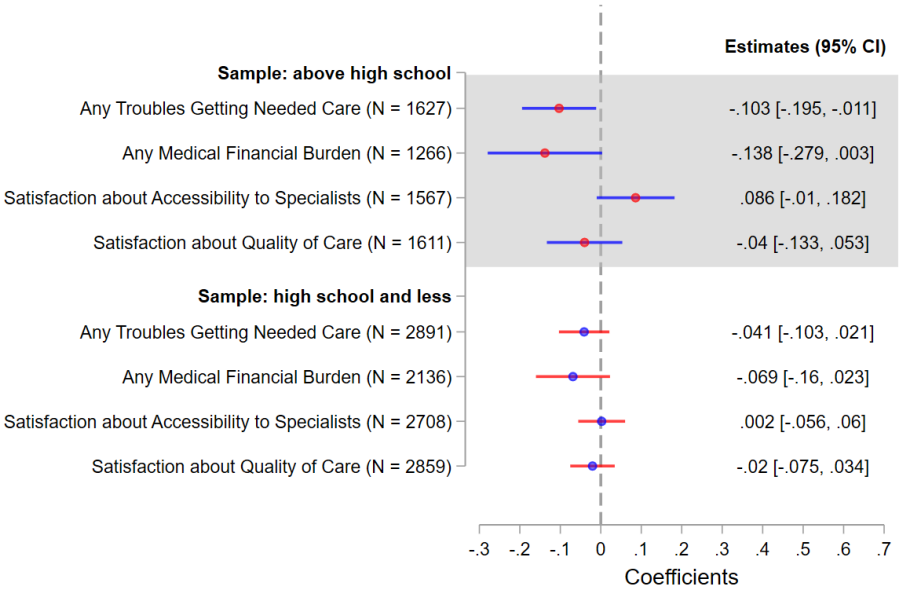


A. By Income Level

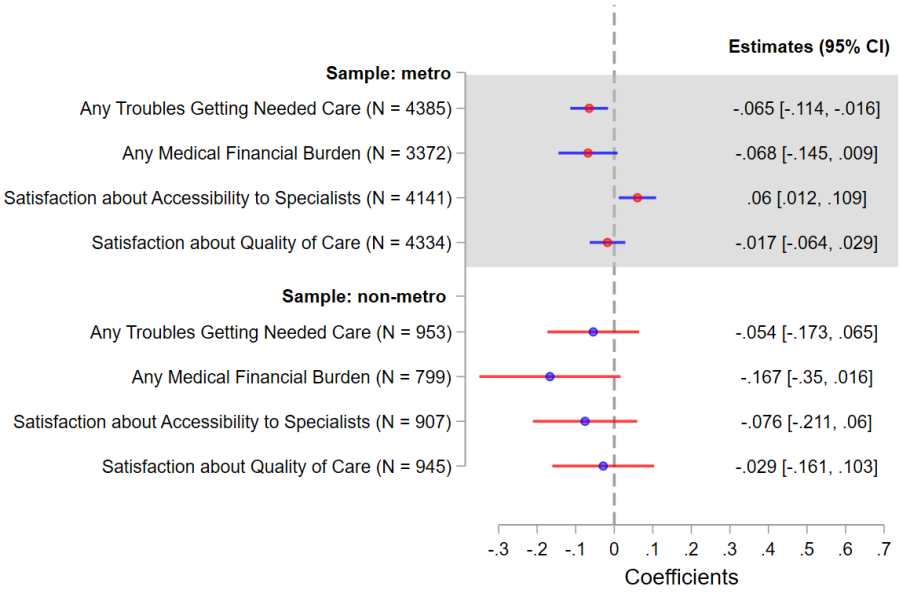


B. By Race/Ethnicity

Figure A8. (Cont.) Association between the Inclusion of ADRD HCCs in Payment Model and Care Experiences – Stratification Analysis



C. By Education Level



D. By Metropolitan Status

Notes: The working sample consists of MA beneficiaries from 2015-2022 MCBS. Beneficiaries with only partial enrollment in an MA plan during the past year at the time of the survey and veteran are excluded. The plotted estimates represent the coefficients for the interaction term between the treatment indicator and the post indicator from a DID estimation, with the dependent variable indicated on the y-axis. In each DID estimation, the treatment group consists of MA beneficiaries with ADRD, and the control group consists of MA beneficiaries without ADRD but with stroke/brain hemorrhage,

complete/partial paralysis, or Parkinson's diseases. The post indicator takes the value of one if 2020 or afterwards, and zero otherwise. The associated 95% CIs are plotted. Robust standard errors are applied.

Table A1. Dynamic Association between the Inclusion of ADRD HCCs in Payment Model and Care Experiences (Event Study)

variable	Coef.	Standard Error	P value	95% CI: lower	95% CI: upper
Outcome: Any Trouble Getting Needed Care (N = 5,339)					
ADRD × 2015	-0.0446	0.0448	0.3199	-0.1325	-0.0433
ADRD × 2016	-0.0156	0.0421	0.7100	-0.0981	0.0668
ADRD × 2017	0.0029	0.0460	0.9492	-0.0872	0.0930
ADRD × 2018	-0.0221	0.0438	0.6148	-0.1080	0.0639
ADRD × 2020	-0.0481	0.0411	0.2422	-0.1288	0.0325
ADRD × 2021	-0.0989	0.0421	0.0188	-0.1814	-0.0164
ADRD × 2022	-0.0909	0.0471	0.0536	-0.1833	0.0014
Outcome: Any Medical Financial Burden (N = 4,172)					
ADRD × 2017	-0.0639	0.0636	0.3148	-0.1886	0.0608
ADRD × 2018	0.0193	0.0624	0.7573	-0.1031	0.1417
ADRD × 2020	-0.0974	0.0584	0.0953	-0.2118	0.0171
ADRD × 2021	-0.1034	0.0565	0.0672	-0.2141	0.0073
ADRD × 2022	-0.1174	0.0609	0.0542	-0.2368	0.0021
Outcome: Satisfaction about Access to Specialists (N = 5,049)					
ADRD × 2015	-0.0301	0.0482	0.5319	-0.1246	0.0644
ADRD × 2016	-0.0012	0.0446	0.9784	-0.0886	0.0862
ADRD × 2017	0.0094	0.0446	0.8323	-0.0780	0.0969
ADRD × 2018	0.0261	0.0411	0.5260	-0.0545	0.1067
ADRD × 2020	0.0119	0.0410	0.7711	-0.0684	0.0923
ADRD × 2021	0.0637	0.0419	0.1283	-0.0184	0.1459
ADRD × 2022	0.0526	0.0462	0.2548	-0.0380	0.1432
Outcome: Satisfaction about Quality of Care (N = 5,280)					
ADRD × 2015	-0.0346	0.0374	0.3554	-0.1079	0.0388
ADRD × 2016	-0.0039	0.0354	0.9123	-0.0734	0.0656
ADRD × 2017	-0.0281	0.0394	0.4766	-0.1053	0.0492
ADRD × 2018	-0.0014	0.0344	0.9678	-0.0687	0.0660
ADRD × 2020	-0.0351	0.0382	0.3587	-0.1100	0.0398
ADRD × 2021	-0.0295	0.0380	0.4368	-0.1040	0.0449
ADRD × 2022	-0.0103	0.0430	0.8102	-0.0946	0.0740

Notes: The working sample consists of MA beneficiaries from 2015-2022 MCBS. Beneficiaries with only partial enrollment in an MA plan during the past year at the time of the survey and veteran are excluded. In each estimation, the treatment group consists of MA beneficiaries with ADRD, and the control group consists of MA beneficiaries without ADRD but with stroke/brain hemorrhage, complete/partial paralysis, or Parkinson's diseases. The event study is specified in Appendix B.3. The year of 2019 is selected as the reference year. Robust standard errors are applied.

Appendix B: Econometric Models

B.1 Difference-in-Differences Model

We employ a DID model to exploit the inclusion of ADRD HCCs in the risk adjustment model for MA plans in 2020 as a quasi-natural experiment. This model compares care experiences between a treatment and a control group before and after the 2020 policy change.

The treated group is defined as MA enrollees who reported having ever been told they have symptoms of ADRD. To construct a comparable control group, we select MA enrollees who: (1) had never been diagnosed with ADRD, and (2) had been diagnosed with conditions such as stroke or brain hemorrhage, complete or partial paralysis, or Parkinson's disease. The selection criteria are grounded in the rationale that patients with these conditions are also likely to see neurologists like those with ADRD. This parallel in healthcare pathways allows for a more equitable comparison, ensuring that differences observed can be more confidently attributed to the effects of the ADRD HCCs integration into the risk adjustment model.

Formally, we build a regression model as outlined in Equation (B.1) below.

$$y_{it} = \beta_0 + \beta_1 treated_{it} \times post_t + \beta_2 treated_{it} + \gamma X'_{it} + \alpha_t + \epsilon_{it}, \quad \text{(B.1)}$$

where y_{it} represents the care experience measure for beneficiary i in year t. The binary variable $treated_{it}$ indicates whether individual i is classified as treated, as defined above. The binary variable $post_t$ takes the value of one for the years following the policy change (2020 and later), and zero otherwise. In a DID framework, the coefficient of the interaction term $treated_{it} \times post_t$, β_1, captures the association between the inclusion of ADRD HCCs in the risk adjusted payment model and the care experience of MA beneficiaries with ADRD. A positive β_1 implies a position association. We apply robust standard errors in the analysis.

To reassure the estimated $\hat{\beta}_1$ unbiasedly measures the association of interest, rather than confounded by other unobserved factors, a critical assumption is that, in the absence of the payment model change, the evolution of the outcomes of interest for the control and treatment groups would have followed a similar trajectory over time. This assumption, commonly known as the parallel-trends assumption, is fundamental to the validity of the DID design. It enables the use of the control group's outcomes as a reliable counterfactual for the treated group.

A notable threat to the parallel-trends assumption is the possibility that the estimated $\hat{\beta}_1$ may pick up confounding effects from some concurrent events, such as the onset of the COVID-19 pandemic in early 2020. To address this concern, we undertake several methodological adjustments. First, we include year fixed effects (α_t) to absorb national-level shocks and contemporary events. Additionally, to account for

potential heterogeneous pandemic impacts across subpopulations, we incorporate several interaction terms in X'_{it}. These include:

(1) interactions between demographic covariates and year indicators, where the demographic covariates encompass age categories, marital status, race/ethnicity, sex, educational attainment, and household size.

(2) the interactions between each health measure and each year indicator, where the health measures include number of functional limitations, number of chronic conditions, and BMI categories.

Our model with these interactions provides greater non-parametric flexibility in accounting for potential heterogeneous exposure to the pandemic, thereby enhancing the robustness of our estimates.

Another potential concern is measurement error arising from proxy reporting, as approximately 27% of the study sample comprises proxy respondents (Table 1). To mitigate the effects of such measurement errors, we include interactions between the self-respondent indicator and all previously described covariates, as well as each time indicator. These interactions allow for a more flexible adjustment, accounting for potential heterogeneity in the patterns and accuracy of proxy reporting.

Moreover, we conduct an event study model, detailed in Appendix B.3 to provide suggestive evidence for the parallel-trends assumption.

B.2: Placebo Tests

We also conduct a series of placebo tests as alternative approaches to support the parallel trends assumption and address the measurement errors described above. The design of these placebo tests involves comparing a group of Medicare Advantage beneficiaries who are not expected to be affected by the inclusion of the ADRD HCC in the risk-adjusted payment model with another group of MA beneficiaries who likewise should not be impacted by the new payment model. Formally, we estimate the following DID model specified in Equation (B.2):

$$y_{it} = \beta'_0 + \beta'_1 placeboTreated_{it} \times post_t + \beta'_2 placeboTreated_{it} + \gamma' X'_{it} + \alpha_t + \epsilon'_{it} \qquad \text{(B.2)}$$

Equation (B.2) mirrors Equation (B.1), with the primary difference being the definition of the placebo-treatment group, denoted as $placeboTreated_{it}$. For instance, one illustrative placebo test designates a placebo treatment group, consisting of MA enrollees diagnosed with diabetes/high blood sugar but not ADRD, and a control group comprising MA enrollees without either diabetes/high blood sugar or ADRD. Since individuals with diabetes and without ADRD are not the primary target of the policy integrating ADRD HCC into the risk adjustment model, we expect to observe a statistically insignificant $\hat{\beta}'_1$ in this placebo test. This would imply that the 2020 revisions to the risk-adjusted payment model are not statistically associated with improved care experiences for non-ADRD MA beneficiaries with diabetes/high

blood sugar. Conversely, if we observe a significant $\hat{\beta}_1'$, it suggests that our benchmark analysis using Equation (B.1) likely picks up confounding bias from concurrent events such as the onset of the COVID-19 pandemic in 2020 or any potential proxy-response bias.

This approach is then extended to a series of placebo tests, with each placebo treated group focusing on a distinct health condition, including hypertension or high blood pressure, myocardial infarction (MI)/heart attack, stroke or brain hemorrhage, osteoarthritis or soft bones, congestive heart failure, emphysema/asthma/COPD, and complete or partial paralysis. The full list of chronic conditions serving as placebo-treatment groups is displayed along the horizontal axis in Figure A6. In this figure, each coefficient of association, along with its corresponding 95% confidence interval, is derived from the results of a specific placebo test.

B.3: Event Study Model

We conduct an event study analysis using Equation (B.3) to provide suggestive evidence for the parallel-trends assumption underlying Equation (B.1). All variables in Equation (B.3) are defined consistently as those in Equation (B.1).

$$y_{it} = \beta_0'' + \sum_{j=2015, j\neq 2019}^{2022} \zeta_j treated_{it} \times \mathbb{I}\{t = j\} + \beta_2'' treated_{it} + \gamma'' X_{it}' + \alpha_t + \epsilon_{it}'' \quad \text{(B.3)}$$

In the equation above, $\mathbb{I}\{t = j\}$ $(2015 \leq j \leq 2022, j \neq 2019)$ is an indicator function. For instance, $\mathbb{I}\{t = 2020\}$ takes the value of one if year is 2020 and otherwise zero. We interact the treatment group indicator, $treated_{it}$, with each year indicator, $\mathbb{I}\{t = j\}$. The year 2019, the last year before the implementation of the new risk-adjusted payment model in 2020, serves as the reference year. The coefficient ζ_j measures the association between the 2020 revised risk adjusted payment model with MA beneficiary's care experience in year j.

This analysis serves two primary purposes. First, if $\hat{\zeta}_j$ ($j \leq 2018$) is statistically insignificant, it provides suggestive evidence supporting the parallel-trends assumption, meaning that in the absence of the 2020 payment model revision, the evolution of care experience among MA beneficiaries with ADRD would follow a parallel trajectory to that of the control group after 2019. Second, if $\hat{\zeta}_j$ ($j \geq 2020$) is statistically significant, it indicates the dynamics of the association between the revised payment model and care experience in the post-revision period. In Figure 4, the $\hat{\zeta}_j$s are plotted with their associated 95% CIs.