Association and Variation Between the COVID-19 Pandemic and Healthcare Quality in the Medicare Shared Savings Program: Insights from a Seven-year Natural Experiment

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Abstract

Potential changes in healthcare quality resulting from variation in pandemic severity since 2020 have received less attention. This study aims to assess the relationship between the pandemic and healthcare quality in Medicare Shared Savings Program (MSSP) accountable care organizations and identify possible heterogeneity in the relationship. The year-by-year difference-in-difference event study of MSSPs between 2016 and 2022 (N=3,390) indicated that one standard deviation increase in standardized cumulative COVID-19 incidence in 2020 was associated with a decrease in total quality score of 0.83 percentage points (95% CI, -0.21--1.44) after controlling for confounders. The reduction in quality score was mostly driven by ACOs with the highest COVID-19 incidence and in the Midwest. We found no evidence for a persisting decline in quality scores in 2021-2022. Public health efforts may need to carefully monitor quality performance and mitigate negative effects during future health crises. Continued investment in strengthening healthcare resilience remains crucial.

Keywords

Medicare Shared Savings Program (MSSP), accountable care organization (ACO), difference-in-difference (DID), quality score, COVID-19.

Introduction

The repercussions of the COVID-19 pandemic on healthcare service have been widely examined, especially the decline in healthcare spending and utilization[1, 2]. Previous data suggested that the quality of Medicare Shared Savings Program (MSSP) accountable care organizations (ACOs) continued to improve in 2020[3-5]. However, potential changes in healthcare quality resulting from variation in pandemic severity since 2020 have received less attention. A clear understanding of the pandemic's impact on healthcare quality is crucial for designing and implementing interventions to strengthen the US healthcare system during and post-pandemic. This study aims to assess the association between the pandemic and healthcare quality in MSSP, Medicare's largest value-based payment model. We also evaluated whether the estimated association varied across regions and by disease severity.

Methods

Data Source

Data on healthcare quality spanning 2016 to 2022 were obtained from the Centers for Medicare and Medicaid Services (CMS) MSSP Public Use Files[6]. Data on COVID-19 cases ranging from 2020 to 2022 came from the Centers for Disease Control and Prevention (CDC) Wonder[7]. Population and mortality data were collected from CDC Wonder[8, 9]. Because of the implementation of Pathways to Success ACO contracts in 2019, two quality score reports were available in January and July 2019 and used to generate a weighted total quality score for 2019[4]. For each MSSP, we defined the participant-attributed state as their reported state with the largest assigned beneficiaries. All data were aggregated at the state level. For all analyses, the MSSP-year served as the unit of analysis.

Variables

Standardized cumulative incidence per year (SCI) was calculated to measure the COVID-19 severity and it represented the standardized ratio of cumulative cases to population for each year. The national and regional unadjusted trend in SCI is shown in **Supplemental Content, Figure 1**. SCI for 2020 to 2022 presents actual COVID-19 severity of each MSSP-attributed state from 2020 through 2022. The outcome variable was the total quality score in percentage (%), which was calculated by CMS from four domains, including patient/caregiver experience, care coordination/patient safety, preventive health, and at-risk populations. There were 28 quality measures across the four domains in 2022[10]. The quality score was determined based on performance against predefined benchmarks, quality enhancement, and the completeness of the reported metrics. Covariates included benchmark minus expenditures, total number of inpatient hospital discharges, primary care services, and number of participating primary care physicians. All ACOs were categorized into four groups based on the state SCI levels in 2020 (first, second, third, and fourth quartiles) and state regions (Northeast, Midwest, South, and West) to examine heterogeneity.

Study Design

A year-by-year difference-in-differences event study design was used. To compare total quality score before and after the pandemic outbreak across different COVID-19 severity levels in the difference-in-differences, we created placebo pandemic occurrence by subtracting 2-4 years to the pandemic outbreak year and imputed SCI values from 2020 to 2016 through 2018, as if the pandemic were to occur in those years.

We adopted this falsification test to determine if potential outcome differences existed in the states prior to the outbreak. The linear regression model estimated was:

$$Y_{ist} = \beta_0 + \sum (\beta_t * time_t * SCI_{ist}) + \delta\omega_{ist} + \alpha_t + \sigma_s + \varepsilon_{ist}$$

Where Y_{ist} denoted the total quality score for MSSP participant i in state s in year t. $time_t$ included 6 indicators for years 2016 through 2022 (2019 as the reference year). $\hat{\beta}_{2020}$ through $\hat{\beta}_{2022}$ estimated changes

in quality score across MSSPs whose primary states had higher COVID-19 severity compared with those with lower severity. $\hat{\beta}_{2016}$ through $\hat{\beta}_{2018}$ estimated expected changes in quality score from the pre-COVID-19 period relative to 2019 in states with varying degrees of SCI, which if statistically significant would indicate existence of differential pre-COVID-19 trends across states. ω_{ist} represented the covariates aforementioned. The model also included year (α_t) and state (σ_s) fixed effects (FE). ε_{ist} represented an error term and standard errors were clustered at the state-level.

Statistical Analyses

Both unadjusted and adjusted regression models were assessed. Heterogeneity analyses across SCI levels and regions were then conducted. Additionally, a series of sensitivity analyses were performed to check the robustness of the estimates, including replacing state FE with ACO FE, excluding South Dakota, which had the highest COVID-19 incidence, using one-year lagged rather than contemporaneous covariates, and replacing SCI with standardized all-cause crude mortality rate (SMR). All analyses were carried out with Stata version 18.0/SE (StataCorp). All statistical tests were two tailed, and the probability of a type 1 error was set at 0.05.

Results

In total, we analyzed 3,390 MMSP-year observations. Characteristics of MSSP ACOs are presented in **Supplemental Content, Table 1.** The total quality score increased from 94.77% in 2019 to 97.83% in 2020 but decreased to 90.67% in 2021 and subsequently (**Supplemental Content, Figure 2**).

However, unadjusted year-by-year difference-in-differences event study estimates indicated that each additional standard deviation increase in SCI was associated with a decrease in total quality score by 0.93 percentage points (95% CI, -0.29--1.56) in 2020 compared to 2019 but quality score returned to pre-pandemic levels since 2021 among MSSPs (**Table 1 and Supplemental Content, Figure 3**). After controlling for confounders, a one-standard-deviation increase in SCI was associated with total quality

score decline of 0.83 percentage points (95% CI, -0.21--1.44) in 2020 compared to 2019 (**Table 1 and Supplemental Content, Figure 3**). The insignificant results from 2016 to 2018 indicated, as expected, no discernible secular trends before the pandemic.

Furthermore, the association between COVID-19 severity and quality score varied depending on SCI degree and area. The decline in quality score in 2020 was mostly driven by ACOs with the top quartile SCI level (**Supplemental Content, Figure 4**) and located in the Midwest (**Supplemental Content, Figure 5**).

Moreover, the results remained unchanged after using ACO FE (**Supplemental Content, Figure 6**), excluding the state with high COVID-19 incidence (**Supplemental Content, Figure 7**), or using one-year lagged covariates (**Supplemental Content, Figure 8**). Replacing SCI with SMR yielded no statistically significant findings, indicating robustness of the initial estimates (**Supplemental Content, Figure 9**).

<Table 1 about here>

Discussion

Our analysis of MSSPs revealed a 0.83 percentage-point decline of the quality score per one-point increase in SCI in 2020 after adjusting for confounders. The reduction in quality score was mostly driven by ACOs with the highest COVID-19 incidence and in the Midwest. We found no evidence suggesting that the pandemic was associated with worse quality scores in 2021 and 2022.

To our knowledge, this is the first study to directly analyze the relationship between pandemic severity and quality score across MSSP ACOs. The year-by-year difference-in-differences event study design, along with the falsification test and several sensitivity checks, allowed us to assess the effects of the COVID-19 pandemic on quality performance over three years.

Prior report and studies not considering variation in pandemic severity indicated that MSSPs showed continued improvement in 2020[3-5]. Nevertheless, upon considering the impacts of the COVID-19 pandemic, we found that total quality score significantly decreased per unit increase in SCI in 2020 across MSSP ACOs. Our results are consistent with the unprecedented healthcare shock occasioned by the pandemic in 2020, including reductions in healthcare expenditure and utilization[1, 2], a greater focus on preventing and treating COVID-19, and patients potentially abstaining from or delaying healthcare[11].

Our findings suggest that the lower quality score observed in 2021 in our descriptive statistics and earlier research[3] was likely not driven by the pandemic. Our results showed a reversal of the decrease in quality performance one year after the pandemic outbreak. It might be due to strategies implemented by health systems to address the public health challenge following the outbreak, like increasing vaccination, which reduced both the overall attack rate and adverse outcomes[12]. It might also be related to healthcare system resilience and adaptability to the health service need and utilization of populations[13].

The impact of COVID-19 on MSSP quality scores was especially pronounced in regions with the highest SCI quartile, likely because higher healthcare use due to COVID-19 surge was associated with lowered quality performance[14]. Also, MSSP quality scores in the Midwest were particularly affected by the pandemic. These could be due in part to a higher degree of rurality in this region and low mask wearing during the pandemic outbreak[15]. Additionally, parents in the Midwest were less likely to report testing their children for COVID-19[16]. The combination of low uptake of protective measures and strained healthcare system may have contributed to a greater negative impact on quality score in the Midwest.

Some limitations should be noted. First, the study is at the MSSP organization level, therefore, inferences about individual patient quality outcomes may be subject to ecological bias. Second, regional differences in the penetration of MSSP could influence the average relationship estimated. Third, the estimated

relationship in 2020 may be underestimated because of the automatic full credit awarded for quality measures under the patient/caregiver experience domain during that year. Fourth, we estimated an average change in overall quality score, and the pandemic impact could vary across the quality domains and individual quality measures. Fifth, the evaluation of seasonal or monthly associations between the pandemic and quality score may provide additional insights.

In conclusion, this analysis sheds light on the adverse effects of the pandemic on quality performance of MSSP ACOs in 2020. Public health efforts may need to carefully monitor quality performance and mitigate negative effects during future health crises. Nonetheless, we found that the COVID-19 pandemic was not associated with further reduction in MSSP quality scores in both 2021 and 2022. Continued investment in strengthening healthcare resilience remains crucial. The stark heterogeneities in quality performance decline across geographical areas suggest that ACOs in areas prone to more serious COVID-19 outbreaks, as well as those in the Midwest, should receive additional resources during these outbreaks. Further research is needed to evaluate heterogeneities in these relationships across health services and patient groups.

Implications for Policy & Practice

1. The COVID-19 pandemic was associated with a decline in quality performance of Medicare Shared Savings Program (MSSP) accountable care organizations (ACOs) in 2020. Public health efforts may need to carefully monitor quality performance and mitigate negative effects during future health crises.
2. The drop in quality scores was primarily seen in ACOs with the highest COVID-19 incidence and in the Midwest. Vulnerable regions require additional support to maintain quality performance during disease outbreak.
3. The rebound in quality performance one year after the pandemic began highlights the potential resilience and adaptability of the healthcare system. Continued investment in strengthening healthcare resilience is critical.

Disclosures

The authors: No reported conflicts of interest.

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Table

Table 1. Year-by-year difference-in-difference estimates of the association of the COVID-19 pandemic and quality score among Medicare Shared Savings Program accountable care organizations from 2016 to 2022.

Variables	(1) Total quality score		(2) Total quality score	
	Coefficient	95% CI	Coefficient	95% CI
SCI 2020 * Year 2016	-0.36	-1.10 - 0.37	-0.32	-1.15 - 0.51
SCI 2020 * Year 2017	-0.36	-0.97 - 0.26	-0.27	-0.90 - 0.36
SCI 2020 * Year 2018	0.59	-0.45 - 1.64	0.71	-0.35 - 1.77
SCI 2020 * Year 2020	-0.93	-1.56 - -0.29	-0.83	-1.44 - -0.21
SCI 2021 * Year 2021	-0.21	-1.09 - 0.67	-0.15	-0.98 - 0.68
SCI 2022 * Year 2022	-0.42	-1.07 - 0.24	-0.33	-0.94 - 0.27
Benchmark minus expenditures (million)			0.03	0.01 - 0.06
Total number of inpatient hospital discharges (hundred)			-1.94	-2.98 - -0.90
Primary care services (hundred)			0.02	-0.00 - 0.05
Number of participating PCPs (hundred)			-0.06	-0.15 - 0.02
Time FE	Yes		Yes	
State FE	Yes		Yes	
Observations	3,390		3,390	
R-squared	0.40		0.42	

Abbreviations: MSSP: Medicare Shared Savings Program. ACO: Accountable care organization. SCI: standardized cumulative incidence of COVID-19.

Notes: Unadjusted (1) and covariate-adjusted (2) year-by-year difference-in-difference estimates of the association between the COVID-19 pandemic and quality score among MSSP ACOs. Cumulative incidence was standardized using data for all 50 states and the District of Columbia, to have mean 0 and standard deviation 1 to facilitate interpretation of regression results. 2019 was the reference year. The coefficients of the interaction terms (from SCI 2020 * Year 2016 to SCI 2022 * Year 2022) are interpreted as the percentage point change of quality score associated with one-standard-deviation increase in SCI. Standard errors were clustered at the state-level.

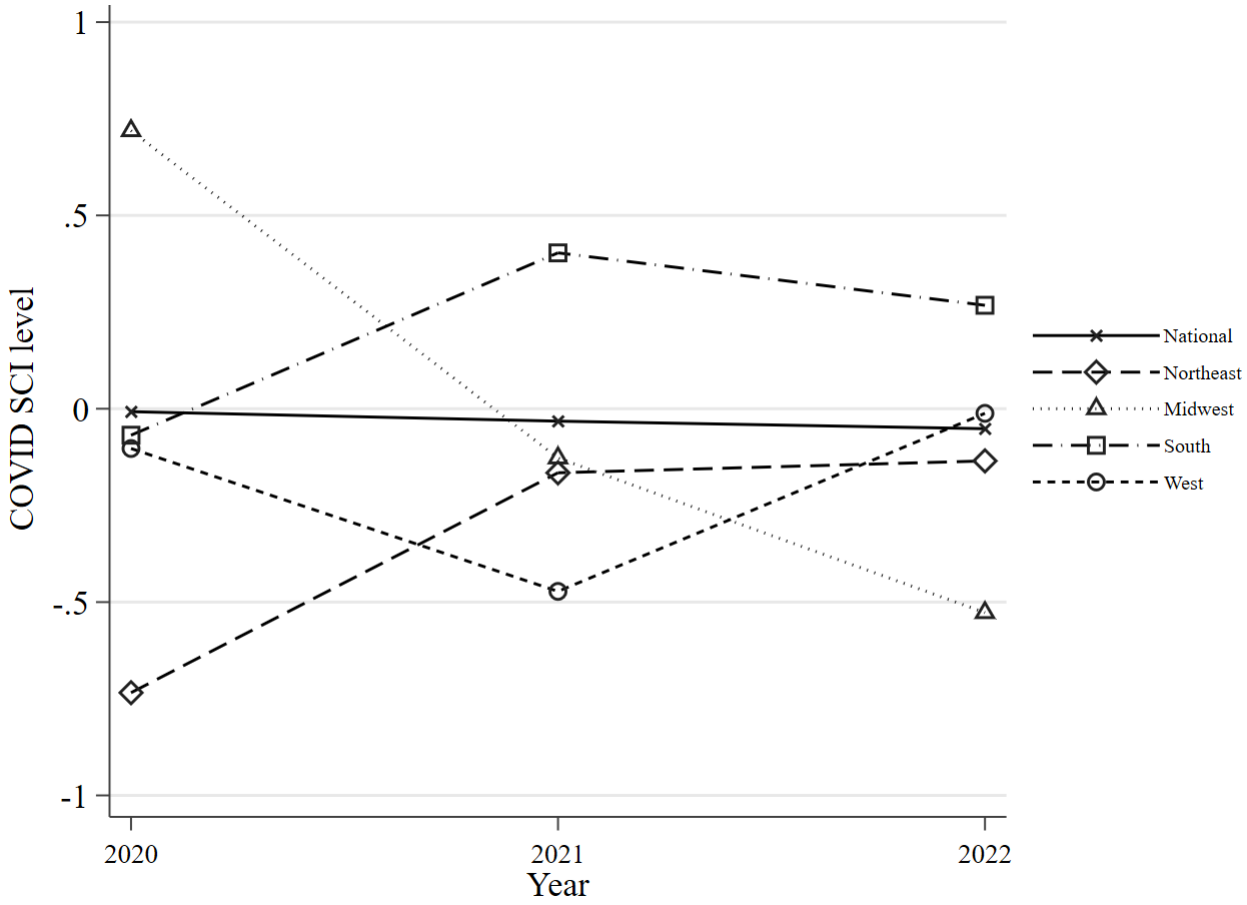
List of Supplemental Content

Table 1. Characteristics of Medicare Shared Savings Program participants from 2016 to 2022 (N=3390).

	2016 (N=429)	2017 (N=469)	2018 (N=547)	2019 (N=541)	2020 (N=513)	2021 (N=475)	2022 (N=416)
Variables	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Total quality score (%)	94.65 (7.39)	92.41 (7.38)	92.91 (6.89)	94.77 (2.81)	97.83 (1.14)	90.67 (7.66)	81.86 (5.89)
SCI	-	-	-	-	-0.01 (0.90)	-0.03 (0.96)	-0.05 (0.98)
Benchmark minus expenditures (million)	1.61 (10.28)	2.35 (10.43)	3.12 (9.88)	3.85 (8.93)	8.08 (13.00)	7.62 (12.78)	9.57 (14.42)
Total number of inpatient hospital discharges (hundred)	3.29 (1.07)	3.25 (0.71)	3.16 (0.65)	3.11 (0.69)	2.68 (0.63)	2.63 (0.57)	2.60 (0.60)
Primary care services (hundred)	103.84 (18.64)	104.63 (17.54)	104.63 (17.48)	109.69 (23.43)	102.34 (25.93)	109.75 (23.56)	112.08 (25.75)
Number of participating PCPs (hundred)	1.72 (2.06)	2.35 (2.85)	2.50 (3.40)	2.57 (3.76)	2.73 (3.74)	3.02 (4.28)	3.28 (3.79)

Abbreviations: SCI: standardized cumulative incidence of COVID-19. Program. PCP: Primary care physician.
Notes: Cumulative incidence was standardized using data for all 50 states and the District of Columbia, to have mean 0 and standard deviation 1 to facilitate interpretation of regression results. The mean and standard deviations of SCI reported above are different from mean 0 and standard deviation 1 because not all states have MSSPs from 2016 to 2022 and the number of MSSPs varies across states. The analyses included 47 states and the District of Columbia, excluding North Dakota, Alaska, and Vermont.

Figure 1. Trends in national and regional SCI levels from 2020 to 2022.

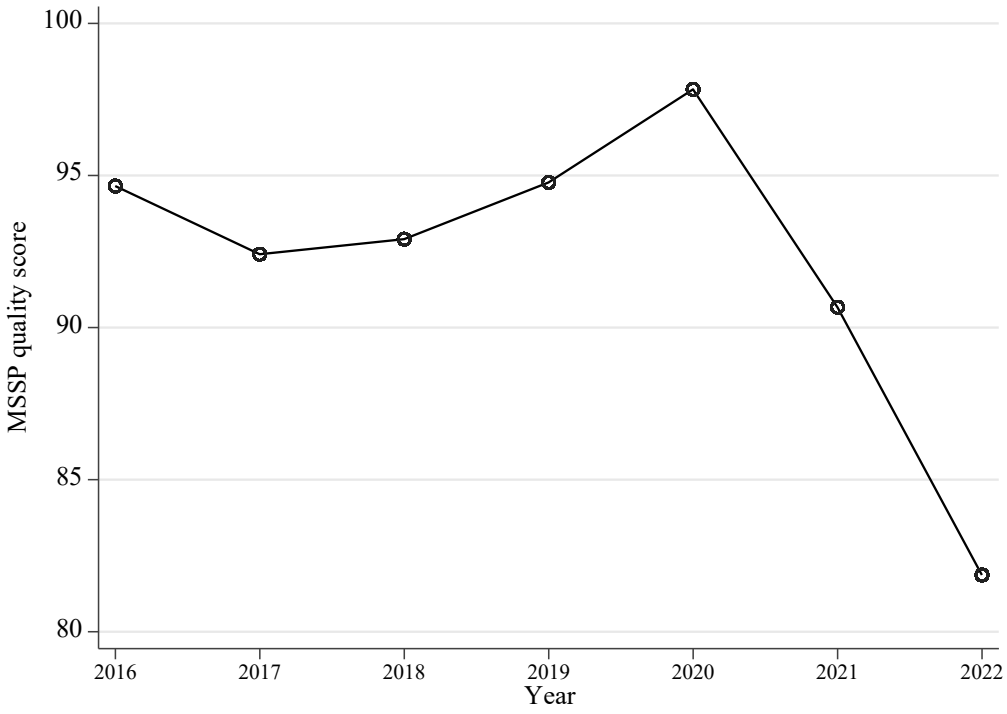


Abbreviations: SCI: standardized cumulative incidence of COVID-19.

Data source: CDC wonder.

Notes: MSSP ACOs in 47 states and the District of Columbia were included in this figure, and MSSP ACOs in North Dakota, Alaska, and Vermont were excluded because of missing observations.

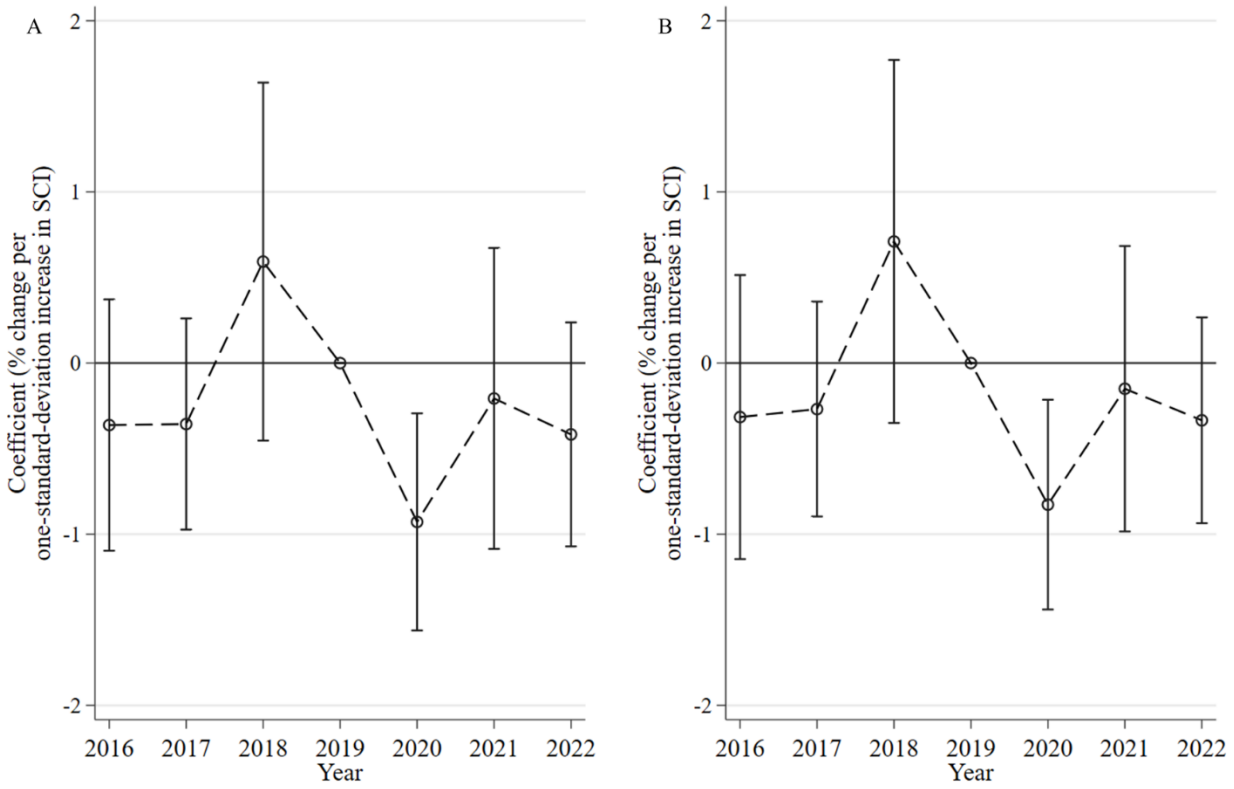
Figure 2. Trends in quality score among Medicare Shared Savings Program participants.



Abbreviations: ACO: Accountable Care Organization

Notes: The unadjusted quality scores do not account yet for any influence from the pandemic, covariates, state and year effects. A reason for quality scores to have increased in 2020 could be that during the pandemic, the patient/caregiver experience was not evaluated, rather, ACO participants were given full credit for that domain due to the emergency health crisis.

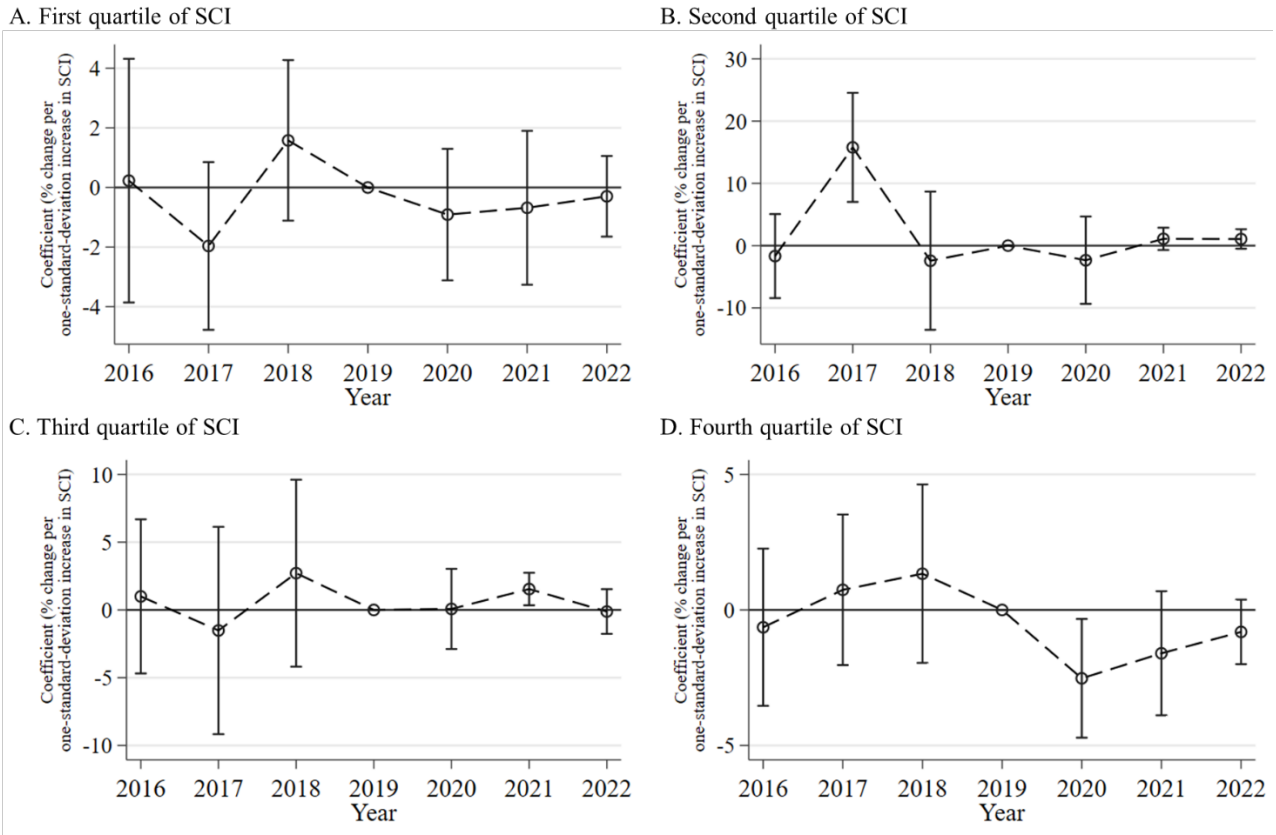
Figure 3. Year-by-year difference-in-difference estimates of the association of the COVID-19 pandemic and quality score among Medicare Shared Savings Program accountable care organizations from 2016 to 2022.



Abbreviations: MSSP: Medicare Shared Savings Program. ACO: Accountable care organization. SCI: standardized cumulative incidence of COVID-19.

Notes: Unadjusted (A) and covariate-adjusted (B) year-by-year difference-in-differences estimates of the association between the COVID-19 pandemic and quality score among MSSP ACOs. Cumulative incidence was standardized using data for all 50 states and the District of Columbia, to have mean 0 and standard deviation 1 to facilitate interpretation of regression results. Covariates include benchmark minus expenditures, total number of inpatient hospital discharges, primary care services, and number of participating primary care physicians. 2019 was the reference year. The coefficients of the interaction terms (from SCI 2020 * Year 2016 to SCI 2022 * Year 2022) shown in the figures are interpreted as the percentage point change of quality score associated with one-standard-deviation increase in SCI. Standard errors were clustered at the state-level.

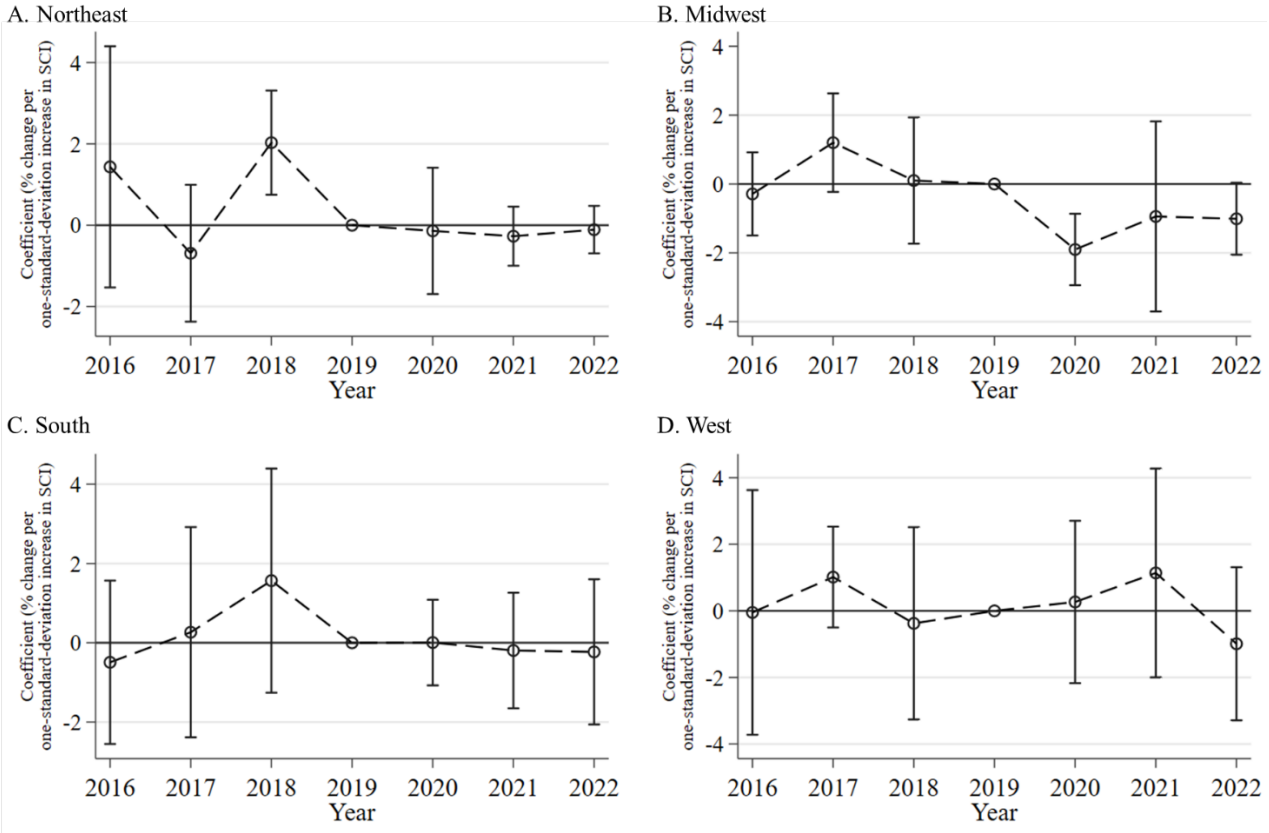
Figure 4. Year-by-year difference-in-difference estimates of the association of the COVID-19 pandemic and quality score among Medicare Shared Savings Program accountable care organizations from 2016 to 2022. Heterogeneity analysis across SCI levels.



Abbreviation: SCI: standardized cumulative incidence of COVID-19.

Notes: Cumulative incidence was standardized using data for all 50 states and the District of Columbia, to have mean 0 and standard deviation 1 to facilitate interpretation of regression results. Covariates include benchmark minus expenditures, total number of inpatient hospital discharges, primary care services, and number of participating primary care physicians. 2019 was the reference year. The coefficients of the interaction terms (from SCI 2020 * Year 2016 to SCI 2022 * Year 2022) shown in the figures are interpreted as the percentage point change of quality score associated with one-standard-deviation increase in SCI. Standard errors were clustered at the state-level.

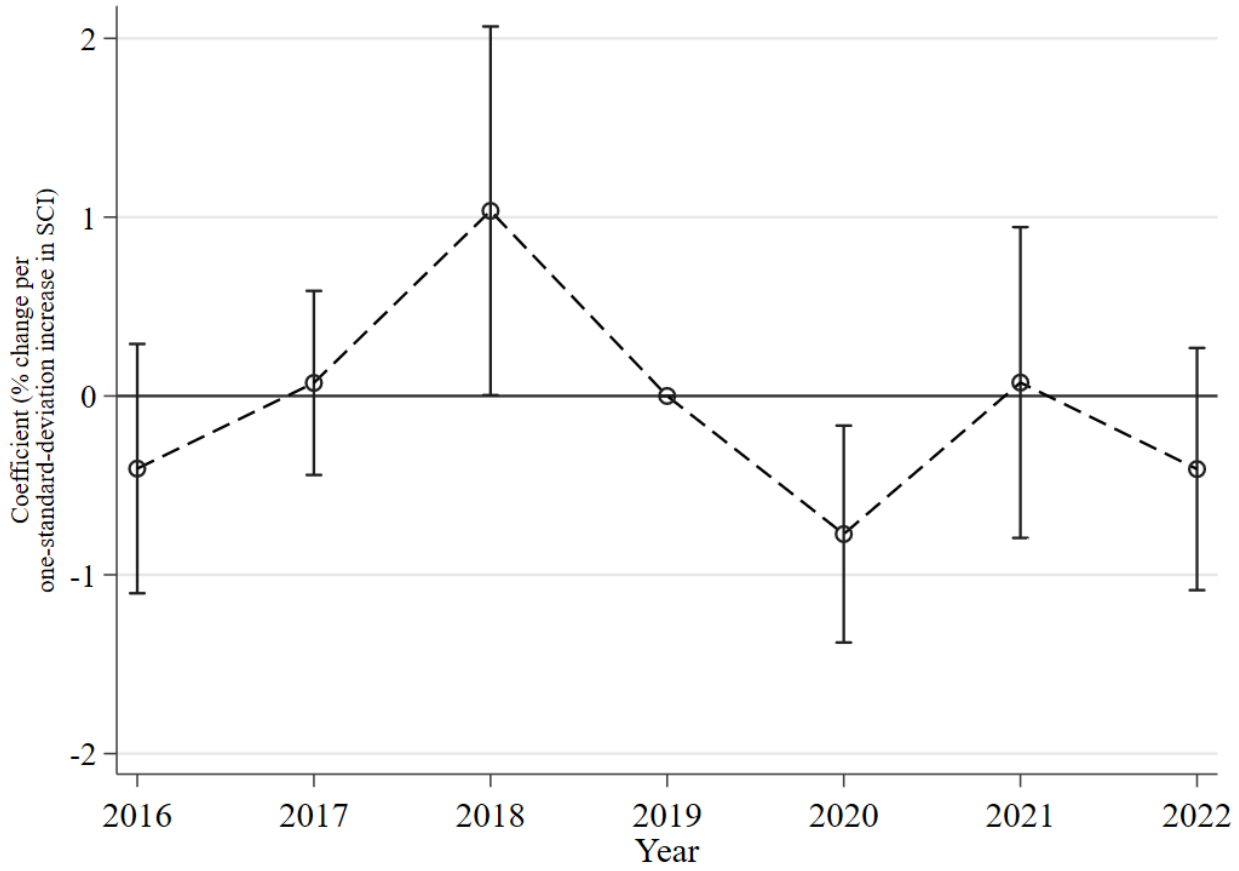
Figure 5. Year-by-year difference-in-difference estimates of the association of the COVID-19 pandemic and quality score among Medicare Shared Savings Program accountable care organizations from 2016 to 2022. Heterogeneity analysis across regions.



Abbreviations: SCI: standardized cumulative incidence of COVID-19.

Notes: Cumulative incidence was standardized using data for all 50 states and the District of Columbia, to have mean 0 and standard deviation 1 to facilitate interpretation of regression results. Covariates include benchmark minus expenditures, total number of inpatient hospital discharges, primary care services, and number of participating primary care physicians. 2019 was the reference year. The coefficients of the interaction terms (from SCI 2020 * Year 2016 to SCI 2022 * Year 2022) shown in the figures are interpreted as the percentage point change of quality score associated with one-standard-deviation increase in SCI. Standard errors were clustered at the state-level.

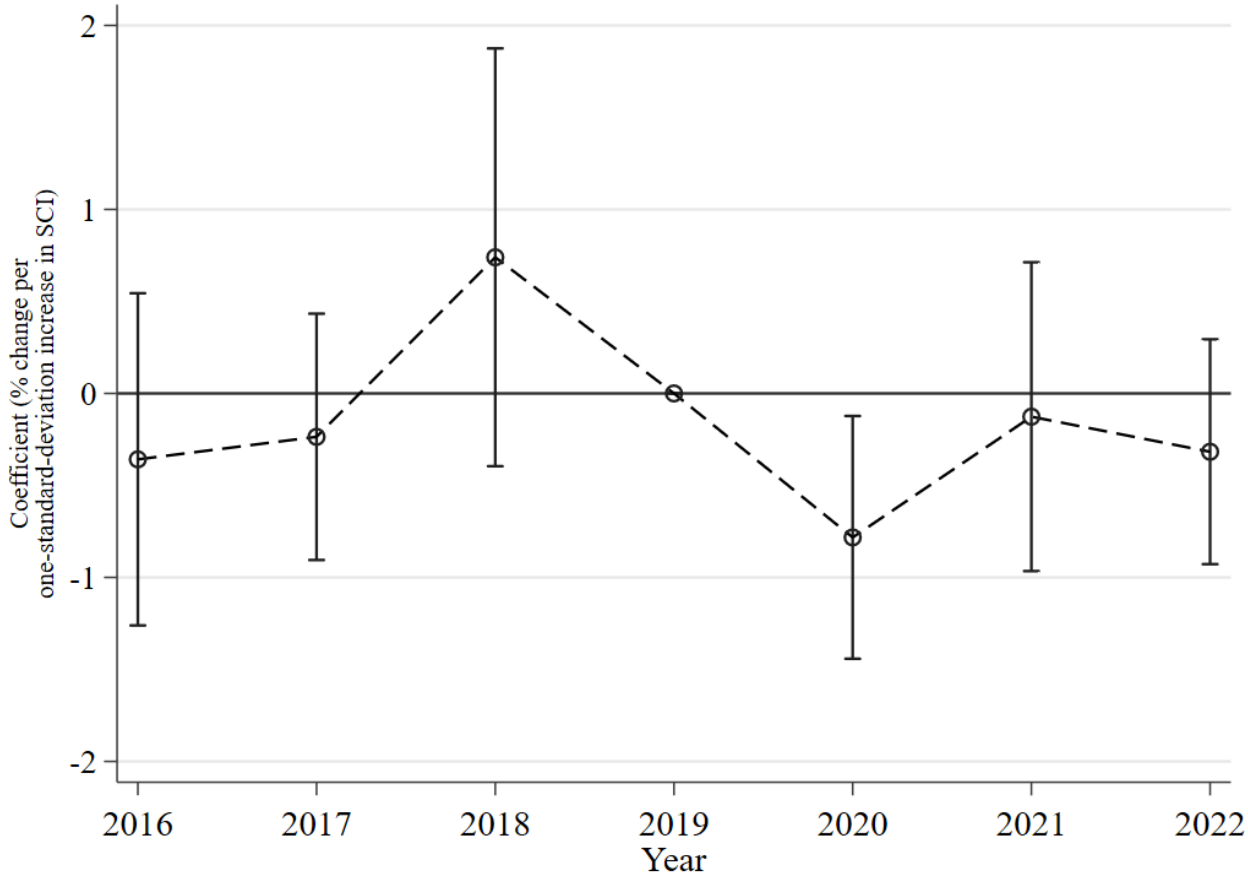
Figure 6. Year-by-year difference-in-difference estimates of the association of the COVID-19 pandemic and quality score among Medicare Shared Savings Program accountable care organizations from 2016 to 2022. Sensitivity analysis incorporating ACO fixed effects rather than state fixed effects.



Abbreviation: SCI: standardized cumulative incidence of COVID-19.

Notes: Cumulative incidence was standardized using data for all 50 states and the District of Columbia, to have mean 0 and standard deviation 1 to facilitate interpretation of regression results. Covariates include benchmark minus expenditures, total number of inpatient hospital discharges, primary care services, and number of participating primary care physicians. 2019 was the reference year. The coefficients of the interaction terms (from SCI 2020 * Year 2016 to SCI 2022 * Year 2022) shown in the figures are interpreted as the percentage point change of quality score associated with one-standard-deviation increase in SCI. Standard errors were clustered at the state-level.

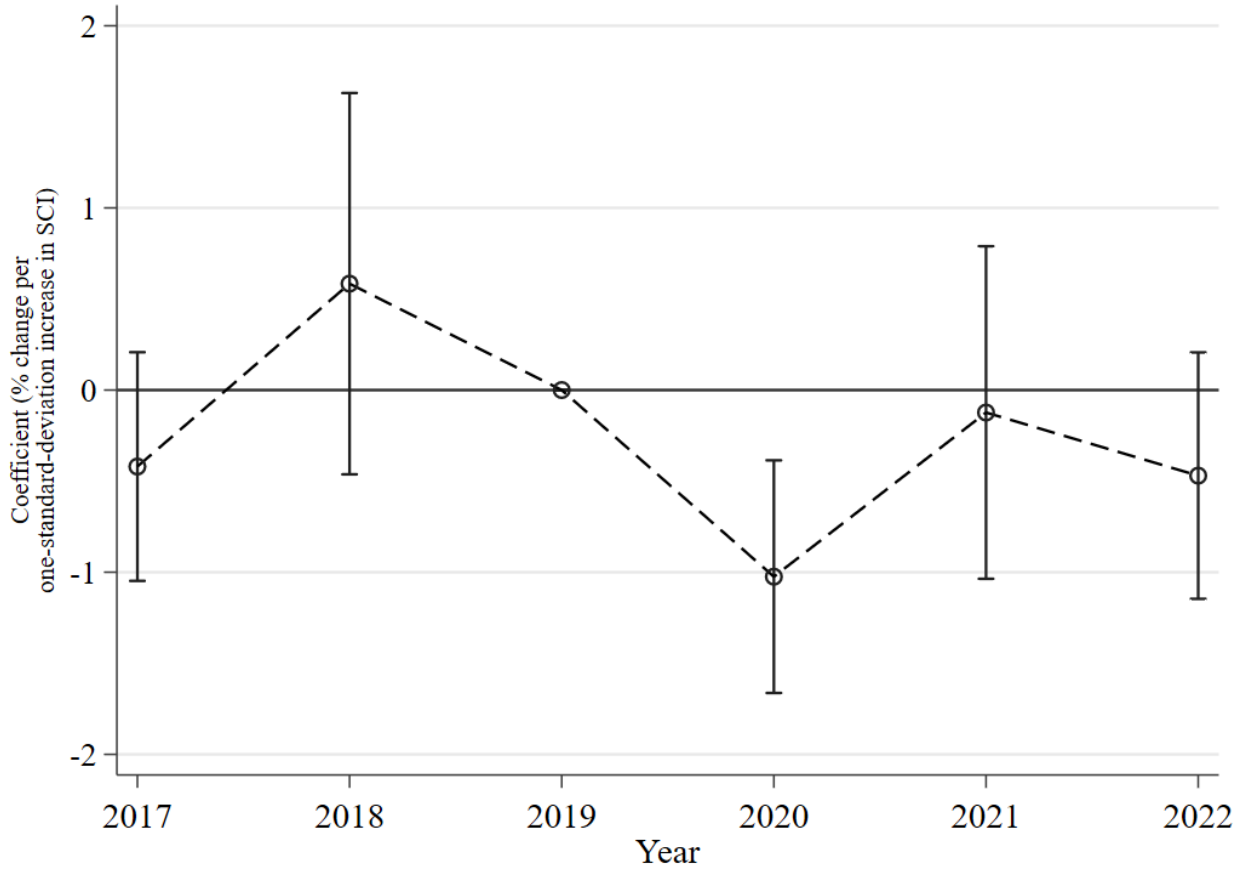
Figure 7. Year-by-year difference-in-difference estimates of the association of the COVID-19 pandemic and quality score among Medicare Shared Savings Program accountable care organizations from 2016 to 2022. Sensitivity analysis excluding South Dakota, which had the highest COVID-19 incidence.



Abbreviation: SCI: standardized cumulative incidence of COVID-19.

Notes: Cumulative incidence was standardized using data for all 50 states and the District of Columbia, to have mean 0 and standard deviation 1 to facilitate interpretation of regression results. Covariates include benchmark minus expenditures, total number of inpatient hospital discharges, primary care services, and number of participating primary care physicians. 2019 was the reference year. The coefficients of the interaction terms (from SCI 2020 * Year 2016 to SCI 2022 * Year 2022) shown in the figures are interpreted as the percentage point change of quality score associated with one-standard-deviation increase in SCI. Standard errors were clustered at the state-level.

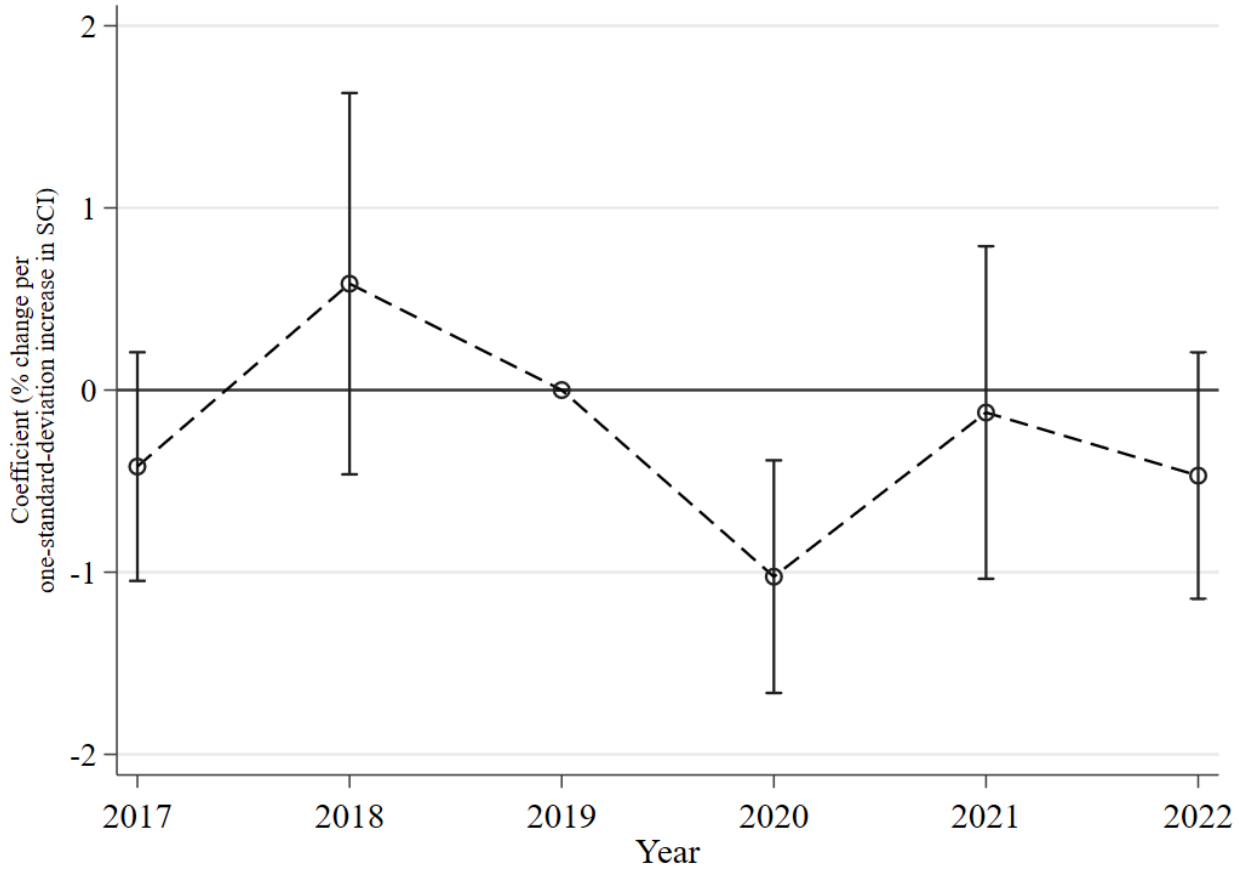
Figure 8. Year-by-year difference-in-differences estimates of the association of the COVID-19 pandemic and quality score among Medicare Shared Savings Program accountable care organizations from 2017 to 2022. Sensitivity analysis using one-year lagged covariates rather than contemporaneous.



Abbreviation: SCI: standardized cumulative incidence of COVID-19.

Notes: The study period was 2017-2022 rather than 2016-2022 in the main analysis because one-year lagged covariates were used. Cumulative incidence was standardized using data for all 50 states and the District of Columbia, to have mean 0 and standard deviation 1 to facilitate interpretation of regression results. Covariates include benchmark minus expenditures, total number of inpatient hospital discharges, primary care services, and number of participating primary care physicians. 2019 was the reference year. The coefficients of the interaction terms (from SCI 2020 * Year 2017 to SCI 2022 * Year 2022) shown in the figures are interpreted as the percentage point change of quality score associated with one-standard-deviation increase in SCI. Standard errors were clustered at the state-level.

Figure 9. Year-by-year difference-in-difference estimates of the association of the COVID-19 pandemic and quality score among Medicare Shared Savings Program accountable care organizations from 2016 to 2021. Sensitivity analysis with standardized all-cause crude mortality rate.



Abbreviation: SCI: standardized cumulative incidence of COVID-19.

Notes: The study period was 2017-2022 rather than 2016-2022 in the main analysis because one-year lagged covariates were used. Cumulative incidence was standardized using data for all 50 states and the District of Columbia, to have mean 0 and standard deviation 1 to facilitate interpretation of regression results. Covariates include benchmark minus expenditures, total number of inpatient hospital discharges, primary care services, and number of participating primary care physicians. 2019 was the reference year. The coefficients of the interaction terms (from SCI 2020 * Year 2017 to SCI 2022 * Year 2022) shown in the figures are interpreted as the percentage point change of quality score associated with one-standard-deviation increase in SCI. Standard errors were clustered at the state-level.