

Supplemental Materials

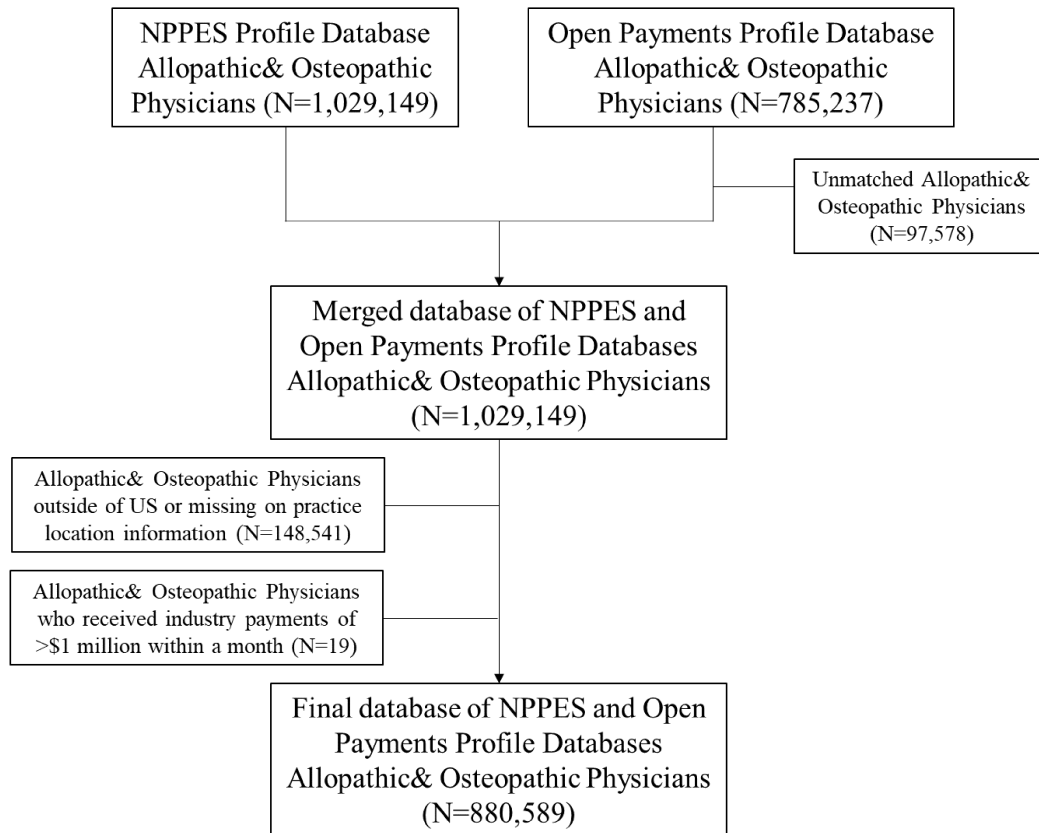
Changes in Industry Marketing Payments to Physicians during the COVID-19 pandemic

Supplementary Figures

- A. Flow of study sample selection.
- B. Monthly trends in the value of industry payments between 2018 and 2020 according to the type of payments.
- C. Monthly trends in the number of industry payments between 2018 and 2020 according to the type of payments.

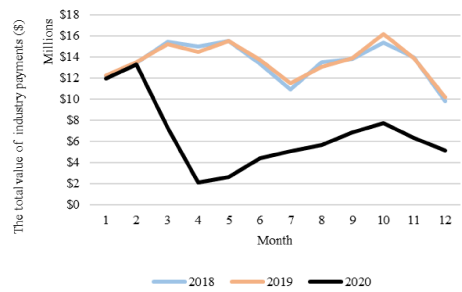
Supplementary Tables

- A. Test of parallel trend assumption
- B. Change in the value of industry payments per physician during the COVID-19 pandemic (i.e., April-December vs. January-February in 2020) compared to 2019 according to physicians' gender and specialty.
- C. Change in value and number of industry payments per physician during the COVID-19 pandemic (i.e., January-February vs. April-December in 2020) compared to 2019 according to the four regions in the US.
- D. Change in the number of industry payments per physician during the COVID-19 pandemic (i.e., April-December vs. January-February in 2020) compared to 2019 according to physicians' gender and specialty.
- E. Change in value and number of industry payments per physician during the COVID-19 pandemic (i.e., January-February vs. April-December in 2020) compared to the average outcomes in 2018 and 2019 according to the type of payments.
- F. Change in value and number of industry payments per physician during the COVID-19 pandemic (i.e., January-February vs. April-December in 2020) compared to 2019 according to the type of payments using ordinary least squares regression models.

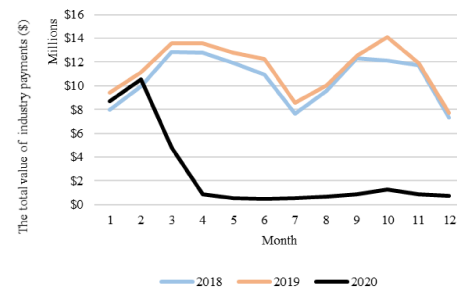
Supplementary figure A. Flow of study sample selection

Supplementary figure B. Monthly trends in the value of industry payments between 2018 and 2020 according to the type of payments

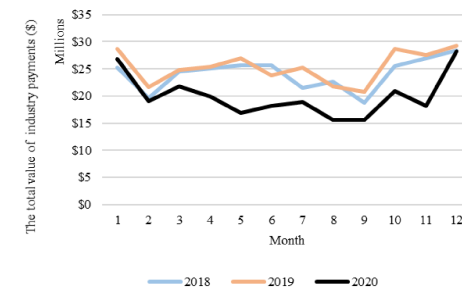
A) Meal



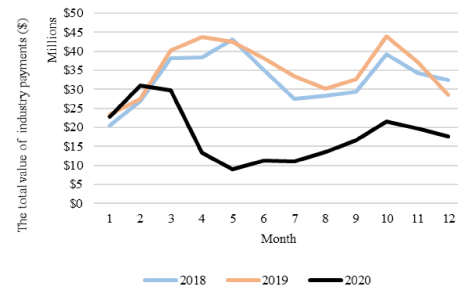
B) Travel



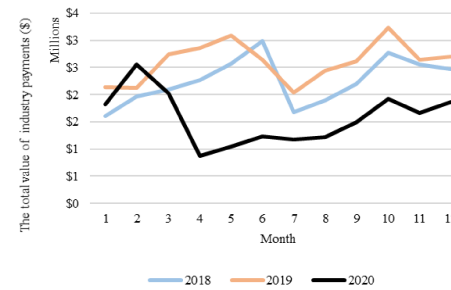
C) Consulting



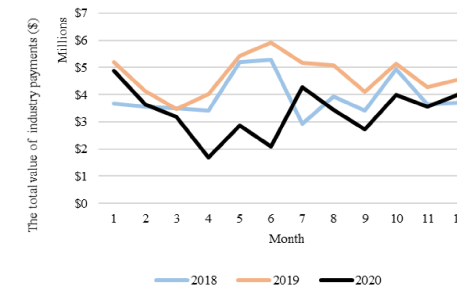
D) Speaking fee



E) Honoraria

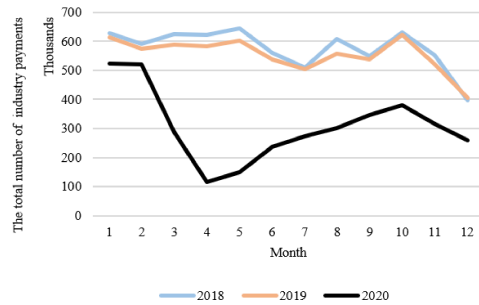


F) Others

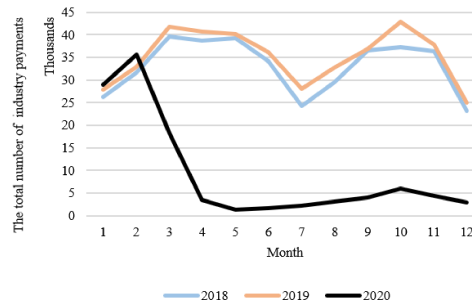


Supplementary figure C. Monthly trends in the number of industry payments between 2018 and 2020 according to the type of payments

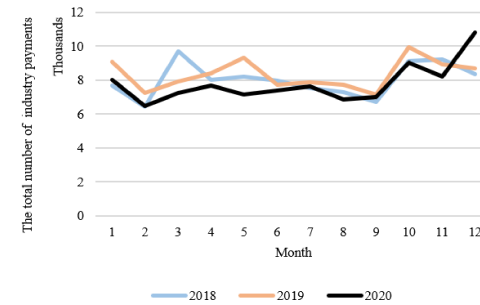
A) Meal



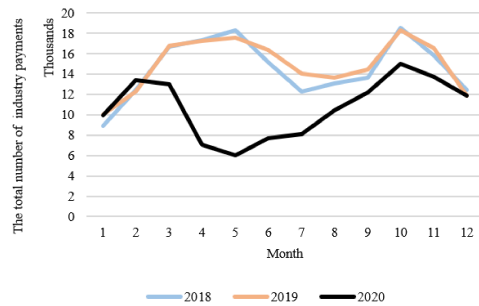
B) Travel



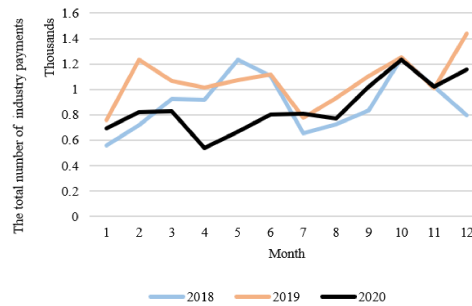
C) Consulting



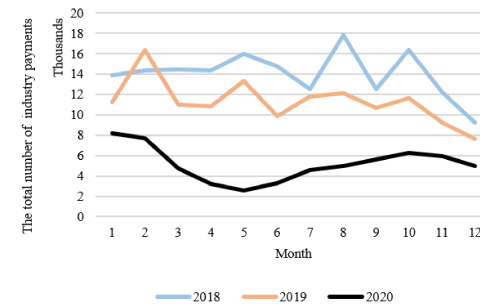
D) Speaking fee



E) Honoraria



F) Others



Supplementary table A. Test of parallel trend assumption

Outcome	Interaction term between the monthly trend and the year indicator (i.e., 2019 vs. 2020)	
	Coefficient estimate [95% CI]	P-value
Value of industry payments	0.97 (0.95 to 1.00)	0.08
Number of industry payments	0.946 (0.942 to 0.949)	<0.05

Notes: We used negative binomial regression models with an interaction term between the month trend variable (continuous from December to February) and the year indicator (i.e., 2019 vs. 2020) during the baseline period (December in a prior year to February). Although p-values were small due to the large sample size (≈ 0.9 million), the point estimates were close to 1.0 (i.e., parallel).

Supplementary table B. Change in the value of industry payments per physician during the COVID-19 pandemic (i.e., April-December vs. January-February in 2020) compared to 2019 according to physicians' gender and specialty.

Physician characteristics	Difference-difference estimates (95% CI) of the value of industry payments per physician		
	Relative % change	Absolute \$ change	p-for-interaction ^a
Gender			
Male	-49.5 (-51.6 to -47.3)	-96.6 (-103.8 to -89.4)	ref
Female	-47.9 (-52.0 to -43.5)	-38.0 (-43.3 to -32.7)	0.14
Specialty			
Primary Care			
Internal Medicine	-45.8 (-52.5 to -38.2)	-49.0 (-60.5 to -37.5)	ref
Family Medicine	-35.3 (-41.8 to -28.0)	-11.4 (-15.1 to -7.7)	0.08
Pediatrics	-38.0 (-57.6 to -9.4)	-8.9 (-15.0 to -2.8)	0.58
Hospitalist	-61.4 (-73.7 to -43.6)	-19.3 (-27.3 to -11.3)	0.29
Surgery			
Obstetrics/Gynecology	-51.1 (-60.3 to -39.6)	-35.6 (-51.5 to -19.7)	0.43
General	-54.7 (-59.6 to -49.2)	-108.2 (-126.3 to -90.1)	0.03
Orthopedic	-52.3 (-56.1 to -48.1)	-224.5 (-258.5 to -190.5)	0.12
Otolaryngology	-55.5 (-65.2 to -42.9)	-56.6 (-75.7 to -37.4)	0.95
Urology	-63.6 (-69.9 to -55.9)	-163.8 (-202.9 to -124.6)	<0.001
Neurosurgery	-51.3 (-61.3 to -38.7)	-205.5 (-284.3 to -126.6)	0.51
Plastic	-53.0 (-68.3 to -30.4)	-97.7 (-158.8 to -36.5)	0.52
Thoracic/Vascular	-49.5 (-58.8 to -38.0)	-187.8 (-255.2 to -120.5)	0.60
Colorectal	-62.2 (-72.3 to -48.4)	-180.0 (-257.6 to -102.4)	0.12
Specialists			
Emergency Medicine	-51.1 (-63.8 to -34.0)	-24.8 (-37.3 to -12.4)	0.58
Psychiatry	-72.2 (-76.0 to -67.7)	-126.1 (-146.4 to -105.7)	<0.001
Anesthesiology	-46.9 (-56.5 to -35.2)	-22.0 (-32.0 to -12.1)	0.58
Radiology	-18.5 (-32.7 to -1.4)	-21.1 (-40.3 to -1.8)	0.01
Cardiology	-48.8 (-53.9 to -43.2)	-165.8 (-192.7 to -138.9)	0.43
Ophthalmology	-58.5 (-64.6 to -51.5)	-139.2 (-168.8 to -109.7)	0.06
Pediatric Specialty	-55.2 (-66.9 to -39.2)	-63.6 (-94.5 to -32.7)	0.34
Neurology	-69.5 (-72.4 to -66.3)	-489.8 (-547.2 to -432.5)	<0.001
Rehabilitation	-59.3 (-68.2 to -47.9)	-50.7 (-72.1 to -29.2)	0.06
Dermatology	-50.0 (-55.5 to -43.8)	-196.0 (-241.7 to -150.4)	0.29
Gastroenterology	-57.5 (-63.3 to -50.8)	-109.5 (-135.8 to -83.3)	0.03
Hematology/Oncology	-37.8 (-46.8 to -27.3)	-195.1 (-260.6 to -129.6)	0.55
Nephrology	-48.1 (-61.8 to -29.5)	-79.3 (-114 to -44.6)	0.51
Pulmonology	-55.5 (-64.0 to -45.0)	-155.9 (-201.7 to -110.1)	0.12
Infectious Diseases	-63.8 (-70.9 to -55.0)	-222.7 (-275.7 to -169.7)	0.01
Endocrinology	-45.6 (-51.4 to -39.0)	-271.5 (-345.0 to -198.0)	0.79
Rheumatology	-62.6 (-67.2 to -57.4)	-483.8 (-574.1 to -393.5)	<0.001
Allergy/Immunology	-38.8 (-53.2 to -20.0)	-98.8 (-185.2 to -12.5)	0.51
Others	-20.1 (-36.0 to -0.1)	-18.1 (-39.1 to -2.9)	<0.001

^aP-value (adjusted for multiple comparisons using the Benjamini-Hochberg method) of the multiplicative 3-way interaction term between i) the year indicator (i.e., 2019 vs. 2020), ii) the month indicator (i.e., January-February vs. April-December), and iii) gender or specialty.

Supplementary table C. Change in value and number of industry payments per physician during the COVID-19 pandemic (i.e., January-February vs. April-December in 2020) compared to 2019 according to the four regions in the US.

Type of payments	Difference-in-difference estimates (95% CI) of the value of industry payments per physician			Difference-in-difference estimates (95% CI) of the number of industry payments per 100 physicians		
	Relative % change	Absolute \$ change	Adjusted p-value	Relative % change	Absolute change	Adjusted p-value
Total	-48.4 (-50.6 to -46.2)	-75.7 (-81.2 to -70.3)	<0.001	-47.4 (-47.7 to -47.1)	-43.6 (-44.2 to -43.0)	<0.001
Northeast	-47.0 (-51.4 to -42.2)	-68.4 (-77.9 to -59.0)	<0.001	-51.7 (-52.4 to -51.0)	-40.2 (-41.4 to -39.0)	<0.001
Midwest	-51.9 (-54.6 to -49.0)	-83.9 (-92.3 to -75.4)	<0.001	-42.4 (-43.0 to -41.9)	-47.7 (-48.9 to -46.6)	<0.001
South	-47.5 (-52.0 to -42.6)	-72.9 (-85.0 to -60.8)	<0.001	-46.9 (-47.7 to -46.1)	-35.9 (-37.2 to -34.7)	<0.001
West	-44.2 (-52.1 to -34.9)	-49.8 (-68.2 to -31.4)	<0.001	-42.6 (-44.2 to -40.9)	-43.1 (-46.0 to -40.2)	<0.001

Four regions (Northeast, Midwest, South, and West) were defined according to the Census Bureau. Difference-in-difference estimates in relative percentage changes were calculated by regression coefficients of the interaction terms between the year indicator (i.e., 2019 vs. 2020) and the month indicator (i.e., January-February vs. April-December) in the multivariable negative binomial models adjusting for physicians' gender, specialty, and practice location. The adjusted absolute changes in outcomes were estimated by calculating the differences in predicted outcomes at each level of the interaction terms for each observation and averaging over the entire sample. P-value was adjusted for multiple comparisons using the Benjamini-Hochberg method.

Supplementary table D. Change in the number of industry payments per physician during the COVID-19 pandemic (i.e., April-December vs. January-February in 2020) compared to 2019 according to physicians' gender and specialty.

Physician characteristics	Difference-difference estimates (95% CI) of the number of industry payments per 100 physicians		
	Relative % change	Absolute change	p-for-interaction ^a
Gender			
Male	-47.3 (-47.7 to -46.9)	-49.7 (-50.5 to -48.8)	ref
Female	-47.9 (-48.5 to -47.2)	-31.5 (-32.3 to -30.6)	0.30
Specialty			
Primary Care			
Internal Medicine	-38 (-38.9 to -37.2)	-35.1 (-36.6 to -33.7)	ref
Family Medicine	-20.6 (-21.6 to -19.6)	-8.9 (-10.2 to -7.5)	<0.001
Pediatrics	-54.6 (-56.1 to -53.0)	-16.7 (-17.6 to -15.8)	<0.001
Hospitalist	-56.2 (-59.8 to -52.3)	-20.5 (-23.3 to -17.6)	<0.001
Surgery			
Obstetrics/Gynecology	-53.1 (-54.4 to -51.7)	-29.1 (-30.8 to -27.4)	<0.001
General	-66.0 (-67.2 to -64.8)	-48.5 (-50.8 to -46.2)	<0.001
Orthopedic	-62.8 (-64.0 to -61.5)	-60.6 (-63.8 to -57.4)	<0.001
Otolaryngology	-64.9 (-66.7 to -62.9)	-39.9 (-42.9 to -37.0)	<0.001
Urology	-56.6 (-58.1 to -55)	-82.1 (-87.1 to -77.0)	<0.001
Neurosurgery	-58.8 (-61.5 to -55.9)	-63.8 (-70.9 to -56.7)	<0.001
Plastic	-66.1 (-68.9 to -63.1)	-48.6 (-54.2 to -42.9)	<0.001
Thoracic/Vascular	-61.4 (-64.4 to -58.1)	-71.6 (-80.9 to -62.3)	<0.001
Colorectal	-66.2 (-70 to -61.9)	-57.4 (-69.3 to -45.4)	<0.001
Specialists			
Emergency Medicine	-46.3 (-48.8 to -43.8)	-11.9 (-13.3 to -10.5)	<0.001
Psychiatry	-57.6 (-59.0 to -56.2)	-59.2 (-62.5 to -55.9)	<0.001
Anesthesiology	-46.8 (-49.0 to -44.4)	-16.8 (-18.5 to -15.2)	<0.001
Radiology	-59.0 (-61.7 to -56.0)	-17.7 (-19.6 to -15.9)	<0.001
Cardiology	-51.5 (-52.5 to -50.4)	-106.2 (-111.1 to -101.4)	<0.001
Ophthalmology	-52.7 (-54.3 to -51.0)	-45.2 (-47.9 to -42.5)	<0.001
Pediatric Specialty	-63.3 (-66.2 to -60.1)	-20.1 (-22.6 to -17.5)	<0.001
Neurology	-51.1 (-52.6 to -49.5)	-147.3 (-156.4 to -138.1)	<0.001
Rehabilitation	-38.4 (-41.8 to -34.8)	-23.2 (-27.3 to -19.0)	0.95
Dermatology	-47.9 (-49.3 to -46.3)	-101.2 (-107.5 to -94.9)	<0.001
Gastroenterology	-57.1 (-58.4 to -55.8)	-112.1 (-117.5 to -106.7)	<0.001
Hematology/Oncology	-60.2 (-61.8 to -58.6)	-128.7 (-136.5 to -120.9)	<0.001
Nephrology	-63.7 (-65.6 to -61.6)	-71.9 (-77.4 to -66.4)	<0.001
Pulmonology	-39.5 (-41.7 to -37.1)	-56.1 (-64.1 to -48.0)	0.48
Infectious Diseases	-63.7 (-66.3 to -60.8)	-78.5 (-87.6 to -69.4)	<0.001
Endocrinology	-41.8 (-44.3 to -39.3)	-113.9 (-128.3 to -99.4)	<0.001
Rheumatology	-55.9 (-57.8 to -53.9)	-241.9 (-262 to -221.8)	<0.001
Allergy/Immunology	-24.6 (-27.9 to -21.2)	-21.5 (-32.1 to -10.8)	<0.001
Others	-44.1 (-46.8 to -41.3)	-17.8 (-19.6 to -16.1)	<0.001

^aP-value (adjusted for multiple comparisons using the Benjamini-Hochberg method) of the multiplicative 3-way interaction term between i) the year indicator (i.e., 2019 vs. 2020), ii) the month indicator (i.e., January-February vs. April-December), and iii) gender or specialty.

Supplementary table E. Change in value and number of industry payments per physician during the COVID-19 pandemic (i.e., January-February vs. April-December in 2020) compared to the average outcomes in 2018 and 2019 according to the type of payments.

Type of payments	Difference-in-difference estimates (95% CI) of the value of industry payments per physician			Difference-in-difference estimates (95% CI) of the number of industry payments per 100 physicians		
	Relative % change	Absolute \$ change	Adjusted p-value	Relative % change	Absolute change	Adjusted p-value
Total	-49.2 (-51.1 to -47.3)	-77.0 (-81.6 to -72.4)	<0.001	-47.9 (-48.2 to -47.6)	-44.6 (-45.1 to -44.0)	<0.001
Meal	-64.0 (-64.3 to -63.7)	-14.9 (-15.1 to -14.8)	<0.001	-46.5 (-46.8 to -46.2)	-37.8 (-38.3 to -37.4)	<0.001
Travel	-93.9 (-94.3 to -93.4)	-19.1 (-20.0 to -18.3)	<0.001	-91.3 (-91.8 to -90.9)	-5.8 (-6.0 to -5.6)	<0.001
Consulting	-18.3 (-25.0 to -11.1)	-8.0 (-11.3 to -4.6)	<0.001	+1.6 (-2.2 to +5.6)	±0.0 (±0.0 to +0.1)	0.50
Speaking fee	-36.9 (-41.1 to -32.4)	-13.3 (-15.4 to -11.3)	<0.001	-34.8 (-37.0 to -32.5)	-0.9 (-0.9 to -0.8)	<0.001
Honoraria	-51.8 (-57.8 to -44.9)	-2.5 (-3.0 to -2.0)	<0.001	-5.5 (-27.6 to +23.3)	±0.0 (±0.0 to ±0.0)	0.68
Others	-17.1 (-32.3 to +1.5)	-1.4 (-2.8 to ±0.0)	0.07	-34.6 (-36.9 to -32.2)	-0.3 (-0.4 to -0.2)	<0.001

Difference-in-difference estimates in relative percentage changes were calculated by regression coefficients of the interaction terms between the year indicator (i.e., 2018/2019 vs. 2020) and the month indicator (i.e., January-February vs. April-December) in the multivariable negative binomial models adjusting for physicians' gender, specialty, and practice location. The adjusted absolute changes in outcomes were estimated by calculating the differences in predicted outcomes at each level of the interaction terms for each observation and averaging over the entire sample. P-value was adjusted for multiple comparisons using the Benjamini-Hochberg method.

Supplementary table F. Change in value and number of industry payments per physician during the COVID-19 pandemic (i.e., January-February vs. April-December in 2020) compared to 2019 according to the type of payments using ordinary least squares regression models.

Type of payments	Difference-in-difference estimates (95% CI) of the value (\$) of industry payments per physician	Adjusted p-value	Difference-in-difference estimates (95% CI) of the number of industry payments per 100 physicians	Adjusted p-value
Total	-82.2 (-86.2 to -78.2)	<0.001	-41.7 (-42.3 to -41.1)	<0.001
Meal	-14.1 (-14.3 to -13.9)	<0.001	-34.9 (-35.4 to -34.4)	<0.001
Travel	-17.2 (-17.8 to -16.5)	<0.001	-5.9 (-6.0 to -5.7)	<0.001
Consulting	-6.9 (-9.6 to -4.2)	<0.001	+0.1 (\pm 0.0 to +0.1)	0.02
Speaking fee	-39.6 (-41.7 to -37.4)	<0.001	-1.0 (-1.1 to -0.9)	<0.001
Honoraria	-2.3 (-2.9 to -1.8)	<0.001	\pm 0.0 (-0.1 to +0.1)	0.83
Others	-2.2 (-3.1 to -1.2)	<0.001	-0.1 (-0.1 to \pm 0.0)	0.13

Difference-in-difference estimates in absolute changes were calculated by regression coefficients of the interaction terms between the year indicator (i.e., 2019 vs. 2020) and the month indicator (i.e., January-February vs. April-December) in the multivariable ordinary least squares regression models adjusting for physicians' gender, specialty, and practice location. P-value was adjusted for multiple comparisons using the Benjamini-Hochberg method.