Hydroxychloroquine for COVID-19: Variation in Regional Political Preferences Predicted New Prescriptions after President Trump's Endorsement

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Abstract

Context: On March 19, 2020, President Donald Trump endorsed using hydroxychloroquine for COVID-19 treatment despite inconclusive evidence of the drug's effectiveness. This study sought to understand the influence of political preferences on prescription uptake by quantifying the relationship between a geographic area's partisan leaning and hydroxychloroquine prescription rates following Trump's endorsement.

Methods: We analyzed hydroxychloroquine prescriptions filled in 205 continental US designated market areas (DMAs) between March 1, 2018, and July 31, 2020, and the percentage of votes for Donald Trump in the 2016 presidential election in each DMA. We estimated associations by using an empirical strategy resembling a difference-in-differences estimation.

Findings: Before President Trump's endorsement, mean weekly hydroxychloroquine prescription rates were similar across DMAs with the highest and lowest Trump vote percentages (0.56 and 0.49 scripts per 100,000). After Trump's endorsement, although both high- and low-Trump-supportive DMAs experienced sharp increases in weekly hydroxychloroquine prescription rates, results indicated a 1-percentage-point increase in share of Trump votes was associated with 0.013, or 2%, more weekly hydroxychloroquine prescriptions per 100,000 people ($b = 0.013$, $t = 2.20$, $p = .028$).

Conclusion: President Trump's endorsement of an untested therapy influenced prescribing behavior, especially when that endorsement aligned with communities' political leanings.

Keywords COVID-19, hydroxychloroquine, political endorsement, prescribing behavior, political preferences

With the onset of the novel coronavirus disease 2019 (COVID-19), medical scientists scrambled to find both prophylactic and therapeutic treatments. By early March 2020, preliminary research suggested hydroxychloroquine

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sulfate (hereafter hydroxychloroquine), taken alone and in combination with azithromycin, was a promising treatment for COVID-19 (Chen et al. 2020; Gautret et al. 2020; Wang et al. 2020). Conservative media gravitated toward hydroxychloroquine instantly (*The Ingraham Angle* 2020a; *Tucker Carlson Tonight* 2020a, 2020b; Wong 2020). Between March 12 and March 18, 2020, Laura Ingraham's and Tucker Carlson's Fox News shows hosted guests who promoted hydroxychloroquine for COVID-19 treatment, with one guest calling the therapy "the second cure to a virus of all time" (*Tucker Carlson Tonight* 2020b).

On March 19, 2020, President Donald Trump touted these early results, calling hydroxychloroquine a potential "game changer" (Trump 2020). Later that day, Ingraham, who had also previously called the drug a "game changer," took credit for influencing Trump's announcement (*The Ingraham Angle* 2020a, 2020b). Nine days later, in response to political pressure, the US Food and Drug Administration (FDA) issued an Emergency Use Authorization (EUA) for the off-label use of hydroxychloroquine and chloroquine phosphate (hereafter chloroquine) from the Strategic National Stockpile to treat patients hospitalized with COVID-19 (Hinton 2020). This political pressure arose through personal efforts by President Trump and his White House Coronavirus Task Force to urge FDA regulators to examine and provide fast-track approval of the antimalarial drugs, including hydroxychloroquine, for COVID-19 treatment (Owermohle 2020; Taylor and Roston 2020).

President Trump's communications relayed more certainty about hydroxychloroquine than the science warranted, thus creating the risk of false hope and confusion if later evidence failed to align with his enthusiasm. The debate over hydroxychloroquine also quickly became polarized. Whereas conservative politicians and media pundits rallied behind Trump's comments, liberal thought leaders, including Democratic presidential candidate Joe Biden, criticized the endorsement as irresponsible (Blevins et al. 2021; Facher 2020).

Early in the pandemic, the benefits of using hydroxychloroquine for COVID-19 prevention and treatment were unknown. Both hydroxychloroquine and chloroquine had demonstrated in vitro antiviral efficacy against coronaviruses (Biot et al. 2006; Hernandez et al. 2020a; Yao et al. 2020). However, evidence of the drugs' effectiveness had not yet extended to treating patients with COVID-19. Despite the unknown benefits of hydroxychloroquine for treating COVID-19, the harms of the drug were familiar, such as increased risk for arrythmia, severe hypoglycemia, and retinopathy (FDA 2020b). Thus, it was unclear to physicians and patients whether the benefits of hydroxychloroquine outweighed the risks.

Following the initial excitement for hydroxychloroquine, subsequent research concluded that hydroxychloroquine and chloroquine did not decrease mortality or reduce hospitalizations in patients with COVID-19 (Cavalcanti et al. 2020; Hernandez et al. 2020a, 2020c; RECOVERY 2020; Skipper et al. 2020). Three large randomized clinical trials—RECOVERY, SOLIDARITY-WHO, and ORCHID-NIH—all prematurely ceased enrolling participants after preliminary results showed no efficacy (Hernandez et al. 2020b; Horby et al. 2020; RECOVERY 2020). Early findings from these trials and other studies led the FDA to revoke its EUA in mid-June (Boulware et al. 2020; FDA 2020a; Tang et al. 2020). Despite mounting evidence against using hydroxychloroquine for COVID-19, conservative media magnified Trump's claim that he was right about the drug (Blake 2020; Grynbaum 2020). Throughout March and April, Fox News guests continued to advocate for the therapy, while hosts characterized skepticism expressed by Dr. Anthony Fauci and the left as political attacks on Trump. On May 18, 2020, President Trump reported he had been taking hydroxychloroquine to prevent COVID-19 (Karni and Thomas 2020). Through late July, Trump continued promoting hydroxychloroquine and pushed the FDA to issue a new EUA, buoyed by a retrospective study showing hydroxychloroquine reduced COVID-19 in-hospital mortality and a viral video of physicians claiming hydroxychloroquine cured COVID-19 (Arshad et al. 2020; Frenkel and Alba 2020).

After President Trump's endorsement of the antimalarial drugs, first-time hydroxychloroquine and chloroquine prescriptions increased significantly throughout the country (Bull-Otterson et al. 2020; Gabler and Keller 2020; Harrigan et al. 2020). Nonroutine provider specialties appeared to drive the early spike in prescriptions, indicating potential new demand for off-label use to treat COVID-19 (Bull-Otterson et al. 2020). Yet unanswered was whether this demand occurred primarily among populations expected to perceive President Trump as a credible source of information about hydroxychloroquine. Was the rise in prescriptions driven by partisan behavior in high-Trump-supportive communities? Or did broad media coverage plus the scientific credibility of the FDA encourage low-Trump-supportive areas to experience a similar rise in hydroxychloroquine prescriptions? To answer these questions, we explored whether prescriptions for hydroxychloroquine and related drugs were associated with communities' political leanings. Specifically, we considered whether a geographic area's support for President Trump in the 2016 election was associated with hydroxychloroquine prescription rates in the months after Trump's March 19, 2020, endorsement.

Methods

Prescription Data

Our prescription data came from IPM.ai, a subsidiary of Swoop, a company that specializes in health care data and AI-based analytics. The data included weekly (beginning each Monday), distinct, retail-pharmacy hydroxychloroquine, chloroquine, azithromycin, and ciprofloxacin prescriptions. By contrast, the FDA's EUA only allowed for using hydroxychloroquine and chloroquine to treat patients hospitalized with COVID-19 (FDA 2020b). We limited our analyses to first-time prescriptions filled in 205 designated market areas (DMAs) between March 1, 2018, and July 31, 2020. Restricting our analysis to first-time prescriptions helped us exclude prescription refills for ongoing, on-label hydroxychloroquine use, such as among patients with lupus or rheumatoid arthritis. We focused on DMAs to achieve more geographic granularity than state-level analysis. DMAs are clusters of counties that form distinct market areas, which Nielsen Media Research uses to measure local television viewing. Nielsen assigns counties to DMAs based on historical viewing patterns, which may be a proxy for similar political preferences (Spenkuch and Toniatti 2016).

Voting, Health, and Sociodemographic Data

We obtained voting data on the 2016 presidential and House of Representatives elections from the MIT Election Data + Science Lab. We gathered information on population counts, COVID-19 cases, and COVID-19 deaths from USA Facts. Definitive Healthcare provided data on health care capacity in the form of number of licensed hospital beds. Sociodemographic characteristics came from the US Census Bureau's American Community Survey 2014–2018 five-year estimates. These data included racial, ethnic, and gender compositions as well as age, income, and education measures. We chose these covariates to control for predictors of COVID-19 cases and deaths, such as age, poverty, gender, and race (Gayam et al. 2020; Ronderos Botero et al. 2020; Shah et al. 2020). All data were publicly available and reported at the county level. We then aggregated county-level values at the DMA level. We restricted the sample to the 205 continental US DMAs because of irregularities in aligning county-level data to DMAs in Alaska and the early suppression of COVID-19 rates unique to Hawaii resulting from that state's stringent travel and quarantine mandates (Hawaii DOH 2020).

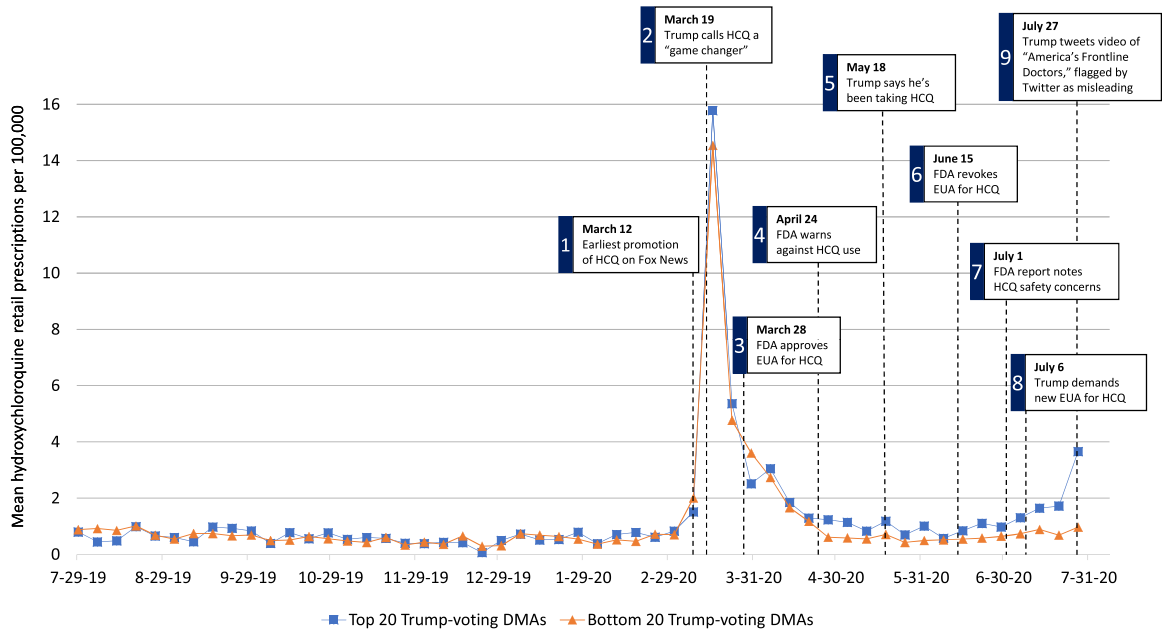
Analyses

To estimate associations between a geographic area's Trump support and changes in hydroxychloroquine prescribing patterns before and after Trump's endorsement of the drug for COVID-19, we used an empirical strategy resembling a difference-in-differences estimation. Our time period of investigation spans March 1, 2018, to July 31, 2020. The preendorsement period includes the weeks of March 1, 2018, to March 15, 2020; the post-endorsement period includes the weeks of March 16, 2020 (i.e., the Monday before Trump's March 19 endorsement), to July 31, 2020. Our estimated regressions compared mean weekly prescription rates before and after Trump's March 19 hydroxychloroquine endorsement, as a function of 2016 Trump vote percentage within a DMA.

Our main outcome of interest was weekly DMA prescriptions of hydroxychloroquine per 100,000 population. We estimated an interaction term between a DMA's percentage of votes for Trump in the 2016 election and an indicator that equaled 1 for the time period after Trump publicly endorsed hydroxychloroquine, controlling directly for time trends and percentage of Trump votes in our regression. We also controlled for time-invariant, DMA-level factors, such as population; licensed hospital beds per 100,000; and race/ethnicity, age, gender, income, and education characteristics. We reported heteroskedasticity-robust standard errors.

To interpret our estimated association as a causal effect requires us to assume that prescription rates across DMAs would have continued along their same trajectories in the absence of Trump's endorsement. Figure 1 shows that the hydroxychloroquine prescription patterns before the week of March 16, 2020, in our data are consistent with this assumption: DMAs with the most and the least Trump support exhibited parallel preexisting time trends. We hypothesized that compared to DMAs with lower Trump vote percentages, DMAs with higher Trump vote percentages would fill more weekly hydroxychloroquine scripts per 100,000 population after President Trump's March 19, 2020, endorsement as a result of Trump's political influence.

We conducted several robustness checks on our main results. First, we repeated our main analyses substituting the postendorsement indicator with a continuous variable for COVID-19 deaths per 100,000 population to identify how prescription rates may have been influenced by the local intensity of COVID-19. Second, we median-split the Trump vote percentage variable to create an indicator that took the value of 1 for all DMAs with a percentage of Trump votes higher than the median 55.3%. We then



Notes: DMA = designated market area; HCQ = Hydroxychloroquine; FDA = US Food and Drug Administration; EUA = emergency use authorization.

Figure 1 Mean weekly hydroxychloroquine retail prescription rates in the top 20 and the bottom 20 Trump-voting DMAs, July 2019–July 2020.

substituted the continuous Trump vote share variable for this indicator to test the sensitivity of the estimated association. Third, we substituted the Trump vote percentage variable with a continuous variable for the percentage of votes for Republican candidates for the House of Representatives in the 2016 election. This tested whether our estimated association was unique to Trump support or to broader partisanship. Fourth, we substituted the 2016 election Trump vote percentage with the 2020 Trump vote percentage, obtained via Politico, to determine whether the estimated association held true for the recent election results. We expected each of these tests to estimate a statistically significant, positive association with weekly hydroxychloroquine scripts per 100,000, similar to the main results.

In addition to hydroxychloroquine prescriptions, we examined weekly, distinct, first-time prescriptions of chloroquine, azithromycin, and ciprofloxacin filled in each DMA as placebo tests of our results. Chloroquine and azithromycin were often mentioned alongside hydroxychloroquine as part of potential COVID-19 prophylaxis and treatment (Gautret et al. 2020; Liu et al. 2020; Shehab, Lovegrove, and Budnitz 2020). However, these drugs were not as widely publicized or politicized as hydroxychloroquine. We hypothesized no association or a slightly positive association between a DMA's Trump support and changes in weekly chloroquine and azithromycin prescription rates before and after Trump's hydroxychloroquine endorsement. We also examined prescription rates of ciprofloxacin, which, like azithromycin, is an antibiotic used to treat infections but was not mentioned by political or scientific pundits as a promising COVID-19 prophylaxis or treatment. We expected no association between DMA-level Trump support and changes in weekly ciprofloxacin prescription rates before and after Trump's hydroxychloroquine endorsement. Although we conducted all analyses using deidentified data, this study received Duke University institutional review board approval and was preregistered at https://osf.io/cwftu.

Results

Descriptive Statistics

Table 1 presents descriptive statistics for all 205 DMAs as well as for the top 20 DMAs with the highest Trump vote percentages (mean 73.5%) and the bottom 20 DMAs with the lowest Trump vote percentages (mean 31.7%) in the 2016 presidential election. The percentages of DMAs' Trump votes ranged from 18.6% to 79.1%. In general, the top 20 Trump-supportive DMAs had smaller mean populations and more licensed beds per 100,000

Table 1 Descriptive Statistics for 205 Designated Market Areas, 2018–2020

	All DMAs (N = 205)	Top 20 DMAs by % Trump votes (N = 20)	Bottom 20 DMAs by % Trump votes (N = 20)
Mean population	1,590,624	420,041	4,989,045
Mean proportion of votes for Trump (%)	54.69	73.51	31.70
Mean licensed beds per 100,000 population	333.86	412.14	256.26
White (%)	79.84	85.88	74.71
Black (%)	10.94	6.09	7.95
Other (%)	5.47	5.16	9.95
Hispanic (%)	12.69	12.40	32.09
Female (%)	50.49	49.74	50.72
Median age	38.70	39.12	36.95
Age 65 or older (%)	16.35	17.17	14.46
Median household income ($)	54,342	50,308	66,579
Families in poverty (%)	10.99	11.13	10.94
Bachelor's degree or higher among those age 25 and older (%)	26.55	20.36	34.40
Mean weekly hydroxychloroquine prescriptions per 100,000 population (before March 16, 2020)	0.66	0.56	0.49
Mean weekly hydroxychloroquine prescriptions per 100,000 population (after March 16, 2020)	2.27	2.48	1.94

Note: DMA = designated market area.

compared to the bottom 20 Trump-supportive DMAs. The populations of the least Trump-supportive DMAs had more racial/ethnic diversity but had similar age and gender compositions as the most Trump-supportive DMAs. The least Trump-supportive DMAs, however, tended to be more educated and to have greater median household incomes.

Across all 205 DMAs, 23,411 weekly retail hydroxychloroquine prescriptions were filled between March 1, 2018, and July 31, 2020. Before President Trump's endorsement of using hydroxychloroquine for COVID-19, mean weekly hydroxychloroquine scripts per 100,000 population were similar across the most Trump-supportive and the least Trump-supportive DMAs (0.56 vs. 0.49 scripts per 100,000). As seen in Figure 1, after Trump's

Table 2 Changes in Weekly Hydroxychloroquine Prescription Rates following President Trump's Hydroxychloroquine Endorsement as a Function of DMA-Level Trump Support in 2016

	Weekly hydroxychloroquine prescriptions per 100,000 population	
	(1)	(2)
Trump 2016 vote percentage	0.002	0.002
	(0.0004)	(0.002)
	[.000]	[.135]
Postendorsement	0.924	0.920
	(0.318)	(0.315)
	[.004]	[.004]
Trump 2016 vote × postendorsement	0.013	0.013
	(0.006)	(0.006)
	[.030]	[.028]
Covariates	No	Yes
Mean weekly hydroxychloroquine prescriptions per 100,000 population	0.927	
Observations	23,411	

Notes: DMA = designated market area. Covariates include DMA population, licensed beds per 100,000 population, race/ethnicity, age, gender, income, and education. The standard errors in parentheses are robust to heteroskedasticity. The associated *p* values in brackets are based on two-tailed *t*-tests with 3 and 16 degrees of freedom for columns 1 and 2, respectively.

March 19, 2020, endorsement, hydroxychloroquine prescription rates spiked for both the most Trump-supportive and the least Trump-supportive DMAs, but rates rose more in the most Trump-supportive areas. From mid-March to late July 2020, the top 20 Trump-supportive DMAs filled more mean weekly hydroxychloroquine scripts per 100,000 (2.48 scripts per 100,000) than the bottom 20 Trump-supportive DMAs (1.94 scripts per 100,000).

Regression Analysis

Table 2 shows our estimated association between DMA-level Trump support and changes in weekly hydroxychloroquine prescription rates before and after President Trump's public endorsement, which was significant when either excluding or including covariates. Following Trump's endorsement of hydroxychloroquine for COVID-19, a 1-percentage-point increase in a DMA's share of votes for Trump in the 2016 election was statistically significantly associated with a 0.013 increase in mean weekly

hydroxychloroquine scripts per 100,000 ($b = 0.013$, $t = 2.20$, $p = .028$). This association represented a 2% increase in weekly hydroxychloroquine scripts per 100,000 for every additional percentage point increase in Trump vote share, compared to the baseline mean rate of 0.66 scripts per 100,000.

There was a positive correlation between DMA-level Trump vote percentage and changes in weekly hydroxychloroquine scripts per 100,000 in March 2019 versus March 2020 (not shown). The West Palm Beach-Ft. Pierce, Florida, DMA was an outlier in the data, with 46.2% of votes cast for Trump in 2016 but a high of 66.27 more mean weekly hydroxychloroquine scripts per 100,000 filled in March 2020 compared to March 2019. This DMA contains Mar-a-Lago, a private club owned by President Trump. When excluding this outlier from the dataset, we estimated that following President Trump's endorsement, a 1-percentage-point increase in a DMA's share of Trump votes was statistically significantly associated with a 0.014 increase in mean weekly hydroxychloroquine scripts per 100,000 population ($b = 0.014$, $t = 2.47$, $p = .013$).

Using the same empirical strategy, we found statistically significant associations between hydroxychloroquine prescription rates and political preferences using 2016 House Republican vote percentages and 2020 Trump vote percentages instead of 2016 Trump vote percentages (table 3). With the median-split Trump 2016 vote share indicator, we estimated that Trump's endorsement was associated with a 0.290 increase in mean weekly hydroxychloroquine prescriptions in high-Trump-supportive DMAs (> 55.3% Trump votes) relative to low-Trump-supportive DMAs (≤ 55.3% Trump votes; $b = 0.290$, $t = 2.26$, $p = .024$). Relative to the baseline mean rate, this association represented a 44% greater increase in weekly hydroxychloroquine prescription rates in high-Trump-supportive vs. low-Trump-supportive areas.

Extensions to Other Drugs

We examined weekly DMA chloroquine, azithromycin, and ciprofloxacin prescription rates following Trump's March 19, 2020, endorsement as placebo tests of our main results. We found statistically significant negative associations between DMA-level Trump support and changes in weekly prescription rates of azithromycin ($b = -0.218$, $t = -11.82$, $p < .001$) and ciprofloxacin ($b = -0.025$, $t = -4.20$, $p < .001$) before and after Trump's endorsement, although these changes were much smaller relative to hydroxychloroquine (table 4). Figure 2 shows the mean weekly prescription rates of ciprofloxacin and hydroxychloroquine before and after Trump's hydroxychloroquine endorsement. The negative estimated

Table 3 Robustness Checks: Changes in Weekly Hydroxychloroquine Prescription Rates as a Function of DMA-Level Political Leaning

	Weekly hydroxychloroquine prescriptions per 100,000 population	
	(1)	(2)
Trump 2016 vote percentage	0.003	0.003
	(0.001)	(0.002)
	[.013]	[.066]
COVID-19 deaths per 100,000 population	–0.051	–0.056
	(0.009)	(0.009)
	[.000]	[.000]
Trump 2016 vote × COVID-19 deaths	0.002	0.002
	(0.0002)	(0.0002)
	[.000]	[.000]
Trump 2016 vote indicator	–0.018	–0.029
	(0.011)	(0.023)
	[.103]	[.215]
Postendorsement	1.469	1.469
	(0.088)	(0.087)
	[.000]	[.000]
Trump 2016 indicator × postendorsement	0.292	0.290
	(0.130)	(0.129)
	[.025]	[.024]
House Republican 2016 vote percentage	0.003	0.004
	(0.0003)	(0.0008)
	[.000]	[.000]
Postendorsement	0.997	1.000
	(0.253)	(0.249)
	[.000]	[.000]
House Republican 2016 vote × postendorsement	0.011	0.011
	(0.004)	(0.004)
	[.014]	[.013]
Trump 2020 vote percentage	0.001	0.004
	(0.0004)	(0.002)
	[.003]	[.026]
Postendorsement	0.814	0.809
	(0.321)	(0.318)
	[.011]	[.011]
Trump 2020 vote × postendorsement	0.014	0.014
	(0.006)	(0.006)
	[.013]	[.012]

(*continued*)

Table 3 Robustness Checks: Changes in Weekly Hydroxychloroquine Prescription Rates as a Function of DMA-Level Political Leaning (*continued*)

	Weekly hydroxychloroquine prescriptions per 100,000 population	
	(1)	(2)
Covariates	No	Yes
Mean weekly hydroxychloroquine prescriptions per 100,000 population	0.927	
Observations	23,411	

Notes: DMA = designated market area. Covariates include DMA population, licensed beds per 100,000 population, race/ethnicity, age, gender, income, and education. The standard errors in parentheses are robust to heteroskedasticity. The associated *p* values in brackets are based on two-tailed *t*-tests with 3 and 16 degrees of freedom for columns 1 and 2, respectively.

associations between DMA-level Trump support and changes in azithromycin and ciprofloxacin prescription rates before and after Trump's endorsement could suggest an overall decrease in doctors' visits during COVID-19, which may have differentially affected high-Trump-supportive and low-Trump-supportive communities (Alexander et al. 2020). In this case, our estimated association between a geographic area's Trump support and changes in hydroxychloroquine prescription rates before and after Trump's endorsement was understated; the uptick in hydroxychloroquine prescriptions would be larger had we been able to account for a disproportionate decline in doctors' visits in Trump-supportive DMAs. These results could also reflect reactance by physicians in low-Trump-supportive DMAs, who intentionally veered away from hydroxychloroquine and chloroquine toward other potential COVID-19 prophylaxis and treatment drugs.

Discussion

In the months following President Trump's endorsement of using hydroxychloroquine to treat COVID-19, prescriptions for the drug increased significantly throughout the country (Bull-Otterson et al. 2020; Gabler and Keller 2020; Harrigan et al. 2020). In addition, increases in hydroxychloroquine prescriptions were higher in areas of the country with greater support for Trump in the 2016 and 2020 elections. Our results suggest a 2% increase in weekly hydroxychloroquine prescription rates for every percentage point increase in DMA-level vote share for Trump. We find evidence of this disproportionate increase among high-Trump-supportive areas

Table 4 Placebo Tests: Changes in Weekly Chloroquine, Azithromycin, and Ciprofloxacin Prescription Rates following President Trump's Hydroxychloroquine Endorsement as a Function of DMA-Level Trump Support in 2016

	Weekly chloroquine prescriptions per 100,000 population		Weekly azithromycin prescriptions per 100,000 population		Weekly ciprofloxacin prescriptions per 100,000 population	
	(1)	(2)	(3)	(4)	(5)	(6)
Trump 2016 vote percentage	−0.00003	−0.0004	0.445	0.179	0.189	0.112
	(0.0002)	(0.0004)	(0.009)	(0.013)	(0.003)	(0.005)
	[.825]	[.242]	[.000]	[.000]	[.000]	[.000]
Postendorsement	0.082	0.082	−0.935	−0.898	−0.832	−0.853
	(0.075)	(0.074)	(0.971)	(0.951)	(0.304)	(0.304)
	[.270]	[.268]	[.335]	[.345]	[.006]	[.005]
Trump 2016 vote × postendorsement	0.002	0.002	−0.217	−0.218	−0.025	−0.025
	(0.002)	(0.002)	(0.019)	(0.018)	(0.006)	(0.006)
	[.309]	[.300]	[.000]	[.000]	[.000]	[.000]
Covariates	No	Yes	No	Yes	No	Yes
Mean weekly prescriptions per 100,000 population	.033		25.275		11.111	
Observations	5,505		25,934		25,660	

Notes: DMA = designated market area. Covariates include DMA population, licensed beds per 100,000 population, race/ethnicity, age, gender, income, and education. The standard errors in parentheses are robust to heteroskedasticity. The associated *p* values in brackets are based on two-tailed *t*-tests with 3 degrees of freedom for columns 1, 3, and 5 and 16 degrees of freedom for columns 2, 4, and 6.

Figure 2 Mean weekly hydroxychloroquine and ciprofloxacin retail prescription rates across 205 DMAs, July 2019–July 2020.

Note: DMA = designated market area.

when accounting for DMA sociodemographic characteristics and health system capacity. This finding also holds when removing the outlier DMA that contained President Trump's resort, Mar-a-Lago. The robustness of the results when using Republican House of Representatives votes instead of Trump votes also underscores the notion that partisan identification, rather than solely Trump support, drives our observed effects. This robustness check reflects the broader partisan divide over hydroxychloroquine among politicians and pundits rallying for or against Trump's endorsement (Blevins et al. 2021; Facher 2020). Taken together, our analyses demonstrate that, after President Trump's endorsement, hydroxychloroquine prescription rates increased significantly across the country, but especially in high-Trump-supportive DMAs.

Our results demonstrate the impact a presidential endorsement of an unproven therapy can have on otherwise nonpolitical health behavior. Although our study identifies partisan patterns of regional uptake of hydroxychloroquine prescriptions after Trump's endorsement, we cannot determine the relative impact of physician versus patient political preferences on our findings. Differences in prescription rates may point to partisan physicians who were more willing to prescribe hydroxychloroquine to patients in high-Trump-supportive areas. Previous studies suggest that physicians relocate to communities that align with their political preferences (Bonica et al. 2020). Thus, it is likely that more Democratic physicians reside and work in Democratic DMAs, and vice versa for Republican physicians. This geographical sorting of physicians along political lines could explain why high-Trump-supportive DMAs experienced greater increases in hydroxychloroquine prescription rates after Trump's endorsement compared to low-Trump-supportive DMAs. Partisan physician behavior is also plausible in the context of research showing that physician partisanship influences treatment decisions on politicized health issues, such as marijuana use and abortion (Hersh and Goldenberg 2016; Zatz et al. 2020). The politicization of COVID-19 and unproven therapies like hydroxychloroquine may have similarly cued political identity, thus motivating partisan-patterned physician prescribing decisions (Gollust, Nagler, and Fowler 2020).

Alternatively, hydroxychloroquine prescription rates after Trump's endorsement may reflect the political attitudes of patients. If patient demand varied by political affiliation, such demand may have driven the differential increase in DMA-level hydroxychloroquine prescriptions. Physicians may have been responding to their patients' preferences such that those preferences tipped the balance in the context of a decision which, at the time, had no medically right or wrong choice. Previous research reveals that

partisan differences in individual self-reported protective health behaviors and policy attitudes toward COVID-19 response became ingrained early in the pandemic (Clinton et al. 2021; Gadarian, Goodman, and Pepinsky 2021). As early as mid-March 2020, Republicans were less concerned about COVID-19 and less likely to report abiding by CDC recommendations than were Democrats (Gadarian, Goodman, and Pepinsky 2021). Differential patient demand for hydroxychloroquine after Trump's endorsement may also be explained by conservatives' decayed scientific trust and increased likelihood of accepting media-disseminated misinformation about COVID-19 (Gollust, Nagler, and Fowler 2020; Jamieson and Albarracin 2020; Motta, Stecula, and Farhart 2020). With limited knowledge about COVID-19 therapies, partisans also relied on cues from political elites (Gollust, Nagler, and Fowler 2020). Thus, whereas Democratic patients may have been hesitant to use hydroxychloroquine, Republican patients may have trusted Trump's endorsement of hydroxychloroquine—and the attitudes toward hydroxychloroquine on display in the right-leaning media attention Trump's endorsement garnered—and may have thus asked for the drug as a COVID-19 treatment.

Limitations

Our study has several limitations. As with any empirical strategy resembling a difference-in-differences estimation, unobserved confounds may bias our estimated association between political preferences and hydroxychloroquine prescription rates after Trump's endorsement. Although parallel pre-trends across DMAs that were the most and the least supportive of Trump in 2016 suggest no systematic difference in prescription rates before President Trump's endorsement, we cannot rule out the possibility that some other, unobserved factor correlated with Trump support was associated with the differential increase in prescription rates. One such factor could be the visibility of Trump's endorsement in the local media, as high-Trump-supportive DMAs may have disproportionately covered news about hydroxychloroquine to appeal to viewers' and readers' preferences (Martin and Yurukoglu 2017). Trump's endorsement also creates a fuzzy time boundary for the intervention period because of the downstream events related to his initial comments, including the FDA's EUA and Trump's announcement that he was personally taking hydroxychloroquine.

Additionally, using DMAs to determine an area's political leaning results in imprecise measures. DMAs are not homogenous, and inferring individual behavior from DMA-level data is difficult without studying physician and

patient attitudes and behavior. More finely grained data, such as the zip code level, may have allowed for a better estimate of the association between political leaning and changes in hydroxychloroquine prescription rates before and after Trump's endorsement. However, we did not pursue zip-code-level analyses to better protect the identity of prescribing physicians.

Lastly, although our analysis identifies partisan patterns in DMA-level uptake of hydroxychloroquine after Trump's endorsement, we cannot identify the causal mechanism driving this relationship. There are at least two alternative hypotheses that could explain the association we found in our data. First, physician political identities or preferences could have influenced the supply of hydroxychloroquine. Physicians in high-Trump-supportive DMAs may themselves have been more conservative and thus more receptive to Trump's endorsement of hydroxychloroquine for COVID-19 treatment. As such, physicians in high-Trump-supportive communities may have been more willing than those in low-Trump-supportive areas to prescribe hydroxychloroquine to patients. A second plausible hypothesis focuses on patient demand, suggesting high-Trump-supportive areas of the country had more conservative patients who were receptive to Trump's endorsement and therefore asked for hydroxychloroquine prescriptions from their physicians.

Our study cannot distinguish which of these mechanisms—physician supply, patient demand, or a combination of both—explains the partisan patterns of hydroxychloroquine prescriptions before and after Trump's endorsement. However, this study does reveal the influence of a federal endorsement on prescription patterns of hydroxychloroquine early in the pandemic. Physicians and patients in high-Trump-supportive and low-Trump-supportive areas responded positively to Trump's endorsement of using hydroxychloroquine for COVID-19 early in the pandemic. However, prescribing patterns were differentially influenced by this endorsement depending on whether the endorsement aligned with a community's political leanings. Thus, in a situation of uncertainty—when there is no gold standard of care—physicians and patients might rely on not only medical expertise but also politicized public health communications when deciding on a course of care.

Conclusion

It is unclear how physicians and patients should have judged the likely benefits and harms of hydroxychloroquine for COVID-19 early in the pandemic. With weak evidence of efficacy but positive messaging about

the drug's potential from both the president and the FDA, reasonable physicians and patients may have judged the benefits of hydroxychloroquine as outweighing the risks. Although this study cannot identify whether partisanship among physicians or patients primarily drove the variation in hydroxychloroquine prescription rates, our findings illustrate the significant influence a presidential endorsement of unproven therapies has on partisans. President Trump's endorsement of hydroxychloroquine, further bolstered by the FDA's EUA, swayed constituents in a manner unmatched by other politicians or public health experts. Conservative media's amplification of hydroxychloroquine's promise before and after Trump's endorsement also likely differentially influenced positive perceptions of hydroxychloroquine among physicians and patients. The partisan correlation with hydroxychloroquine prescriptions underscores that political leaders should not forge ahead of the science and promote unproven therapies. It is already difficult for physicians and their patients to weigh the potential benefits and risks of treatments that have yet to be rigorously evaluated. Politicians should limit polarizing messages and let public health experts do their jobs so physicians and patients can make treatment decisions without worrying that their judgments are being unduly influenced by politics rather than medicine.

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