

# The Politicization of Ivermectin Tweets During the COVID-19 Pandemic

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**Background.** We explore the ivermectin discourse and sentiment in the United States with a special focus on political leaning through the social media blogging site Twitter.

**Methods.** We used sentiment analysis and topic modeling to geospatially explore ivermectin Twitter discourse in the United States and compared it to the political leaning of a state based on the 2020 presidential election.

**Results.** All modeled topics were associated with a negative sentiment. Tweets originating from democratic leaning states were more likely to be negative.

**Conclusions.** Real-time analysis of social media content can identify public health concerns and guide timely public health interventions tackling disinformation.

**Keywords.** disinformation; ivermectin; public opinion; social media; Twitter.

The promotion of ivermectin, a Food and Drug Administration (FDA)-approved antiparasitic drug used to treat onchocerciasis and intestinal roundworm infection, as a coronavirus disease 2019 (COVID-19) therapeutic agent has challenged the medical and scientific community. Recommendations to repurpose ivermectin as a COVID-19 therapy materialized when ivermectin showed in vitro efficacy against the virus [1]. Subsequently, multiple studies including randomized controlled trials (RCTs) investigating ivermectin's therapeutic and prophylactic role against COVID-19 in vivo yielded inconsistent treatment effects [2]. The emergent nature of the pandemic combined with initial lack of a vaccine resulted in trials of ivermectin

outside RCT settings in several countries [3]. Several meta-analyses reported promising results, but flaws and statistical biases in included studies generated cautionary calls for evidence of stronger treatment effects before widespread adaptation as a COVID-19 treatment [2], resulting in early adopters and concerned beholders.

The politicization of key strategies comprising the United States' COVID-19 pandemic response resulted in significant discrepancies in the uptake of vaccinations and nonpharmaceutical interventions such as social distancing and mask wearing. Television viewers, who reported using conservative media channels such as Newsmax, One American News, or Fox News as news sources, held more misconceptions about the COVID-19 pandemic and vaccines [4]. The association between party affiliation and health behaviors contributed to a 3-fold higher COVID-19 death rate in Republican versus Democratic counties [5]. Mounting cases and death tolls and ivermectin's availability, acceptability, and affordability motivated some consumers to seek this non-FDA-approved therapy despite the lack of the scientific community's support for ivermectin as a COVID-19 treatment [6].

High prevalence of disinformation (defined as false information with the intent to harm) [7, 8] forced social media companies to develop policies to combat the spread of mis- and disinformation [9]. Understanding the extent and impact of disinformation is vital for government officials and public health agencies to predict population behavior, shape messaging of evidence-based guidance to healthcare providers, and allocate resources [10]. In this study, we explore the ivermectin discourse and sentiment in the United States with a special focus on political leaning through the social media blogging site Twitter.

## METHODS

### Data Collection and Processing

On October 5, 2021, using Twitter's Application Programming Interface (API) to access Twitter's COVID-19 stream, we collected all English-language tweets from April 1, 2021 to October 5, 2021, where the user's location indicated a tweet from the United States, and the tweet contained the keyword "Ivermectin". We used Python version 3.9.1 software (Python Software Foundation, Wilmington, DE) for all data processing and analyses. Institutional review board approval was not required because this study used only publicly available data.

### Sentiment Analysis

Before performing sentiment analysis, we preprocessed tweets into plain text, which required the removal of hyperlinks,

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Twitter handles, “#” symbols, and reply tweets. We used the NLTK (Natural Language Toolkit) library [11] to remove words that provide little semantic meaning (ie, “stop” words) such as “their”, “who”, and “is” [12]. We used Python’s SentiStrength Library [13] to identify and classify the sentiment (positive or negative) of these preprocessed tweets. SentiStrength uses a lexicon-based classifier as well as a rule-based algorithm to measure sentiment on a scale of  $-4$  (most negative) to  $4$  (most positive). We calculated the average sentiment for all tweets by state and compared mean sentiment to the political party of the candidate winning the state in the 2020 presidential election [14].

### Topic Modeling

Using the Gensim library in Python, we applied an unsupervised machine-learning algorithm called Latent Dirichlet Allocation (LDA) to group tweets using a representative set of words into word clusters. We analyzed these word clusters to determine the content of each topic. To optimize the number of topics in our analysis, we trained and evaluated LDA models trained with 2–30 topics based on their topic coherence score, which summarizes the semantic similarity among high-scoring (frequent) words within topics. We ultimately chose a 6-topic LDA model that produced the highest score. An author (C.U.L.) without access or insight into the topic modeling labeled the topics using the 30 most frequently used terms, which were ranked by weight. A subset of authors then evaluated the topic labels to reach a consensus and identified example tweets whose content pertained  $>99\%$  to a specific topic (Table 1).

## RESULTS

We identified 420 101 tweets from April 1, 2021 to October 5, 2021 that contained the keyword ivermectin and were generated by a user in the United States. Users in the most populous states created the most tweets: California users generated the most tweets (50 631) followed by users in Texas and Florida (48 857 and 32 885 tweets, respectively).

### Sentiment Analysis

The overall mean sentiment for tweets was negative ( $-0.25$ ) throughout the study period. Figure 1 shows variation and visual clustering in mean sentiment among states. Red (more positive) and blue (more negative) shadings indicate mean sentiment above (below) the overall mean. The states with the least negative sentiment were South Dakota and Florida (mean  $= -0.14$  and  $0.17$ , respectively), whereas the states with the most negative sentiment were Minnesota and Idaho (mean  $= -0.36$  and  $0.32$ , respectively). As depicted by the state boundary in Figure 1, states carried by the Republican presidential candidate (marked with red boundaries; median

sentiment being  $-0.24$ ; interquartile range [IQR],  $-0.21$  to  $-0.25$ ) had less negative sentiment than those carried by the Democratic candidate (marked with blue boundaries; median sentiment  $= -0.274$ ; IQR,  $-0.25$  to  $-0.28$ ).

### Topic Modeling

The LDA model identified 6 topics expressed in our sample of tweets, which were labeled subjectively based on their respective keywords (Table 1). Approximately half of the tweets belonged to the topic “Ivermectin effectiveness and safety studies: Scientific Merits” (196 874 tweets), which included the concern for validity of the scientific studies and safety of ivermectin as a treatment for COVID-19. The next most popular topics included “Safety of Ivermectin for Animal Use in Humans” (48 277), “Discussion on how the Anti-Vaxxers are promoting Ivermectin and endangering people” (47 922), and “Big Pharma/Governments blocking alternative treatments including Hydroxychloroquine and Ivermectin across the globe” (46 456).

On average, tweets discussing ivermectin on Twitter used negative words resulting in a negative sentiment. Not surprisingly, people tweeting on Ivermectin effectiveness and safety studies: Scientific Merits (a more fact-based and therefore more neutral topic) used fewer negative words (mean sentiment  $= -0.20$ ), whereas people tweeting on “Pharma/Governments blocking alternative treatments including Hydroxychloroquine and Ivermectin across the globe” (a very charged topic) frequently used negative words (mean sentiment  $= -0.36$ ). Regardless of topic, tweets displayed more negative sentiments in states leaning democratic.

### Ethics Approval and Consent to Participate

The University of Texas Southwestern Human Research Protection Program Policies, Procedures, and Guidance did not require institutional review board approval, because all data were publicly available. The data that support the findings of this study are available upon request to the corresponding author.

## DISCUSSION

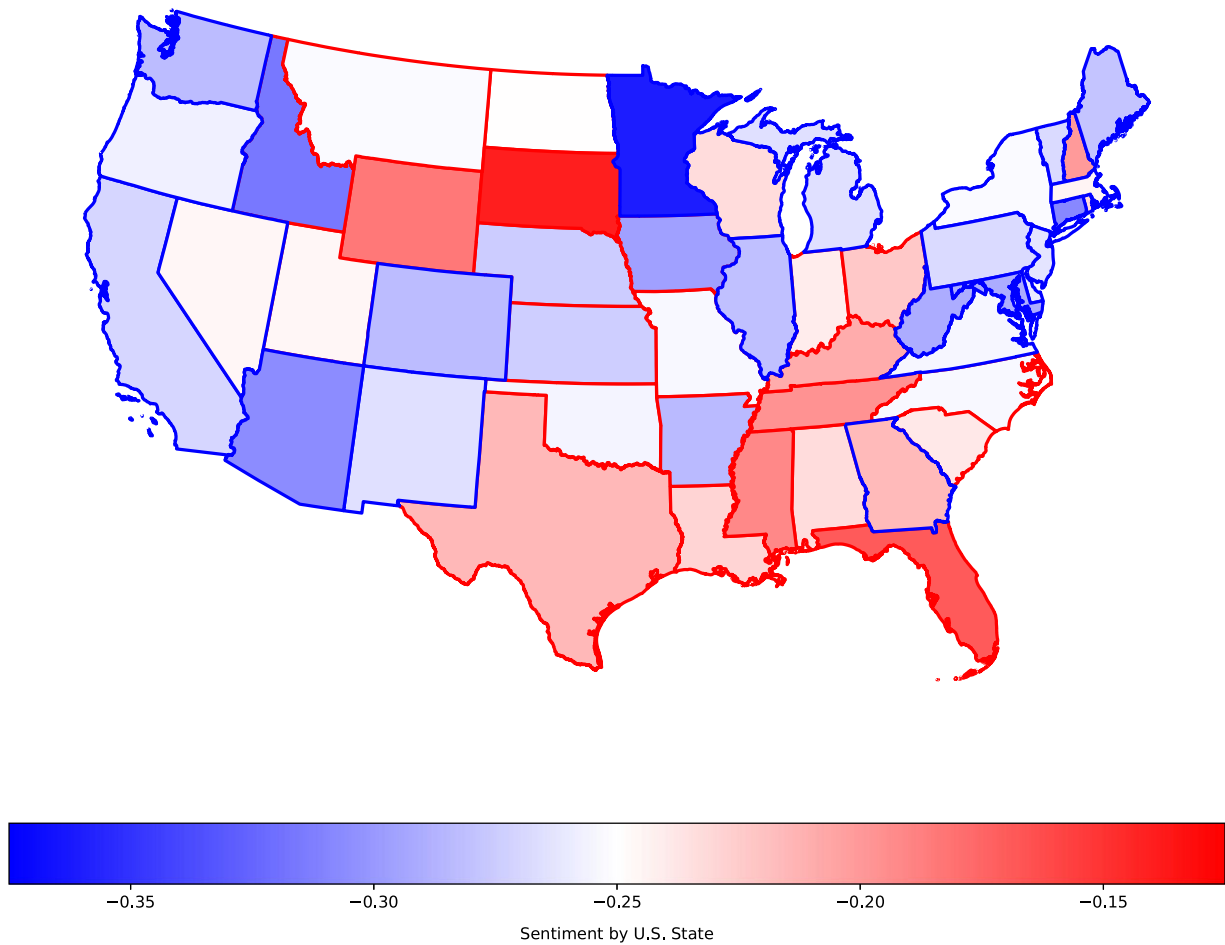
Negative sentiments and a heavy focus on ivermectin safety and efficacy studies represent the main findings of our study analyzing COVID-19 tweets containing the word ivermectin in the United States. States varied in sentiments expressed in tweets, and political ideology seemed to be an important differentiator for this finding. In general, states that voted Democratic in the 2020 presidential election had a more negative sentiment in tweets with the keyword ivermectin than states that voted Republican, suggesting a strong politicization of this important health topic. Political preference and the likely associated news

**Table 1. Topic Modeling Analysis of Tweets and Subsequent Sentiment Analysis of Each Topic<sup>a</sup>**

Topic	Tweets/Topic n (%)	Topic Sentiment	Sentiment in States Learning		Keywords	Representative Tweet
			Republican	Democratic		
Ivermectin effectiveness and safety studies: Scientific Merits	196874 (46.9)	-0.22	-0.20	-0.23	study, talk, find, man, one, this, report, show, read, article, right, never, overdose, infection, link, hit, efficacy, today, dose, lie	Crucial, game-changing info, just published today, written by an unbiased researcher in the UK. Written for health professionals & policy makers: laypeople might want to skip to page 15 for conclusions. <a href="https://t.co/x1fdA12EeqZ">https://t.co/x1fdA12EeqZ</a> #Ivermectin #COVID19 Thanks to [...] <a href="https://t.co/5o7qYGT5i">https://t.co/5o7qYGT5i</a>
Safety of Ivermectin for Animal Use in Humans	48277 (11.5)	-0.20	-0.19	-0.21	take, people, use, human, call, also, make, prevent, horse, know, medicine, get, would, need, everyone, want, one, animal, help, believe	Why did ppl have to be stupid and take horse paste when they could only take 6 grams every 12 h. Only for 2 days. Ppl are crazy about everything. So they get sick. Ivermectin has been a safe drug for years until ppl started taking animal bs. I still believe its safe.
Discussion on how the anti-vaxxers are promoting ivermectin and endangering people	47922 (11.4)	-0.30	-0.29	-0.30	get, work, anti, like, know, think, take, say, horse, people, would, vaxxer, try, make, thing, really, well, one, vax, come	*this is just to say* I have blocked the extended family members who promoted ivermectin on fb and who are still not fucking vaccinated not sorry they are dangerous so dumb and so loud
Big Pharma/Governments blocking alternative treatments including hydroxychloroquine and ivermectin across the globe	46456 (11.1)	-0.36	-0.36	-0.39	drug, hcq, india, use, treatment, work, could, new, effective, see, may, say, would, cure, doctor, research, get, like, evidence, case	"These contracts cannot be broken, even if an effective treatment is discovered. This may explain why countries are not rushing to approve ivermectin, for example. It could also explain why it is difficult for governments to reverse course, given the money paid to pharma companies"
US Governments block ivermectin and hydroxychloroquine	42754 (10.2)	-0.21	-0.21	-0.22	use, hydroxychloroquine, treatment, many, people, work, would, overdose, get, works, day, vaccine, say, seizure, zinc, taking, CDC, country, hcq, go	Our government and many others are willfully contributing to citizen deaths by banning, discouraging use of proven COVID therapeutics HCO and Ivermectin. They don't care about you. With early access to these, the whole thing would be over. PS, the vax will kill you eventually.
Effects on hospitals and physicians: ivermectin refusal and ivermectin overdoses	37818 (9.0)	-0.28	-0.26	-0.30	treat, patient, doctor, hospital, say, use, give, human, story, news, die, good, get, prescribe, FDA, approve, drug, work, tell, year	[...] To make the point clearer, both Durant & McAlister (2 largest micropolitan areas in SE OK) are 100% full in the ICU. When that happens, patients back up into the ER. Most hospitals able to handle a GSW in SE OK only have 3-9 ICU beds. A handful of ivermectin ODs makes this true.

Abbreviations: CDC, Centers for Disease Control and Prevention; COVID19, coronavirus disease 2019; ER, emergency room; fb, Facebook; FDA, US Food and Drug Administration; GSW, gunshot wound; hcq, hydroxychloroquine; ICU, intensive care unit; info, information; ODs, overdoses; OK, Oklahoma; ppl, people; SE, southeast; UK, United Kingdom.

<sup>a</sup>Twitter handles have been censored from the table using the annotation [...].



**Figure 1.** Sentiment analysis by US State. State boundaries represent 2020 presidential election results (red = republican, blue = democratic) and state fill represents the sentiment of coronavirus disease 2019-related tweets containing the word “Ivermectin” in the state.

source preference affected the public’s opinion on the use of ivermectin to treat COVID-19.

All modeled topics were associated with a negative sentiment. With a very specific and narrow keyword such as ivermectin, all topics were closely related. However, tweets expressed 2 very polar opinions. One discussion topic reflected frustration and anger over promoting human ivermectin use without sufficient scientific evidence, resulting in overdoses that further overwhelmed the healthcare system during a surge in cases. The other topic reflected concerns about governments, “big pharma”, and healthcare providers blocking the use of treatments hailed as COVID-19 panacea, such as ivermectin and hydroxychloroquine.

Sentiment and topic analysis of tweets is insufficient to derive conclusions about whether the clustered topics are for or against the use of ivermectin as a COVID-19 prophylaxis or treatment. However, the major topics discussed in online public forums regarding ivermectin use for COVID-19 infections and the associated negative sentiment strongly signal to public

health authorities that further investment to develop effective educational messaging regarding ivermectin is needed.

Because the COVID-19 pandemic unmasked the challenge of combating health disinformation on social media [8] at a time when social media platforms are the major source of information for a large proportion of the public [15], investing in innovation to address disinformation has become paramount. Yesterday’s potential COVID-19 therapeutic (miraculous treatment as interpreted by the public) may become tomorrow’s therapeutic with equivocal outcomes (ineffective treatment as interpreted by the public), and although health information transfer to the public may be faster than among the scientific community, keeping the public informed and protected from disinformation has gained tremendous importance. In the case of ivermectin, unnecessary spending by insurers on ivermectin prescriptions was estimated at \$2.5 million in the week of August 13, 2021 alone, making investment in the combat of disinformation not only an important public health issue but also an economic imperative [16].

Early detection and identification of disinformation has been challenging during the COVID-19 pandemic because data and knowledge are continuously aggregated and scientific understanding of the nature and management of the disease has evolved rapidly [17, 18]. Many social media companies adapted different ways of blocking or tagging disinformation on their platforms as a first step. Real-time analysis of existing social media content and generation of new social media content by public health agencies may offer an opportunity to close the gap between scientific evidence and public knowledge more rapidly and increase public trust. Potential future interventions may include automated tools such as Public Health Information bots or targeted education of specific populations.

### Limitations

Our study has several limitations that must be discussed. First, because Twitter provides a convenient API, we limited our study to only 1 social media site. By excluding other social media sites, we may have introduced some bias. Second, we used the Twitter user location in the users' accounts when we analyzed sentiment across states. The account location may not reflect the actual location of the user at the time of tweet and is more likely to represent their home base. Because we deleted duplicate tweets, our topic analysis might be skewed away from topics that are frequently retweeted. Because twitter users may not be representative of political leanings in the United States, our sample may be skewed.

We used the presidential election results on a state level. Because counties may have voted differently within a state, this study missed differences in political preferences at the county level. Another limitation to our study is the challenge that sentiment analysis can underperform when handling sarcastic text. Because COVID-19-related tweets frequently contain sarcasm, more research to improve accuracy of sarcasm detection is required. Our study also fell short in regards to identifying actual mis- and disinformation. We are working on tools to automate this task in future studies.

### CONCLUSIONS

Tweets with the keyword ivermectin had universally negative sentiment during our study period. Voting results in the 2020 presidential election were associated with the polarity of sentiments across the states. The major topic of discussion among the public was ivermectin safety and efficacy studies. Our study adds to the growing evidence supporting the use of natural language processing for real-time analysis of social media content to early identify public health concerns and to guide timely interventions tackling health disinformation.

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**Conflicts of interest.** C. U. L. reports stock ownership in Celanese Corporation and Markel Corporation. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

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