

## **“Please follow the doctors” or “doctors are making this pandemic hoax”: how people view medical experts during the COVID-19 pandemic in 2020**

### **Introduction**

The COVID-19 pandemic, started in December 2019 in Wuhan, China, has become a global pandemic for more than a year by now. Doctors are the ones who first felt the emergency and pressure as the virus started to spread in communities, together with medical researchers who have been working tirelessly to understand more about the virus and to develop treatments and vaccines. At the same time on social media platforms, misinformation has spread like the virus itself, most of which are medical-related, and need the expertise of the medical community to mitigate the influence. However, with the large amount of information being shared online, researchers have noticed the lack of quality information online about COVID-19, especially in its early stages (Cuan-Baltazar et al. 2020). Social media platforms are not often friendly to professional and expert opinions, as they are not weighted over other sources. For example, YouTube subordinated expertise to the logic of likability (Marchal & Au, 2020), making it hard for professional sources to stand out.

A recent Pew Research report found that since the pandemic, there has been a growing trust in medical scientists overall (from 35% in 2019 to 43% in 2020), but the growth is only significant among Democrats in the US context (for Democrats and Democrat-leaning respondents, the growth was from 37% to 53%, while no significant change was seen among the Republican and Republican-leaning respondents, Pew Research 2020). This suggests that political ideology plays an important part in people’s attitude toward the professional medical community in the US. The lack of trust in professionally trained medical experts would divert the information seeking to

alternative sources. Studies have shown that lower trust in medical experts could lead to the public's belief about misinformation in scientific topics (Stecula et al 2020, Jerit et al 2020).

Understanding the public views about doctors and medical experts would inform further research about the user characteristics that are associated with trust or skepticism of doctor's expertise, and how such attitudes could be associated with medical misinformation in such a global health crisis.

Understanding public attitudes toward the medical experts could shed light on how to better communicate the science about a contagious disease to enhance trust, how to mitigate medical misinformation in such a crisis in an increasingly polarizing online environment, and how to ensure compliance of public health measurement. This study takes a mixed-methods approach, combining text mining techniques and qualitative textual analysis to examine a public Twitter dataset during the COVID-19 pandemic.

This study used two derived datasets that contain different sets of keywords related to doctors and medical experts in general and with different medical specialties and diseases. The two datasets are drawn from Twitter dataset that has been collected since January 2020 about covid related topics (Chen et al., 2020). The first derived dataset was used to detect patterns of discussions using a LDA topic modeling and sentiment analysis on tweets with relevant keywords, and was supplemented by a qualitative analysis of tweet texts. The major topics and sentiment analysis are based on tweets with selected keywords, such as "doctor", "expert", and terms of medical specialties, and the analysis is about the overall discussion patterns of tweets containing these terms. Qualitative analysis of the tweets reveals more details about the publicly expressed attitudes toward medical experts. It could identify some nuances in such conversation,

which can be hard to be captured with the computer-assisted methods. The second dataset is supplementary to the former, as many of the mentions of health conditions and specialties are also relevant to the discussion of medical expertise, with or without the mentioning of keywords like “doctor” or “expert”. It also helps to see how other health issues are discussed within the context of the pandemic.

## **Literature Review**

This study examines how the expertise and authority of doctors and other medical experts (such as scientists) are discussed on Twitter during the COVID-19 pandemic, focusing on the expressed attitudes and opinions. Twitter has become a popular health information source, as demonstrated in Love et al (2013)’s study on vaccination information contents. There are studies on what kind of information about specific health conditions is shared on Twitter, for example, a content analysis shows that Dementia was talked about on Twitter with shared links to news and health information sites, as well as recent research results (Robillard et al. 2013). Topic modeling has been commonly used to detect health-related topics on Twitter, such as tobacco use (Prier et al, 2011).

This study is interested in the discussion patterns about medical experts, and such expressions are deeply rooted in politics. Therefore, understanding how social media, Twitter in particular, have been used in past political campaigns and affairs is equally important in examining how people use Twitter to seek and discuss health-related information. Researchers have paid specific attention to the rise of Trump on Twitter during his presidential election campaign, and how Twitter has become polarized in opinions. Ott (2017) attributes the logics of Twitter that promote and sustain simplicity, impulsivity and incivility to Trump’s rise on Twitter and the winning of

the election. Groshek and Koc-Michalska (2017) suggested that a passive or uncivil social media use was associated with the support of the conservative populist candidates in the 2016 presidential election. Conover et al. (2011) found the retweets of political contents showed that the left- and right-leaning users formed two distinctive, highly partisan structures. The study by Grover et al (2019) points out that Twitter has played significantly in polarizing users. Urman (2019) finds that across countries, the highest level of polarization on Twitter happened in the two-party systems with plurality electoral rules. Opinions on other issues like climate change are also highly polarized on social media, with deniers showing more hostility towards the believers and vice versa, and the deniers are more active during natural disasters (Tyagi, et al. 2020). In the study of US Congress members' engagement with COVID-19 and anti-racist topics on Twitter, Panda et al (2020) found that the Democrats and Republicans have different views on the pandemic, with the former concerning more about public health, the latter focusing on small businesses and the economy; for the anti-racist movement, the Democrats showed concern over police brutality, while the Republicans discussed the issue less frequently and criticized the violence during the protests.

The COVID-19 became a global pandemic roughly at the same time with the Democratic primary in 2020 heating up, growing along with the increasing contentions about the presidential election on social media. Political polarization and partisanship have played a key role in shaping the online conversation about the pandemic in the United States (Jiang et al, 2020; Motta et al. 2020). The partisanship has largely shaped the sharing and commenting of fact-checking about political candidates on social media (Shin and Thorson, 2017). A topic modeling study of the tweets by Democratic and Republican affiliated House and Senate members shows very

divergent topics, for example, the Democratic affiliated tweets tend to focus on health disparity, testing, and public guidelines, while the Republican affiliated tweets tend to focus on vaccine development, hospital resources and equipment. Their focuses on other non-medical issues also diverge (Guntuku et al, 2021).

The polarization of news coverage in mainstream media about COVID-19 (Hart et al, 2020) may have contributed to the polarized attitudes of COVID-19 in the U.S. Gadarian et al (2020) conducted a survey that found political differences are the most significant factor in differentiating health behaviors and policy preferences during the pandemic. The media consumption has affected the tendency to believe and endorse misinformation. In the studies about COVID-19 misinformation, the right-leaning media is seen to be linked to such tendency (Motta et al, 2020), and particularly the use of social media and conservative media sources are linked to the belief of conspiracy theories and misinformation (Jamieson and Albarracin 2020). Yang et al (2020) found through a content analysis of tweets that the pandemic has largely been politicized, and both social bots and humans were generating low-credibility information. Hamamsy & Bonneau (2020) also found that the links shared in the tweets about the COVID-19 treatments and medications are not very scientific, and are likely to be from conservative-leaning media sources.<sup>1</sup> Although this study is not looking at social media misinformation, our analysis also shows that the lack of trust in medical experts is closely related to the sharing of misinformation.

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<sup>1</sup> This study will not take individuals' media consumption into account, but knowing such connection would help the in-depth analysis, because the user descriptions and contents in the tweets that indicate political ideology inclination could provide context for understanding the tweets.

In addition to investigating misinformation, there is a wide range of scholarly inquiries about the COVID-19 pandemic using social media data. Since the outbreak, researchers have looked at the changing discourse patterns on social media, using topic modeling and sentiment analysis to identify such patterns (e.g. Xue et al. ,2020). Looking to understand major public awareness and concerns about the pandemic, Boon-Itt and Kunkan (2020) found a generally negative outlook toward the pandemic (data ranging from December 2019 to March 2020), which was done at the earlier stage. Wicke and Bolognesi (2020) used topic modeling to classify the tweets, and analyzed how the war metaphor as a framing option was used to talk about specific topics (e.g. virus treatment). Other studies (e.g. Lwin et al. 2020) looked at the dominant emotions during the pandemic over time. Singh et al.'s (2020) look at social media conversations about COVID-19 found that the myths and poor quality information were not as dominant as previous crises. Other studies determined that the changing sentiments and topics were always corresponding to new developments in the pandemic (such as new incidents of outbreak), the announcement of new clinical trial results, or the White House public announcements (Medford et al, 2020, Hamamsy & Bonneau, 2020).

Studies also focused on how specific issues were addressed and perceived through the analysis of tweets. For example, Sanders et al (2020) looked at the topics and sentiments about the conversation on masks. Others identified ageist tweets (Jimenez-Sotomayor et al, 2020), compared citizens' attitude toward their leaders (Trump in the US and Modi in India) through assessing sentiments and emotions (Dubey, 2020). Glowacki et al (2000) took a similar approach, with keywords search in public tweets to examine major topics around addiction and substance concerns during the pandemic. Koh and Liew (2020) studied how loneliness was

talked about during the pandemic by conducting a topic modeling, and identified three overarching themes: the community impact of loneliness, the effect of social distancing, and the effects on mental health. Similar studies have also been done in other cultural contexts. For example, Xi et al (2020) analyzed how older adults were portrayed on Weibo (a Chinese platform similar to Twitter) by analyzing relevant Weibo topics (similar to Twitter's hashtags), finding mostly positive expressions and attitudes toward them during the pandemic. These studies mainly focused on the earlier stages of the pandemic and provided an extensive description of what was discussed on social media from various aspects. As well, comparisons of different user groups were also analyzed for topics and sentiments, and no significant difference in sentiments between physicians and general Twitter users was found, but the topics are quite different between these two groups (Sullivan et al, 2020). Put together, these findings become a good starting point for my study that looks at Twitter data for a whole year.

### *Research Questions*

The research questions for this study are:

- What are the major topics and sentiments shown in the public tweets about medical experts (doctors and scientists) during the COVID-19 pandemic?
- What are major attitudes toward medical experts being expressed during the COVID-19 pandemic in 2020 public tweets?
- What are the characteristics that are used to define a medical expert in the pandemic as shown in the Twitter discussions?

This study contributes to the existing literature of analyzing the online discourses about COVID-19. As the pandemic has a profound impact on everyday life on a global scale, and social media now has become an essential part of everyday conversation, the studies of discussion patterns are thus important for us to better understand the central concerns and dominant emotions during the study period. This will inform public health and other policy-making agencies.

This study takes a mixed-method approach, which further confirms the need of qualitative analysis in studies with text mining techniques so as to examine the complexities in natural language. It examines the public attitudes towards a specific professional group, whose expertise is defined with multiple standards, and is also heterogeneous within such a group, adding further complexities to the analysis. It could further inform studies to develop tools to automatically detect positive and negative views about expertise beyond sentiment analysis. It will also better inform studies on how to effectively mitigate medical misinformation and build trust of the medical community.

The public attitudes towards medical experts have real consequences in risk perception and health behavior. For example, researchers show that the level of trust in medical experts affects how likely people's beliefs about vaccination will change (Setcula, Kuru, and Jamieson, 2020). Trust in science and politics becomes a key predictor of accepting and adopting protective measures, such as social distancing and hand washing (Dohle et al, 2020). This study is a first step to analyze the online discourse about medical experts during the pandemic, and it could inform future research about such consequences.



## Data collection

I used the data from a publicly available Twitter COVID-19 dataset (Chen, et al. 2020) for this research. This dataset is organized by date; within each day, there are 24 different files representing an hour's tweets each. The dataset has been collected since January 28, 2020, and they added data since January 21 retrospectively. According to the README description, as of this manuscript (v2.43 of the dataset), the total number of tweets in the dataset is 1,386,739,774, and about 64.51% of them are English tweets, followed by 12.91% Spanish tweets. Following Twitter's Terms of Use, what is available to download are tweet ID files that need to be rehydrated for further use.

I took an event-driven approach to the data collection, by first identifying the key events through a COVID-19 timeline from the New York Times and Wikipedia, focusing on medical-related events, like the breakthroughs in treatment and preventive measures, variants of the virus, news related to significant medical professionals, and days significant counts of infections and deaths were reached. I also selected days that are considered turning points of the pandemic, such as the lockdown of Wuhan (Jan 23, 2020).

**Table 1 Selected dates for data collection and analysis**

Date	Major event or milestone
Jan 21, 2020	First case in the U.S.
Jan 23, 2020	The lockdown of Wuhan
Feb 3, 2020	U.S. declares public health emergency

Feb 7, 2020	The Chinese whistleblower doctor, Li Wenliang, died
Feb 11, 2020	WHO named COVID-19 as the official name of the disease
Feb 29, 2020	First death case in the U.S.
Mar 11, 2020	WHO declared global pandemic
Mar 21, 2020	Trump tweeted about Hydroxychloroquine and Azithromycin
Apr 2, 2020	Global cases passed 1 million
Apr 14, 2020	U.S. announced halting fund for WHO
May 27, 2020	The death number reached 100,000
July 9, 2020	WHO announced that COVID-19 can be airborne
July 17, 2020	U.S. recorded the highest single-day rise in cases anywhere in the world so far
Aug 8, 2020	The total cases reached 5 million
Sep 22, 2020	The death number reached 200,000
Sep 28, 2020	Global COVID-19 death surpassed 1 million
Oct 2, 2020	Trump tested positive for COVID-19
Nov 9, 2020	President-elect Biden announced COVID-19 transition team, Pfizer published vaccine results, the U.S. passed 10 million COVID-19 cases
Nov 18, 2020	Pfizer BioNTech vaccine is 95% effective
Dec 11, 2020	FDA authorized emergency use of Pfizer vaccine
Dec 29, 2020	Confirmed new variant from UK found in the U.S.

I collected all 24 hours' tweets for each day listed above, and hydrated the tweets. For each day's data, I filtered out non-English tweets and removed duplicates in the text field. I then used the

keywords “doctor” or “expert” to select relevant tweets for a “general” dataset, and a list of medical specialties to select relevant tweets for a “specialty” dataset. After this, I concatenated the tweets for all dates to form the final “general” and “specialty” datasets. The general dataset has a total number of 97674 English tweets, and the specialty dataset has 22155 tweets.

For my quantitative analysis, I focused on the actual texts of the tweets, so my pre-processing was only for the “text” field. I turned them all to lowercase letters, removed punctuations, handles (@mentions), words that contain numbers, #signs for hashtags, and urls. Then I lemmatized the words, tokenized them, and removed stopwords. For the general dataset, since all the tweets contain “expert” or “doctor” in the tweets, these words would appear to have the highest frequency in the corpus, so I removed both. Other frequently appearing terms that have been removed are “coronavirus”, “corona”, “covid”, and “pandemic”. I took a slightly different approach to the pre-processing of the specialty dataset. Since not all tweets contain “expert” or “doctor”, they are not the high-frequency terms that should be removed. As the dataset is built from a long list of terms related to medical specialties and related colloquial terms, the relative proportion of tweets containing a single keyword in the list is small, and they are more meaningful in understanding the tweets. Therefore, I kept the keywords from the list in the analysis.

In this study, a medical expert (or a real doctor) refers to those who have professional training in modern Western medicine and credentials in related fields of expertise, and those who adhere to and advocate for CDC and WHO guidelines. Admittedly, these guidelines can also be controversial, are not always reflecting the best evidence-based medical research, and can

change over time, but this simplified definition is for analysis. In the qualitative analysis below, further explications will be provided in specific cases. The analysis of the tweets will also show how medical experts are defined in social media discussion, or what makes a real medical expert in the context of the COVID-19 pandemic. It is also noticeable that there are discussions of whether someone qualifies as the “right” expert the public and political leaders should go to. For example, an infectious disease expert will have much higher credibility than someone in a different specialty, although they are both professionally trained.

*Description of the two working datasets*

**Table 2 Top terms and bigrams for dataset 1**

<b>Term</b>	<b>Frequency</b>	<b>Bi-gram</b>	<b>Frequency</b>
say	14363	Public health	2640
health	10150	Wear mask	2475
people	9063	Li Wenliang	2348
Trump	8610	Task force	1662
China	8187	Try warn	1530
Chinese	7924	Infectious disease	1372
death	7851	Rage death	1075
virus	7247	Chinese rage	1050
die	6575	Sound alarm	1002
warn	5977	Warn world	929

The count of uni-and bigrams of the general dataset was done after removing stopwords, search keywords, and the terms of high frequency, such as “COVID”, “coronavirus”, “pandemic”. The results show that the pandemic was situated with the context of the presidential election; a large

number of tweets also mentioned China. The pandemic is clearly a public health issue, and further analysis shows that mask wearing was extensively debated, in which doctors and experts were cited on both sides. Li Wenliang, an alarm sounding doctor in China, is among the top high frequency bi-grams, as his death led to a wide range of mourning online. “Infectious disease” also appeared frequently in the general dataset’s tweets, as one of the most relevant medical fields of specialty in the pandemic.

**Table 3 Top terms and bigrams for dataset 2**

<b>Term</b>	<b>Frequency</b>	<b>Bi-gram</b>	<b>Frequency</b>
disease	9266	Infectious disease	5591
infectious	6127	Heart disease	1946
heart	3089	Disease specialist	620
diabetes	3006	Heart problem	473
people	2627	Chinese virologist	453
say	2473	Cause death	358
Dr	2251	Public health	357
virologist	2045	Disease cancer	335
death	1975	Lung disease	327
health	1626	Institute virology	326

As for the specialty dataset, the uni- and bigram count was done without removing search keywords, because it is a long list that contains so many words, and each group of tweets with a keyword in it only takes a small portion of the entire set. As expected, the high frequency terms or bigrams are related to the list of keywords, which contains specialties and common health conditions that are related to COVID-19. The largest number of tweets contain “infectious

disease” and related keywords, and further analysis shows that it mainly involves the discussion of infectious disease experts, what they said or did, and their qualifications. Another group of high frequency terms involve “virology” and “institute”, which is possibly related to the virology institute in Wuhan, at the center of the debate of the origin of the virus.

### **Topic modeling and sentiment analysis**

Sentiment analysis was done for the entire general dataset, by specialty in the specialty dataset, and as well by each topic in the general dataset. In this section, I will cover the first two sentiment analyses, discuss the topic modeling, and then return to the sentiment analyses by topic.

The sentiment analysis was performed using VADER lexicon (Hutto et al., 2014). The sentiment scores range from -1 to 1, with 0 being neutral sentiment, -1 the most negative, and 1 the most positive.

The general dataset has a positive mean sentiment score of 0.487, and a negative mean sentiment score of -0.534, with the most positive score at 0.9976 and the most negative score at -0.9955.

The overall sentiment in the general dataset is slightly negative (mean= - 0.065). The sentiment score for each topic will be shown and discussed together with the results of topic modeling.

Here is an example of a tweet with very negative sentiment talking about “bad doctors”.

*@xxxx Our death rate is so high cause we have the worse doctors in the world. Doctors who not ready for this pandemic are bad doctor. Bad doctor are like bad cops we need to weed them out. Fired them. Bad doctors just move away and be bad somewhere else. <https://t.co/d34aNLw1bf>*

The specialty dataset has a mean positive score of 0.489, a mean negative score of -0.515, and the overall sentiment is slightly positive (mean=0.013). The most positive score is 0.987, and the most negative score is -0.993.

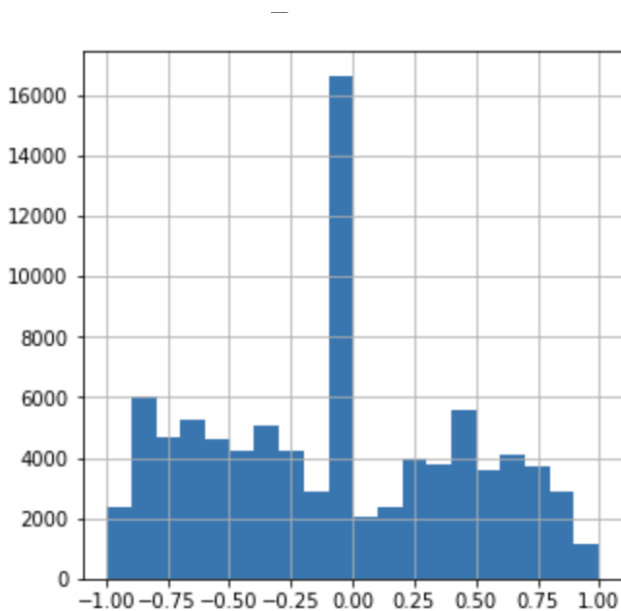
**Table 4 Sentiment scores by specialty**

<b>Specialty</b>	<b>Mean</b>	<b>Min</b>	<b>Max</b>
Overall	0.013	-0.993	0.987
Cardiology	-0.056	-0.993	0.986
Radiology	0.189	-0.982	0.982
Infectious Disease	0.033	-0.974	0.976
Pediatric	0.047	-0.984	0.980
Neurology	0.048	-0.964	0.930
Endocrinology	-0.114	-0.975	0.992
Respirology	-0.084	-0.968	0.966
Immunology	0.157	-0.933	0.952
Virology	-0.011	-0.892	0.977
Psychiatry	-0.067	0.977	-0.963

For the specialty dataset, I conducted both the overall sentiment analysis and the sentiment analysis over tweets grouped by specialties. It is, however, important to note that the sentiment score does not reflect people’s expressed attitude toward experts in these specialties, because only few tweets are relevant in this category. However, there are still some meaningful results to

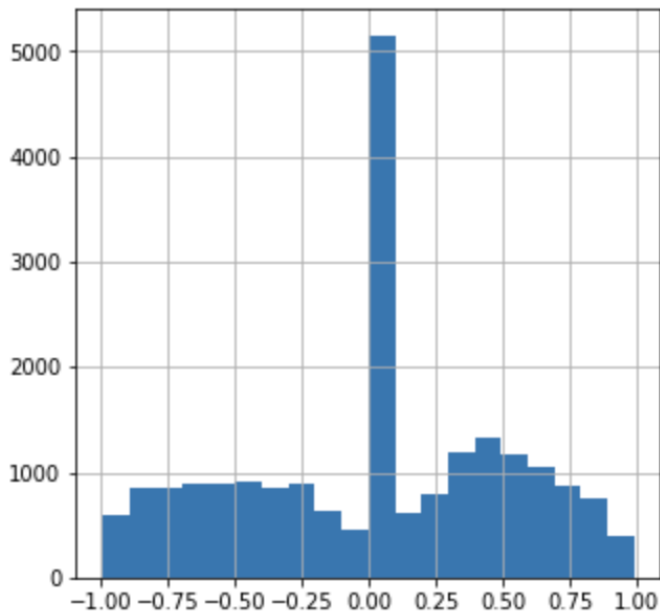
be discussed. The overall sentiment is slightly positive, with some polarized opinions. The result of the sentiment analysis for the specialty dataset shows that the most negative specialty is endocrinology, and the most positive specialty is radiology. The sentiment score distributions for the two datasets are displayed in figures below. We can notice that the spike at the center represents the neutral tweets (sentiment score = 0.0), and the negative sentiment for the general dataset is slightly skewed to the right, with more tweets leaning toward the “very negative” side.

**Figure 1 Sentiment score distribution for general dataset**



**Figure 2 Sentiment score distribution for specialty dataset**





A LDA topic modeling was conducted on both datasets. To determine the right number of topics, the perplexity score is used. The number of topics and the corresponding perplexity score were tracked using scikit-learn. Because the perplexity score is difficult to interpret, I also examined each topic qualitatively to help determine the final number of topics.

For the general dataset, I chose 6 topics as the best model, and the specialty dataset has 5 topics, which are the best interpretable results.

To examine the results of each topic, 10% of the tweets from each dataset were selected for review, and the top 10 keywords for each topic were used to search for the selected tweets and determine the representative tweets.

**Table 5 Topic modeling results for the general dataset**

Topic #	Keywords in topic	# of Tweets	Topic description	Representative Tweets	Sentiment Score (mean, max, min)
1	expertise, science, life, scientist, care, listen, people, health, need	17303	Emphasis on respecting scientific expertise, listening to experts, politicians have no expertise, suspicion of experts (or opposite)	<p>There you have it folks "the experts" have confirmed it. Are these the same "experts" who told us to stay home, wear a mask, and inflated the COVID numbers!? Well, they can keep their expertise they are #Frauds #TrumpPence2020 <a href="https://t.co/5pF7cda wO3">https://t.co/5pF7cda wO3</a></p> <p>i wish people with no medical expertise would stop posting authoritatively about coronavirus, you'll pardon me for only relying on the advice of trained professionals on such a matter.</p> <p>#WearAMask It's no mystery why #TrumpHasCovid . Listen to medical experts and scientists: #WearADamnMask <a href="https://t.co/t1jTMzla 10">https://t.co/t1jTMzla 10</a></p> <p>Since he has no interest in getting coronavirus under control he should just quit and let Biden in with the doctors and scientists now. <a href="https://t.co/5rqlgGv gru">https://t.co/5rqlgGv gru</a></p>	0.050, 0.997, -0.971

2	Wenliang, disease, whistleblower, news, virus, Wuhan, warn, China, death, Chinese	19321	The Chinese doctor Li Wenliang as the whistleblower of the outbreak in Wuhan	<p>Rest In Peace, Dr #Li Wenliang. My sincere condolences to his family, friends and colleagues. #coronavirus #Wuhan Li Wenliang: Wuhan hospital announces death of whistleblower doctor after hours of confusion - CNN <a href="https://t.co/lzyOWeMrDq">https://t.co/lzyOWeMrDq</a></p> <p>I feel so sad about this. The Chinese are dragging people out of their homes to put in quarantine. Thank you, Li Wenliang for your great service and sacrifice. R.I.P.</p> <p>BBC News - Li Wenliang: Coronavirus kills Chinese whistleblower doctor <a href="https://t.co/KleweFEngN">https://t.co/KleweFEngN</a></p>	-0.337, 0.977, -0.977
3	Risk, believe, face, ask, country, public, say, wear, mask, health	13311	The kinds of risks, wearing masks, beliefs about doctor's views or misinformation about doctors	<p>Video does not work. I can't believe 100,000 doctors are coming to tell you that covid19 virus developed by military department in P4 Wuhan as a military bio-weapon is a hoax. These doctors have never been to an IC, know nothing about Wuhan. Are WHO followers. <a href="https://t.co/ZozNVxERIP">https://t.co/ZozNVxERIP</a></p> <p>@xxxx: Do you still</p>	0.000, 0.964, -0.968

				<p>believe everything you are told by the media? Or Govt bought "experts" or big pharma?</p> <p>A rushed covid vacc...</p> <p>I still can't believe doctors were even accused of falsifying a pandemic for monetary benefits! But glad we don't have to worry about that from our President anymore!  <a href="https://t.co/T9edsM7sjb">https://t.co/T9edsM7sjb</a></p> <p>@TyWarkentin          @BanksPatriot          @ChrisBuryNews          @jwgop          @kayleighmcenany          If you don't believe the media reports, visit a covid floor at a hospital and see for yourself. Do you have any doctors or nurses in your family?</p>	
4	Force, good, try, world, work, think, nurse, tell, help, vaccine	18877	The coronavirus task force (with experts in them), issues related to vaccine development, approval and effectiveness (quoting or questioning experts on these), the situation in the world (US versus world)	<p>Or we will all just have to be vaccinated and not once but seasonally as the experts will tell us and they will be the same experts who will be on the payroll of Bill Gates who's company will be profiting from the vaccines and seasonal vaccines          #COVID19          #vaccine          #MoneyTalks  <a href="https://t.co/3rIPRqgFta">https://t.co/3rIPRqgFta</a></p>	0.063, 0.982, -0.975

5	Month, case, work, positive, worker, treat, plan, say, patient, test	11582	About tested positive cases, case numbers and tests, essential workers, doctors saving patients	<p>@DanCrenshawTX Pathetic statement. TX now leads the nation in Covid 19 cases. When have you shown up at a hospital ER, ICU, dialysis unit, or clinic? Spoken to doctors &amp; nurses in the middle of this?</p> <p>@simonmwuk @alanmcn1 The "casedemic" is their assumption that PCR tests are only detecting false positive cases, and doctors also are confusing and misdiagnosing all cold and flu cases as covid-19 (in all countries). In essence they think science and medicine "got it all wrong" or are "in on it".</p>	0.012, 0.971, -0.968
6	Scientist, live, know, president, want, people, say, Biden, die, Trump	17280	US president (and presidential election)-related, the political world and scientific authority, relationship between presidential candidates or presidents and scientists/experts	<p>@realDonaldTrump Dear President Trump. You as USA President should have gathered the best scientists, doctors, biologists and all professions related to medicine, to move the process toward finding the vaccine for corona virus. It would give You Mr. Trump so much of credits for upcoming election.</p> <p>@apwriter Any of these candidates would handle it fine. They'd have a fully</p>	-0.078, 0.971, -0.996

				<p>staffed CDC and HSS, with real scientists and medical experts in place. They all would fund a research response team, back when people were first dying in Muhan. Trump played anti-science politics instead. **</p> <p>#trump #TrumpFailed It is amazing to me that thousands can believe that scientists, epidemiologists, CDC, doctors, hospitals and the media are all lying about Covid, but one rich man is telling the truth. All those people got together &amp; decided to make up the severity of Covid.</p>	
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The topics cover many general issues related to COVID-19, such as wearing masks, the vaccine development and conspiracy, the effects of lockdown, and mostly, the US and world politics. There are also topics that are specifically related to the medical community, such as calls to follow experts’ advice, to trust in science, and also descriptions of the situation in hospitals. There is one particular topic (Topic 2) that is about the Chinese doctor Li Wenliang who was seen as the “whistleblower” of the virus, who was then reprimanded by the local police, and was later infected and died of the virus.

From the analysis of the topics above, we can see that all these topics reveal particular aspects of the public attitudes towards medical experts. Topic 1 is directly related to the tension around scientific (medical) expertise, whether to follow experts or to doubt them, and also what constitutes “expertise”. It is essentially about whether medical experts and scientists should be trusted in the midst of many uncertainties. Topic 2 is predominantly about the Chinese doctor Li Wenliang, particularly his death and his sounding of the alarm at the pandemic’s early stage. This is a typical example of how a doctor became a central focus of the news -- he was among the first few Chinese doctors who sounded the alarms but had to pay a price of being reprimanded by the authorities and later dying of coronavirus infection. People paid tribute to him for his bravery. This topic came up largely because of the tweets selected on February 7, 2020, on the day of the death of Li Wenliang, and he soon became known worldwide as a “whistleblower” doctor. In some tweets, people expressed their respect and anger toward the Chinese government. It is the most negative topic in this dataset, because it contains many terms related to people’s anger and rage about this news.

Topic 3 involves different kinds of risks related to COVID-19, and there are also a large amount of tweets talking about different “beliefs” about what doctors did in the pandemic. There are some pieces of popular misinformation about doctors that many people strongly believe, such as doctors faking the hospital death data for more money, or doctors creating this pandemic hoax.

Topic 4 covers very diverse issues. It contains a lot of discussion about the coronavirus task force of the White House, with the experts working in it. There are also issues related to vaccine development, approval and effectiveness, in which experts were praised or questioned. There are also discussions about the situation in the world, particularly as a comparison to the US. Topic 5

is about the positive cases, the numbers and issues with testing, and the work done by essential workers, such as doctors saving patients. Topic 6 is concerned with the US presidents and the election. It covers the tension between political and scientific authority, highlighting how the presidential candidates were treating experts and scientists.

We should note that a negative sentiment score does not necessarily mean that the user is not supportive of doctors or does not trust them. A negative sentiment score can be the result of the presence of multiple terms that have negative compound scores, which may not be related to the expressed attitude toward doctors. Some people use very strong negative terms to urge people to follow doctors. Here is an example:

@xxxx Hey losers that are not concerned about covid!

Once your stupid ass'es gets covid, don't complain, don't go to the hospital, die a miserable death you fks!

Don't waste first responders & hospitals time! As you did nothing but ridicule medical experts!

How's chuck woolery?

I next turn to the analysis of the specialty dataset.

**Table 6 Topic modeling results for specialty dataset**

Topic #	Top keywords	# of tweets	Topic	Representative Tweets	Sentiment score (mean, max, min)
1	Know, infectious, year, diabetes,	7400	Deaths related to COVID-19	@JackPosobiec Well can't	-0.086, 0.982, -



	cancer, die, death, people, heart, disease		and other underlying conditions didn't get treated, COVID risks related to underlying conditions	because of Fauci Birx Redfield - More people have died by suicide and not having their elective surgeries cancer heart disease than have of Covid	0.993
2	Science, radiology, make, new, use, specialist, patient, mask, infectious, disease	4788	Recognizing infectious disease specialists' expertise, decision makers should trust (or choose) the right expert	<p>RT @ebroskie1234: "Dr. Scott Atlas is not an epidemiologist, is not an infectious disease specialist," Wallace said. "He has no training in..."</p> <p>It's amazing to read the list of Biden's COVID panel and see no Biden family members. Just virologists, epidemiologists and infectious disease specialists.</p> <p>@vlamers @PMorgan28385916 @Surgeon_General 'Premier medical doctor.' 😞😞</p> <p>He's an anesthesiologist. Hardly qualified to manage infectious outbreaks, as was evidenced by his mishandling of the HIV outbreak in IN.</p> <p>I guess the next one through the</p>	0.167, 0.961, -0.961

				Trump admin revolving door will be a radiologist.	
3	Condition, pediatric, care, lung, high, patient, case, health, risk, diabetes	3570	A “pediatric” topic, mostly informational and about pediatric complications, and others are about pre-existing underlying conditions, and the long-term effects of COVID-19	WE ARE ALL ADULTS IN THE ROOM, THE HYPOCRISY IN OUR FACES DOESN'T HELP NEWSOLINNI IN HIS CASE, IT IS TIME WE ALL RISE UP, TAKE OUR LIVES BACK. <b>THIS RESTRICTIVE CODE WAS SET UP BY A RETIRED PEDIATRICIAN.</b> WHAT DOES HE KNOW ABOUT HERD IMMUNITY & OUR LIVES  <a href="https://t.co/JqrZAhPR3f">https://t.co/JqrZAhPR3f</a>	-0.098, 0.976, -0.981
4	Lockdown, national, Fauci, image, vaccine, state, test, say, disease, infectious	3607	About national policies or measures, like lockdown, vaccine, and testing, Dr. Fauci’s expertise recognized	RT @AllThingsNatSec: In a former life I was fascinate by virology and infectious diseases. Anthony Fauci was one of my heros. He is a world renowned expert in infectious diseases. This is an insult. <a href="https://t.co/Tc1Blxu1FK">https://t.co/Tc1Blxu1FK</a>  @lynnv378 @Mama_Liberal I worked in Tulane	0.116, 0.956, -0.955

				HIV/AIDS Immunology research dept in 1980s & have been reading research on Pfizer, Moderna & Astrazenica vaccines. Until CDC Director Nominee Dr. Rochelle Walensky, MD, MPH takes over, I don't trust any vaccines.They are all still in trial everywhere	
5	Goldman, China, say, pediatrician, virus, vaccine, Wuhan, virology, cardiac, virologist	2790	This is about the origin of the virus, the idea that it probably came from China's top virology institute (a "virology" topic)	@TheJusticeDept Chinese virologist: China's government 'intentionally' released COVID-19 <a href="https://t.co/9JkI5YR93u">https://t.co/9JkI5YR93u</a> #FoxNews  @y0umustwhipit @reg_llama @fakenewsshater @itsJeffTiedrich Trump isn't a doctor or scientist. Lay blame where it belongs with the CCP refusing to let in CDC and WHO and China who still lies about its numbers, and Fauci a career virologist who on JAN 27 said he wasn't concerned and was at every single conference.	-0.096, 0.927, -0.972

Similar to the general dataset, not all tweets selected were relevant to attitudes toward medical experts, because of the way this dataset was formed. The tweets selected for analysis also address important issues during the pandemic.

Topic 1 talks about the deaths due to COVID-19 or other more common chronic conditions.

There is generally a complaint about measures like lockdown that prevented people from maintaining their routine healthcare for chronic conditions and that more people were dying from these pre-existing conditions rather than COVID-19. Topic 2 is mainly about recognizing infectious disease specialists' expertise, arguing that decision makers should choose and trust the right expert (infectious disease expert or epidemiologists, not doctors in other specialties). Topic 3 is a "pediatric" topic, and most of the tweets about pediatricians or pediatrics are informational, such as pediatric complications. Other tweets in this topic overlap with topic1, talking about pre-existing conditions and long-term effects of COVID-19. Topic 4 is about national policies and public health measures, such as lockdown, vaccine, and testing. It is also worth noting that Dr. Fauci's expertise is highlighted and recognized. Topic 5 is mainly about the discussion on the origin of the virus, and most tweets pointed out its connection to a virology institute located in Wuhan, although to date there has been no evidence. This topic has a lot to do with virologists, with the appearance of some top virologists' names in China and their accounts.

The topic modeling of the two datasets shows that although there are many influencers on social media talking about the pandemic-related issues, the centrality of the discussion is still quite clear: Trump and Fauci are the two names mentioned frequently in tweets, together with the

Chinese alarm-sounding doctor Li Wenliang (topic 2 of general dataset), and these are the only names appearing in the top 10 words of all the topics.

### **Interpretation of the tweets**

The sentiment score indicates an overall positive or negative sentiment of a tweet, but it is a compound score that measures the entire tweet, regardless of the keywords and their contexts, or whether a tweet is relevant to the research topic. In order to get a better picture of what people really think of medical experts during the pandemic, a qualitative analysis was conducted. The qualitative analysis revealed nuances and complexities that could not be seen with topic modeling and sentiment analysis. In fact, as the datasets were built using keywords search only, not all resulting tweets are relevant. I sampled tweets from the general dataset and coded them as “relevant” to doctors’ expertise: 237 were coded as “relevant”, and 740 were not relevant. For the selected tweets from the specialty dataset, 41 were relevant and 181 were not. If this proportion reflects the entire dataset, we could conclude that only a small portion of the tweets are indeed about the expressed attitude toward doctors and relevant experts.

A qualitative analysis could identify the patterns of tweets that are relevant (i.e. with expressions relevant to “attitudes”), and perform further analysis about the kinds of attitude and their meanings in a contextualized way, despite the context information often being limited. The in-depth analysis of this collection of tweets reveals a more complicated picture of the public’s view of doctors and medical experts in the pandemic.

### *Complexities in coding and analysis*

1% of the tweets from the datasets were randomly selected from the general dataset (977 from the general dataset, and 222 from the specialty dataset). A coding schema for the analysis was developed iteratively. First, tweets were manually categorized as “relevant” and “not relevant”, that is, whether a tweet contains an expression that is relevant to attitudes, such as the evaluation of expertise, authority, and other qualities of doctors or medical experts. Although all the tweets contain a keyword like “doctor” or “expert”, or some sort of specialty, some of them were simply making a neutral statement such as “an expert suggests...”, or “I’m going to see my doctor”. The specialty dataset also has a lot of tweets simply discussing pre-existing conditions. If a doctor is cited in a news story, or a tweet just describes the story of a doctor, they are counted as “not relevant”. Among the 977 tweets from the general dataset, 237 were relevant (24.3%), and 41 out of the 222 selected tweets (18.5%) from the specialty dataset were relevant.

Second, the kind of attitudes or opinions were identified, such as trust, support, suspicion, frustration, uncertainty, and so on. For example, there were tweets calling on either the public or the decision makers to follow doctors’ advice, which is an endorsement of doctors’ authority and expertise. Some tweets criticized doctors for exaggerating the severity of the pandemic so that the government could take control of people’s lives, and those tweets called the pandemic “a hoax” and experts “fake”. This shows a general suspicion of doctors’ expertise. Finally, additional characteristics of the tweets were coded, such as whether it is a tweet directed to someone or not, whether it was original or retweeted, and whether the user spoke on behalf of him/herself or quoted other sources.

Because Twitter texts are short and are read out of context, it is hard to determine what the authors meant when the tweets mention “doctor” or “expert” or their specialties. The meaning

could be literal, that is, a professionally trained, authentic doctor, with appropriate qualifications to speak about the pandemic and other medical issues. Alternatively, the tweets could also be referring to doctors who endorse popular misinformation, viewing those doctors positively. With quotation marks being used (“doctors”, “so-called experts”), the meanings can get further complicated. Authors use quotation marks or the term “so-called” to signal a disapproval of the expertise of the doctors, either as the doctors have argued against what the authors are in favor of, or because the doctors have made a claim that turns out to be incorrect. There are also cases when people cite doctors and experts to oppose lockdown and mask mandates, and to support the “hoax” argument. Real doctors’ expertise was also questioned by people who believed popular misinformation or conspiracies, and the doctors were thus seen as “corrupted” or “fake”.

To simplify, I coded every relevant tweet on the basis of the implied attitude toward real, professionally trained doctors and medical experts as was defined for the previous analyses (see the introduction). For example, if a tweet showed a positive view about a doctor endorsing something being fact-checked as false, then the tweet was coded as “negative”. As previously mentioned, if a tweet had a negative sentiment score, the attitude toward real doctors could be positive, or vice versa.

*So there is less than 0.25% of the population infected with covid19 and doctors are now advising we should all wear face masks? Pure scaremongering because over 99.75% haven't got it! It's becoming a joke.*

In this tweet, the doctors were seen as “scaremongering” by advising people to wear masks. The sentiment score is 0.296, which is quite positive, but the tweet expressed a negative view of doctors. Other tweets with negative sentiments could be criticizing those who do not follow experts, but the expressed attitude toward experts was positive.

If a tweet criticized political leaders for “not following experts”, it was generally coded as “positive”, because it suggested that the user believes that experts have authority over political leaders. However, in this case, later analysis of tweets showed that people were also talking about politicians following the “wrong” experts and making wrong decisions,. To code these tweets will need further case-by-case interpretation of the tweets’ contexts, like who the experts the messages referred to.

The expressions about emotional feeling towards doctors, such as showing gratitude and sympathy, were categorized as “emotional support”. These tweets mainly talk about how doctors and nurses are working hard at the frontline and are risking their lives to fight the virus in the hospitals. There were also stories about doctors who died from the infection. The tweets were not about the doctors’ expertise or authority, but they included additional positive characteristics.

The discussions of medical experts and doctors are deeply entangled with the political tensions. As the pandemic took place in the year of the presidential election of the US, large numbers of tweets were concerned with the president and other candidates, or were commenting on their responses to the pandemic and expert opinions. The tweets commented on how presidential candidates and other politicians treated medical experts, whether they listened to (or followed) experts or dismissed their advice in making decisions, or whether the politicians followed the “wrong” experts. Other countries such as the UK and Canada have followed similar patterns. The focus of these tweets were on the politicians instead of experts, and the attitude toward experts can only be inferred from the user’s attitude toward the politician.



It should be mentioned that as short texts, many tweets could not be fully understood without knowing the contexts. The analysis is only based on the texts as they were seen. Sometimes, it was difficult to determine what was meant by “expertise”, “legitimacy”, or the “qualifications” of doctors with such limited contextual information. Additionally, the retweets are often truncated due to the setting of the Twitter API, and retweeted content does not always reflect the view of those who retweeted them. The lack of context information added to the complexity in interpreting their meanings, as they can be read out of context. If the tweet itself did not have sufficient information about whether the mentioning of doctors or experts was positive or negative, it was not counted.

#### *To trust or not trust science and experts*

The topic modeling reveals a larger pattern of the discussion related to medical experts on Twitter. The qualitative, in-depth analysis helps dig deeper into the texts to understand each topic and what the real attitudes toward medical experts are present. First of all, the analysis does show a central tension about the trustworthiness of doctors and scientists, of their expertise, qualification, and authority, which is mainly discussed in topics 1, 3, and 4 of the general dataset. Topic 2 of the specialty dataset is also about this major tension.

The lack of trust in medical experts reflects a general suspicion and disrespect of science and medicine, and a belief that the measures such as lockdown and mask mandate are not for medical reasons, but for the government to control individuals and suppress their freedom. Large number of tweets expressed suspicion of the government, big pharmaceutical companies (“big pharmas”), and doctors in creating the pandemic “hoax”. Similar contents are recurring over time: the doctors are counting all deaths in hospitals as coronavirus deaths to get more money for

their hospitals; doctors refused to use the Trump-endorsed Hydroxychloroquine to treat COVID patients because it was not profitable for big pharmaceutical companies; and COVID-19 is not as deadly as a common flu and the doctors were just fear mongering.

*RT @xxxx: Do you still believe everything you are told by the media? Or Govt bought "experts" or big pharma? (Tue Sep 22 10:59:14 +0000 2020)*

*@xxx @xxx @xxx All "expert" scientists that denied HCQ's effectiveness treating China's virus should be indicted on countless murder charges.*

*POTUS Trump was right-again, HCQ works when "nonpartisanly" applied. <https://t.co/mEa7jpfogW> (Sat Aug 08 08:57:54 +0000 2020)*

*🙏More REAL Doctors speaking out about the HOAX.🙏*

*GOD Bless ALL Doctors who stand with truth & patients and their families. ❤️🙏*

*Sell outs who sided with Big Pharma should be named & shamed & lose their right to practice medicine. Weaponized "experts" who betrayed us all. <https://t.co/GI1ELzT2Pf> (Sat Aug 08 08:25:37 +0000 2020)*

*@xxxx @xxxx @xxxx @xxxx Why stupid? Because I'm not buying Into this fear mongering and doing exactly what I'm told by so called experts? So far 227,000 people have died from covid19. On average approximately 650,000 die from the common flu each year. Remember there's a vaccine for the flu. (Fri Oct 30 04:09:52 +0000 2020)*

In the above tweets, we can see that the denial of the existence of the pandemic is highly associated with a lack of trust in medical experts. The doctors were placed at the opposite side of lay people, and their expertise is seen to be used as a suppressing power. On the contrary, those “doctors” pointing out the pandemic as a hoax were praised for their bravery and were called “real” doctors because they were on the side of “the people”.

Another possible explanation of the lack of trust of experts is that doctors, CDC and WHO were thought to lack knowledge about the virus. Therefore, they made inconsistent decisions and recommendations based on their wrong understanding. In this view, doctors are supposed to be the most knowledgeable people on this matter, but they did not meet the public's expectations and are therefore not trustworthy. In their eyes, Dr. Fauci, as the leader of the White House coronavirus task force, together with WHO and CDC, are to be criticized for their inconsistent and constantly-changing messages, while Trump was portrayed as a hero that was in line with the interests of the ordinary people, and had done everything in the first place to contain the disease.

*What do you want PRESIDENT TRUMP to do ?! He stopped international flights almost immediately on a situation we've never experienced before. China hid and lied about the facts. Since then he's been bounced around by "experts" Faucchi says yes than no than yes, plus others CDC, WHO, <https://t.co/Y3UbwTVVPf> (Fri Jul 17 22:30:43 +0000 2020)*

*@xxxx @xxxx @xxxx @xxxx No. I'm not into doctor worship. They haven't been right about a single thing since covid started. They probably brought it into the country coming back from their ponsy skiing trips in January. They're the weirdest, most insecure people and they have a lot to answer for. (Fri Jul 17 22:36:55 +0000 2020)*

These tweets all showed a strong distrust of doctors for they do not have adequate knowledge, or their knowledge being distorted by other factors. The first one questions doctors' expertise because of their selective support of protests, which is a sign that they are being politicized and are not really making recommendations based on their professional training. Others argue that the doctors should be accountable for the spread of the virus as they provide inconsistent information and even disturbed the right decision made by the president.

On the positive side, doctors were seen as the real authority to be trusted, and every decision the government makes should follow their advice. Their expertise was highly regarded and often contrasted with politicians. Doctors were regarded as representing science, and having authoritative voices about the pandemic. The politicians should listen to them and make the right decisions. The authority and expertise of the doctors should not be politicized but instead be used to save lives. Here are some examples that all suggest that we should listen to doctors or real experts, and science should be respected and not politicized, in which the authority of doctors are highlighted.

*I don't know who needs to hear this but a #pandemic is not a political issue. That's why we should be listening to doctors vs. politicians. This is not about freedom. It's about health. <https://t.co/FJ1IKAv6NG>  
<https://t.co/RTOGx28Nqj> (Fri Jul 17 22:49:20 +0000 2020)*

*We still can't get a handle on this virus because we continue to politicize every aspect of it. Should we listen to the morons on social media that barely graduated high school or the doctors and scientists that actually know what the fuck they are talking about? #WearAMask (Thu Jul 16 20:10:24 +0000 2020)*

### *Politically divided views*

The views of doctors and medical experts are politically divided, largely in line with the views of Trump and other right-wing populist-leaning leaders in the world. The Trump supporters' tweets tend to draw a connection between issues like mask wearing and vaccination with state control. They also tend to believe that the pandemic itself is a hoax, and question the expertise of leading experts. Such a divide is mainly along the political ideologies and party affiliations (Democrats vs Republicans in the US). Topics 3, 4, and 6 of the general dataset and topic 4 of the specialty dataset all touched upon these issues. In line with the major tension between trust or not trust of

doctors, there are also divides around major issues such as mask wearing, lockdown and vaccination, in line with the political divide.

Among these topics, Trump and Fauci were frequently mentioned names, representing authorities in politics and science. People criticized Trump and his administration for not following experts' advice and even muzzled them. In the following tweet, the user argues that Trump does not listen to the top expert in response to the pandemic, which is a typical example of numerous tweets presenting the "Trump versus Fauci" dichotomy. The anti-Trump voices are often in support of Fauci's expertise and qualification.

*Per Dr. Fauci, the last time he and trump spoke about the pandemic was when trump was sick with Covid.  
In other words, if it isn't relevant to his health personally, trump doesn't care to hear from America's top infectious disease expert during a once-in-a century pandemic.*

*@xxxx We can't get any work done with Donald Trump in office, fighting against the election despite baseless claims. We CAN begin planning, though. Already Joe Biden has reached out to experts and created a #COVID19 task force. A REAL one. Dr. Fauci will be invited after Trump's out.*

The above tweet compares Trump with Biden in how they treat medical experts, in this case, Dr. Fauci, which according to this user, should have been listened to and trusted by the Trump administration.

On the other hand, while Dr. Fauci was regarded by those who say they trust science as a trustworthy source, his qualification was also questioned by many who denied there was a pandemic in the first place.

*@xxxx @xxxx @xxxx You should stay home if your scared and no one should get sick with anything and she shouldn't have to learn from the government how to take care of herself ,what are we 3!!! So many doctors came forward and said cv is very treatable but fraud fauci only wants a va\$\$ine.*

For example, in the above tweet, this user argued that individuals have the ability to take care of themselves in the pandemic and should not rely on anything from the government. The user sees the vaccine as a government initiative that is not aiming at providing a solution to the pandemic. Instead, the user regarded Fauci as corrupted by promoting the vaccine for money. In this way, Fauci's authority and expertise are questioned, as "many doctors" do not agree with him.

### *What Counts a Real Expert*

There are varied characteristics used to define a medical expert by people on Twitter. Based on the analysis of tweets, claiming someone as a real "expert" is made on different grounds. Professional training and expertise is one criterion. Regardless of one's political ideology, people recognize that being a doctor requires years of training, and doctors are in a good position to comment on and make recommendations during such a pandemic. Their opinions should have real impact. In this sense, doctors have much higher credibility and reputation than a journalist, non-medical researchers, and social media influencers. In the two examples below,

*@xxxx @xxxx @xxx But you are aware that Devi Sridhar is not an expert on Covid? She's a social anthropologist which is admirable in its own right but unethically gives people advice she is not qualified to give.  
(Wed Dec 02 15:37:45 +0000 2020)*

*Once again @FoxNews promoting lies for profit. There have been multiple studies showing masks are effective when worn properly but Fox wants their viewers to believe a reporter knows more than epidemiologists and infectious disease experts. #COVID19  
<https://t.co/UryrMJmhEq>  
(Fri Sep 25 19:33:44 +0000 2020)*

Recognizing one as a real expert is also based on the facts that the doctor/expert is claiming. These could be the facts that have been checked and approved by CDC and WHO, which are generally considered as true claims about the pandemic. However, the “facts” that make a doctor “real” could be from popular conspiracy theories or misinformation, and those who spread these facts (such as the pandemic is a hoax, and HCQ is effective, etc.) are regarded as “brave” because they speak for the people instead of the suppressive power. In the example below, Fauci’s credibility was denied because of his association with the “elite”.

*Mr Fauci the fraud! He's no doctor, he's a lying elite fraud! <https://t.co/TJ2YTDVGFc>  
(Fri Jul 24 22:37:05 +0000 2020)*

Another way a doctor is recognized is through their care for patients, as shown in many tweets about doctors risking their lives to save patients in hospitals. The tweets are showing emotional support for them.

*Our daughter, Clara, working with Covid patients as a young doctor in Anchorage [Anchorage] Alaska. I am very proud, but also concerned about her in harm's way.  
(Mon Aug 31 00:07:08 +0000 2020)*

*#COVID19 #essentialworkers #doctors @ Anchorage, Alaska <https://t.co/DyK0vTLYTg>*

*In the imminent future, pts will die because there simply aren't enough people to care for them. MDs and RNs will burn out. The most precious resource the U.S. against COVID-19 isn't some miracle drug. It's the expertise of its health-care workers—and they are exhausted. <https://t.co/nGCUI51D7G>  
(Mon Dec 14 19:07:32 +0000 2020)*

*They are called heroes amid the pandemic, but medical frontliners are not indestructible.*

*Days before National Heroes Day, Dr. Karen Abat-Senen became the 40th health worker to die of #COVID19.*

*She was not only a doctor, she also used her voice to send hope amid trying times.*  
<https://t.co/1DoMZGr69h> (Mon Aug 31 10:40:00 +0000 2020)

There are many similar tweets that praised the contributions of doctors, particularly those at the frontline. Doctors are recognized for their heroic action, compassion, and the heavy burdens on them without proper support. Although this is not so much about the expertise of doctors, this is an important component to consider when thinking about what makes a doctor “real” in the public discourse.

In many cases, people were asking for the “right” expert to address the issues of their concerns. To be considered as a real expert thus also means one needs to be in the right specialty, although what is “right” is largely defined by Twitter users themselves. It is not about whether people trust or do not trust medical experts in general, but a matter of what kind of expert is trustworthy. In the context of a global pandemic, infectious disease experts, epidemiologists, and someone with relevant specialties have much higher perceived trustworthiness than someone who is not, even if he or she is in the medical field.

*@xxxx I prefer an expert like Dr. Fauci to give me information on COVID-19. Not a radiologist that doesn't understand who RT is.*  
(Thu Nov 05 03:25:18 +0000 2020)

*@Centrists2Cents @thehill Follow REAL doctors who are treating COVID patients. Remember, Dr. Fauci is a research doctor and never sees patients. We need ALL medical professionals weighing in. I feel this is where the Trump Adm. has failed. We are letting Dr's Fauci and Birx call all the shots.*

By contrast, the tweet above regards Fauci as not qualified because he is a researcher and has not had direct encounters with patients.



Overall, the qualitative analysis reveals the complexities in Twitter discussions about medical experts. The discussions are highly politicized, and issues of respecting science and medical expertise are connected with many political issues. Medical experts are seen as part of the larger social institutions that created the “hoax”, collaborating to control individual lives, and the changing advice over time as the virus progresses is seen as evidence of their lack of professionalism and qualification. In such views, the doctors are on the opposite side of “the people”. The positive attitudes include following doctors’ advice, respecting the science, and recognizing their authority and expertise in making claims and offering advice to the public. The tweets also expressed the willingness to follow their own doctor’s advice or someone they personally have connection with and who has such expertise.

The qualification for a “real” doctor in the Twitter discussion is based on three major characteristics, that is, doctors have professional training and knowledge that make them distinct from other kinds of authorities and expertise in the pandemic; doctors possess certain “facts” and they are either verified and widely accepted; doctors care for their patients and try their best to save lives, even at the price of their own, regardless of the political divide and other contentions.

## **Discussion**

The topic modeling of the general and specialty datasets has found topics specifically related to the attitudes and opinions about medical experts. These topics are: respecting science and experts (follow experts, listen to doctors), the belief about how doctors view the pandemic, the nature of the virus (knowledge and treatment), Trump and Fauci, infectious disease experts, the issues of children’s health, the doctor’s role in lockdown decisions, and the discussions of underlying

conditions. Other tweets include common subjects during the pandemic, such as wearing masks, the impact of lockdown, and vaccines; these tweets fell into the topics from the topic modeling. Both datasets have slightly negative sentiment scores.

The qualitative analysis reveals that only a small proportion of the tweets can be categorized as “relevant”. The central tension of the tweets regarding the expertise and authority of medical experts is around the trustworthiness of them and the science behind. For those who think that doctors are not trustworthy, the doctors are regarded as collaborators with the government to suppress individual freedom, and their interests are entangled with big pharmaceutical companies for more profits. Doctors are seen as being accountable for making this pandemic “hoax” for political and financial purposes, and their expertise was questioned because they provided inconsistent information to the public. The other side acknowledged medical experts’ authority and expertise in providing advice to the public and decisions on policies and strategies to contain the disease. Doctors were also highly praised for the work they did at the frontline. Both positive and negative views were also deeply entangled in the political tensions around the U.S. presidential election. The analysis also shows that in the Twitter discussion, a “real” doctor or medical expert has to have proper professional training and knowledge, to have possessed certain facts about the pandemic, to be in the right specialty related to the pandemic, and to show their compassion and care working in such a stressful time of crisis.

### *Discussion*

There has been a growing number of research using computational methods to examine social media discussions, particularly on Twitter, about the COVID-19-related topics, ranging from the

general pandemic issues to specific ones like the vaccine, or the views of public health agencies such as CDC. Topic modeling and sentiment analysis are commonly used techniques in analyzing large corpus of texts. This study belongs to the collective endeavor to understand the discursive patterns on social media, and to inform public health agencies and the medical community about more effective ways to communicate important messages during a public health crisis.

This study takes a mixed-methods approach, adding qualitative analysis to topic modeling and sentiment analysis to make in-depth findings about a large dataset. The qualitative analysis plays an important part to reveal some nuances that could not be found through topic modeling and sentiment analysis. A major challenge involves determining which tweets are relevant, and what counts as a “positive” or “negative” attitude. The discussions of doctors and their expertise are embedded in different contexts, which are not always obvious from the tweet text itself. The quoted sources and retweets, together with the use of irony and quotation marks further complicated this process. It requires a close reading of the texts to understand their meanings and what the exact attitude was expressed. The qualitative analysis could pave the way for better annotation of tweets that are relevant to a given issue.

The findings of the discussion patterns on Twitter suggest that with “doctor” and “expert” as keywords, the major tension is around trusting experts and science, and whether to follow experts’ advice, and the views about medical experts are politically divided. The results conform to recent studies showing that political ideologies and partisanship are playing a key role in shaping people’s understanding of science, medicine, and other public health messages during such a crisis (Rao et al, 2021). Although this study does not examine the association, reading the

tweets could reveal a person's preference of political party and candidates. The topic modeling results for both datasets also show that people are still looking for authorities with either expertise or political power (Fauci or Trump), and those are also placed in the center of controversy for what they said and did.

Using a specialty dataset as a comparison and supplement helps us to see the variations in the discursive patterns. The specialty dataset was used because some users may have expressed their attitudes without mentioning "doctors" or "experts", but they instead mentioned doctor's specialties (for example, "a cardiologist says"). The specialty dataset does not contain so many relevant tweets, but the findings still reflect some important characteristics of the pandemic discussion. Major underlying conditions and chronic diseases are taking up this dataset, as people expressed their concerns about the negative impact of lockdown on the access to medical services for these patients, and the higher risks when contracting COVID-19. In the analysis of topics, it shows that people recognize the expertise of infectious disease experts, mainly Dr. Fauci.

People have divided views about issues like mask wearing, lockdown, the vaccine, and school opening, and these issues are also connected with the attitude toward medical experts. Expert opinions matter much for decision making, and the views are divided along the line of positive or negative views about medical experts. People who suggested that we should follow experts' advice tended to be pro-mask, pro-vaccine, have concerns about lifting lockdown and reopening schools too soon, and oppose large-scale gatherings like political rallies. On the contrary, those who think that the pandemic is a hoax and the doctors are collaborating with the government to suppress individual freedom tend to disregard mask requirements, want to reopen the economy

and schools, and are often anti-vaccination. However, this tendency does not always hold true because even among experts themselves, there are different views regarding these issues. Further research should follow this line to identify the relationship between one's attitude toward medical experts and other related issues.

From a global perspective, these two Twitter datasets contain only English tweets, which mainly come from English-speaking countries, with users from the US, UK, Canada, and Australia composing a significant proportion of the entire dataset. There are also large numbers of tweets from India, as well as countries like New Zealand and South Africa. The geographical variations have not been the major consideration for this study, but even the English-only tweets could reveal an unbalanced representation of the COVID-related issues. While many issues are quite universal, like the consequences of lockdown, the mask mandate, and the debates about school opening, Trump and Fauci are the central figures that have been mostly talked about in the Twitter conversations, showing that the discussions are still very much U.S.-centric.

This study also has implications for further research of medical misinformation on social media. As this study has shown, the attitudes toward medical experts are quite polarized, and those who share negative attitudes toward medical professionals also often share information that is likely to be false. For example, multiple users in my in-depth analysis sample mentioned the effectiveness of Hydroxychloroquine in treating COVID-19, together with the expression of distrust of doctors who do not support this medication as treatment. Identifying users who show low or little trust of doctors or use anti-science terms would be a way to detect likely misinformation, or the vice versa.

## **Limitations**

This study did not look at changes over time. The pandemic evolved at multiple stages in 2020, and there are some important events or milestones at each stage. While this was how the dataset for analysis was formed, this study did not take the change over time into consideration for simplicity of the analysis. Further research must be done to compare different time periods, for example, before and after WHO's announcement of global pandemic and Pfizer's announcement of the vaccine's effectiveness.

The ways in which the two datasets were generated could also lead to limitations of the analysis. Both of the two datasets contain a large proportion of irrelevant tweets. For the specialty dataset, the keywords list is not comprehensive. It does not include everything that might be about medical specialties relevant to COVID-19. The selection of keywords could be improved in the future studies.

The issues of trusting doctors and sciences are very complicated, and short texts like tweets can often be read out of context. Topic modeling and sentiment analysis could help researchers to quickly find out some general patterns in a dataset with a large number of posts, but they could not be used to detect the nuances in the tweets. As has been mentioned before, the overall compound sentiment score of a tweet does not reflect the user's expressed attitude towards the medical community. The negative sentiment score does not always mean a negative attitude being expressed. Future research should find a way to detect the inconsistency between the overall sentiment of a tweet and the actual attitudes or views expressed in the tweet.

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