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Giridhar Reddy Bojja

Dakota State University, giridhar.bojja@trojans.dsu.edu

Martinson Ofori

Dakota State University, martinson.ofori@trojans.dsu.edu

Jun Liu

Dakota State University, jun.liu@dsu.edu

Loknath Sai Ambati

Dakota State University, loknathsai.ambati@trojans.dsu.edu

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Early Public Outlook on the Coronavirus Disease (COVID-19): A Social Media Study

Completed Research

Giridhar Reddy Bojja

Dakota State University

giridhar.bojja@trojans.dsu.edu

Martinson Ofori

Dakota State University

martinson.ofori@trojans.dsu.edu

Jun Liu

Dakota State University

jun.liu@dsu.edu

Loknath Sai Ambati

Dakota State University

loknathsai.ambati@trojans.dsu.edu

Abstract

The recent outbreak of the coronavirus (COVID-19) brought with its public concerns and fears about a global epidemic. With the increase in the popularity, usage, and reach of social media, this research examined the early public outlook on COVID-19 using SM-Platform, Twitter.com. The current study employed a mixed-method approach in collecting and analyzing public tweets by combining quantitative sentiment analysis with a qualitative thematic analysis. Our results revealed positive sentiment prior to the spread of the disease. The sentiment then turned negative as the disease spread, accompanied by a large amount of fear as rumors. In a thematic analysis we also uncovered nine key topics on the disease including, but not limited to, prevention, symptoms and spread of disease. Our study will provide an understanding of social media and public health outbreak surveillance. The findings of the research revealed the usefulness of twitter mining to illuminate public health education.

Keywords

CoVID-19, Coronavirus, Social media, Twitter, Sentiment Analysis, Thematic analysis, Health Communication, China.

Background

In the past two decades, two main types of coronaviruses have been discovered globally – Middle East Respiratory Syndrome Coronavirus (MERS-CoV) and Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV). Coronaviruses have previously been identified in mice, chicken and other animals and often caused life-threatening pneumonia when identified in humans (van der Hoek et al. 2004). However, at the end of 2019, unknown strains of pneumonia were detected in the Chinese city of Wuhan (WHO 2020a). Subsequently the disease was identified as a novel coronavirus which had not been previously identified. The World Health Organization (WHO) announced an official name for the disease to be Coronavirus Disease 2019 (COVID-19) while also indicating the disease to be caused by a virus named SARS-CoV-2. COVID-19 causes respiratory disease extending from basic cold to extreme intense respiratory disorder (SARS). Common symptoms include fever, cold and difficulty in breathing (CDC 2020). At the time of this report, no known vaccine had been developed as a means of prevention, however, to prevent further spread of the disease, the WHO continues to work closely with global experts, governments and partners to gain more knowledge on the disease (WHO 2020a).

The fast-paced spread of the disease and the morbidity associated with contracting COVID-19 has caused a global panic. In many cases, people turn to social media to post or seek out news on the disease. Among the various social media websites, Twitter.com is widely used for discussions on public health (Neiger et al. 2012). It is viewed as a medium for exchange of news and information regarding public health events, confirmed by its adequacy for analyzing events during the H1N1 pandemic planning activities (Sullivan et

al. 2012). In the time of global emergencies, public respond, react and mobilize on the situation in order to help people in need (Palen et al. 2010). Twitter's ability for wide reach, functionality, and low costs can possibly catch pandemic patterns, gather data, and disperse knowledge. The utilization of twitter underpins its capability to impact public health outbreak surveillance endeavors in a new and inventive manner (Khan et al. 2010). It has also been used in epidemic tracking for general influenza, malaria, and Ebola outbreaks (Boit and El-Gayar 2020; Broniatowski et al. 2015; Deiner et al. 2016; Lazard et al. 2015; Signorini et al. 2011). Given the distress and public outcry associated with the spread of the COVID-19, there is an inherent gap on where the public understanding of the disease lies. On issues of public health, there is often a disparity between credible news shared by stakeholders and the public sentiments. The general varying perspectives makes it difficult to empirically measure public understanding of issues raised during distressing situations such as disease outbreaks. This study aims to use social media analytics to close the inherent gap in extant literature by investigating the notion and general public sentiment on the topic of COVID-19. Accordingly, this study will explore the behavioral panorama of the social media users and imminent discussions around early outlook on CoVID-19. Therefore, we investigate following research questions:

- *What is the net sentiment and emotion change over time on COVID-19 on Twitter?*
- *What are the prevalent themes discovered over time on Twitter regarding COVID-19?*

Methods

This study employs a mixed method approach. This approach allows one to identify aspects of a phenomenon more accurately by approaching it from different vantage points using different methods and techniques. A quantitative approach employing machine learning techniques was used to collect the data and perform sentiment and emotion analysis. Qualitative approach was used to perform thematic analysis.

Data Sources and Search Strategy

This study employs social media analytics to identify public sentiments, emotion and related topics of interest on COVID-19. We mined publicly available social media data using Crimson Hexagon's ForSight platform (Crimson Hexagon 2019a). The advantage of using Crimson Hexagon software is that it facilitates data collection and provides insights into online conversations in terms of sentiments and emotions. The ForSight platform has access to the full Twitter Firehose (through a direct partnership with Twitter) and provides access to complete coverage of all tweets globally since 2010. We mined data starting 6 months before the earliest reports of the disease appeared in news and other outlets online. In effect, our search query targeted tweets on COVID-19 posted between July 2019 and February 2020. Our search query targeted various names the COVID-19 has been referred to since its detection. We use the full name (coronavirus), the initial provisional name (2019-nCov), and the new official name of this novel strain of the disease (COVID-19) (CDC 2020). To enable the capture of tweets before various names were given, we also search for tweets about pneumonia that mentions specifically Wuhan or China. We did not add any exclusion terms to the initial search in order to gather as much volume as possible. Figure 1 shows the specific keywords used in our search.

```
(
  coronavirus OR (corona AND virus)
  OR nConv*19 OR (2019*nConv)
  OR COVID*19 OR (2019*COVID)
  OR (pneumonia AND (Wuhan OR China))
)
```

Figure 1. Search query

Data Analysis

The ForSight platform uses Buzz monitors as pretrained classifiers that perform unsupervised clustering, sentiment and emotion analysis. During sentiment analysis, posts are classified as positive, negative or neutral. ForSight performs sentiment analysis using a vast training set of over 500,000 hand-labelled posts (Crimson Hexagon 2019b). Emotion analysis is also conducted on the platform by categorizing posts into six feelings of emotion based on the *Ekman 6: anger, fear, disgust, joy, surprise, and sadness* (Crimson Hexagon 2018).

To identify the prevalent themes in the tweets, we use the Cluster Module. This module is one of four visualizations available on ForSight that samples words from 1,000 up to 10,000 posts per day for the chosen time frame for unsupervised clustering (Crimson Hexagon 2019c). The platform then arranges them into interconnected bubbles as a representation of the relationships between the words in online conversations.

Some news outlets have compiled a comprehensive timeline on the COVID-19 outbreak (Al Jazeera 2020; Antonio 2020; CNN Editorial Research 2020). Using these sources as a guide, we analyze the twitter activity in a systematic manner consisting of four phases:

- **Phase 1 (July 1, 2019 – December 11, 2019).** This is the entire phase before the first reports of pneumonia starts to surface in Wuhan inside mainland China.
- **Phase 2 (December 12, 2019 – January 4, 2020).** Also known as the rumor phase, this phase analyzes activity on twitter when the virus was still not known. Several differing opinions existed at this time on what the disease could be.
- **Phase 3 (January 5, 2019 – January 29, 2020).** Here, we look to identify what happens after an official report released by government website in Wuhan reports 59 cases of the disease (7 of them severe) while stating the disease is neither SARS-CoV or MERS-CoV¹.
- **Phase 4 (January 30 – February 2020).** In this phase, we examine the effect after the WHO declaration of COVID-19 as a “*public health emergency of international concern*” (WHO 2020b).

Thematic Analysis

Thematic analysis emphasizes identifying, analyzing and interpreting patterns of meaning within the data. Using a randomly selected sample of 5,000 tweets exported from ForSight, we also conduct a thematic analysis of the tweets using the MAXQDA software. Random sampling performed by ForSight guarantees that there is an equivalent possibility of choosing any single tweet. We invited two PhD students that are not related to the research to code all 5,000 tweets. We calculated the inter-evaluator agreement with Cohen’s Kappa (Viera et al., 2005). A Kappa value of 1 indicates perfect agreement whereas a Kappa value of 0 or less indicates agreement by chance.

Discussion and Results

COVID-19 outbreak over the period

We mined a total of 40,759,360 posts between 1st July 2019 and 20th February 2020. As shown in Figure 2, on most days prior to Phase 1 activity, there were less than 150 posts, discussing the disease or cases of pneumonia. Phase 2 also shows moderate twitter activities with the highest number of tweets occurring between December 15th.to December 17th. In Phase 3, January 5th sees a moderate rise in number of tweets, which then goes down in the following days but then starts a gradual rise from January 19th. Phase 4 shows heavy twitter activities with the days before February 11th showing over a million tweets a day and about an average of 750,000 tweets a day afterwards

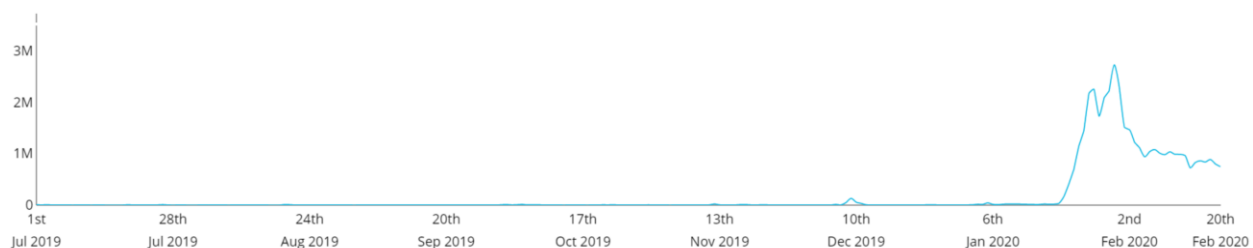


Figure 2. Trend of discussion on COVID-19

¹ <http://wjw.wuhan.gov.cn/front/web/showDetail/2020010509020>

over 87% of negative posts as compared to 13% of positive posts. With so many rumors flying around the new virus, there is a high amount of fear (61.4%) and disgust (24.8%). The emotion and sentiments for this period are shown in Figure 6. Table 1 compares the sentiments and emotion across the different time-periods.

As we show in Figure 7 the two themes can be inferred from the clusters formed from posts in this phase: 1) **Locations of Outbreaks**. Geographic locations such as Wuhan and China are mentioned several times in tweets on the disease while moderate mentions of Hong Kong and Taiwan are also mentioned. 2) **Unknown Disease**. Mentions of atypical pneumonia, viral pneumonia, new cases, and calls for containments can also be seen in the clusters.

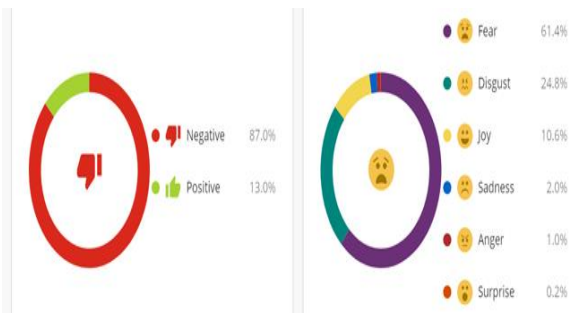


Figure 6. Sentiment and Emotion on COVID-19 from Phase 2.

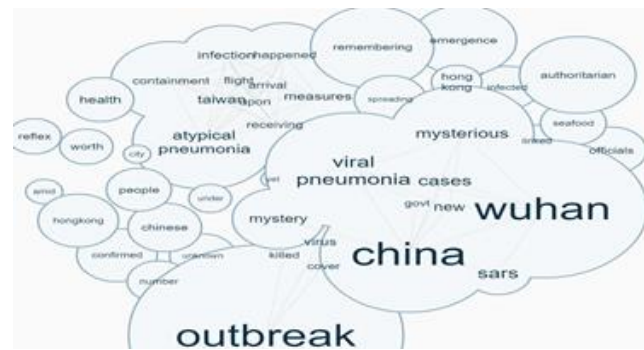


Figure 7. Topic clusters on COVID-19 from Phase 2.

Date	Main Press Highlight	Sentiment		Emotion					
		Negative	Positive	Fear	Disgust	Joy	Surprise	Sadness	Anger
December 12 - December 29	Chinese state broadcast CCTV reports new viral outbreak was in Wuhan, China.	85.4	14.6	25.9	39.3	27.7	0.9	4.5	1.8
December 30 - December 31	China alerts WHO on several cases of unusual pneumonia in Wuhan.	93.8	6.2	68.1	18.0	11.2	0.5	0.5	1.6
January 1 - January 4	Huanan Seafood Wholesale Market closed as possible source of virus.	85.3	14.7	61.9	25.1	10.0	0.1	2.0	0.9

Table 1. Highlights from Phase 2.

Phase 3 (January 5, 2019 – January 29, 2020)

Although this period culminated in over 14M tweets, the ruling-out of the disease of SARS-CoV and MERS-CoV did not spark an immediate increase in number of tweets. Generally, the volume of tweets remained around 5,000 daily up to January 8. The volume of tweets then rose to above 10,000 daily, starting a steep rise on January 18 which peaked at 2.5M tweets on January 26. The sentiments for this period are 73.3% negative and 26.7% positive. As displayed in Figure 8, we notice an emotion change from fear in the previous phase to *disgust* (35.8%), *joy* (20.7%) and *fear* (19.7%).

Date	Main Press Highlight	Sentiment		Emotion					
		Negative	Positive	Fear	Disgust	Joy	Surprise	Sadness	Anger
January 5 - January 6	Experts rule out the possibility of SARS-CoV and MERS-CoV.	74.8	25.2	34.1	49.9	11.1	0.5	3.5	0.9
January 7 - January 10	Chinese authorities identify the virus as a novel coronavirus (2019-nCoV).	84.5	15.5	33.1	39.0	18.5	0.1	6.7	2.5
January 11 - January 12	61-year-old man dies after respiratory failure caused by severe pneumonia.	74.0	26.0	26.3	16.3	31.6	0.1	25.4	0.4

were number of tweets which also discussed on Chinese population, and Chinese government and authorities.

Symptoms: There were lot of tweets which discussed COVID-19 symptoms. Identifying these symptoms at early stages and taking necessary medical attention can save lives.

Food: There were numerous tweets on food such as sea food, and pork/bacon. Some tweets mentioned halal food and vegetarian diets. There was lot of discussions and concerns on eating seafood as it was rumored to be linked to the corona virus. Some twitter users suggested others not to eat meat and was propagating wrong information, claiming eating meat causes coronavirus. The misinformation such as “eating seafood causes corona virus” calls for health authorities to disperse educational messages as soon as possible to stop spread of wrong information among users.

Politics: Tweets related to politics and political reference were captured in this theme. There were numerous tweets that referred to President Donald Trump, asking for help to stop spread of disease in U.S.A. Some twitter users who support a particular party used this outbreak to attack the opposition.

Health organizations and media: This theme includes the tweets that mentioned a media organization such as Fox news, CNN and ABC News, and also those that mentioned health organizations such as World health Organization (WHO), Center of Disease Control (CDC), and Global Health. The majority of the tweets indicates critical views towards a certain media and health organizations.

Emotions: Tweets which expressed emotions towards COVID-19 outbreak such as fear, anxiety, and anger was categorized in this theme. Corona virus outbreak has created fear among people in social media. Many tweets have shown concern, fear and anxiety related to corona virus spread. Use of vulgarity was common. Government and concerned authorities should make sure that right information is shared so as to reduce the fear among people.

Humor: Even in times of distress social media, users still found time to poke humor at events. There were several tweets containing general humor and sarcasm. There also existed some users who were simply trolling to gain clout on social media. Although most humorous tweets on such issues are generally harmless, they can sometimes be problematic as they could easily be misconstrued as racist when taken out of context. Additionally, such humor tweets could take attention away from real issues or people who need attention.

General Posts: Posts captured in this theme simply captured tweets that didn’t necessarily fall in any of the categories discussed above. Most of such tweets simply shared general sentiments on the disease.

Themes (%)	Sample Tweets
Prevention (6.8%)	<p>“Shit just got real 🤔 Protect urself by wearing face masks and wash hands frequently”</p> <p>“Please make some time to read articles about this Corona Virus. We need to have serious learnings about this one bcoz its REALLY DEADLY. Indeed, Prevention is better than Cure so let’s ask our gov’t to ban all flights coming from these affected areas https://t.co/BpZgKOcB4q”</p>
Spread of disease (11.45%)	<p>“Global case tally of the novel #Wuhan #pneumonia #coronavirus = 221: 🌐217 in China 🌐198 in Hubei province (Wuhan) 🌐14 in Guangdong 🌐5 in Beijing 🌐1 in Japan 🌐2 in Thailand 🌐1 South Korea”</p> <p>“Holy fuck France confirmed two cases of corona virus. And one in paris 🤔 shit is getting real now”</p>
Symptoms (5.2%)	<p>“For most patients, the #coronavirus begins and ends in their lungs, 20% end up in ICU. COVID19 patients might start out with a fever and cough that progresses to pneumonia or worse. Are hospitals around the world ready for this?#COVID #COVID19 #China #wuhan #冠状病毒”</p> <p>“Symptoms of Corona Virus 🚫Fever 🚫Cough 🚫Shortness of breath #CoronaAwareByVILJAYFans”</p>
Food (7.3%)	<p>“Chinese Muslims are safe from the corona virus just because of halal eating https://t.co/xM6oozUToM”</p> <p>“RT @chhapidassi Hello China!!! #NoMeat_NoCoronaVirus STOP EATING MEAT 🙏 CORONA virus come from 🇨🇳 U china people can kill innocent animals and this kind of thing God is never happy. @SaintRampalJiM Now Watch satsangh (IST- 7:30pm to 8:30pm sadhna TV. https://t.co/2QDPGf2H1W”</p>
Politics (2.1%)	<p>“If we keep Republicans we get more Angry rage rallies opioid deaths corona virus pollution global warming fires iran war tariffs inflation low wages farmer bankruptcy cuts to social security klan marches in dc and lies lies lies from republicans”</p> <p>“@realDonaldTrump What are you doing to prepare America for the inevitable Corona virus pandemic?”</p>
Health organizations and media (13.72%)	<p>“Name changes as of yesterday - established by the World Health Organization-@WHO: #nCoV2019 virus is now 🇺🇸SARS-CoV-2 #nCoV2019disease is now 🇺🇸#COVID19 #SARSCoV2 “I wasn’t worried until I realized they’re trying to coverup this #Wuhan outbreak. No media coverage & Twitter is actively hiding it like a MAGA tag. There’s ZERO chance this isn’t trending. This #Corona virus outbreak must have them terrified to be oppressing free speech.”</p>

Emotions (9.15%)	"okay that corona virus stuff from china is pretty scary bruh!!!" "f**k corona virus all my homies hate corona virus"
Humor (7.6%)	"We gotta beat the corona virus by only drinking modelo" "*someone offers me some food and I say no thank you because I dont want to take their food* "Madam, this is Africa, dont worry, there is no Corona Virus here" Okay thank you, and I proceed to take his food hahaha"
General Posts (36.68%)	"What is Corona Virus? - a thread https://t.co/Z3pA3norJn " "My account got suspended for 12 hours cause I told someone I hope they get the corona virus 🤔🤔🤔🤔"

Table 4. Sample tweets and percentage of tweets from Thematic Analysis

Conclusion and Future Implications

In this study, we have presented a comprehensive social media analysis on the spread of COVID-19 related information on Twitter. We investigated the behavioral panorama of social media users and emanant discussions around early outlook on COVID-19. Using social media analytics tool ForSight provided by Crimson Hexagon, we mined and analyzed over 40M COVID-19 related posts in a timespan starting 6 months from the first reports of the disease (December 2019 to February 2020). The study addressed two main research questions.

First, we investigated the change in sentiment and emotion overtime on COVID-19. We found that in general the net sentiment on the coronavirus was positive (72%) in the first phase of our selected timespan when the disease was non-existent. Tweets in this time period expressed joy mainly due to the happiness with research efforts towards discovering vaccines for MERS-CoV and SARS-CoV. In the second to fourth phases however, we found that sentiments were extremely negative. Phase 2 had 87% negative sentiment with the prevalent emotion being fear (61.4%). In Phase 3, there was 73.3% negative sentiment and posts displayed predominantly disgust (35.8%). In the last phase of our analysis, sentiment was 78.1% negative and 32.9% disgust emotion were uncovered in posts.

Second, we discussed the prevalent themes which inherent in posts on COVID-19. Using a thematic analysis, we grouped posts into nine themes: Prevention, Spread of disease, Symptoms, Food, Politics, Health organizations and media, Emotions, Humor and General Posts. From the health and public domain perspective, these themes will help foster a general understanding of how the public discusses disease outbreaks. For example, prevention tweets can help public health officials to gauge the public understanding of the disease when preparing various communique used for control measures. This is in addition to insights on symptoms will assist in targeted education of the public. Even further, outbreak of new symptoms can advise healthcare agencies and research labs on what to lookout for in developing appropriate measures to control the infection and spread at an early stage. We believe that social media can act as an effective educational tool for the general public and even allow twitter users to track the spread of disease. This will allow users to feel safe and take measures if a possibility exists of the disease spreading to a location close to them. These themes will help epidemiologists and corresponding agencies to arrange the required resources for preventing and fighting illness and diseases. Since our analysis did not use any advanced text mining techniques, future researchers may use such techniques to help improve the analysis and theme development in a much more granular way especially as this is an ongoing pandemic as at the time of this study.

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